



Technology in the 2015 Paris Climate Agreement and beyond



By Heleen de Coninck, Radboud University
Ambuj Sagar, Indian Institute of Technology Delhi



International Centre for Trade
and Sustainable Development

Issue Paper No. 42

Technology in the 2015 Paris Climate Agreement and beyond

By Heleen de Coninck, Radboud University
Ambuj Sagar, Indian Institute of Technology Delhi



Published by:

International Centre for Trade and Sustainable Development (ICTSD) International Environment House 2

7 Chemin de Balexert, 1219 Geneva, Switzerland

+41 22 917 8492 Fax: +41 22 917 8093

E-mail: ictsd@ictsd.org Internet: www.ictsd.org

Chief Executive: Ricardo Meléndez-Ortiz

Core Team:

Pedro Roffe: Senior Associate, Innovation, Technology and Intellectual Property

Ahmed Abdel Latif: Senior Programme Manager, Innovation, Technology and Intellectual Property

Acknowledgments

This paper was written at the request of the International Centre for Trade and Sustainable Development (ICTSD). A draft was presented at a UNEP workshop “Technology issues under the 2015 Paris Agreement” on March 26 and 27, 2015 at the UNESCO premises in Paris, France. The authors thank Ahmed Abdel-Latif and Pedro Roffe at ICTSD for their support, helpful comments and fruitful discussions, the UNEP workshop participants for their constructive comments and the interviewees for their time and insights.

Heleen de Coninck is associate professor in innovation studies at the Environmental Science department at Radboud University’s Faculty of Science.

Ambuj D. Sagar is Professor of Policy Studies at the Indian Institute of Technology Delhi.

The views expressed in this publication are the personal views of the authors and do not necessarily reflect the views of any institution with which they are affiliated, nor the views of ICTSD’s funding institutions.

For more information about ICTSD’s Programme on Innovation, Technology and Intellectual Property visit our website at <http://ictsd.org/programmes/ip/>

ICTSD welcomes feedback and comments to this document. These can be sent to Pedro Roffe (proffe@ictsd.ch).

Citation for the Issue Paper:

Heleen de Coninck and Ambuj Sagar; (2015); *Technology in the 2015 Paris Climate Agreement and beyond*; ICTSD Programme on Innovation, Technology and Intellectual Property; Issue Paper No. 42; International Centre for Trade and Sustainable Development, Geneva, Switzerland, www.ictsd.org

Copyright © ICTSD, 2015. Readers are encouraged to quote this material for educational and non-profit purposes, provided the source is acknowledged. This work is licensed under the Creative Commons Attribution-Non-commercial-No-Derivative Works 3.0 License. To view a copy of this license, visit <http://creativecommons.org/licenses/bync-nd/3.0/> or send a letter to Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, US.

ISSN 1684-9825

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS	iv
LIST OF BOXES	v
FOREWORD	vi
EXECUTIVE SUMMARY	viii
1. INTRODUCTION AND APPROACH	1
2. BACKGROUND	2
3. OVERVIEW OF CURRENT EFFORTS	3
4. ISSUES AROUND TECHNOLOGY IN THE 2015 PARIS CLIMATE AGREEMENT	6
4.1 Differentiated Perspectives on Technology	6
4.2 Specific Areas of Focus for the Technology Mechanism	6
4.3 Institutional Functioning of the Technology Mechanism	7
4.4 Indicators and INDCs on Technology	9
5. CURRENT THEMES AND PROPOSALS AROUND TECHNOLOGY	10
6. OPEN QUESTIONS	12
6.1 Capabilities and Institutions: Enabling Environments Are Not Enough	12
6.2 How to Make Technology Actors Think About Finance	12
6.3 How to Measure Progress on Technology	13
6.4 Concerns Over the Emergence of Potentially-Disruptive New Technologies and Industries	13
7. CONCLUSION	14
8. AN AGENDA FOR PRACTICAL ACTION	15
REFERENCES	16
ANNEX I LIST OF INTERVIEWEES	19

LIST OF ABBREVIATIONS AND ACRONYMS

CBDRRC	Common but differentiated responsibilities and respective capabilities
CDM	Clean Development Mechanism
COP	Conference of Parties
CTCN	Climate Technology Centre and Network
CTN	Climate Technology Network
EGTT	Expert Group on Technology Transfer
GCF	Green Climate Fund
GEF	Global Environment Facility
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
MOI	Means of Implementation
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plans
NDE	National Designated Entities
R&D	Research and Development
RDD&D	Research, Development, Demonstration and Deployment
TEC	Technology Executive Committee
TM	Technology Mechanism
TNA	Technology Needs Assessments
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change

LIST OF BOXES

Box 1 TEC products to date (based on UNFCCC TT:CLEAR website)

FOREWORD

There are high expectations for the Paris Conference of the Parties (COP) of the United Framework Convention on Climate Change (UNFCCC) to be an important milestone in global efforts to combat climate change. Such efforts encompass a wide range of measures and actions at all levels. Chief among them is the large scale diffusion of climate technologies.

For this reason, enhancing technology development and transfer has been a key objective of the UNFCCC since its inception. In 2010, Parties to the UNFCCC established the Technology Mechanism (TM) with the aim to enhance action on technology development and transfer in support of climate change mitigation and adaptation. The TM has two components: a policy arm, the Technology Executive Committee (TEC), and an implementing institution, the Climate Technology Centre and Network (CTCN). Both bodies are now up and running. At the same time, technology continues to feature in negotiations leading to the Paris conference as it figures in country submissions and in Intended Nationally Determined Contributions (INDCs).

In this context, we thought it was timely to reflect on the TM's experience in its short period of existence, on the challenges facing it and on how to further strengthen the climate technology development and transfer arrangements for an agreement that might emerge from the Paris Conference. We entrusted this task to two well known scholars - Heleen de Coninck and Ambuj Sagar - who both have been closely involved in international policy discussions on climate technology collaboration in recent years.

Their paper *Technology in the 2015 Paris Climate Agreement and beyond*, presents an incisive and sober analysis of the challenges and difficulties facing international action to enhance the diffusion of climate technologies, particularly in the UNFCCC/TM context but also beyond it. The paper builds in this regard on previous ICTSD publications which have looked into the TM's operationalisation process.* Through a study of the literature, interviews with negotiators and stakeholders, and an analysis of the submissions on technology in the framework of the Durban Platform, the authors identify elements of a reinvigorated agenda for action in this field.

The authors argue that the Paris climate agreement should acknowledge the TM's potential for supporting and advancing technology transfer and strengthen it, in particular for rapid and effective realisation of the nationally determined contributions. They also consider a number of proposals on technology which have been put forward for inclusion in the Paris agreement such as improved policy frameworks including particularly, improved Research and Development (R&D) climate cooperation and strengthened technology networks between countries. The authors argue that the TM's mandate would not need to be expanded to accommodate such proposals but what would be necessary is depoliticising the TEC, so that it functions more as an expert body, and providing stable long-term funding to support the CTCN possibly through a privileged link to the financial mechanism.

Finally, the authors raise a number of questions which require further reflection. For instance, should the enhancement of specific innovation capabilities, beyond mere "enabling environments" and markets be part of the UNFCCC realm? How to measure progress when technology is included in nationally determined contributions? And, finally, how to facilitate climate action in the face of the implications at the firm, industrial, and national levels of the emergence of potentially-disruptive new technologies and industries?

