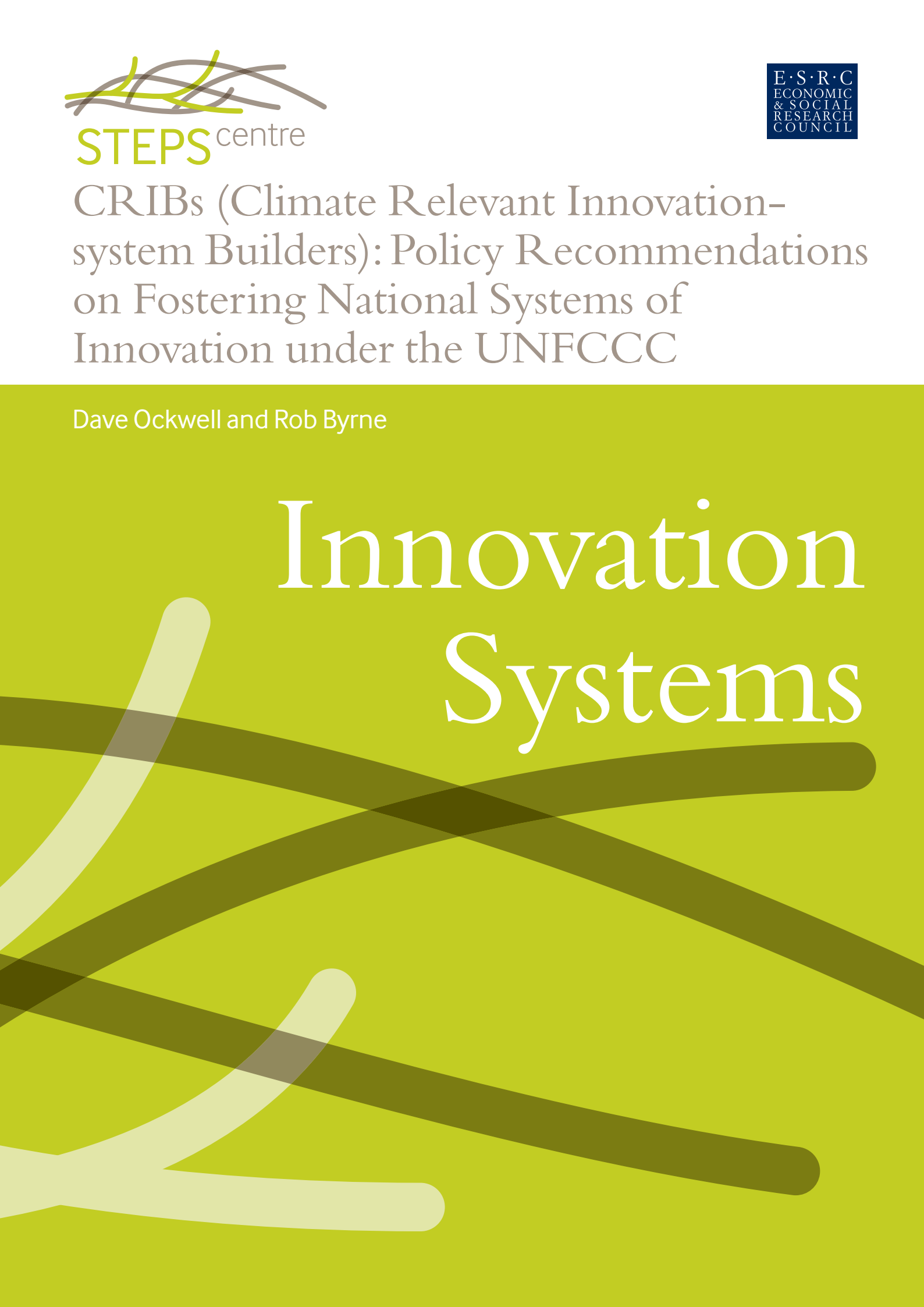
STEPS centre

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

CRIBs (Climate Relevant Innovation-system Builders): Policy Recommendations on Fostering National Systems of Innovation under the UNFCCC

Dave Ockwell and Rob Byrne



STEPS centre

CRIBs (Climate Relevant Innovation-system Builders): Policy Recommendations on Fostering National Systems of Innovation under the UNFCCC

National systems of innovation (NSIs) provide the context within which all processes of technology development, transfer and uptake occur - they refer to the network of actors (e.g. firms, universities, research institutes, government departments, NGOs) within which innovation occurs, and the strength and nature of the relationships between them. Nurturing NSIs in relation to climate technologies provides a powerful new focus for international policy with potential to underpin more sustained and widespread development and transfer of climate technologies. This working paper builds on an invited presentation by one of the authors at a workshop on NSIs convened by the Technology Executive Committee (TEC) of the United Nations Framework Convention on Climate Change (UNFCCC). It identifies policy recommendations for consideration of the TEC. The intention is both to inform possible recommendations by the TEC to the UNFCCC Conference of the Parties (COP) and to highlight potential areas for future work that the TEC could undertake on this issue.

About the authors

David Ockwell is a Senior Lecturer in the Department of Geography at the University of Sussex. He co-convenes the STEPS Centre's energy and climate domain and is also affiliated to the Sussex Energy Group and the Tyndall Centre. His research, teaching and policy work focuses on climate and energy policy with particular interests in: low carbon development in developing countries; discourse and framing effects in environmental policy; and public engagement with climate change.

Rob Byrne is a Research Fellow in SPRU - Science Policy Research Unit at the University of Sussex. He also co-convenes the STEPS Centre's energy and climate change domain in the STEPS Centre. Rob's work is mainly in low carbon technological innovation in developing countries, and has been involved particularly in research on East Africa and China.

About the STEPS Centre

Today's world is experiencing rapid social, technological and environmental change, yet poverty and inequality are growing. Linking environmental sustainability with poverty reduction and social justice, and making science and technology work for the poor, have become central challenges of our times. The STEPS Centre (Social, Technological and Environmental Pathways to Sustainability) is an interdisciplinary global research and policy engagement hub that unites development studies with science and technology studies. We are developing a new approach to understanding and action on sustainability and development in an era of unprecedented dynamic change. Our pathways approach aims to link new theory with practical solutions that create better livelihoods, health and social justice for poor and marginalised people. The STEPS Centre is based at the Institute of Development Studies and SPRU (Science Policy Research Unit) at the University of Sussex, with partners in Africa, Asia and Latin America. We are funded by the ESRC, the UK's largest funding agency for research and training relating to social and economic issues.

www.steps-centre.org.

Follow us on Twitter **@stepscentre**

Other titles in this series include:

Approach	Pathways to sustainability: an overview of the STEPS Centre approach
1. Dynamics	Dynamic Systems and the Challenge of Sustainability
2. Governance	Understanding Governance: pathways to sustainability
3. Designs	Empowering Designs: towards more progressive appraisal of sustainability
4. Agriculture	Agri-Food System Dynamics: pathways to sustainability in an era of uncertainty
5. Health	Health in a Dynamic World
6. Water	Liquid Dynamics: challenges for sustainability in water and sanitation

For more STEPS Centre publications visit:

www.steps-centre.org/publications

This is one of a series of Working Papers from the STEPS Centre
www.steps-centre.org.

ISBN: 978-1-78118-210-9

IDS Institute of Development Studies
US University of Sussex SPRU – Science & Technology Policy Research
E·S·R·C Economic & Social Research Council

CRIBs (Climate Relevant Innovation-system Builders)

Policy recommendations on fostering National Systems of Innovation under the UNFCCC

David Ockwell

Rob Byrne

STEPS Working Paper 76

Correct citation: Ockwell, D. and Byrne, R. (2014) *CRIBs (Climate Relevant Innovation-system Builders): Policy recommendations on fostering National Systems of Innovation under the UNFCCC*, STEPS Working Paper 76, Brighton: STEPS Centre

First published in 2014

ISBN: 978-1-78118-210-9

For further information please contact: STEPS Centre, University of Sussex, Brighton BN1 9RE
Tel: +44 (0) 1273915673; Email: steps-centre@ids.ac.uk; web: www.steps-centre.org

Contents

Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
CDM	Clean Development Mechanism
CICs	Climate Innovation Centres
COP	Conference of the Parties
CRIBs	Climate Relevant Innovation-system Builders
CTCN	Climate Technology Centre and Network
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
EPO	European Patent Office
GEF	Global Environment Facility
IADB	Inter-American Development Bank
ICTSD	International Centre for Trade and Sustainable Development
IPRs	Intellectual Property Rights
NDEs	National Designated Entities
NGO	Non-Governmental Organisation
PV	Photovoltaics
R&D	Research and Development
TEC	Technology Executive Committee
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation
NSI	National System of Innovation
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

National systems of innovation (NSIs) provide the context within which all processes of technology development, transfer and uptake occur. They encompass the network of actors (e.g. firms, universities, research institutes, government departments, non-governmental organisations) within which innovation occurs, and the strength and nature of the relationships between them. Nurturing NSIs in relation to climate technologies provides a powerful new focus for international policy with potential to underpin more sustained and widespread development and transfer of climate technologies.

This working paper builds on an invited presentation by one of the authors at a workshop on NSIs convened by the Technology Executive Committee (TEC) of the United Nations Framework Convention on Climate Change (UNFCCC). It identifies policy recommendations for consideration of the TEC. The intention is both to inform possible recommendations by the TEC to the UNFCCC Conference of the Parties (COP) and to highlight potential areas for future work that the TEC could undertake on this issue.

Key policy recommendations

The core aim of policy should be to support interventions which enable actors and institutions to act as Climate Relevant Innovation-system Builders (CRIBs). The key is to do so via nationally nested, demand-driven interventions that are internationally networked, facilitating learning across different contexts in order to build indigenous technological capabilities and well-functioning, context-sensitive NSIs.

Policy should focus on achieving four overarching goals:

1. Build networks of diverse stakeholders who work together in projects, programmes and other interventions;
2. Foster and share learning from research and experience;
3. Promote the development of shared visions amongst stakeholders;
4. Support diverse experimentation with technologies and practices.

A range of detailed policies and actions that Parties might implement to achieve these goals is detailed in Section 6 of the report.

It is recommended that these be achieved via adoption under the Convention of two complementary proposals:

1. Proposal 1: Strengthen the capacity of national designated entities (NDEs) under the Climate Technology Centre and Network (CTCN) by funding and supporting the establishment of national level Climate Relevant Innovation-system Builders (CRIBs) within developing countries.
    a. CRIBs would play a strategic, facilitating role, linking up relevant national actors, targeting and coordinating project and programme level interventions to maximise benefits to NSIs.
    b. CRIBs (through NDEs) would coordinate with the CTCN to communicate national priorities (with due knowledge of national policy priorities and local realities).

    c. The CTCN (as per its existing remit) would then act to network CRIBs internationally, facilitating knowledge flows and access to international technological capabilities based on a more detailed understanding of national and local capabilities and needs.

2. Proposal 2: Use climate technology projects and programmes explicitly to build climate innovation systems.
    a. If pursued jointly with Proposal 1, this role can be facilitated by CRIBs, in coordination with the CTCN.
    b. If pursued in isolation, this can be achieved by revising the remit and approach of the CTCN to integrate a climate innovation system-building approach into projects, programmes and related interventions, and to provide advice, via NDEs, on how Parties can bolster their own NSIs.

Proposal 1 should be highlighted as the preferred option with most potential to foster the development of NSIs around climate technologies in developing countries. Proposal 2 would be best used to augment the remit of the CTCN, mainstreaming a focus on NSIs. Proposal 2 could, however, be pursued on its own if Proposal 1 were seen as too ambitious.

It should be emphasised to the COP that both proposals (particularly Proposal 1) would support nationally-driven and nationally-appropriate actions. Both proposals would help Parties to foster climate technology development and transfer in ways that respond to their own nationally-determined needs and priorities. The report concludes with possible recommendations for further work by the TEC on this issue.

1. Introduction

1.1 *Aim of this report*

This report builds on a recent invitation by the TEC for the authors to present at a workshop[1] in Bonn on 'Strengthening national systems of innovation in developing countries'. The aim of this paper is to elaborate on the material presented at the workshop, providing a written source for members of the TEC and other stakeholders to refer to as thinking and action progresses on this subject, both under the UNFCCC and under other related initiatives.

1.2 *A 'pathways' perspective*

We start from an explicit recognition that there is no single, uncontested pathway towards achieving climate technology transfer and development, nor is there any single outcome or development trajectory that such pathways might support. Rather, multiple possible pathways exist and multiple potential end points, all of which have material consequences in the distribution of benefits – who wins, who loses, whose interests are represented and whose marginalised – that result along the way. The societal services and functions that climate technologies facilitate (e.g. energy production via low carbon technologies to serve the needs of poor rural communities) are realised dynamically out of the interplay of various co-evolving complex systems (social, technological, environmental) and any particular unfolding of these dynamics constitutes a specific development pathway amongst multiple possibilities (Leach *et al.* 2007).

Each of these complex systems themselves, and their combination, can be framed in different ways. And each framing informs – and is informed by – a narrative that interprets the world in a particular way, reflecting and reinforcing the perspective of the narrator. As understood here, a narrative is used to "suggest and justify particular kinds of action, strategy and intervention" (Leach, Scoones and Stirling 2010: 3) and so attempts to enrol actors and their resources into particular ways of achieving development goals. If this enrolment is successful then a particular direction of development is privileged, the result of which is an unfolding pathway co-evolving contingently and uncertainly in the interplay between these privileging forces and the various complex systems noted above.