* *Realizing the potential of the UNFCCC Technology Mechanism: Perspectives on the Way Forward*; ICTSD Programme on Innovation, Technology and Intellectual Property, (2012), Issue Paper No. 35; International Centre for Trade and Sustainable Development, Geneva, Switzerland, www.ictsd.org

International action and efforts can play an important role in supporting and accelerating the diffusion of climate change technologies. The Paris climate conference presents an important opportunity to boost these efforts which should be seized. However, we should also acknowledge that the building of capabilities and skills for absorption of climate technologies, R&D, innovation and manufacturing in most developing countries remains a long-term process where the role of national actors and institutions remains key.

I sincerely hope that you find that this issue paper contributes towards improving our understanding of the challenges facing international efforts to enhance the development and diffusion of climate change technologies. I also hope that all stakeholders - governments, international organisations, firms and NGOs - will find the paper a useful input in the context of deliberations leading to the Paris conference.



Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

This paper aims to explore ways to help strengthen the climate technology development and transfer arrangements for an agreement that might emerge from the upcoming 2015 UNFCCC COP in Paris, and the implementation of any such agreement. Through a study of the literature, interviews with negotiators and stakeholders, and an analysis of the submissions on technology in the framework of the Durban Platform, a reinvigorated agenda for action in this field starts to emerge.

We know from existing scholarly work that effective technology transfer requires the building of innovation capabilities in developing countries through transfer of both tacit and explicit knowledge and skills rather than mere technical assistance, but this is a complex task and mostly lacking in practice. Moreover, efforts on networking between key actors within developing countries and with counterpart entities in developed countries are essential for allowing actors in innovation systems to interact fruitfully.

At the same time, strengthening policy and institutional frameworks in order to advance and support technology development and transfer is important. Although the lion's share of this work needs to be undertaken by actors within developing countries, this could be considerably strengthened through international support. It is therefore clear that at the very least, any Paris climate agreement should acknowledge the potential of the current UNFCCC mechanism for supporting and advancing technology transfer, the Technology Mechanism (TM), and strengthen it, in particular for rapid and effective realisation of the nationally determined contributions.

In addition, parties, in particular developing countries, argue in their submissions that the financial mechanism needs to support technology transfer, including building long-term capabilities and skills for R&D, innovation and manufacturing. Specific proposals to strengthen a climate-compatible technological transition in developing countries include improved R&D cooperation, strengthened networks and interactions within and between countries, an IPR regime that facilitates access to climate technologies, and various forms of technology standards. It is noted that the mandate of the Technology Mechanism does not need to be expanded for this, but it would require depoliticising the Technology Executive Committee (TEC), so that it functions more as an expert body, implementing the Technology Mechanism's mandate more vigorously, and providing stable funding support to the Climate Technology Centre and Network (CTCN) in particular, possibly through a privileged link to the financial mechanism.

Although the sources consulted in this study yielded some concrete proposals for a way forward for technology in the 2015 Paris Climate Agreement, a number of open questions and barriers still remain. These include the continued questions on whether the enhancement of specific innovation capabilities, beyond mere "enabling environments" and markets ought to be part of the UNFCCC realm. Moreover, how to make the finance and technology communities more aware of each other's concerns, opportunities and challenges? How to measure progress if technology is included in nationally determined contributions? And, finally, how to facilitate climate action in the face of the implications at the firm, industrial, and national levels of the emergence of potentially-disruptive new technologies and industries? These remain questions which require further deliberation.

1. INTRODUCTION AND APPROACH

This paper aims to explore the ways to help strengthen the climate technology development and transfer arrangements for an agreement that might emerge from the upcoming 2015 UNFCCC COP in Paris, and the implementation of any such agreement.

The term ‘technology development and transfer’ (shortened further as ‘technology’ in this paper) refers to the process of development, transfer, adaptation, and deployment of technologies to facilitate a climate-compatible technology transition. This process is underpinned and supported by a range of technical and non-technical activities. Technology is a long-standing issue in the UN climate change negotiations, rooted in article 4 of the United Nations Framework Convention on Climate Change (UNFCCC, 1992). While there have been some efforts in this area - such as the Technology Needs Assessments - it has been contentious and for years remained in essential deadlock in the Expert Group on Technology Transfer (EGTT) and the SBSTA technology transfer discussions. This changed when in the Bali Action Plan (2007) technology was recognised as one of the elements of a post-2012 climate agreement, leading to the Copenhagen Accord establishing a Technology Mechanism, which was formalised in the 16th Conference of Parties (COP) in the Cancun Agreements in 2010.

Since Cancun, subsequent COPs have detailed further rules and procedures around the Technology Executive Committee, which became the “policy arm” of the Technology Mechanism and established a new implementing institution, the CTCN, which is to provide technology-related assistance on the demand of developing countries and form an international network of climate-related stakeholders. In addition, a new and improved round of Technology Needs Assessments was implemented (UNFCCC, 2013).

The question, however, remains how the UNFCCC institutions could better help developing countries identify and fulfil their technology needs, and become more effective and comprehensive at supporting climate technology innovation in those developing countries that require assistance (Gehl Sampath et al., 2012; Bhasin et al., 2014). The current regime remains insufficient to address the huge challenges of mitigation - transitioning from fossil-based to low-carbon energy systems and of reducing global energy consumption - and adaptation, while maintaining or improving livelihoods and reducing poverty. Is the limited remit of the UNFCCC institutions just a budget issue or does the present design of the Technology Mechanism limit its ability to meet the enormous climate technology needs of developing countries? Through a comprehensive review of the existing literature, a study of country submissions under the UNFCCC, semi-structured interviews with experts, stakeholders and negotiators¹ and various other informal conversations, this paper aims to shed some light on these issues.

Section 2 of the paper provides a brief background detailing the essential references on climate technology development and transfer. Section 3 introduces the state of the current UNFCCC technology institutions and tools. Subsequently, the key issues that seem to be critical to advancing technology under the UNFCCC are discussed. Section 4 focuses on the themes that emerged from the interviews and the literature concerning technology and the 2015 Paris Climate Agreement. Section 5 reviews the recent country submissions under the UNFCCC. In Section 6, the authors step back and present their perspective on what they feel are essential aspects of the climate technology debate going forward that need to be addressed if the UNFCCC institutions are to meet the technology expectations of developing countries. Section 7 is the conclusion. Section 8 outlines an Agenda for Practical Action to carry forward the suggestions made in this paper.

1 The list of names can be found in Annex 1

2. BACKGROUND

Technology as an enabler for development has received much attention in the existing literature. Scholars have tirelessly emphasised that technology is more than just hardware (e.g., Lall, 1992; Ockwell et al., 2010; Maskus and Okediji, 2010), and that R&D is more than academic institutions or innovation in firms (Leach and Scoones, 2006). Even though in numerous reports and documents of the UNFCCC, the World Bank and other institutions (IPCC, 2000; etc.), this continues to be recognised, in reality, the rhetoric and operations of programmes continue treating mere provision of technology and associated knowledge as a universal fix (Cherlet, 2014), including in key climate sectors such as energy and agriculture. Policy changes, access to services, projects and programmes are frequently suggested or implemented by donors or UN organisations with sparse consideration for the question whether the institutions and capabilities can accommodate and govern such well-intended actions.

There is an ongoing debate about the causality of technology and investment in, for example, low-carbon technology. While some argue that investment follows good capabilities and institutions (e.g., Glachant, 2015; Dechezleprêtre et al., 2013), others state the opposite: that with economic development, investments will follow which leads to more technology transfer, better institutions and greater capabilities. The reality may be more systemic; different functions need to be fulfilled at the same time and interact, and what works, depends greatly on the specific circumstances, meaning that generalisations are difficult to make (Bergek et al., 2008; Lema and Lema, 2013; Nygaard and Hansen, 2015).

This is illustrated by the juxtaposition of developed and developing countries in the literature on innovation. The traditional, seminal literature sources on technology and innovation are focussed on developed country contexts (e.g., Bergek et al., 2008; Lundvall, 1992; North, 1990; Nelson and Winter, 1977). There is a long-standing consensus in the literature that this hardly translates to developing countries: in situations of weak institutions and low capabilities (or, in the words of innovation scholars, underdeveloped innovation systems), the same interventions are much less likely to generate the desired outcomes (Lall, 1992; Sagar et al., 2009; Ockwell et al., 2010). It is clear that national and international circumstances and a myriad of contextual factors matter more to the future of technology in a developing country than the technological characteristics (Dai and Xue, 2015; Tigabu et al., 2015; Bhasin et al., 2014).

Furthermore, underlying the debates on technology also is the question of markets and enabling environments. Haselip et al. (2015) argue that the discussions on climate mitigation and technology are shaped by a rise of “technocratic neoliberal”, pro-market viewpoints. This had led to an almost exclusive and barely questioned conviction of many Parties that markets are the only valid answer to addressing climate change and possible actions by the state should receive less emphasis. This is also observed by Watkins et al. (2015), who argue that other types of intermediaries, such as industry associations, may be additional nodes or focal points for technology transfer efforts, a discussion started by Smits and Kuhlmann (2004).

3. OVERVIEW OF CURRENT EFFORTS

The UNFCCC, cognisant of the central role that technology plays in reaching its objective, currently organizes its technology-related efforts under the Technology Mechanism (TM), which is an umbrella mechanism established in 2010 at COP16. The objective of the Technology Mechanism is “to facilitate the implementation of actions for achieving”:

- the “objective of enhanced action on technology development and transfer is to support action on mitigation and adaptation in order to achieve the full implementation of the Convention” (UNFCCC, 2010: para 113)
- nationally determining technology needs, based on national circumstances and priorities (UNFCCC, 2010: para 114), and
- the objective “to accelerate action consistent with international obligations, at different stages of the technology cycle, including research and development, demonstration, deployment, diffusion and transfer of technology” (UNFCCC, 2010: para 115).

The Technology Mechanism is defined as having two bodies: the Technology Executive

Committee (TEC, which is the policy arm of the Technology Mechanism) and the CTCN which is the implementing arm of the Technology Mechanism.

The TEC comprises of 20 members and has a broad mandate that includes the facilitation of “collaboration on the development and transfer of technologies for mitigation and adaptation between governments, the private sector, non-profit organizations and academic and research communities” and seeks “cooperation with relevant international technology initiatives, stakeholders and organizations” (UNFCCC, 2010: para 121). So far, the TEC’s main activities include a number of thematic dialogues that have been closely orchestrated by the TEC and the UNFCCC Secretariat, the production of a number of policy briefs and signalling priority areas to the COPs. Since its first meeting in September 2011, the TEC has met eleven times (with the eleventh meeting held in September 2015). The members are elected by the COP and reflect a geographical representation, but are supposed to be technology experts and act in their personal capacity and not on behalf of their countries.

Box 1. TEC products to date (based on UNFCCC TT:CLEAR website)

Thematic dialogues and workshops:

- TEC 10 held an in-session thematic dialogue on distributed renewable energy (March 2015)
- Workshop on National Systems of Innovation (October 2014)
- TEC 9 held a thematic dialogue on Climate Technology Financing (August 2014)
- TEC 7 held an in-session workshop on TNAs (September 2013)
- TEC 6 held a thematic dialogue on the research, development and demonstration of environmentally sound technologies (June 2013)

TEC Briefs:

- Distributed Renewable energy (November 2015)
- Technologies for adaptation in the agriculture sector (November 2014)
- Technologies for adaptation in the water sector (November 2014)
- Results and success factors of TNAs (October 2013)
- Possible integration of the TNA process with NAMA and NAP processes (October 2013)
- Using roadmapping to facilitate the planning and implementation of technologies for mitigation and adaptation (October 2013)

The CTCN's core objective is to “facilitate a network of national, regional, sectoral and international technology networks, organizations and initiatives” (UNFCCC, 2010: para 123) that, among other things, responds to requests made by developing countries through their National Designated Entities (NDEs), the focal points in countries of the CTCN.

So far, the focus of the CTCN, which has been operational since February 2014, is on coaching NDEs on submission of requests for one-off activities such as a specific technical assistance programme, and responding to those requests. Up till July 2015, the CTCN website lists 21 requests from 11 countries (and two groups of countries). The requests are roughly equally distributed between adaptation and mitigation, and cover various sectors. The vision of the CTCN in the long term is that it would help build global, regional and national networks of relevant actors that can turn to each other for knowledge, training, experience and capacity in order to effectively implement climate technologies.

In addition, the UNFCCC has overseen several rounds of the production of Technology Needs Assessments (TNAs). These TNAs, which are supposed to be generated through inclusive stakeholder-led processes with the assistance of accurate information, data and decision-making tools, aim to identify technology options, but also prioritise them (UNDP, 2010). TNAs can become very elaborate and detailed documents. The TNA process is intended to result in technology action plans, strategies and programmes within the countries, but it is unclear whether so far they have seen much follow-up.

Less specifically on technology, various UNFCCC instruments affect technology transfer, such as the CDM, of which some claim a sizeable share of projects has contributed to technology transfer (Murphy et al., 2013) or even accumulation of technological capabilities (Lema and Lema, 2013). In addition, sector-based Nationally Appropriate Mitigation Actions (NAMAs) or National Adaptation Plans (NAPs) may contribute, although this has not been

researched. But perhaps the major UNFCCC instrument that will have a bearing on the Technology Mechanism (and other technology-related activities) is the Financial Mechanism, as will be discussed later.

Outside of the UNFCCC, an enormous range of efforts in countries, by international organisations and in bilateral cooperation contribute to one or more of the elements of low-carbon or climate-resilient technology transition in developing countries. Hultman et al. (2013) and Ockwell et al. (2014) discuss overviews from various perspectives and Coninck and Puig (2015) review initiatives such as the World Bank/infoDev's Climate

Innovation Centres, the UNEP/UNIDO's National Cleaner Production Centres and numerous bilateral efforts to evaluate which functions in developing countries' innovation systems are covered. One key conclusion is that while effective technology transfer requires the building of innovation capabilities in developing countries through transfer of associated and tacit knowledge as well as explicit knowledge rather than mere technical assistance, this is mostly lacking in practice. In addition, the studies note that efforts on networking in developing countries act as the "mortar" of the actors and functions of innovation systems and could be strengthened through international efforts.