Implicit in this description is the notion that multiple framings, narratives and pathways are possible. Different groups of actors will interpret the world in different ways, influenced by their own experiences, situations, understandings, values and interests. Favouring certain framings over others, they will seek to promote narratives that would help to create their preferred development pathways. Some narratives will be more dominant than others, perhaps because they are promoted by powerful actors, and are likely to be manifested in interventions. Other narratives remain marginalised, perhaps because they are promoted by groups who are themselves marginalised or powerless (Byrne *et al.* 2012).

[1] Details of the workshop, and Ockwell's presentation, are available on the UNFCCC website: http://unfccc.int/ttclear/templates/render_cms_page?s=events_ws_nsi

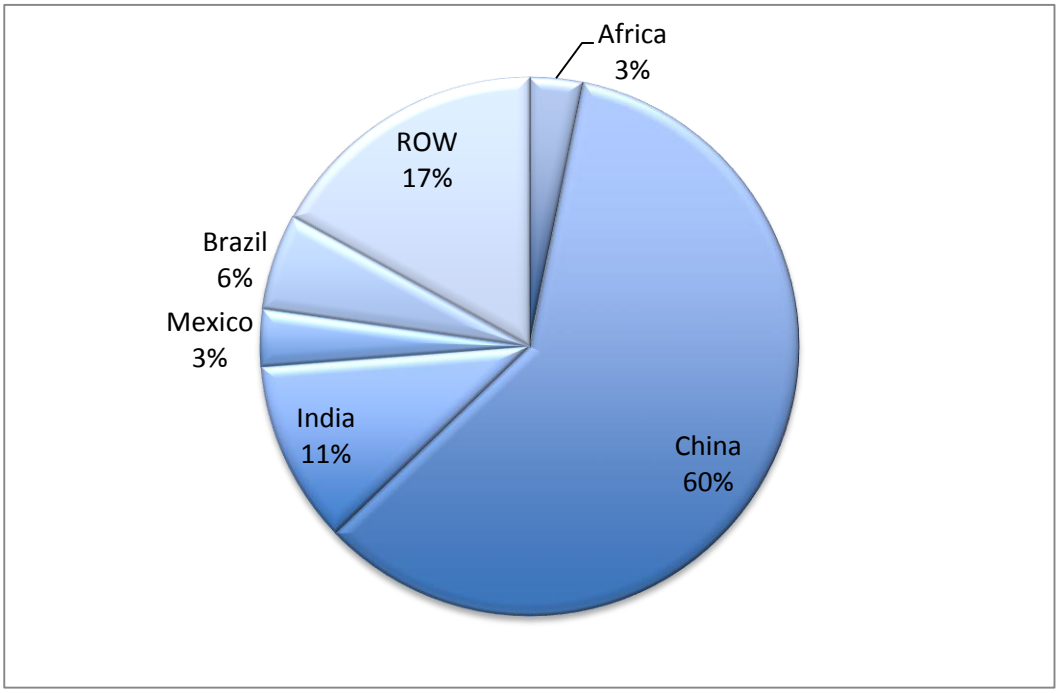
This means there are material consequences to how we frame problems and solutions. It is therefore critical to start by addressing how international policy on climate technology transfer is framed, and to reflect on the limitations of the framing that currently dominates.

1.3 *Why do we need to reframe international policy on climate technology transfer?*

Climate technology transfer and development forms a core commitment under multiple articles of the UNFCCC. In support of this commitment, there are two mechanisms that provide significant levels of support for technology transfer to developing countries: the Global Environment Facility (GEF, which has been in operation since 1991) and the Clean Development Mechanism (CDM, which is one of the flexible mechanisms of the Kyoto Protocol). To date, the GEF has provided finance to developing and transition economies totalling around USD 3.6 billion plus USD 23.7 billion in additional co-finance (GEF 2012). Whilst this is a significant amount of finance, the CDM has facilitated about USD 350 billion of investment[2]. However, despite these commitments and policy efforts, the extent to which meaningful levels of technology transfer and development have been achieved, and the distribution of associated finance, has been uneven and focussed around a limited number of technologies. For example, Figure 1.1 illustrates the distribution by country or region of cumulative investment to date under the CDM. Here we see that the vast majority of investment has accumulated in a small number of countries. Figure 1.2 illustrates how these relative finance streams do not correspond to the relative emissions levels of these countries. In particular, Africa stands out as receiving disproportionately low levels of finance compared to its emissions. Figure 1.3 illustrates how the majority of investment related to renewable energies has been in a small number of well-established technologies – only wind and solar PV (photovoltaic) being remotely towards the scale of 'new' renewable energy technologies.

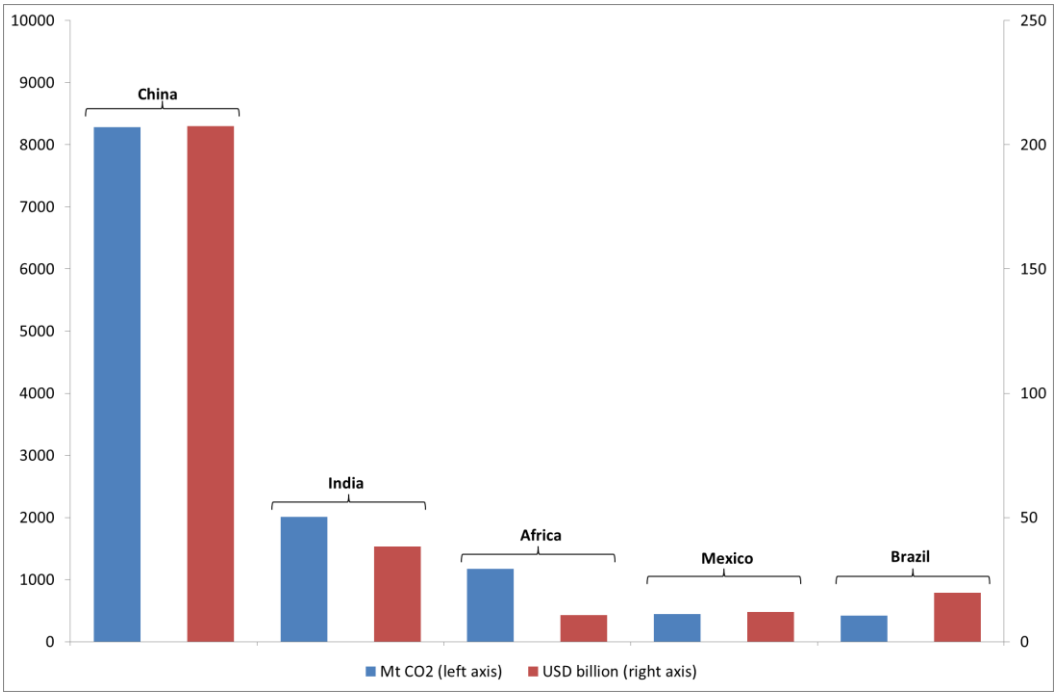
[2] See the CDM pipeline, available via: http://www.cdmpipeline.org

Figure 1.1. Distribution of cumulative investment under the CDM



Notes: ROW = Rest of World. Figures represent % of total accumulated investment by the end of January 2014. Source: Authors, based on analysis of the CDM pipeline (http://www.cdmpipeline.org)

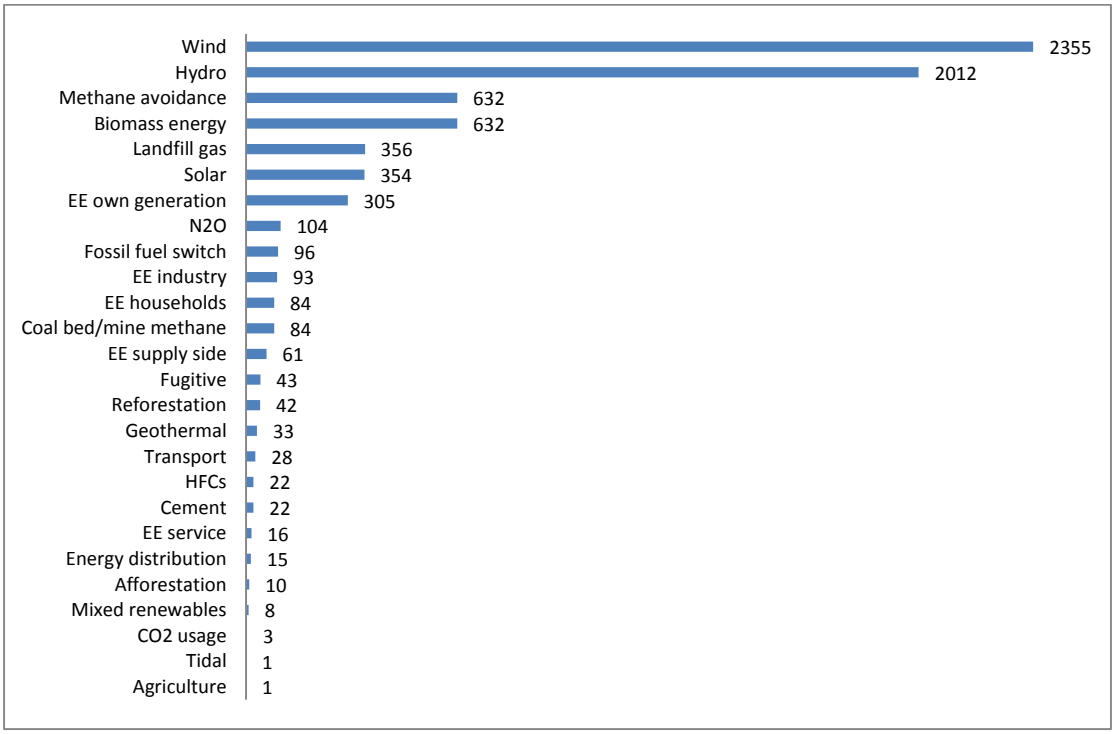
Figure 1.2. CO_2 emissions and CDM project investment



Notes: Figures represent national or regional CO_2 emissions (million tonnes) and CDM investment received (in USD billion) by the end of January 2014.

Source: Authors, based on World Development Indicators and analysis of the CDM pipeline (http://www.cdmpipeline.org)

Figure 1.3. Number of registered CDM projects as at end of January 2014, by project type (7412 total registered projects)



Source: Authors, based on analysis of the CDM pipeline (http://www.cdmpipeline.org)

There is, then, clearly a need to revisit the way in which international climate policy understands the problem of climate technology transfer and development. As will become clear in subsequent sections, the first step is to move beyond the traditional understanding of the problem as being one of 'hardware financing'. This is based on the erroneous assumption that climate technologies (understood as pieces of hardware, or 'kit') will be widely developed and transferred if the positive externalities of climate mitigation and adaptation can be internalised through market mechanisms.

Finance is most certainly part of the picture. The argument of this report is not that finance or market mechanisms that seek to rectify market failures are not necessary parts of the solution. They are definitely necessary; but they are certainly not sufficient. As we will explain, based on decades of research in the fields of Innovation Studies and recent advances in the field of Socio-Technical Transitions, technological hardware is merely an artefact resulting from a combination of social practices, knowledge and capabilities. Once this is recognised, we begin to see why a simple hardware financing approach to international climate technology policy is insufficient. *Social practices* co-evolve with technologies and define directions of innovation and broader processes of technical change (climate compatible or otherwise). *Knowledge* (amongst firms and other actors) of many kinds forms the basis from which to develop technologies and innovations. And *technological capabilities* (of firms, users and other actors) incorporate the knowledge, skills and other resources required to realise technical and innovative change.

An NSI connects together relevant actors and provides the environment within which these capabilities are nurtured and put to use. Those countries that have benefited most from the CDM, for example, are also those that have developed important new technological

capabilities of relevance to various climate technologies, nurtured via the development of functioning NSIs in these key climate technology areas (e.g. bioethanol in Brazil, solar and wind in India and China). As well as realising the necessary but insufficient role of hardware financing mechanisms, we are therefore introduced to a fruitful new way to understand the problem of climate technology transfer, development and uptake. Furthermore, this understanding points to a vital way in which policy interventions might be refocused on nurturing NSIs with potentially profound long term impacts on widespread, climate compatible technological change and development.

To some extent, recent moves under the Convention and elsewhere – most notably the establishment of a Climate Technology Centre and Network (CTCN) under the new Technology Mechanism (and similar centre-based approaches being implemented by other actors, such as the Climate Innovation Centres led by InfoDev, the UK Department for International Development (DFID) and Danida, and the various GEF funded initiatives) – have potential to act as innovation system builders, nurturing and learning across NSIs. But, as Section 3 of this report sets out, careful attention is needed to a number of other policy priorities beyond those which these centres are currently considering or implementing. This report aims to set out tangible policy interventions that might take a focus on nurturing NSIs into the mainstream, and (slowly but surely) achieve exactly the kind of widespread climate compatible technological change and sustainable development that is at the heart of the UNFCCC and efforts to tackle climate change across the globe.