4. ISSUES AROUND TECHNOLOGY IN THE 2015 PARIS CLIMATE AGREEMENT

This section will discuss, based on commonalities and differences highlighted by technology and finance experts in semi-structured interviews and our own analysis, several salient issues that provide a basis for further discussion on technology in the 2015 Paris Climate Agreement. From the interviews, it is clear that a Paris climate agreement ought to make a reference to the Technology Mechanism, both to allow for an acceptable agreement, and for providing and coordinating technology- and capability-related necessities for the eventual realisation of nationally determined contributions.

4.1 Differentiated Perspectives on Technology

“Technology transfer” is defined by the 2000 IPCC Special Report on the issue as “a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions. It comprises the process of learning to understand, utilize, and replicate the technology, including the capacity to choose it, adapt it to local conditions, and integrate it with indigenous technologies” (IPCC, 2000). In the UNFCCC, this broad definition of technology transfer is widely accepted but not embraced uniformly in practice, which impacts the appropriateness of technology development and transfer responses (Nygaard and Hansen, 2015).

The interviewees interpret this reading of technology transfer to explicitly include human capabilities and capacity, including capabilities for repair, maintenance, adaptation, localisation and innovation of the hardware and the “orgware” that is being transferred. However, although all interviewees were clear about this, they also indicated that others, including many Parties, fail to see technology transfer in the same way. In particular, Annex-I countries are perceived to consider technology

transfer mostly as the exclusive sale of technology hardware, possibly accompanied by some basic operational skills, to other countries. This is not unique to the UNFCCC: similar difficulties have arisen in the context of the TRIPS Agreement (Moon, 2011).

This implicit or perceived disagreement on what constitutes technology transfer - and hence what are the technology-related obligations under the UNFCCC - might be at the heart of some of the contentiousness around technology institutions in the UNFCCC. This difference in perspectives seems to be particularly stark between those countries at the “receiving end” and those at the “sharing” of technology transfer - most commonly, between developing and developed countries. For example, there is substantial work highlighting that the successful uptake of technologies requires a range of local capabilities (see, for example, Lall, 1992; Ockwell, 2009; Watson, 2010; Sagar et al., 2009) which has implications for effectiveness of efforts to assist developing countries deploy climate-compatible technology (Sagar and BNEF 2010). Therefore, the building of these capabilities is seen as an important issue in developing countries but it does not necessarily receive the same level of attention in developed countries. This could be one of the more implicit manifestations of the persistent division between Annex-I and non-Annex I countries, often colloquially called “the firewall” in the climate negotiations, as it leads to very different views on what is a feasible and fair way forward in the technology discussions.

4.2 Specific Areas of Focus for the Technology Mechanism

The interviews revealed remarkable agreement on where priorities of technology cooperation in the UNFCCC instruments should be. Although acknowledging that the TM is a step in the right direction, all interviewees were in agreement that cooperation on strengthening of innovation capabilities in developing countries,

through activities such as cooperative R&D, needs to become a prominent action item of the Technology Mechanism. Some proposed concrete ideas on what such cooperation could look like, based on the needs of the institutions they work in themselves. In addition, some mentioned other aspects that could be included, but that were not mentioned or supported by all interviewees. Specific ideas include:

- R&D cooperation: It is thought that twinning, larger research programmes and long-term collaborations, including south-south cooperation, can greatly help with the building of much-needed innovation capabilities in developing countries. Currently, though, such collaborations are extremely limited (Ockwell et al., 2014), although there are some examples such as the Indo-US Joint Clean Energy R&D Centre. Firms are often disinclined to invest in cooperative R&D, for risks associated with early-stage R&D, and for competitiveness reasons in R&D for commercial applications. Therefore, the reluctance of donor agencies and the financial mechanism of the UNFCCC to fund high-risk R&D needs to be resolved in order to make this happen. The need for mitigation funding generally to have a certain outcome, such as measurable emission reductions, presents a barrier to these type of initiatives that have an uncertain outcome.
- Technology standards: The TEC or the CTCN could collaborate with other institutions to work on the development of (voluntary) standards for technology. These could include quality standards, preventing the sales or dumping of low-quality goods in developing country markets, as well as carbon or energy efficiency of vehicles, appliances or installations.
- Strengthening networks: Although building a global network of knowledgeable and skilled organisations and individuals is a core objective of the CTCN, it so far has given priority to responding to requests from developing-country Parties. Networking, including focused on

strengthening capabilities of local actors, could be improved through many measures, but cooperation in an appropriate field is considered most effective. The Climate Technology Network (CTN) as part of the CTCN remains weak and there is lack of a vision of what a fully functioning CTN would eventually look like.

- A climate-friendly Intellectual Property Rights (IPR) regime: IPR, a long-standing and particularly contentious issue in the negotiations and in TEC meetings, was mentioned by several of the interviewees. Those who mentioned IPR in interviews acknowledged that IPR is primarily a positive force for innovation in climate-friendly technologies, but might in specific cases be a barrier to technology transfer. They recommend that any international effort related to the existing IPR regime (nationally or internationally) should be tailored to address climate technology needs of developing countries without undercutting the broader role that IPRs might have in providing incentives to innovators and disseminating information and knowledge. The TEC, in its key messages to COP-18 in Doha (2012) noted that "IPRs were identified as an area for which more clarity would be needed on their role in the development and transfer of climate technologies, based upon evidence on a case-by-case basis" (TEC, 2012).

It is considered that for most these actions, the TM's mandate would not have to change. However, both the TEC and the CTCN would need to take greater initiative in these areas and actively pursue possibilities to find adequate funding for relevant activities.

4.3 Institutional Functioning of the Technology Mechanism

All the interviewees felt that the TM is a necessary and useful entity that needs continued acknowledgement in the 2015 Paris climate agreement. However, they almost unanimously felt that more could and should be done for the TM to live up to its potential and expectations.

The mandate is generally thought to be broad and extensive enough, but the current level of implementation, and in particular the funding situation, is seen as insufficient.

Part of the explanation might be that the TM is still relatively young: the CTCN truly started operations only in early 2014, about a year before our interviews. However, expectations that the TEC and CTCN would be able to fully fulfil their mandates and make an impact were relatively low for two reasons: the perception that the TEC is more of a negotiation body than a committee for technological and policy prioritization and advice, and the lack of coordination between the TM and the financial mechanism. These comments are discussed in more detail below.

Although the TM's mandate seems to be sufficient, the question is whether the institutional design of the CTCN and the TEC are set up to reach the full potential of its mandate.

4.3.1. *Negotiations continue in the TEC*

While the TEC is mandated to be an expert, executive body that develops policy and technological advice on issues related to technology development and transfer, interviewees consistently indicated that the body is overly political and suffers from being a veritable extension of the UN climate change negotiations. This means that the traditional divide between developed and developing countries plays a dominant role in its deliberations.

This is thought by some to hamper progress, although others emphasise that it is unavoidable. Practitioners and experts who are also TEC members either have been negotiators, or sooner or later are likely to become involved in the negotiations. Several TEC members even are full-time civil servants and negotiators, both on the developed- and the developing-country side. One stakeholder stated that developed and developing countries both contribute to politicising the TEC by nominating negotiators as TEC members.

Why is this problematic? The problem can be observed in the practical reality of the TEC, for instance when discussing the work programme. Parties that were initially opposed to a certain specific task of the TEC but agreed to it in a COP decision as part of a negotiation package may be able to slow down or even stop its implementation in the context of the TEC through their TEC member.

In this way, the TEC is unlikely to go beyond what the least ambitious Party is ready to support, even though the agreed mandate leaves room and even calls for operation beyond the lowest common denominator.

4.3.2. *Coordination between Technology Mechanism and financial mechanism*

In August 2014, the Technology Executive Committee held a thematic dialogue and made recommendations on the linkages between the Technology Mechanism and the financial mechanisms of the UNFCCC, in particular the Global Environment Facility (GEF) and the Green Climate Fund (GCF) (UNFCCC, 2014). This recommendation included the suggestion that the Standing Committee on Finance, the GEF and the GCF could benefit from the experience of the TEC with how activities could be financed that have a long-lasting impact on the capabilities and institutions in developing countries, in addition to leading to measurable mitigation and adaptation. The issue was discussed during COP20 in Lima in December 2014, but no conclusion could be reached.

Our interviews show a broad agreement that there indeed needs to be a solid and robust link between the Technology Mechanism and financial instruments and institutions. This has two perspectives. First, in order to make a difference, the CTCN in particular needs larger budgets than it currently can access based on earmarked donations from a limited number of willing developed countries. Second, in order to utilize climate finance to truly enable an effective and sustainable climate technology transition in developing countries, the GCF and other institutions need to engage in more than just financing hardware and pay particular

attention to supporting activities that will allow domestic capabilities to be built in developing countries. Currently, the GCF does not seem to consider such aspects.

4.4. Indicators and INDCs on Technology

A small number of interviewees indicated that an interesting area of exploration might be whether in the Intended Nationally Determined Contributions (INDCs), elements on technology could be included. This then would raise the question what such contributions would look like. Obvious indicators, such as investments in climate technology RD&D, could be included, or a target for such investments could be set.

Although a step forward, this would still largely ignore functions in innovation systems that go beyond just means for investment. Much more needs to be done in

terms of building capabilities and competent institutions, education systems, productive and innovative industries and firms, and effective bureaucracies with a collaborative attitude. Would it be possible to include indicators around capability building? Or include a target on a number of international R&D collaborations with research institutions in a specific developing country in key sectors as identified in the TNA of that country?

In addition, could targets be set around technology implementation in a country and local content requirements? Some literature suggests that problems emerge around such policies in the absence of an existing institutional, knowledge and entrepreneurial fundament in a country (Rennkamp and Boyd, 2015). The obvious conclusion is that enabling and enhancing such capabilities in a country needs to be part of an INDC around technology.

5. CURRENT THEMES AND PROPOSALS AROUND TECHNOLOGY

There are a number of themes and proposals regarding technology that appear in recent Party submissions and the current draft negotiation text of the ADP, and that are also consistent with the views expressed in many of the interviews. Not surprisingly, perhaps, an overwhelming fraction of the technology-related submissions come from developing countries, given their concern about implementing their national determined contributions and the relative lack of concrete action on means of implementation (MOI). The July 2015 ADP draft negotiation text contained two options for the Technology Mechanism in general: either strengthening it through, e.g., establishing linkages with the Financial Mechanism, enhancing the role of the private sector and provisions for accounting, or not strengthening the Technology Mechanism at all.

Accordingly, most of the submissions are fundamentally aiming to ensure that developing countries have access to adequate and dependable means of implementation to help them achieve their INDCs and that all Annex-II countries are contributing a fair share. Many of the proposals in the ADP negotiation text also mention these aspects. The following is a synthesis of these proposals:

1. Just as there is an expectation of commitments on mitigation, there should also be commitments on means of implementation - finance, technology, and capacity building - which are also a part of the obligations of industrialized countries under the UNFCCC. Furthermore, it has been suggested that these should be of a similar (legally-binding) nature as mitigation commitments. Concretely, a “global goal on technology development and transfer”, consistent with the 1.5 or 2°C temperature rise limit, is suggested in the ADP text, without providing details about what such a global goal could look like.

As a counterpoint, there is also an opposing view by some Parties that means of implementation (MOI) should not be seen as a legal obligation or an obligation to be included in INDCs. It is suggested that COP decisions are a better venue for prescribing the MOI.

2. MOI commitments should represent a fair effort relying on a principle-based reference framework. This emerges from both the submissions and the ADP draft negotiation text. Furthermore, in order to achieve their objectives (and in accordance with the UNFCCC), MOI must represent new, additional, adequate, predictable and accessible financial resources, including for the transfer of technology, by developed country Parties. While additionality and adequacy traditionally have received much attention in the discussions regarding MOI, the notion of predictability in the means of implementation is also of significance since it is necessary for appropriate long-term planning on mitigation and adaptation action by developing-country Parties as well as by facilitating actors.

Accordingly, relevant roadmap and targets regarding support for MOI should be outlined by Annex-II Parties. This might include quantified goals for finance and technology.

3. In order to enhance transparency and comparability, the relevant information could be communicated through a standardized format (for example, using the common tabular format developed under the Bali Action Plan). The use of common accounting rules as well as common currency for commitments on finance and technology support by Annex-II Parties would also help in enhancing comparability of effort. Entry of this information in an online registry of INDCs related to finance, technology and capacity building has also

been suggested as a way of making the information more easily available (and presumably also providing an incentive for Parties to undertake appropriate actions on MOI, which such information-based disclosures can facilitate).

Such steps also will help address the issue of transparency of support, (complementing the mandate of the transparency of action) given the attention in the Durban platform and other venues. In fact, some Parties have gone so far as to suggest explicit MRV of the provision of financing and technology from Annex-II Parties so as to motivate Parties to follow through on their commitment and enhance comparability.

4. Most Parties seem to agree that existing institutional frameworks, such as GCF, should be used for implementation of agreements on means of implementation. However, language in the negotiating text on this issue is still square-bracketed, and negotiations on linking the Financial Mechanism and the Technology Mechanism did not reach agreement at COP20 in Lima.
5. The level of developing country mitigation efforts should be contingent on adequate and measurable finance, technology and capacity building support from Annex II countries. Developing country parties should clarify the extent to which the implementation of INDCs is dependent upon the provision of financial resources, technology transfer and capacity building. They may also list different scenarios or levels of action based on the level of Annex-II Parties' support (for example, "no/low/medium/high levels").
6. There are also a number of explicit suggestions regarding actions to advance technology development and transfer in the submissions as well as the draft negotiation text. These are of three categories:
 - a. Enhancing access to technology through an international mechanism on IPR; buying specific technologies (or licenses) and then making them available at concessional terms to developing countries or other international agencies; not asserting patent rights for the use of specific technologies for specific outcomes in specific countries; and domestic policy commitments by developed countries to leverage support from their private sector firms.
 - b. Strengthening technology research, development, demonstration and deployment (RDD&D) for climate technologies through greater support for RDD&D; engaging in cooperative RD&D; establishing a technology transfer facility that could help accelerate the translation of research to early stage technologies; and provision of technical support for development of endogenous technologies as well as deployment and diffusion of technologies.
 - c. Supporting capacity building in developing countries through skills training for planning and implementation; technical capabilities for technology development and deployment; domestic institution building; and strengthening the National Systems of Innovation.