1.4 *Structure of this report*

This report is structured as follows. Section 2 ("Setting the scene") provides a brief, non-technical overview of the relevance of NSIs and innovation system building for international climate policy. In Section 3, the report summarises the policy issues that need to be addressed in order to nurture NSIs. Section 4 sets out the key overarching goals that policy interventions need to fulfil. Building on this, the section briefly reviews some relevant existing initiatives and the extent to which they could be, or already are, delivering against these goals. It then articulates two proposals through which actions under the Convention (and beyond) could proactively nurture NSIs to significantly boost the development, transfer and uptake of climate technologies in developing countries, before concluding with recommendations for the TEC.

2. Setting the scene: National systems of innovation

The UNFCCC's Technology Executive Committee (TEC) recently convened a meeting on strengthening National Systems of Innovation in developing countries[3]. This is possibly the most positive step forward for efforts under the UNFCCC to date. In this section we provide a non-technical introduction to why this is such a positive step. The latter part of the report – particularly Section 4 – gives more detail on how to take these efforts forward.

2.1 *The problem with hardware financing*

First, a bit of background. Developing countries need the right kind of support to address climate change challenges, and to develop along low carbon, climate resilient trajectories. The UNFCCC is supposed to help this to happen by supporting the transfer and development of climate technologies (technologies for climate change mitigation and adaptation). To date, however, there has been huge frustration at the failure of activities under the Convention to deliver at anything like the speed or scale needed. So why has it not worked?

Our research at the STEPS Centre demonstrates that a core reason is the current policy framing of the problem as one requiring 'hardware financing'. Climate technologies are more expensive than conventional technologies, so market mechanisms are put in place to internalise the positive externalities of climate mitigation and adaptation currently not captured in the market (e.g. the Clean Development Mechanism, CDM, and various financing efforts under the Global Environment Facility, GEF). So these mechanisms help to pay for technologies that might not otherwise be affordable.

All this ignores the fact that technological *capabilities* are a prerequisite for countries to be able to absorb new technologies.

2.2 *Sowing seeds*

Technological capabilities are like soil in a garden. Without initial efforts to nurture the soil's fertility, scattering seeds (bits of technology hardware) is unlikely to lead to a flourishing garden (technological change and development). Moreover, commercial gardening contractors (technology investors) are unlikely to invest effort in sowing seeds in unfertile gardens in the first place.

Hardware financing mechanisms, therefore, serve simply to reinforce the comparative advantages of different countries. The majority of investment from the CDM, for example, has gone to countries like China (60%) and India (11%) with comparatively high levels of existing technological capabilities. In contrast, Africa as a whole has only received 3%; the amount going to sub-Saharan Africa being much smaller still. The CDM has tended also to fund established, close-to-market technologies rather than nurturing the development and uptake of new technologies (Ockwell and Byrne 2014).

[3] See http://www.steps-centre.org/event/unfccc-workshop-strengthening-national-systems-innovation-developing-countries-live-webcast/

2.3 *How National Systems of Innovation can help*

So how do countries develop the technological capabilities they need to attract technology transfer and development? The key, according to decades of research in the field of Innovation Studies and more recent work on Socio-Technical Transitions, is to focus on nurturing *National Systems of Innovation (NSIs)*. NSIs can be understood as the gardens within which the fertile soil is to be nurtured. They provide the context within which all processes of technology development, transfer and uptake occur. National Systems of Innovation encompass the network of actors (e.g. firms, universities, research institutes, government departments, NGOs) within which innovation occurs, and the strength and nature of the relationships between them.

The idea of looking after these gardens – nurturing National Systems of Innovation – would begin to address the problem that hardware financing cannot fix. It could underpin more sustained and widespread transfer and development of climate technologies. As such, it provides a powerful new focus for international policy.

2.4 *From gardens to gardeners*

Moreover, insights from the above literatures suggest the existence of Innovation System Builders – key individuals who act to link actors and institutions up across niches of climate technology activity. To extend our analogy, these are the gardeners who want their particular garden to thrive, preparing the fertile ground for leaps ahead in technological capability development (see, for example, our research on the off-grid solar PV market in Kenya[4]). This is a powerful insight for policy efforts that could seek to fulfil the role of Innovation System Builders.

2.5 *A change in thinking?*

By convening a two day workshop on NSIs, the TEC – the body responsible for overseeing implementation of the UNFCCC's Technology Mechanism – has signalled its interest in this powerful way forward for UN climate policy. The meeting involved presentations from seventeen international experts, together with significant time set aside for members of the TEC to ask questions and discuss the various issues raised.

2.6 *What happens now?*

The TEC's 2014/15 work plan[5] indicates that it will be giving further consideration to the issue of NSIs in 2015.

Nurturing National Systems of Innovation will take effort and capacity. Following a discussion of the issues policy must address for nurturing NSIs, given in the next section, the remainder of this report sets out a detailed vision of how the TEC (and other relevant actors) might take this work forward. It includes overarching policy goals, a review of the coverage of existing policy mechanisms and concrete policy proposals to address existing gaps.

---

[4] http://steps-centre.org/project/low_carbon_development/

[5] http://bit.ly/tecworkplan

3. Issues policy must address to nurture NSIs

Having outlined the relevance and key building blocks of NSIs, in this section we deal with two key issues that must be considered when designing policy mechanisms geared towards developing and learning across NSIs. We first deal with the need to understand the nature of knowledge, in particular the difference between tacit and codified knowledge and the greater relevance of the former to developing technological capabilities. This includes attention to the contentious (and often over-emphasised) issue of Intellectual Property Rights (IPRs). We then deal with the need to understand the multitude of context specificities that are essential to address when designing successful policy interventions. This helps to suggest what kind of generic policies enable attention to be paid to context specificities and, as a result, are more likely to enable sustained and widespread development, transfer and uptake of climate technologies.

3.1 *Tacit vs. codified knowledge*

As implied in Section 2 above, knowledge flows are a core component of technology transfer and are essential to building technological capabilities. A core function of NSIs is therefore to create the enabling conditions for nurturing such flows between firms and other key actors within a country and with relevant actors internationally. However, understanding the nature of these flows, and the relevance of different types of knowledge, is critical to avoiding fixation on particular policy foci that are unlikely to yield significant benefits in terms of building technological capabilities within developing countries. In particular, differentiating between tacit and codified knowledge, and the greater significance of the former to building technological capabilities, is essential.

Codified knowledge is knowledge that is articulated in some way. This can include IPRs (legal rights over ideas, including copyrights, trademarks and patents), but it also often includes a range of other proprietary knowledge such as trade secrets that have not necessarily been formally or legally protected. The latter overlaps with the second type of knowledge – namely, *tacit knowledge*. Tacit knowledge refers to human-embodied knowledge acquired through experience of doing things, and would extend to more institutionally-embodied knowledge where firms and other organisations develop capabilities around, for example, management systems and approaches that are passed on through generations of employees. So, codified knowledge might relate to engineering and manufacturing processes (e.g. for manufacturing advanced wind turbine blades or developing drought-tolerant crops) whereas tacit knowledge would relate to the applied engineering, systems integration or plant breeding and modification *skills* necessary to effectively work with a new engineering, manufacturing or biotech process.

Even when providing a simple definition of tacit and codified knowledge it is very quickly obvious that relevant tacit knowledge is a prerequisite for codified knowledge to have any use or relevance to a firm or industry. Think, for example, of giving a standard, local car mechanic access to the patents for core components of a new design of Formula 1 racing car engine. It is highly unlikely that the mechanic would be able to successfully build the car without access to the engineering, design and mechanical experience of specialised Formula 1 development and manufacturing teams (the latter being tacit and neither codified nor legally protected in

any way). It is often these processes of more tacit knowledge-acquisition that more accurately characterise learning by firms and other actors as NSIs increase in levels of sophistication and scale and lead towards processes of innovation and change. Foster and Heeks (2013), for example, characterise these tacit learning processes under three categories: learning by doing (e.g. by engaging in production processes); learning by using (e.g. making adjustments to get new technolgies to fit specific tasks); and learning by interaction as actors interact and work with other actors across innovation systems. None of these categories of learning and capability development rely explicitly on access to codified knowledge; rather, they represent far more fundamental processes of tacit knowledge-sharing and deeper learning.

However, the centrality of tacit knowledge, or experience working with the technology and processes in question (or related technologies), has tended to be overlooked within international discussions around climate technology development and transfer in favour of a fixation on codified knowledge, and IPRs in particular. As a result, IPRs have become a politically contentious issue within negotiations under the UNFCCC. The debate tends to be framed around two opposing perspectives. On the one hand, some (often developing-country) parties and observers claim that developing countries must have free access to IPRs for climate technologies. On the other hand, other (often developed-country) parties and observers claim that the key barrier to climate technology transfer to developing countries is the weak IPR protection regimes in many developing countries which, they argue, provides a disincentive to international, technology leading companies to deploy new climate technologies in those countries.

In a detailed analysis of the background to these two conflicting perspectives on IPRs in relation to climate technologies, based on a comprehensive review of available empirical evidence (which covered a suite of clean energy and energy efficient end-use technologies based on a range of studies by different organisations), Ockwell *et al.* (2010a) demonstrate three key things. Firstly, the two perspectives can best be understood as having emerged from alternative motivations for developed and developing countries to become party to the UNFCCC. For developed countries, the key driver was a desire to avoid future economic costs of climate change. This had to include climate (particularly low carbon) technology transfer to developing countries to mitigate future emissions from economic development in these countries (simultaneously providing opportunities for offsets against developed countries' own emissions). For developing countries, a core incentive was the promise of access to new technologies – technology ownership being directly correlated with economic wealth and still largely weighted towards the global north. Without understanding these background motivations, it is difficult to move beyond the political impasse concerning IPRs.

The second insight is that there is empirical evidence to support both sides of the IPR debate. On the one hand, in none of the cases analysed did developing-country firms lack access to the technologies in question, and none reported IPRs as having constituted a barrier to technology access to date. Anecdotal evidence tended to reinforce the centrality of tacit knowledge (as opposed to IPRs) as the key barrier: for example, Indian LED manufacturers at the time reported that their lack of experience (the source of tacit knowledge) of white spectrum LED manufacturing processes was the key barrier to them entering this new market (not access to patents). On the other hand, several of the firms reported that IPRs would become a more significant consideration were they to attempt to reach the technological frontier in their sectors (e.g. thin film solar PV as opposed to conventional PV panels). The idea that empirical evidence can be marshalled on both sides of the IPR debate is further supported by more recent analysis by Abdel Latif (2012). Based on a collaborative project by the United Nations Environment Programme (UNEP), the European Patent Office (EPO) and

the International Centre for Trade and Sustainable Development (ICTSD), which included detailed analysis of patent databases and an extensive survey of developing and developed-country firms involved in clean energy technologies, Abdel Latif (2012) reports that IPR protection was not found to be a significant barrier to technology transfer. Firms interested in licensing to developing countries were seen to be more concerned about other attributes – including favourable markets, the investment climate, human capital and scientific infrastructure – and many firms were willing to offer flexible terms to developing countries that had constrained capacities.

This links directly to the final insight from Ockwell *et al.*'s (2010a) analysis, and the key point in the context of understanding the role and importance of a focus on building NSIs. Focussing on building technological capabilities, which necessitates a focus on innovation system building, is the best way in which to achieve more sustained development and transfer of climate technologies to developing countries. This would deliver against the background motivations of *both* developed *and* developing countries. In other words, it would promote climate technology access and economic development, mitigating future emissions whilst simultaneously underpinning broader, long term, climate-compatible development.

This brings us to the crux of the matter in relation to the focus of this report. Nurturing climate innovation systems in developing countries is the key to achieving more sustained processes of self-defined, context-sensitive climate technology development, transfer and uptake in those countries. These innovation systems are necessary to build the technological capabilities of various actors within the developing country, taking into account the different context-specific and climate technology needs of local firms and communities. Knowledge flows are critical to building these capabilities. However, the qualitative type of knowledge that is relevant and likely to have most impact on host country capabilities will vary according to the wide range of context-specific considerations discussed below.

In some cases knowledge will be codified, and in some cases this codified knowledge will be in the form of IPRs (as opposed, for example, to trade secrets). But IPRs are only a small part of a much bigger picture. Access to IPRs does not ensure developing-country access to climate technologies. Access to other knowledge, particularly tacit knowledge, is often a more important barrier. In many cases tacit knowledge and knowledge acquired through working with technologies, most often under license and protected by patents, has played a far more significant role than access to IPRs *per se*. IPRs are only likely to be prohibitive once developing-country firms reach the technological frontier. IPRs should thus be considered as sometimes necessary, but never sufficient, as a focus of policy mechanisms that aim to build NSIs. Instead, policy mechanisms focussed on nurturing innovation systems should be prioritised. Ways in which this might be achieved are explored in detail in Section 4.