6. OPEN QUESTIONS

The literature, interviews and submissions have yielded a number of concrete points and proposals. However, in addition to the clear areas of agreement, a number of open questions emerges, implicitly or explicitly, that could be considered for further discussion. Four issues are reviewed here.

6.1 Capabilities and Institutions: Enabling Environments are Not Enough

It is clear that suitable enabling environments are absolutely critical for the successful development, transfer, adaptation, and deployment of climate technologies. Yet scholarly work as well as conversations with experts and practitioners makes it abundantly clear that the development of local capabilities and institutions to guide, manage and support this process is no less critical. This is particularly urgent and important for Least-Developed Countries.

Yet the development of such capabilities and institutions is not an easy task, and even less so as to how international efforts might dovetail with local efforts for such a goal. In fact, the international development literature is replete with examples of unsuccessful capacity-building initiatives. Thus, there is still much to be done in understanding how such capacity may be developed in developing countries. South-South cooperation, especially in sharing of experiences, may be particularly relevant. While such cooperation has been increasing in recent years, much more can be done to fully harness its potential. (UNCTAD 2012).

This notion of building local capabilities and institutions, in some sense, is a key element if the TM is to be effective in fulfilling its objectives. But this places a huge burden on the TEC as well as the CTCN, in some sense, since these institutions and capabilities have to reflect the local context and also be responsive to local needs and conditions. That means that the programs of the TM that are guided

by the TEC and designed and operationalized by the CTCN must be tailored to the context of individual developing countries. That is a major task of any operational entity. Meeting this challenge still remains a major concern for the TM.

6.2. How to Make Technology Actors Think About Finance

While there is a clear recognition of the importance of finance in facilitating technology development and transfer, the finer nuances of financial aspects relating to the deployment and diffusion of climate technologies don't seem to receive as much attention in the climate domain. Much of the discussion, in fact, is focused on quantity of finance rather than the structure of finance. While the former is clearly important, given that there is very limited climate finance available to developing countries (especially smaller countries which are overlooked by the large-scale financiers) and specific and riskier technology-related endeavours, the latter does require further attention.

For example, an important question pertains to the derisking of new technologies to make them attractive to private investors. This involves not only mitigating technical risk but also other forms of risk - for example, country political risk, local currency risk, and institutional risk - that investors consider routinely when making investments in developing countries. In many cases, in fact, developing countries may not even have the domestic capital markets that can absorb the large amounts of climate finance that might flow in, or have the domestic fund-raising capabilities (through bond markets, for example) to appropriately complement and leverage the international funds. What might the regulatory infrastructure need to look like in order to facilitate the flow of green credit? These kinds of issues and questions need to be examined in detail, best practices shared and creative solutions explored.

6.3. How to Measure Progress on Technology?

There is a profusion of activities and programmes on climate technology by bilateral aid agencies, multilateral and intergovernmental organizations, and by the private sector. In this melange of efforts, how can progress on the technology front under the UNFCCC be measured? This seems to be a key question for multiple reasons. First, given the variety of efforts by country Parties, especially the Annex-II Parties that have an obligation under the UNFCCC to support technology development and transfer, how does one assess the efforts by various countries in a manner that is comparable, and subsequently how can an assessment be made in terms of adequacy, which by definition, has to be in relation to meeting the objectives of the UNFCCC. Second, should this assessment be in terms of financial and other resources provided or should it be in terms of outcomes achieved in terms of reduction of greenhouse gas emissions, establishment of adaptation efforts, or building of capacity? These are relatively open questions that will require further consideration as the UNFCCC moves forward in the technology arena.

6.4. Concerns Over the Emergence of Potentially-Disruptive New Technologies and Industries

The recent rise of China's manufacturing base in clean energy technology, which was a consequence of the careful design and continuous investment in its national innovation system, including in innovation capabilities, capable institutions and RD&D (Gallagher, 2014), as well as the rise of several sectors in China and other emerging economies (Watson et al., 2010; Chaudhary et al., 2015) have shown that the current owners of technology will not maintain their first-mover advantage forever, and will face competition in innovative technology sooner or later.

This is seen as a threat by policymakers in Annex-II countries wishing to maintain high living standards and continuously creating local jobs. Creating one's own competitors in climate technology areas in which Annex-II countries themselves have been investing significant public money to generate much-needed employment could therefore be seen as a barrier to further technology cooperation, in particular to investment in innovation capabilities in developing countries. The "market formation-only" strategy promoted by some developed countries in the TEC and more broadly in the negotiations, and the reluctance to discuss IPR issues, could also be seen as symptoms of these concerns. It should be noted that these kinds of tensions are not only between Annex-II and major emerging economies but also, for example, between established firms (such as fossil-only players) and emerging firms in the renewable space.

One may argue that the technological dominance of some of the established players will peter out in any case, and that investment in capabilities and institutions around climate technologies at least may lead to a lower-carbon and more climate-resilient development path in developing countries and industries. After all, the rise of the manufacturing sector in China has been implemented mostly due to its own investments, legitimate acquisition and licencing from developed countries, optimised for economic development rather than protection of the environment. Although licencing was done in collaboration with firms from industrialised countries, this development was not financially supported by developed countries. A different orientation might have led to a less carbon-intensive pathway. This issue presents a dilemma that manifests itself in the UN climate negotiations.

7. CONCLUSION

This paper addressed the question of what themes and issue relating to technology development and transfer that need to be considered in the envisioned Paris agreement of December 2015 in order to allow UN climate institutions to make a positive and significant impact on the global climate-compatible technology transition.

Our research indicates that the Paris agreement should continue recognising and supporting the existing Technology Mechanism, and that the scope of the Technology Mechanism's mandate would not have to be extended. However, the Paris climate agreement could emphasise certain key aspects related to:

- Strengthening the Technology Mechanism's activities in the field of R&D cooperation, technology standards and a more climate friendly IPR regime as well as truly strengthening the global network of institutions working on climate technology in different phases of the technology cycle with a particular focus on Least- Developed Countries and adaptation technologies. These recommendations are roughly consistent with the findings of earlier sources on gaps in the climate technology arena.
- Strengthening the links between the Technology Mechanism and the Financial Mechanism, but in a finance-smart way that takes into account the specificities

of technology matters as well as finance matters.

- Including technology-related activities in INDCs and developing indicators for measuring the progress on technology as a means of implementation.
- Depoliticising the TEC so that it emphasises independent technical and policy expert guidance responding to real world questions. This expert guidance could focus on what is needed in the policy domain to help the Technology Mechanism more effectively meet its mandate of facilitating technology development and transfer to support developing countries in meeting their mitigation and adaptation objectives.

Potentially an independent review of the Technology Mechanism might provide additional useful insights and a validation of the findings of this study. It is recommended that these aspects, and potentially others that might be revealed if a review of the Technology Mechanism would be conducted, are given serious consideration in the run-up to the 2015 Paris Climate Agreement so that the mechanisms related to technology in the UNFCCC can reach their full potential, and the implementation of emission reductions that enable the two degree target to stay within reach is not put in further danger.

8. AN AGENDA FOR PRACTICAL ACTION

The discussion in this paper points towards a number of concrete actions that potentially could be included in a 2015 Paris agreement on climate change relating to technology, and in support of implementing the agreement's provisions.

First, the agreement should reflect that it welcomes and appreciates the constructive role the Technology Mechanism can play, but also that its operations and funding situation needs to be enhanced.

Second, the design of the TEC needs to effectively help it to:

- a) Develop itself into a body that assesses options and pathways to enhance technology transfer and gives concrete policy advice;
- b) Conduct a review and reality check of the INDCs from the perspective of technology development and transfer arrangements, and provide recommendations of actions that can contribute to the feasibility of INDCs;
- c) Develop indicators for technology action, measuring progress in low-carbon and adaptation innovation systems, in an internationally comparable way and taking into account CBDRRC;
- d) Identify specific and substantial actions, including international support, for strengthening such innovation systems;

- e) Engage private sector, civil society and research communities in working groups that lead to widespread, voluntary or eventually enforced, climate-resilience product standards that contribute to mitigation (through carbon or efficiency standards) and adaptation (through climate resilience standards).

Third, the CTCN could be requested to:

- a) Develop a practical and ambitious vision and work plan for the Climate Technology Network, with the objective of building innovation and strategic capabilities in all developing countries, but in particular in LDCs, in a collaborative spirit;
- b) Develop a programme for R&D collaboration in climate technologies for longer-term, deep emission reductions that aims at (tacit) knowledge transfer and cooperation;
- c) Develop good practices for technology and innovation system operations and governance of national and technology innovation systems.

Finally, the GCF should be requested to develop, in collaboration with the institutions in the Technology Mechanism, a concrete vision of how its finance efforts are going to contribute towards a transformative change and the capabilities and institutions required for that change to occur, and explore a stronger and financial link with the Technology Mechanism, in particular the CTCN.

REFERENCES

- Bergek, A., S. Jacobsson, B. Carlsson, S. Lindmark, and A. Rickne, 2008. “Analyzing the functional dynamics of technological innovation systems: A scheme of analysis,” *Research Policy*, 37(3), 407-429.
- Bhasin, Shikha, Gabriel Blanco, Sophy Bristow, Rob Byrne, Lachlan Cameron, Heleen de Coninck, Zhang Fang, Kelly Sims Gallagher, Raluca Ionita, Tom Mikunda, Ambuj Sagar and Laura Wuertenberger, 2014. “Climate technology in context: Synthesis Report on Climate Technology and Development.” April 2014: ECN: Petten, Netherlands. Available via climatestrategies.org.
- Chaudhary, Ankur, Chetan Krishna and Ambuj Sagar, 2015. “Policy making for renewable energy in India: lessons from wind and solar power sectors,” *Climate Policy*, 15(1), 58-87, DOI: 10.1080/14693062.2014.941318
- Cherlet, Jan, 2014. “Epistemic and Technological Determinism in Development Aid.” *Science, Technology, & Human Values* 39(6): 773-794.
- Coninck, Heleen, de and Daniel Puig, 2015. “Assessing climate change mitigation technology interventions by international institutions.” *Climatic Change* 131 (3): DOI 10.1007/s10584-015-1344-z.
- Dai, Xiyin and Lan Xue, 2015. China’s policy initiatives for the development of wind energy technology. *Climate Policy* 15(1): 30-57.
- Dechezleprêtre, A., M. Glachant and Y. Ménière, 2013. What drives the international transfer of climate change mitigation technologies? Empirical evidence from patent data. *Environmental Resources Economics* 54(2): 161-178.
- Gallagher, Kelly Sims, 2014. The Globalization of Clean Energy Technology. Lessons from China. MIT Press: Cambridge, MA.
- Gehl Sampath, Padmashree; John Mugabe and John Barton; (2012); Realizing the potential of the UNFCCC Technology Mechanism: Perspectives on the Way Forward; ICTSD Programme on Innovation, Technology and Intellectual Property; Issue Paper No. 35; International Centre for Trade and Sustainable Development, Geneva, Switzerland, www.ictsd.org
- Haselip, James, Ulrich Elmer Hansen, Daniel Puig, Sara Trærup and Subash Dhar, 2015. Governance, enabling frameworks and policies for the transfer and diffusion of low carbon and climate adaptation technologies in developing countries. *Climatic Change* 131 (3): 363-370.
- Hultman, Nathan, Katherine Sierra, Jason Eis and Allison Shapiro, 2012. “Green Growth Innovation: New Pathways for International Cooperation.” GGGI and the Brookings Institution - Global Economy and Development.
- IPCC, 2000. Methodological and Technological Issues in Technology Transfer. Bert Metz, Ogunlade Davidson, Jan-Willem Martens, Sascha Van Rooijen and Laura Van Wie Mcgrory (Eds.). Cambridge University Press: Cambridge, United Kingdom. 432pp.
- Lall, S., 1992. “Technological capabilities and industrialization.” *World Development* 20 (2): pp. 165-186.
- Leach, M. and I. Scoones, 2006. The Slow Race. Making technology work for the poor. DEMOS: London, UK. ISBN 1 84180 162 3.

- Lema Adrian and Rasmus Lema, 2013. "Technology transfer in the clean development mechanism: insights from wind power." *Global Environmental Change* 23:301-313.
- Lundvall, B., 1992. National Systems of Innovation: Towards a theory of innovation and interactive learning. Pinter, London, United Kingdom.
- Maskus, K. E., and R. L. Okediji, 2010. Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options. ICSTD Issue Paper No. 32: Geneva, Switzerland.
- Moon, Suerie, 2011. Meaningful Technology Transfer to the LDCs: A Proposal for a Monitoring Mechanism for TRIPS Article 66.2. ICTSD Policy brief Number 9: Geneva, Switzerland.
- Murphy Kevin, Grant Kirkman, Stephen Seres and Erik Haites, 2013. "Technology transfer in the CDM: an updated analysis." *Climate Policy* 15(1): 127-145.
- Nelson, R. and S. Winter, 1977. In search of a useful theory of innovation. *Research Policy* 6: pp. 36-76.
- North, D.C., 1990. Institutions, Institutional Change, and Economic Performance. Cambridge University Press, New York NY, USA.
- Nygaard, Ivan and Ulrich Elmer Hansen, 2015. The conceptual and practical challenges to technology categorisation in the preparation of technology needs assessments. *Climatic Change* 131(3): doi:10.1007/s10584-015-1367-5.
- Ockwell, D., Ely, A., Mallett, A., Johnson, O. and Watson J., 2009. "Low Carbon Development: The Role of Local Innovative Capabilities," STEPS Working Paper 31, Brighton: STEPS Centre and Sussex Energy Group, SPRU, University of Sussex.
- Ockwell, D. et al. (2010), "Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework", OECD Environment Working Papers, No. 12, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5kmfplm8xxf5-en>
- Ockwell, David, Ambuj Sagar and Heleen de Coninck, 2014. "Collaborative research and development (R&D) for climate technology transfer and uptake in developing countries: Towards a needs driven approach." *Climatic Change* DOI 10.1007/s10584-014-1123-2.
- Rennkamp, Britta and Anya Boyd, 2015. "Technological capability and transfer for achieving South Africa's development goals." *Climate Policy* 15:1, 12-29, DOI: 10.1080/14693062.2013.831299
- Sagar, Ambuj, Cath Bremner and Michael Grubb, 2009. "Climate Innovation Centres: A partnership approach to meeting energy and climate challenges." *Natural Resources Forum* 33: 274-284.
- Sagar, A.D. and BNEF (Bloomberg New Energy Finance). 2010. "Climate Innovation Centres: A New Way to Foster Climate Technologies in the Developing World," a World Bank-infoDev and UNIDO report, Washington DC, USA.
- Smits, R. and S. Kuhlmann, 2004. The rise of systemic instruments in innovation policy. *International Journal of Foresight Innovation Policy* 1 (1/2): 4-30.
- TEC, 2012. Summary of the Fourth meeting of the UN Framework Convention on Climate Change Technology Executive Committee. Available on <http://www.iisd.ca/crs/climate/tec/tec4/html/ymbvol205num1e.html>.