3.2 *Context specificities in technology needs and appropriate knowledge flows*

A final key consideration that policy interventions must negotiate is the need to focus on a needs-based approach to policy which properly responds to the context-specificities that define the appropriateness of climate technology options and related knowledge flows in any given situation (Ockwell and Mallett 2012). Hulme (2008, 2009) alludes to the importance of context-specificities through his emphasis on how the idea of 'climate change' has been dominated by certain constructions of the issue that ignore the multiple spatially and culturally contingent understandings and meanings of 'climate', and hence (by implication) potentially undermine constructive ways forward for society to both interpret and decide how to respond to a changing climate. This has fundamental implications when considering

knowledge transfer between different contexts (between different NSIs and the myriad of actors therein – firms, communities, policy actors, industry associations and so on) insofar as it implies contingencies both in terms of what kind of knowledge and related technology might be appropriate across different contexts, and in terms of the type of policy intervention that will be effective in brokering knowledge transfer and technological capability building. These issues are unpacked below.

The extent to which different types of knowledge and technology are likely to be appropriate depends on a range of context-specificities, such as their applicability within different socio-technical circumstances and their applicability within different physical, cultural and economic contexts. For example, the technological needs of communities with different wealth levels need to be understood – poorer communities, for example, might perhaps have a greater need for technologies related to subsistence needs; wealthier communities might have priorities around transport, or processing goods to add value. Questions need to be asked as to what extent climate technologies facilitated under existing international policy mechanisms are pro-poor (for a useful point of departure, see Urban and Sumner 2009, and Byrne *et al.* 2014). In poor rural areas, for example, it might be more viable to explore adaptive innovation around low maintenance configurations of solar PV and LED technologies, as opposed to clean options for centralised energy generation that might better suit urban industrial interests. And in adapting to climate change, technologies such as drought-resistant strains of crops, or knowledge regarding new farming methods in increasingly flood-prone areas, might be of more relevance to poor people than advanced engineering solutions for strengthening coastal flood defences.

This interest in the extent to which the needs of poor people are being met through policy interventions around climate technologies speaks to an emerging concern amongst development practitioners and researchers with the idea of 'inclusive innovation' (see, for example, IDRC 2011). In essence, this is a concern with the extent to which technology innovation and diffusion serves the needs of poor and marginalised people. As Foster and Heeks (2013) demonstrate, whilst an innovation systems perspective is well suited to better understanding innovation in a pro-poor context, this emphasis on inclusivity and pro-poor innovation and diffusion of technologies requires attention to a number of specific considerations that are underplayed in traditional innovation systems-based approaches to analysing policy and practice. These include a need to attend more to the role of processes of technology diffusion, informal demand-side actors and intermediaries, and the role of localised and informal institutions.

A range of different physical and environmental considerations are also likely to come into play in determining the context-specific considerations to which policy and practice must attend if appropriate knowledge flows and capacity building are to be brokered. For example, different wind technology solutions are viable under different ambient conditions, and in other conditions are not viable at all. Carbon capture and storage (CCS) technologies would need to be adapted to suit both local fuel sources and geological storage options (Tomlinson, Zorlu and Langley 2008). And these physical spatial variations are also likely to accompany socio-cultural considerations – for example, energy efficiency or clean, decentralised energy options need to work within the context of existing cultural (behavioural) practices and existing infrastructure; and so on. So a range of different spatial and socio-cultural considerations come into play when considering what types of knowledge flows and technologies are likely to work or be appropriate within different developing-country contexts.

There are also critical context-specific considerations regarding the ways in which knowledge flows are likely to be most effectively brokered in order to build technological capabilities within different developing-country contexts. The needs of rapidly emerging economies are likely to differ significantly from the needs of other developing countries, and particularly least developed countries, in this respect. However, it is important to note that even across such contexts, appropriate levels of knowledge flows are likely to vary according to the specific climate technology in question and the availability of existing (or related) technological capabilities in different country contexts. A distinct need exists to understand and chart the distribution, nature and level (productive through to innovative) of different technological capabilities for working with different climate technologies across and within different country contexts. For example, to what extent do different developing countries, regions, firms, or communities therein, have the capabilities to work with technologies at different stages of commercial development (e.g. dealing with higher investor risk at earlier stages of technology development), or to work with the hardware and software components involved? One example of this would be a technology like CCS, which involves more complex systems management capabilities than small-scale solar PV (Ockwell et al. 2010b).

Importantly, consideration of the existing levels of relevant technological capabilities has material implications for which part of the innovation chain would benefit from targeted interventions. In Kenya, for example, where solar PV assembly has only recently begun, interventions focussed on demonstrating process manufacturing techniques might be most appropriate. In the wind industry in China, on the other hand, were it not already considered sufficiently advanced, knowledge flows might be more effectively targeted via international collaborative efforts at the early R&D stage (see Ockwell, Sagar and Coninck 2014 for a discussion of collaborative R&D and climate technology transfer). Such nuanced understandings of relative technological capabilities inter- and intra-nationally have a key contribution to make to better orienting international policy efforts in ways that can be effectively targeted towards nurturing innovation systems and developing technological capabilities.

In their discussion of collaborative R&D and climate technology transfer, Ockwell *et al.* (2014) draw on Sagar's (2009) typology of the different climate technology needs against which collaborative R&D efforts might be targeted via national or multilateral actions under the UNFCCC. This typology broadly classifies climate technologies into three categories: first, those that already exist and might meet developing-country needs; second, those that do not yet exist, but which might be developed to meet nascent needs via targeted policy incentives; and, third, technologies that might be needed to meet future needs. The discussion above highlights the important need to extend Ockwell *et al.*'s (2014) analysis in order to further consider the appropriateness of such a framework at different stages along the innovation chain – moving away from a fixation on R&D and recognising the potential value (depending on context) of interventions at other stages of the innovation chain. Authors such as Bell (1997, 2009, 2012) have elucidated how technological capabilities are often developed incrementally in developing-country firms via international knowledge flows that facilitate gradual increases in levels of sophistication. This implies that, in many countries (and particularly in many least developed countries where levels of capabilities are low in many areas), international knowledge flows might be much better targeted at climate technologies that are already widely commercially available, building 'upwards' from there to more sophisticated capabilities. The impact in terms of building sustainable innovation systems in the long term is likely to be no less profound. Note that this also speaks to the importance of policy interventions that attend to the existing levels of capabilities within specific country and technology contexts.

To some extent this focus on context-specificities might be interpreted as confounding policy efforts, especially those at the national and multilateral levels that characterise actions under the UNFCCC. Some observers might push instead for the identification of non-context specific issues so that more generic policy approaches might be developed and applied. Indeed, there has been, and still is, a tendency for international climate policy to focus at this level. For example, the generic failure of markets to capture the positive externalities of lower carbon technologies was a key rationale behind the kind of 'hardware financing' approach that has characterised policy in this field to date. Other generic issues might include socio-technical lock-in to existing high carbon technologies or agricultural technologies that are over-reliant on high levels of water or fertilizer inputs. However, notwithstanding country-driven activities through institutions such as the GEF, the tendency to focus on policy options that are not sensitive to context-specificities is, as argued above and below, a key reason why climate technology transfer efforts under the Convention are likely to have met with limited success to date. In fact, a policy focus on nurturing innovation systems is the key way in which these past policy shortcomings can be overcome. Interventions that aim to play an 'innovation system builder' role in developing countries provide the basis for designing policy approaches characterised by non-context specific (generic) processes or interventions. Following the ideas provided by Strategic Niche Management[6] (SNM), such processes and interventions include network building, fostering learning, consensus building and experimentation. They are generic change processes but they respond to context-specificities and so can be used to develop and strengthen inclusive innovation systems in particular places. In the final section of this report we explore some concrete ways in which these climate policy interventions can play this nurturing, innovation system builder role.

[6] Strategic Niche Management is a particular approach to understanding socio-technical change. See the discussion and references in Byrne *et al*. (2014) for more detail.

4. Policy recommendations

Sections 1 and 2 have argued that a policy approach focussed on nurturing innovation systems has the potential to facilitate more widespread and sustained transfer, development and diffusion of climate technologies in developing countries. NSIs would also make significant contributions to countries' potential for economic growth. In this final section we therefore focus on practical policy recommendations for nurturing NSIs, which can be pursued at national and multilateral levels. The core aim is to support interventions that enable actors and institutions to act as *Climate Relevant Innovation-system Builders (CRIBs)***.** The key is to do so via nationally nested, demand-driven interventions that are internationally networked and based on learning across different contexts in order to build indigenous technological capabilities and well-functioning, context sensitive innovation systems.

We begin by articulating the overarching goals that policy needs to achieve. We then briefly review the existing international climate policy landscape to highlight key policies that an innovation system building approach can (and should) use and build upon. We conclude with key policy recommendations and options for the institutional architecture through which these could be delivered.

4.1 *Overarching policy goals and related policy interventions*

The overall goal of policy must be to build functioning innovation systems that augment the transfer, development and diffusion of climate technologies and practices in developing countries, enhancing technological capabilities through a range of targeted interventions. These must be inclusive in their approach – attending to the self-defined needs of those countries and different groups within them – if climate technology uptake is to be widespread and underpin future climate-compatible development pathways. The literatures from which this report draws suggest that the various interventions that have achieved some measure of success in building NSIs were designed and implemented on the basis of careful and context-specific understanding of the needs in the market and of users. One notable intervention, examined in Byrne *et al*. (2014) is Lighting Africa[7], which conducted highly detailed studies of the lighting practices and needs of poorer users in Kenya (and elsewhere). This suggests that further gains might be achieved by including users more actively in the design of promising solutions to their needs, rather than merely observing these needs and eliciting users' feedback on products already in the market. The overall desired result would be to provide protective spaces in which climate-compatible technologies and practices can be fostered; thus promoting their adoption, adaptation and further innovation.

In order to achieve this, we suggest the following overarching policy goals should orient interventions. However, it is important to note that interventions to build innovation systems are deeply interdependent. They are therefore best implemented together in systemic fashion rather than separately. We conclude this subsection with a table (Table 4.1) which articulates a range of specific policy interventions which should be pursued in order to fulfil

[7] Lighting Africa is an International Finance Corporation programme that has helped to create and accelerate the market for solar lanterns in Africa, especially in Kenya. See its website for the wide range of information it has generated on various off-grid lighting markets in African countries: www.lightingafrica.org

each goal. In subsequent subsections we go into detail on how efforts under the Convention and parallel climate technology initiatives could deliver such interventions.

4.1.1 Goal 1: Build networks of diverse stakeholders

Efforts are required to link diverse arrays of stakeholders, from technology importers and suppliers, through to policy makers and technology users. Such networks enable the flow of knowledge amongst stakeholders, each of whom can bring different resources, experiences and perspectives to bear on problem-framing and problem-solving activities. They can also become a fundamental element of innovation systems by establishing the linkage component of capabilities. But these linkages must be strong and meaningful. In order to achieve this, stakeholders need to work proactively together in projects, programmes and other interventions. In doing so, they are more likely to build mutual trust and understanding, as well as identify strengths and weaknesses in local technological capabilities. Simultaneously, by pursuing such activities, new technological capabilities can be built, including the development of relevant knowledge and skills.

4.1.2 Goal 2: Foster and share learning

Learning is critical to the development of technological capabilities and functioning innovation systems, and the resulting successful markets for climate technologies that these can support. A key role for policy lies in commissioning research – whether market research, academic analysis, monitoring and evaluation, baseline studies, R&D and so on – and making sure the results are publicly available. Because contexts evolve in unpredictable ways, incremental innovation supported by reflexive analysis offers a practical strategy to shape climate-compatible development pathways. Research at all levels from local to international, and from different perspectives, can provide crucial information to help realise such reflexive change. The public availability of such information can play a fundamental role in reducing perceived risks amongst both potential investors and technology users, as well as enhance the transparency of policy processes. This facilitates clear and evolving understandings of things like user needs and preferences, appropriate hardware components, relative performance of different technology brands, approaches that have met with success, factors that contributed to difficulties or failures and how to overcome these, training and education needs, and so on. The resulting learning and experience can feed into future projects and programmes, whether publicly or privately funded.

4.1.3 Goal 3: Promote the development of shared visions

Linked to the need to build meaningful networks and foster learning, there is the need to create shared visions of what climate-compatible development looks like in particular contexts, and what roles climate technologies play in those contexts. This is not simply a top-down effort in which climate technology solutions are chosen and then stakeholders are persuaded of their merit through dissemination and awareness-raising activities. As everyone is affected by both climate change and efforts to address it, consensus-building around climate-compatible development is critical. Learning from research and experience provides an essential component for constructive debate and is itself enhanced by the flow of knowledge through diverse stakeholder networks. By fostering understandings of what climate technologies can and cannot provide, how they work and the ways others have benefited from them, visions can develop around informed understandings of different technological options. It also affords opportunities for users to provide feedback on both their self-defined needs and their experiences (good and bad) with different technologies. As a

result, shared visions develop amongst technology users, suppliers and other stakeholders relating to what and how climate technologies can underpin different development pathways. This simultaneously provides vital user feedback into both technology design and the configurations and brands that vendors and suppliers provide, with attendant implications for potential market size and profitability.

4.1.4 Goal 4: Support diverse experimentation

Again linked to learning, funding is needed to provide protected spaces for experimentation with promising climate technologies, practices and policies. Stakeholders throughout the supply chain need to gain experience of climate technologies and learn what works and what does not within specific contexts (across different countries, regions, villages, technologies, etc.). Experimentation can target a range of different aspects. It might, for example, include supporting new multi-stakeholder projects that test and develop ideas. These could relate to new technical configurations, new hardware, new practices around existing technologies, new consumption and production practices that could improve the benefits accrued by users, and so on. Experiments might also focus on mutually supportive interventions that link different stakeholders across markets, thereby building supply chains and fostering new market opportunities where potential market players lack awareness of each other and/or potential market opportunities they might target. Interventions could also experiment with working 'upwards' through value chains, building on existing markets to develop progressively higher-value segments, adding value to existing sectors and fostering increasing economic returns from climate technology initiatives across developing countries.