- Tigabu, Aschalew Demeke, Frans Berkhout and Pieter van Beukering, 2015. “Functional evolution and accumulation of technological innovation systems: the case of renewable energy in East Africa.” *Science and Public Policy*: pp. 1-18. doi:10.1093/scipol/scu073.
- UNCTAD, 2012. “Technology and Innovation Report 2012: Innovation, Technology and South-South Collaboration,” UNCTAD, Geneva.
- UNDP, 2010. “Handbook for conducting Technology Needs Assessment for Climate Change”. Available via http://unfccc.int/ttclear/templates/render cms_page?TNA_hab.
- UNFCCC, 1992. “United Nations Framework Convention on Climate Change.” Available on: www.unfccc.int
- UNFCCC, 2010. “Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. Addendum: Part Two: Action taken by the Conference of the Parties at its sixteenth session.” FCCC/CP/2010/7/Add.1.
- UNFCCC, 2013. “Third synthesis report on technology needs identified by Parties not included in Annex I to the Convention.” FCCC/SBSTA/2013/INF.7: <http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf>
- UNFCCC, 2014. “Linkages between the Technology Mechanism and the Financial Mechanism of the Convention: recommendations of the Technology Executive Committee.” FCCC/CP/2014/6: <http://unfccc.int/resource/docs/2014/cop20/eng/06.pdf>.
- Watkins, Andrew, Theo Papaioannou, Julius Mugwagwa, Dinar Kale, 2015. National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: a critical review of the literature. *Research Policy* 44: 1407-1418.
- Watson, Jim, Rob Byrne, David Ockwell, Michele Stua and Alex Mallett, 2010. “Low Carbon Technology Transfer: Lessons from India and China.” Sussex Energy Group, University of Sussex, Brighton.

ANNEX I. LIST OF INTERVIEWEES

In addition to the full interviews listed below, Rossi, Daniel Buiria Clark and Griffin Thompson have contributed to the insights in this paper. conversations with Gabriel Blanco, Carlos

Name	Affiliation	Date of interview
Dixon, Bob	<ul style="list-style-type: none"> Global Environment Facility (GEF) 	December 9, 2014
Sadeghzadeh, Seyed Mohammad	<ul style="list-style-type: none"> Shahed University, Iran TEC member 	December 10, 2014
Zhang, Xiaohua	<ul style="list-style-type: none"> National Center for Climate Change Strategy and International Cooperation, China TEC member 	December 11, 2014
Sharma, Sudhir	<ul style="list-style-type: none"> UNEP DTU Partnership, Denmark 	January 6, 2015
Lee, Arthur	<ul style="list-style-type: none"> ChevronTexaco, United States TEC observer and member TEC Task force 	January 7, 2015
Mathur, Ajay	<ul style="list-style-type: none"> Bureau for Energy Efficiency, India 	January 16, 2015
Noboa, Eduardo	<ul style="list-style-type: none"> National Institute of Energy Efficiency and Renewable Energy (INER), Ecuador TEC member 	January 23, 2015
Widge, Vikram	<ul style="list-style-type: none"> International Finance Corporation (IFC) 	January 27, 2015

ICTSD has been active in the field of intellectual property since 1997, among other things through its programme on Innovation, Technology and Intellectual Property (IP), which since 2001 has been implemented jointly with UNCTAD. One central objective of the programme has been to facilitate the emergence of a critical mass of well-informed stakeholders in developing countries that includes decision-makers and negotiators, as well as representatives from the private sector and civil society, who will be able to define their own sustainable human development objectives in the field of IP and advance these effectively at the national and international level. The programme has generated an issue paper series on Intellectual Property Rights and Sustainable Development with the intention of offering a clear, jargon-free synthesis of the main issues to help policy makers, stakeholders and the public in developing and developed countries to understand the varying perspectives surrounding different IPRs, their known or possible impact on sustainable livelihoods and development, and different policy positions over the TRIPS Agreement and other relevant international intellectual property arrangements. This issue paper series is the consequence of a participatory process involving trade negotiators, national policy makers, as well as eminent experts in the field, the media, NGOs, international organizations, and institutions in the North and the South dealing with IPRs and development.

Other Publications from the Innovation and IP theme include:

- Competition Analyses of Licensing Agreement, Considerations for Developing Countries under TRIPS. Issue Paper No.41 by Hiroko Yamane, 2015.
- The Implementation of Exhaustion Policies, Lessons from National Experiences. Issue Paper No. 40 by Shubha Gosh, 2013.
- Protecting Shared Traditional Knowledge: Issues, Challenges and Options. Issue Paper No. 39 by Manuel Ruiz Muller, 2013.
- Mapping Prevailing Ideas on Intellectual Property: Preliminary Findings from a Survey. Issue Paper No. 38 by Jean-Frédéric Morin, 2013.
- Fast-tracking Green Patent Applications: An Empirical Analysis. Issue Paper No. 37 by Antoine Dechezleprêtre, 2013.
- Unpacking the International Technology Transfer Debate: Fifty Years and Beyond. Issue Paper No. 36 by Padmashree Gehl Sampath and Pedro Roffe, 2012.
- Realizing the Potential of the UNFCCC Technology Mechanism. Perspectives on the Way Forward. Issue Paper No. 35 by John Barton, Padmashree Gehl Sampath and John Mugabe, 2012.
- Bridging the Gap on Intellectual Property and Genetic Resources in WIPO's Intergovernmental Committee (IGC). Issue Paper No.34 by David Vivas-Eugui, 2012.
- The Influence of Preferential Trade Agreements on the Implementation of Intellectual Property Rights in Developing Countries. Issue Paper No. 33 by Ermias Tekeste Biadgleng and Jean-Christophe Maur, 2011.

For further information, visit www.ictsd.org

About the International Centre for Trade and Sustainable Development.

Founded in 1996, the International Centre for Trade and Sustainable Development (ICTSD) is an independent think-and-do-tank based in Geneva, Switzerland and with operations throughout the world, including out-posted staff in Brazil, Mexico, Chile, Senegal, Canada, Russia, and China. By enabling stakeholders in trade policy through information, networking, dialogue, well-targeted research and capacity-building, ICTSD aims to influence the international trade system so that it advances the goal of sustainable development. ICTSD co-implements all of its programme through partners and a global network of hundreds of scholars, researchers, NGOs, policymakers and think-tanks around the world.