4.1.5 Specific policies and interventions for delivering on the overarching goals

Table 4.1 details a (non-exhaustive) list of specific policies and interventions that would deliver against these overarching goals and contribute to climate innovation system building.

Table 4.1. Specific policies for delivering against the overarching goals for building climate innovation systems in developing countries

Goal 1. Network building
Linking diverse stakeholders nationally
" " " internationally
" " " locally
" " " across markets
" " " across sectors (private/public/NGO/research etc.)
Linking 'supply-side' actors (e.g. supply chain, policy, NGO, etc., actors) with technology users
Linking national government with technical experts
Linking national firms with international firms
Goal 2. Learning
Commission market research
Commission research into technology user needs and preferences
" " " technology performance
" " " education and training needs
Monitoring and evaluation of projects/programmes
Conduct baseline studies
Conduct comparative research across local/national/international scales that addresses the various research foci above
Make results of research and monitoring and evaluation publicly available
Create spaces for stakeholders to reflect on research and experiences
Provide training for firms
Provide training for suppliers and installers
Provide training for technology users/villages/households
Advise/develop technology certification schemes
Advise on education and training needs (up to and including postgraduate training)
Goal 3. Foster shared visions
Convene consensus building events with different national stakeholder groups
Convene scenario building events to discuss alternative development pathways that different climate technologies might contribute to/constrain
Facilitate opportunities for different stakeholders to feedback into the technology design and configuration process
Goal 4. Provide protected spaces for experimentation
Encourage/incentivise treatment of 'failures' as valuable points for learning
Commission projects as experiments (examples of potential foci for experimentation are provided below)
Experiment with technological hardware
" " policies
" " social practices in relation to climate technologies
" " new stakeholder configurations
" " production processes
" " linking stakeholders across markets to create new market opportunities and market awareness
" " value adding experiments working upwards through supply chains

4.2 *Existing international policy mechanisms*

Whilst working towards the overarching goals above, it is essential that policies designed to nurture NSIs are implemented in a way that recognises and builds on existing relevant policy mechanisms and institutions. Designing effective policy also requires an understanding of what these existing initiatives are doing that is of relevance to nurturing NSIs and where there are gaps that need to be filled. Here we review three core areas of relevant policy efforts: the CTCN; the World Bank's Climate Innovation Centres (CICs); and four parallel climate technology centre and network initiatives currently being funded by the GEF.

It should be noted that a range of other institutions (e.g. IRENA – the International Renewable Energy Agency), policies, mechanisms (e.g. the CDM) and centre-based models (e.g. Innovación Chile, CGIAR – the Collaborative Group for International Agricultural Research) also exist and deserve explicit consideration when implementing the recommendations within this report. It is, however, beyond the scope and space available here to provide a full review of all relevant initiatives. Some points of reference that do provide a level of review and analysis of other initiatives include Sagar (2010) and (Ockwell *et al.* 2014).

4.2.1 Climate Technology Centre and Network (CTCN)

In the context of actions under the Convention, one of the most relevant institutions is the CTCN[8], the operational arm of the UNFCCC's Technology Mechanism under the strategic guidance of its own advisory board (see Figure 4.1). As its name suggests, the CTCN is structured around a core climate technology centre that coordinates a broader network. The *Centre* is hosted and managed by UNEP in collaboration with the United Nations Industrial Development Organisation (UNIDO) and supported by 11 centres of excellence located in developing and developed countries.

Figure 4.1. CTCN Structure and relationship to UNFCCC

Source: http://www.unep.org/climatechange/ctcn/AboutUs/tabid/155769/Default.aspx

The CTCN's *Network* refers to a range of technical experts and centres of excellence who have expertise that might be matched against requests for technical assistance from countries. Requests from countries come from national designated entities (NDEs). NDEs (usually

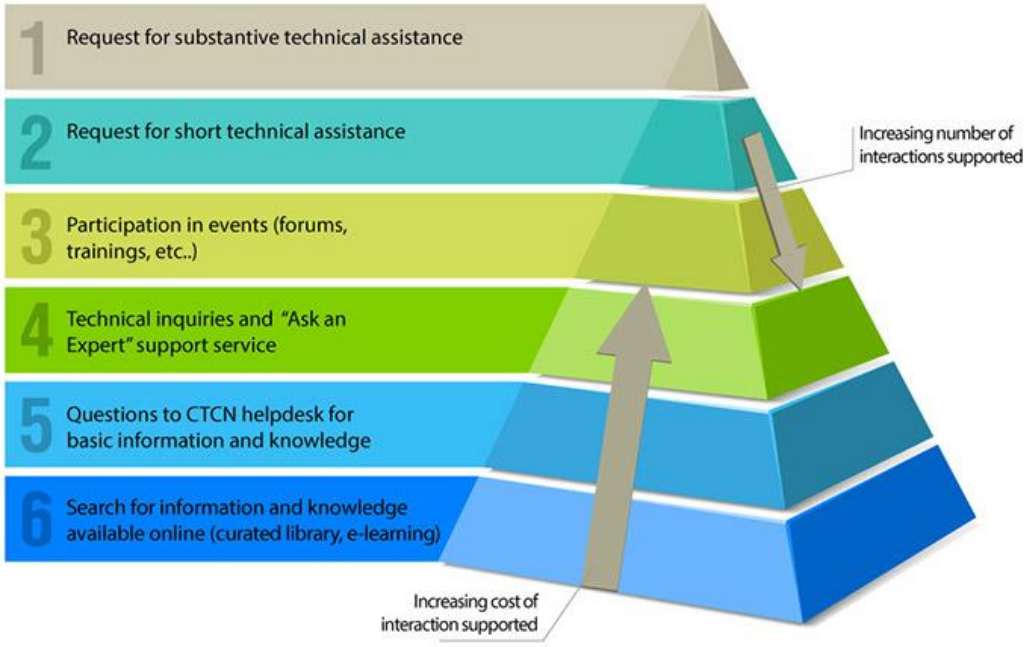
[8] See http://ctcn-public.mijnlieff.nl/

government ministries or agencies[9]) are granted responsibility by Parties to the Convention to manage national technology related requests to the CTCN. These requests are coordinated by the Centre, which responds itself to some while others are farmed out to relevant experts in the Network. This NDE-instigated approach attempts to facilitate a process that is demand-driven by Parties. There are three core services offered by the CTCN (see CTCN 2014 for a detailed description of these services):

1 Provide technical assistance to developing countries to enhance transfer of climate technologies
2 Provide and share information and knowledge on climate technologies
3 Foster collaboration and networking of various stakeholders on climate technologies

The first core service follows requests from NDEs whilst the other two services can be initiated by the CTCN or other stakeholders, as and when common needs are identified. Figure 4.2 illustrates how these services are interrelated.

Figure 4.2. Hierarchy of CTCN services



Source:
http://www.unep.org/climatechange/ctcn/Services/Introduction/tabid/771787/language/en-US/Default.aspx

[9] For a full list, see: http://unfccc.int/ttclear/templates/render_cms_page?s=TEM_ndes

From the perspective of building NSIs, there are several key points to note with regard to the CTCN:

1. The Network is not an in-country network of actors of relevance to different (existing or emerging) climate technologies as prescribed in the overarching goals in Section 4.1.
2. There is nothing, in theory, stopping Parties requesting, via NDEs, support from the CTCN in advising on and instigating the kind of climate innovation system building policies detailed in Table 4.1.
3. NDEs are usually government institutions – not locally nested, climate technology specific institutions.
4. At present the CTCN's activities do not explicitly recognise the need to nurture NSIs as a key part of the technology transfer, development and diffusion process – although elements of innovation system building are implicit within two of the CTCN's core services: those focussed on information and knowledge sharing and fostering collaboration and networking between stakeholders.
5. The recognition of knowledge sharing, networking and the emphasis on capacity building elaborated in the operating manual for NDEs suggests significant potential for the CTCN to coordinate its efforts to achieve a more explicit focus on innovation system building. However, this would require more explicit attention to, and understanding of, NSIs and processes for strengthening them to be integrated into the CTCN's approach. In Section 4.3 we provide details of two concrete proposals for achieving these NSI building and strengthening processes in the CTCN's activities.

4.2.2 Climate Innovation Centres (CICs)

Beyond the CTCN, there are other initiatives and organisational actions that need consideration, with which efforts targeted towards nurturing NSIs for climate technologies need to coordinate. The World Bank (via infoDev), in collaboration with DFID and Danida, are in the process of implementing a number of Climate Innovation Centres (CICs)[10]. CICs have been launched (or have business plans and are in the process of being launched), in seven locations: Kenya, India, Ethiopia, South Africa, Morocco, Vietnam and the Caribbean. The CICs' focus is on financing local entrepreneurship around climate technologies via "… a tailored suite of financing and services that support domestic SMEs [Small and Medium sized Enterprises]"[11]. As such, and given their networked, international reach, the CICs represent an important initiative with which to engage in any attempt to foster NSIs. However, their explicit finance/innovation/entrepreneurship focus limits them to only one small (but nevertheless important) part of any more systemic approach to nurturing NSIs. This is not to say, however, that climate innovation system building could not be integrated as part of the CICs' broader activities under an extended remit. This may be something that infoDev/DFID/Danida and/or national governments and local partners in the CICs might wish to consider in future. CICs are, after all, likely to represent important networks of climate technology relevant individuals and organisations across the public, private and NGO sectors and provide excellent potential routes for identifying and engaging with key actors.

[10] See http://www.infodev.org/articles/cicbusinessplans

[11] http://www.infodev.org/articles/climate-technology-read-more-about

4.2.3 GEF funded initiatives

The other key initiatives of note here are those being implemented by the GEF under its Long-Term Program on Technology Transfer. These include[12]:

1. The project 'Pilot Asia-Pacific Climate Technology Network and Finance Center', which is being implemented with the Asian Development Bank (ADB) and UNEP.
2. The project 'Finance and Technology Transfer Centre for Climate Change' by the European Bank for Reconstruction and Development (EBRD).
3. The project 'Pilot African Climate Technology Finance Center and Network' by the African Development Bank (AfDB) (which includes regional partners who are part of the CTCN consortium).
4. The regional project 'Climate Technology Transfer Mechanisms and Networks in Latin America and the Caribbean (LAC)' by the Inter-American Development Bank (IADB) (which is currently in preparation; again, with regional partners who are part of the CTCN consortium).

As with the CICs, the emphasis of the second of these various initiatives (the EBRD one) is mostly focused on finance. However, the other three all have elements that pertain to a more networked, capacity building focus and hence have potential to act as innovation system builders via a more explicit system-building focus. For example, the ADB-led Asia-Pacific initiative (number 1 above) includes aims of[13]: facilitating a network of national and regional technology centres, organisations, and initiatives; building and strengthening national and regional climate technology centres and centres of excellence; designing, developing, and implementing country-driven climate technology transfer policies, programs, demonstration projects, and scale-up strategies. These activities are pursued in parallel to another part of the initiative that focuses explicitly on finance.

Whilst detailed information is difficult to obtain on number 3 (the AfDB-led African initiative), it seems that, as well as a core finance component, more network and capacity building activities will be included, with publicity materials released by AfDB suggesting that "enhancing networking and knowledge dissemination" is seen as the key way the project will "scale-up deployment of [climate technologies]"[14]. The final, IABD, one (number 4) is not yet operational. However, it is focused on network and capacity building. As well as providing finance, it seeks to "… strengthen existing activities on [environmentally sound technologies] in LAC and aim at the consolidation of long-term collaborative initiatives that are aligned with the objectives and modalities of the Technology Mechanism under UNFCCC"[15]. Planning,

---

[12] See http://unfccc.int/resource/docs/2013/sbi/eng/05.pdf and http://unfccc.int/resource/docs/2014/sbi/eng/inf03.pdf (Appendix 1)

[13] http://www.adb.org/sites/default/files/pub/2012/pilot-asia-pacific-climate-technology-flyer.pdf

[14] http://www.afdb.org/en/news-and-events/article/afdb-creates-african-pilot-climate-technology-and-finance-centre-with-gef-support-13344/

[15] http://www.iadb.org/en/projects/project-description-title,1303.html?id=RG-T2384

assessments and networks are at the foreground of the activities proposed under this initiative.

As with the CTCN, however, the extent to which these GEF-funded initiatives support the development of NSIs strongly depends on the extent to which an explicit focus on innovation system building can be mainstreamed across the various activities. The language used is open to a systemic focus, but achieving real differences to NSIs will depend on more deliberate integration of climate innovation system building activities across the board.

4.2.4 Gap analysis of existing policy

In order to get an overview of the extent to which the initiatives reviewed above are delivering the kind of policy interventions that would be likely to achieve climate innovation system building, delivering against the overarching goals articulated in Section 4.1 above (via activities akin to those detailed in Table 4.1 above), the following table (Table 4.2) provides a colour coded, graphical overview of the current and potential coverage of each initiative. Table 4.2 also provides a useful overview of the aggregate pattern of coverage across the initiatives. Each initiative is assessed, based on available public documentation, on the extent to which it: a) explicitly includes activities akin to the policy options under each goal within its existing remit and structure (the green Ys for "yes" in the table); b) has potential to deliver against a policy option within (or with incremental adjustments to) its existing remit and institutional structure were this to be considered desirable (the yellow Ps for "possible" in the table); and c) whether delivering against a goal is outside the scope of the initiative without significant revisions to remit and institutional structure (the red Ns for "no").

Several key observations can be made from Table 4.2:

1. Most initiatives have potential within, or via incremental adjustments to, their existing remit and structure to extend their activities to include explicit climate innovation system building activities.
2. At present, however, there is very limited explicit focus on activities that would nurture climate innovation systems in developing countries.
3. The most coverage exists in the area of network building. However, even this coverage is patchy with most initiatives focusing on high-level national or, more commonly, international networking activities, or linking national entities with international technical experts. Many of the essential networking activities that are necessary to build innovation systems in ways that will result in sustained, climate compatible technological change are generally not addressed (e.g. linking with technology users or fostering local networks along supply chains).
4. Learning receives a small amount of very patchy coverage across the initiatives.
5. Fostering shared visions and providing protective spaces for experimentation are not covered at all at present.

Table 4.2. Gap analysis of international policy mechanisms against climate innovation system building goals

Notes: This table illustrates the extent to which policy options that might deliver against the overarching climate innovation system building goals articulated in Section 4.1 above are: a) explicitly addressed under the existing remit and structure of the various international initiatives discussed in Section 4.2 (the green Ys for "yes" in the table); b) could potentially be addressed within, or with incremental adjustments to, their existing remit and institutional structure were this to be considered desirable (the yellow Ps for "possible" in the table); and c) the option is outside of the scope of an initiative without significant revisions to remit and institutional structure (the red Ns for "no"). The initial row also indicates whether innovation system building is an explicit goal of each initiative.

Key:

CTCN = Climate Technology Centre and Network

CIC = Climate Innovation Centre (World Bank/DFID/Danida initiative)

ADB = Pilot Asia-Pacific Climate Technology Network and Finance Center – Asian Development Bank (ADB) and UNEP

EBRD = Finance and Technology Transfer Centre for Climate Change – European Bank for Reconstruction and Development (EBRD)

AfDB = Pilot African Climate Technology Finance Center and Network – African Development Bank (AfDB)

IADB = Climate Technology Transfer Mechanisms and Networks in Latin America and the Caribbean (LAC) – Inter-American Development Bank (IADB)

Y	= Yes – Explicit aim of initiative
P	= Possible – Potential to deliver within, or with incremental changes to, existing remit and institutional structure
N	= No – Outside scope of initiative (without significant revisions to remit and institutional structure)

Climate innovation system building goals	CTCN	CIC	ADB	EBRD	AfDB	IADB
Explicit focus on climate innovation system building?	N	N	N	N	N	N
1. Network building						
Linking diverse stakeholders nationally	P	Y	Y	N	P	Y
" " " internationally	Y	Y	Y	N	Y	Y
" " " locally	P	P	P	N	P	P
" " " across markets	P	P	Y	N	P	P
" " " across sectors (private/public/NGO/research etc.)	Y	P	Y	N	Y	P
Linking 'supply-side' actors (e.g. supply chain, policy, NGO, etc., actors) with technology users	P	P	P	N	P	P
Linking national government with technical experts	Y	P	Y	Y	Y	Y
Linking national firms with international firms	Y	P	Y	N	Y	P
2. Learning						
Commission market research	P	N	P	N	P	P
Commission research into technology user needs and preferences	P	N	P	N	P	P
Commission research into technology performance	P	N	P	N	P	Y
Commission research into education and training needs	P	N	P	N	P	P
Monitoring and evaluation of projects/programmes	P	N	Y	N	P	P
Conduct baseline studies	P	N	P	Y	P	P
Conduct comparative research across local/national/international scales that addresses the various research foci above	P	N	P	N	P	P
Make results of research and monitoring and evaluation publicly available	P	N	P	P	P	P
Create spaces for stakeholders to reflect on research and experiences	P	N	P	N	P	Y

Climate innovation system building goals	CTCN	CIC	ADB	EBRD	AfDB	IADB
Provide training for firms	P	N	P	P	P	P
Provide training for suppliers and installers	P	N	P	P	P	P
Provide training for technology users/villages/households	P	N	P	N	P	P
Advise/develop technology certification schemes	P	N	Y	P	P	Y
Advise on education and training needs (up to and including postgraduate training)	P	N	P	P	P	P
3. Foster shared visions						
Convene consensus building events with different national stakeholder groups	P	N	P	N	P	P
Convene scenario building events to discuss alternative development pathways that different climate technologies might contribute to/constrain	P	N	P	N	P	P
Facilitate opportunities for different stakeholders to feedback into the technology design and configuration process	P	N	P	N	P	P
4. Provide protected spaces for experimentation						
Encourage/incentivise treatment of 'failures' as valuable points for learning	P	N	P	P	P	P
Commission projects as experiments (examples of potential foci for experimentation are provided below)	P	N	P	P	P	P
Experiment with technological hardware	P	N	P	P	P	P
Experiment with policies	P	N	P	N	P	P
Experiment with social practices in relation to climate technologies	P	N	P	N	P	P
Experiment with new stakeholder configurations	P	N	P	N	P	P
Experiment with production processes	P	N	P	P	P	P
Experiment with linking stakeholders across markets to create new market opportunities and market awareness	P	N	P	P	P	P
Experiment with value adding experiments working upwards through supply chains	P	N	P	P	P	P

4.3 *Climate Relevant Innovation-system Building under the UNFCCC*

Table 4.1 lists a host of activities that policy can support to nurture climate innovation system building. In this final section we deal with how this could best be facilitated under the UNFCCC. The section is divided into two parts which pertain to two linked options for achieving climate innovation system building under the UNFCCC. Ideally both options would be implemented. The first option is more ambitious and needs to be demand-led by Parties. The second option, however, can be implemented directly by the CTCN/TEC and integrated into the CTCN's explicit remit and guide future activities that respond to demand from NDEs. This second option can also be integrated into the practices of other multilateral initiatives, including the GEF-funded initiatives discussed in Section 4.2 above. There is also no reason why the CICs could not extend their remit in order to engage in these broader, climate innovation system building activities (their emerging networks of actors within the countries in which they are operating certainly make them well placed to do so).

In summary, the two proposals below involve the following:

1. **Proposal 1:** Strengthen the capacity of NDEs by funding and supporting the establishment of national level Climate Relevant Innovation-system Builders (CRIBs). CRIBs would play a strategic, facilitating role, linking up relevant national actors, targeting and coordinating project and programme level interventions to maximise benefits to NSIs. CRIBs (through NDEs) would coordinate with the CTCN to communicate national priorities (with due knowledge of national policy priorities and local realities). The CTCN (as per its existing remit) would then act to network CRIBs internationally, facilitating knowledge flows and access to international technological capabilities based on a more detailed understanding of national/local capabilities and needs.
2. **Proposal 2:** Use climate technology projects and programmes explicitly to build climate innovation systems. If pursued jointly with Proposal 1, this role can be facilitated by CRIBs, in coordination with the CTCN. If pursued in isolation, this can be achieved by revising the remit and approach of the CTCN to integrate a climate innovation system building approach into projects, programmes and related interventions, and to provide advice, via NDEs, on how Parties can bolster their own NSIs.

The proposals are presented in more detail below. It is important to emphasise that the success (practically and politically) of these proposals relies on them remaining country driven and demand-led. The intention is to devolve as much agency as possible to individual countries, whilst providing international support in the form of funding and expertise. This conforms both to the spirit of the Convention and to specific commitments to supporting climate technology transfer, development and diffusion.

4.3.1 <u>Proposal 1: Strengthening capacities of NDEs via establishment of Climate Relevant Innovation-system Builders (CRIBs) within individual countries</u>

- It is clear from empirical research that effective innovation systems emerge around specific climate technologies via targeted, long term efforts by specific actors or 'champions' (acting as innovation system builders).
- Where this has been driven via strategic interventions (e.g. CGIAR, Innovación Chile, the Carbon Trust) it has required nationally situated, long term institutional presences

that pursue approaches that engage with, and are sensitive to, the needs and contexts of the people and organisations with whom they engage.

- In the context of the Convention this can be achieved by strengthening the capacities of NDEs by supporting the establishment of dedicated Climate Relevant Innovation-system Builders (CRIBs).
- CRIBs would play a strategic facilitating role within countries, acting as the focal and convening point for a national network of actors across the spectrum of those involved in innovation systems (from users, through supply chains, to NGOs and policy makers) and championing the development of climate innovation systems around different technologies. Their core remit would be to link together national actors around a strategic, long term, nationally defined vision (cognisant of national policy goals and local realities). They would develop detailed knowledge of national capabilities, key areas where opportunities exist for rapid development and growth, and identify areas where international expertise and knowledge sharing is required.
- In this way, CRIBs would support NDEs in liaising with the CTCN to facilitate targeted, nationally driven access to international expertise.
- CRIBs would have a remit that focused explicitly on sustainable development via enhanced activities around climate technologies (at both commercial and household levels, thus delivering against both human development and economic growth agendas).
- CRIBs would provide strategic oversight, advising on how to target climate technology programmes and projects in a coordinated way that responds to identified priority areas for both rapid growth and long term capacity building.
- CRIBs would also lead on the implementation of Proposal 2 below, ensuring that all climate technology projects and programmes nationally are explicitly designed to contribute to building the country's climate innovation system.
- CRIBs could be based within government departments, or within existing centres of expertise within countries, or established as independent entities linked to NDEs. From the perspective of building and sustaining capacities in the long run, the latter two approaches would be preferable.
- The creation of CRIBs will assist in overcoming an important concern regarding the potential for the CTCN's network to become too large and unwieldy. CRIBs would significantly bolster the capacities of NDEs, ensuring that the demand-led vision of the CTCN is meaningfully realised and that technical assistance sought via the CTCN is targeted at nationally-defined priorities based on in-depth knowledge of national capabilities and needs (something which is realistically beyond the capacity of NDEs, which, at present, generally consist of a small percentage of a civil servant's time).
- Funding is envisaged via a portfolio of sources, including the Green Climate Fund (which might fund core centre costs), the GEF, national governments, donors, NGOs, other multilateral organisations, and the range of other international actors with an interest in funding sustainable development and climate change mitigation or adaptation-oriented projects and programmes.
- As with the CTCN, careful attention is needed upfront to ensure that activities conform to the funding criteria of the GEF, the Green Climate Fund and other potential funders (e.g. donors and the development banks). This may require specific tailoring and packaging of different initiatives accordingly.
- The key added value of such funding being channelled through, or at least engaging with, CRIBs is the opportunity to increase coordination and ensure every dollar spent leverages further benefits in building climate relevant aspects of NSIs via a grounded understanding of the context-specific needs of individual countries and technologies.

- This would provide the most powerful and effective means of mainstreaming climate innovation system building activities within individual countries, with a myriad of benefits in terms of driving sustainable, long term, climate technology development, transfer and diffusion.

4.3.2 Proposal 2: Extending the remit of the CTCN to ensure climate technology projects and programmes contribute to 'innovation system building'

- Ideally Proposal 2 would be pursued in tandem with Proposal 1, with CRIBs, in their supporting role to NDEs, leading the national implementation of Proposal 2 in liaison with the CTCN.
- Should Proposal 1 above be considered too ambitious or meet with resistance, Proposal 2 can still be implemented via an extension to the CTCN's remit and explicit recognition of climate innovation system building as a core aim of the CTCN.
- In reality it is likely some Parties will pursue Proposal 1 whilst others will not. Proposal 2 is therefore designed to work effectively within such a context.
- Proposal 2 essentially involves mainstreaming climate innovation system building across all climate technology projects and programmes, ensuring every opportunity is taken to use projects and programmes to achieve climate innovation system-building impacts. More detail on the specifics of how projects and programmes can be used as opportunities for climate innovation system building, in line with the overarching goals outlined in Section 4.1, is provided in Section 4.4 below.
- A monitoring and evaluation system would be developed (either at a national level by CRIBs, or at an international level by the CTCN, with potential to advise NDEs on its national application) to enable any projects or programmes to be assessed on the basis of their potential to contribute to climate innovation system building within (and beyond) the country in question. Recommendations would then be made as to how the climate innovation system-building potential of projects and programmes might be increased, to the long term benefit of sustainable development goals within each country.
- A broader monitoring and evaluation system should also be implemented by the CTCN to ensure the ongoing assessment and development of how climate innovation system building is progressing across different countries and regions and make recommendations on priority areas for further work.
- This will likely require some additional resources to enable the CTCN to integrate climate innovation system building analyses into its approach and to secure any additional expertise that might be appropriate to ensure an understanding of climate innovation system building is represented within its core staff and network of experts.
- This expertise should also be explicitly made available, via the CTCN's network, to NDEs (and CRIBs if implemented) in support of any relevant climate technology activities in-country.
- A similar approach to mainstreaming climate innovation system building across projects and programmes could also be integrated in a similar way under the existing parallel initiatives funded under the GEF (see Section 4.2).

4.4 *Realising Proposal 2: How to mainstream climate innovation system building across projects and programmes*

Whilst it is possible to pursue explicit climate innovation system building activities of the nature detailed in Tables 4.1 and 4.2 above, it is also possible to use any climate technology project or programme as a powerful climate innovation system-building tool. This requires mainstreaming a focus on building innovation systems across all projects and programmes and designing and implementing them as real-world experiments so as to better foster learning, capability and system building.

To facilitate experimentation in such projects, it is clear that there is a role for donors (and other funders, including inter-governmental organisations and NGOs) as they can provide adequate protection against the full force of market selection pressures. It is under these conditions that stakeholders can experiment to generate the learning needed for the sustained development, transfer and diffusion of climate technologies and practices, and nurture the development of climate innovation systems.

But there are other aspects to the design of projects and programmes that appear to be important. First, we should be clear about what a project or programme is meant to achieve: is it the demonstration of a ready-made solution for others to imitate or is it experimentation to contribute understanding of what solutions could work? Second, the motivation of project participants needs to be considered as does, third, the scope of projects. And, finally, the way in which projects relate to each other can have powerful impacts, which also generates implications for the role of institutions at national and international levels. Each of the aspects related to projects, donors and other public funding bodies, as well as national and international institutions, is elaborated below. Included in these elaborations are non-exhaustive suggestions of how each aspect of projects might relate to the four goals recommended above: (1) build networks of diverse stakeholders; (2) foster and share learning; (3) promote the development of shared visions; (4) support diverse experimentation.

4.4.1 <u>Projects as experiments</u>

Projects and programmes should be seen and used as experiments that are implemented in order primarily to learn rather than aiming solely to achieve or demonstrate particular solutions. In other words, they could be recast as experiments to make this learning function clearer, in a similar sense to the way R&D activities are often characterised. As such, the measures of success of a project (or programme, experiment) need to be considered carefully. For example, quantitative indicators can be useful but they can become the sole focus of evaluation. A range of qualitative 'indicators' could help to identify more subtle but important impacts, such as the kinds of knowledge created from experimentation or the nature of relationships fostered in network-building. This could also help to reduce the tendency to assess projects and programmes in 'failure' versus 'success' terms, thereby encouraging the sharing of outcomes. In essence, this is about the need to redefine success as the generation of important lessons rather than ready-made solutions.

In terms of the four goals recommended above, this aspect of projects most clearly relates to supporting diverse experimentation (goal 4). But the purpose of experimentation, as has been argued, is to create opportunities for learning and so there is a direct link to the goal of fostering and sharing learning (goal 2). That is, the experiments themselves are the spaces in which learning is fostered. However, learning is only useful to broader innovation system building if it is shared. These lessons will, of course, be immediately available to project

participants who, by working together, will form a network (at least for the duration of the project) and thereby contribute to network-building (goal 1). But, for wider and longer-term network and innovation system building, lessons need to be shared publicly. This will not only help to build networks of diverse stakeholders (by providing lessons of potential interest to actors external to projects themselves) but can also promote the development of shared visions by grounding possible visions in real-word experience (goal 3).

4.4.2 Motivation of project participants

In order for projects and programmes to generate useful learning, the participants must be motivated to solve real problems. That is, the problems the project or experiment explores need to be relevant to those involved and so should be defined by them. The motivation will be further enhanced if the participants have material interests in the outcomes; if the learning will have value for them. There is a clear link here with the issue of risk. Whilst mitigating risk is important, particularly for private sector actors, the elimination of risk could be demotivating. So, participants should be expected to invest some material resources in experiments, partly to demonstrate to others their commitment but also to ensure that they have a stake in the outcomes.

This aspect of projects highlights the need for them to be attractive to potential participants and so, considering the goal of building diverse stakeholder networks (goal 1), reinforces the point above that problems should be defined by potential participants. Moreover, this self-definition of problems will raise the chances that projects will be both relevant to diverse stakeholders and create opportunities for learning from a diversity of individual perspectives and particular contexts. Clearly, there are links to fostering and sharing learning (goal 2). But responding to participant motivations for project involvement is also more likely to mean deeper commitment to projects and efforts to develop shared visions (goal 3). And, if attempts to attract a wide variety of participants are successful then there will be more opportunities to conduct a diversity of experiments, thereby linking with goal 4.

4.4.3 The scope of projects

It is clear that learning is facilitated by deep interactions amongst a broad range of actors who can bring their problem-solving efforts to bear on the many dimensions of development pathways as they unfold in different contexts. This suggests that there needs to be experimentation on many of these dimensions simultaneously. However, it would be extremely difficult for a small number of actors to achieve this. To overcome this difficulty, either complex projects involving a wide range of stakeholders could be implemented or many simpler projects could be implemented programmatically, each one operating on a selection of the dimensions of a development pathway. Each approach will have its advantages and disadvantages. The point is to generate learning across the multiple dimensions of a pathway so that climate technologies and practices can emerge in a co-evolutionary process. The assumption here is that co-evolutionary learning will tend to produce mutually reinforcing technologies and practices that operate in sympathy with their context, thereby increasing the chances of widespread adoption of those technologies and practices, and their sustainability.

Another important point here relates to continuity of efforts. Here, programmes may have the potential to deliver innovation system building in ways that individual projects may not. Funders often want to see results within a few years. Although funders should monitor progress and stop activities when they are clearly not functioning, really making headway on an innovation system might take much more than a project period – although the potential

contribution of individual projects should not be underestimated. Nevertheless, unless within a programmatic context with a timespan of say ten to fifteen years, or within the context of a more coordinated national approach to commissioning projects (as would be achieved via the creation of the CRIBs advocated in Proposal 1 above), projects run the risk of being one-off efforts with very limited structural contributions. A related point is a trusting relationship between different actors. In societies where contracts do not play a huge role, but relations make the difference, having the same person run the same programme (or CRIB) for longer can be a key success factor.

In terms of the recommended goals, projects (or programmes) with a wide scope – as indicated by the range of development dimensions along which a project or programme is operating – are more likely to result in a diversity of learning opportunities and lessons generated. Most clearly, this links with the goal of fostering and sharing learning (goal 2). And, of course, this links clearly with the recommendation to support diverse experimentation (goal 4). But projects with wide scope are also likely to need to engage with a wide range of actors and so they increase the opportunities to build networks of diverse stakeholders (goal 1). If there is support for projects and programmes over the longer term – as per the point above about continuity of efforts – then there is also more chance that such networks will develop strong relationships (also contributing to goal 1). The combination of learning from diverse experimentation and the continuity of network building should also help actors to develop shared – and grounded – visions (goal 3).

4.4.4 Interactions with other projects

Following on from the previous recommendation, even complex projects or programmes of projects could be constrained in their learning, particularly if the funding is from a narrow range of sources. Moreover, if they are under the same management they will be dependent on the particular abilities of that management. Projects or programmes implemented from *different* perspectives, if encouraged to interact meaningfully over the long term, can generate learning that helps to achieve dramatic results. This requires some degree of coordination, of course, but not necessarily management. That is, the individual projects and programmes need to be able to communicate directly with each other as well as via a central actor. It is here that value could be added via the involvement of, and coordination through, the CTCN – this value added would be significantly enhanced via the creation of CRIBs as per Proposal 1 above.

Encouraging interaction across projects clearly links with the recommendation to foster and share learning (goal 2) but there are also links to the other goals. Interactions will help to further build networks of diverse stakeholders (goal 1) by creating opportunities for various stakeholders to meet and share their knowledge. But interactions of this kind can also create spaces in which stakeholders discuss, debate and develop shared visions (goal 3). And, awareness and understanding of other projects means the possibility to ensure that any new projects or programmes do not replicate unnecessarily experiments already conducted, thereby contributing to the goal of supporting diverse experimentation (goal 4).

4.4.5 Role of donors and other public funding

Many private sector actors, particularly small players in developing countries, cannot risk much of their capital to undertake experiments. However, there might be significant benefits if they were able to do this, for themselves and for wider society. Therefore, a substantial share of the risk inherent in experimentation could be borne by donors, who can justify their financial support in terms of these potential social benefits. Other sources of public funding,

including via the Green Climate Fund and the regional development banks, could serve a similar purpose – although it is important to ensure that funding sources are also accessible to smaller actors who might not have the capacities to engage with large, multilateral funding streams (suggesting a role for donors and NGOs in bridging or plugging this gap). The involvement of public funding also has the additional significant benefit of making learning from projects publicly available, thus contributing to wider learning and long term capacity building.

Another aspect of the risk issue is the stability and long term provision of support, as noted above in regard to the continuity of efforts. If the support is unstable, intermittent or short term then it is more likely to increase risk than mitigate it. This is not to argue that support should be unconditional. There needs to be a way to maintain motivation in individual projects but the thematic, or overarching, support can be maintained so that there is confidence amongst stakeholders that it is worth them investing effort in particular experiments.

Linking with the recommended goals, we can see that the risk-bearing nature of public funding will more likely foster learning (goal 2), because of the space it creates in which to experiment (goal 4). And public funding means a greater likelihood to share learning, because of the demand to make available publicly-funded research (goal 2). But the public availability of lessons can also help in building wider networks of stakeholders (goal 1). And wider availability of learning can help in public discussions and debates about shared development visions (goal 3).

4.4.6 Role of institutions

In order to achieve all of the above, appropriate institutional structures are necessary. Under the current CTCN structure, this would fall to NDEs to implement. However, it is highly unlikely that NDEs, amongst all their other competing priorities, will have the capacity to meaningfully pursue such priority system-building concerns. It is this that drives the rationale for the creation of CRIBs under Proposal 1 above. In the absence of CRIBs, the CTCN would, as per Proposal 2, need to look towards mainstreaming climate innovation system building through its own approach to developing, supporting, monitoring and evaluating projects and programmes.

Finally, with regard to the recommended goals, institutions of the kind discussed can provide formal channels and mechanisms for coordination and linking. So, institutions can link to other institutions in formal arrangements, whether they are sub-national, national or international. This directly helps to achieve network building (goal 1). It also helps to coordinate sharing of lessons from projects (goal 2) and, indeed, can be useful for coordination of projects and programmes themselves such that there is a continuing diversity of experimentation (goal 4). And, exploiting formal links and stakeholder networks, institutions can organise more structured forums in which to develop shared visions (goal 3).

4.5 *Suggestions for the TEC*

Based on the analysis and discussion of policy options in this report, it is suggested that the TEC consider the following actions. These are divided between: 1. Possible recommendations to be made to the COP for supporting the establishment of Climate Relevant Innovation-system Builders (CRIBs) and extending the remit of the CTCN; 2. Possible recommendations to the COP on nationally appropriate actions for developed and developing country Parties; and, 3. Possible follow up work for the TEC.

4.5.1 **Possible recommendations to the COP on funding the establishment of Climate Relevant Innovation-system Builders (CRIBs) and extending the remit of the CTCN**

A comprehensive approach to mainstreaming the development of NSIs to support more widespread and sustained development, transfer and uptake of climate technologies in developing countries requires funding and support to implement either or both of Proposals 1 and 2 in Section 4.3 above. This responds directly to the gap analysis of existing funding and policy approaches in Section 4.2.4 and Table 4.2 above.

These recommendations are firmly rooted in the TEC's remit [16]. The TEC's priority recommendation to the COP should therefore be to table consideration by Parties of these two proposals, which can be summarised as (see Section 4.3 above for further detail on each proposal):

1. Proposal 1: Strengthen the capacity of NDEs under the CTCN by funding and supporting the establishment of national level Climate Relevant Innovation-system Builders (CRIBs) within developing countries.
    a. CRIBs would play a strategic, facilitating role, linking up relevant national actors, targeting and coordinating project and programme level interventions to maximise benefits to NSIs.
    b. CRIBs (through NDEs) would coordinate with the CTCN to communicate national priorities (with due knowledge of national policy priorities and local realities).
    c. The CTCN (as per its existing remit) would then act to network CRIBs internationally, facilitating knowledge flows and access to international technological capabilities based on a more detailed understanding of national/local capabilities and needs.

2. Proposal 2: Use climate technology projects and programmes explicitly to build climate innovation systems.
    a. If pursued jointly with Proposal 1, this role can be facilitated by CRIBs, in coordination with the CTCN.
    b. If pursued in isolation, this can be achieved by revising the remit and approach of the CTCN to integrate a climate innovation system building approach into projects, programmes and related interventions, and to provide advice, via NDEs, on how Parties can bolster their own NSIs.

Proposal 1 should be highlighted as the preferred option with most potential to foster the development of NSIs around climate technologies in developing countries. Proposal 2 would

[16] See the Conference of the Parties decision 1/CP.16, paragraph 121.

be best used to augment the remit of the CTCN, mainstreaming a focus on NSIs. Proposal 2, could, however be pursued on its own if Proposal 1 were seen as too ambitious.

It should be emphasised to the COP that both proposals (particularly Proposal 1) would support nationally driven and nationally appropriate actions and increase Parties' agency to foster climate technology development and transfer in ways that respond to their own, nationally determined needs and priorities.

As part of the TEC's remit to give special consideration to least developed country Parties (decision 1/CP.16, para. 121(c)), it should be emphasised that in least developed countries where NSIs tend to be weakest, the establishment of CRIBs under Proposal 1 has even more potential to contribute to both the development, transfer and uptake of climate technologies and broader processes of economic development and creation of new markets, added value and new industrial activity.

4.5.2 Possible recommendations to the COP on nationally appropriate actions for strengthening NSIs

The TEC should recommend the following actions to Parties as policy and programme priorities that will augment climate technology development and transfer by building and strengthening NSIs. As with the recommendations above, these actions are firmly rooted in the TEC's remit as noted above.

The following actions, policies and programmes, drawn from Table 4.1 and designed to address the overarching policy goals outlined in Section 4.1 above, could be recommended to Parties:

4.5.2.1 Goal 1: Network building

1. Foster networks that link diverse stakeholders of relevance to technological capabilities around climate technologies nationally, internationally, locally, and across markets and sectors (private/public/NGO/research, etc.)
2. Work to link these networks to technology users
3. Establish links between national, regional and local government and national and international technical experts
4. Link national firms with international firms (at any level – not necessarily firms at the technological leading edge – all international knowledge exchange is important).

4.5.2.2 Goal 2: Learning

1. Commission market research to understand the nature and extent of existing national markets for climate technologies
2. Commission research into technology user needs and preferences to understand the nature of national markets and opportunities to adapt climate technologies to fit with national user needs and preferences, leading to new national market creation
3. Commission research into technology performance to inform actions to improve reliability of climate technologies and the introduction of national standards
4. Commission research into education and training needs around climate technology installation, use and vending
5. Implement monitoring and evaluation of climate technology projects and programmes, aiming to support systemic learning from, and responding to, failures as well as successes

6. Conduct baseline studies of climate technology use, sales of specific technologies, availability of specific technologies, existing and potential markets, etc.
7. Conduct comparative research across local/national/international scales that addresses the various research foci above, paying close attention to scale specific considerations that emerge
8. Make results of research and monitoring and evaluation publicly available so that potential market entrants can learn from, and respond to, empirical evidence on the size, nature and potential of national markets
9. Create spaces for stakeholders to reflect on research and experiences, such as via workshops, conferences, trade shows, etc. (and use the reach of the networks advocated above to engage relevant stakeholders in such learning events)
10. Provide training for firms via formal, accredited courses
11. Provide training for suppliers and installers via formal, accredited courses
12. Provide training for technology users/villages/households – this can be formal or informal but should be led by accredited providers
13. Provide advice to firms on, and support development of, technology certification schemes
14. Provide advice on education and training needs (up to and including postgraduate training) for working with climate technologies.

4.5.2.3 Goal 3: Foster shared visions

1. Convene consensus-building events with different national stakeholder groups
2. Convene scenario-building events to discuss alternative development pathways that different climate technologies might facilitate or constrain
3. Facilitate opportunities for different stakeholders to feedback into the technology design and configuration process.

4.5.2.4 Goal 4: Provide protected spaces for experimentation

1. Encourage or incentivise treatment of 'failures' as valuable points for learning – this can be done via the research and monitoring and evaluation efforts advocated above
2. Commission projects explicitly as experiments (as opposed to 'solutions'), experimenting with a range of factors, including:
    - technological hardware
    - policies
    - social practices in relation to climate technologies
    - new stakeholder configurations
    - production processes
    - linking stakeholders across markets to create new market opportunities and market awareness
    - value adding experiments working upwards through supply chains.

4.5.3 Follow up work for the TEC

The TEC's workshop on NSIs provided an important starting point for its contribution in the area of NSIs. Looking forward to the TEC's 2015-16 rolling work plan, together with fulfilling Activity 4.3 of the TEC's 2014-15 rolling work plan ("Further work on enablers and barriers, taking into account the outcomes of the workshop on NSIs"), there are several follow-on activities that would make valuable contributions to Parties and other actors seeking to develop and strengthen NSIs around climate technologies.

The key issue that the actions below are designed to address is the absence to date of an attempt to integrate consideration of NSIs into activities under the Convention. There is therefore significant value in commissioning desk-based analysis and supporting deeper empirical research that builds on the insights in this current report on the value of an NSI-based approach to climate technology development and transfer, and aims to learn lessons from NSI-focussed analysis of existing international and national initiatives. Such research would provide valuable, empirically-grounded support to the nationally appropriate actions recommended above.

Action	Deliverables	Expected outcomes	Technology Executive Committee function / Conference of the Parties mandate
1. Provide support to Parties for articulating in-depth analyses of NSIs, including existing capabilities, relevant institutions, etc. 2. Commission work to identify examples of successful NSI building around specific climate technologies and participatory historical analysis of the factors that contributed to successful NSI building in these cases and how these might be replicated across different contexts (see, for example, the work of Byrne *et al.* 2014 on solar PV in Kenya) 3. Commission a desk-based gap analysis, augmented with expert interviews, on the strengths and weaknesses of	a. National reports on NSI building b. TEC briefs c. Key messages to COP	Enhanced, empirically grounded understanding among Parties and stakeholders of how to operationalise and institutionalise an NSI based approach to addressing barriers and creating enabling environments for climate technology development and transfer Enhanced understanding on barriers and enablers	Analyse policy and technical issues related to the development and transfer of technologies (decision 1/CP.16, para. 121(a)) Recommend actions to promote the development and transfer of technology (decision 1/CP.16, para. 121(b)) Recommend guidance on policies and programmes (decision 1/CP.16, para. 121(c)) Promote and facilitate collaboration on the development and transfer of technologies (decision 1/CP.16, para. 121(d)) Recommend actions to address barriers

existing international initiatives in building NSIs for climate technologies. This should build on the initial sketch provided in Section 4.2.4 and Table 4.2 of the current report. 4. Commission further desk based research, including expert interviews, to understand the extent to which NSI building was an aim of the Lighting Africa initiative, and ways in which the initiative provides explicit lessons for operationalising the lessons in this report. 5. Similar to the report commissioned by infoDev on CICs (Sagar 2010), commission a desk based study looking at detailed case studies of existing Centre based initiatives and the lessons that could be learned for building NSIs (potential case studies include CGIAR, Innovación Chile and the Carbon Trust)			(decision 1/CP.16, para. 121(e)) Seek cooperation with relevant international technology initiatives, stakeholders and organisations (decision 1/CP.16, para. 121(f)) Initiation of the exploration of issues relating to enabling environments and barriers, including those issues referred to in document FCCC/SB/2012/2, paragraph 35 (decision 1/CP.18, para. 60)

4.6 *Conclusion*

Building on insights from the Innovation Studies and Socio-Technical Transitions literatures, this report has argued that policy focussed on developing and strengthening NSIs could significantly increase and sustain the development and transfer of climate technologies to developing countries. Nurturing NSIs provides a focus for generic policy interventions at national and international levels that are able to respond to the context-specific needs of different countries, technologies and social practices therein. By focussing on the overarching goals of *building networks, fostering shared learning and shared visions, and supporting*

experimentation through projects and programmes, international climate policy focussed on nurturing NSIs could have a profound impact on climate technology development and transfer, achieved via the more detailed policy interventions outlined in this report (see especially Section 4.5).

It is time for international climate policy to make the shift towards using policy interventions as *Climate Relevant Innovation-system Builders (CRIBs)*. This would best be achieved via adoption by the COP of the two Proposals outlined in this report (see Section 4.3). Both proposals (particularly Proposal 1) would support *nationally driven and nationally appropriate actions* and increase Parties' agency to foster climate technology development and transfer in ways that respond to their own, *nationally determined needs and priorities*. The aim should be to build indigenous technological capabilities and well-functioning, context-sensitive NSIs via nationally nested, demand-driven, internationally networked activities with learning shared across different contexts. It is these NSIs (understood from a broader, socio-technical perspective) that will provide the bedrock of technological change and sustainable, climate compatible development well into the future.

Within the broader perspective introduced at the beginning of this report of fostering pathways of climate technology transfer and development that deliver against the self-defined needs of poor countries and poor people who live in them, it is clear that a CRIBs based approach has strong potential to deliver. By focussing on nurturing NSIs, CRIBs can go beyond the limits of existing 'hardware financing' policy approaches to extend the promising advances made by the CTCN, and related international initiatives, in ways that better support sustained climate compatible development in individual countries along self-defined pathways.

There is an opportunity here for a new framing of international climate technology policy around nurturing NSIs. Decades of empirical research support the idea that this policy framing would have significantly more impact than one built around hardware financing approaches.

We look forward to positive steps forward by the TEC in the months to come, to the creation of Innovation-System Builders, via the establishment of CRIBs in developing countries, and to a new turn in international policy efforts.

Let the gardens grow…

References

Abdel Latif, A. (2012) 'The UNEP-EPO-ICTSD project on patents and clean energy: A partnership to better understand the role of intellectual property rights in the transfer of climate friendly technologies' in Ockwell, D. G. and Mallett, A. (eds) *Low carbon technology transfer: From rhetoric to reality,* Abingdon: Routledge

Bell, M. (1997) 'Technology transfer to transition countries: are there lessons from the experience of the post-war industrializing countries?' in *The Technology of Transition: Science and Technology Policies for Transition Countries*, D. Dyker (ed.), pp. 63-94. Budapest: Central European University Press.

-- (2009) *Innovation Capabilities and Directions of Development*, STEPS Working Paper 33, Brighton: STEPS Centre.

-- (2012) 'International technology transfer, innovation capabilities and sustainable directions of development' in *Low carbon technology transfer: from rhetoric to reality*, Ockwell D. and Mallett A. (eds.), Oxford: Routledge.

Byrne, R., Ockwell, D. G., Urama, K., Ozor, N., Kirumba, E., Ely, A., Becker, S. and Gollwitzer, L. (2014) *Sustainable energy for whom? Governing pro-poor, low carbon pathways to development: Lessons from solar PV in Kenya*, STEPS Working Paper 61, available at http://steps-centre.org/wp-content/uploads/Energy-Access-online.pdf Brighton: STEPS Centre

Byrne, R., Smith, A., Watson, J. and Ockwell, D. (2012) 'Energy Pathways in Low Carbon Development: The Need to Go Beyond Technology Transfer' in Ockwell, D. G. and Mallett, A. (eds) *Low carbon technology transfer: from rhetoric to reality,* Abingdon: Routledge.

CTCN (2014) 'CTCN Operating Manual for National Designated Entities (NDEs)', Climate Technology Centre & Network

Foster, C. and Heeks, R. (2013) 'Conceptualising Inclusive Innovation: Modifying Systems of Innovation Frameworks to Understand Diffusion of New Technology to Low-Income Consumers', *The European Journal of Development Research* 25**:** 333-355.

GEF (2012) 'Implementing the Poznan Strategic and Long-Term Programs on Technology Transfer', GEF, http://www.thegef.org/gef/sites/thegef.org/files/publication/GEF_PoznanTT_lowres%20final.pdf

Hulme, M. (2008) 'Governing and adapting to climate. A response to Ian Bailey's Commentary on 'Geographical work at the boundaries of climate change'', *Transactions of the Institute of British Geographers* 33**:** 424-427

Hulme, M. (2009) *Why We Disagree About Climate Change*, Cambridge: Cambridge University Press.

IDRC (2011) 'Innovation for Inclusive Development: Program Prospectus for 2011–2016', Ottawa: IDRC.

Leach, M., Scoones, I. and Stirling, A. (2010) 'Governing epidemics in an age of complexity: Narratives, politics and pathways to sustainability', *Global Environmental Change - Human and Policy Dimensions* 20**:** 369-377

Ockwell, D. and Byrne, R. (2014) *Sustainable energy for whom? Build capacity, don't just fund hardware*, Politics Reconsidered blog, http://politicsreconsidered.net/2014/03/17/sustainable-energy-capacity/ (March 2014)

Ockwell, D., Sagar, A. and Coninck, H. (2014) 'Collaborative research and development (R&D) for climate technology transfer and uptake in developing countries: towards a needs driven approach', *Climatic Change,* 1-15

Ockwell, D. G., Haum, R., Mallett, A. and Watson J. (2010) 'Intellectual property rights and low carbon technology transfer: Conflicting discourses of diffusion and development', *Global Environmental Change* 20**:** 729-738

Ockwell, D. G. and Mallett, A. (2012) (eds.) *Low Carbon Technology Transfer: From Rhetoric to Reality*, Abingdon: Routledge

Ockwell, D. G., Watson, J., Mallett, A., Haum, R., MacKerron, G. and Verbeken, A. (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 Paper 12, OECD Publishing, DOI: 10.1787/5kmfplm8xxf5-en

Sagar, A. (2009) 'Technology Development and Transfer to Meet Climate and Developmental Challenges', background note for UNDESA Background Paper for Delhi High Level Conference, New Delhi, India, 22-23 October 2009

Sagar, A. (2010) 'Climate Innovation Centres: A new way to foster climate technologies in the developing world?' An infoDev publication in collaboration with UNIDO and DFID, www.infodev.org

Tomlinson, S., Zorlu, P. and Langley, C. (2008) 'Innovation and Technology Transfer. Framework for a Global Deal', Report, London: E3G and Chatham House

Urban, F. and Sumner, A. (2009) *After 2015: Pro-Poor Low Carbon Development*, IDS In Focus Policy Briefing, Issue 9, Brighton: Institute for Development Studies