United Nations
Framework Convention on
Climate Change

TEC Brief #7

Technology Executive Committee

Strengthening National Systems of Innovation to Enhance Action on Climate Change

Why this TEC Brief?

Technological change is one of the key arms in our arsenal of weapons to combat climate change. A country's capabilities to drive and enable this change thus take on a critical role. The implications of our ability to manage a climate technology transition are enormous: a recent study suggests that to keep the global rise in temperature to less than 2 °C, the additional cost of deploying energy technologies between 2016 and 2050 is USD 40 trillion (IEA, 2015). As developing countries may account for up to 90 per cent of energy demand growth to 2050 (IEA, 2015), the importance of their technological capabilities to manage this transition effectively and efficiently cannot be overstated.

A country's technological capabilities are determined in part by the effectiveness of its national system of innovation (NSI). An NSI is a network of actors, institutional contexts and linkages that underlie national technological change. The NSI should thus play a central role in supporting a country's efforts to enhance action on climate change mitigation and adaptation. It also helps a country to meet other developmental challenges and add value to its national economy.

An NSI consists of:

- **Actors:** Organizations that participate in technology development and transfer
  e.g. technology firms, universities and financiers
- **Institutional context:** Norms, cultural practices and laws that shape actor efforts
  e.g. government policies that affect how the private sector invests in a particular sector
- **Linkages:** Interactions and relations between the actors and the institutional context
  e.g. flows of information and knowledge, and collaboration between firms, universities and research institutes

We, the Technology Executive Committee (TEC) of the UNFCCC, acknowledge the key role that NSIs play in combating climate change. In this TEC Brief, we outline the current state of NSIs in developing countries. We then highlight how developed countries and the international community may work together to support these countries in strengthening their NSIs, enhancing both national climate action and sustainable development.

Highlights

- **A NSI plays a central role** in supporting a Party in undertaking efficient and effective technological change in response to climate change. It also supports them to achieve their sustainable development objectives.
- **To accelerate global climate efforts, there is a need to support developing countries in strengthening their NSI.** Effective NSIs are essential for enhancing developing countries' capacity to absorb, distribute, diffuse and deploy climate technologies, adapt these technologies to their needs, and implement and maintain them. This will also support continued technological development and adaptation to regional needs.
- **Strengthening NSIs requires three key complementary actions:**
  1. Develop the fundamental elements: (i) build a strong education system, (ii) invest in research, development and demonstration (RD&D) and (iii) implement enabling policies (including to support market creation);
  2. Focus on specific climate technologies that help to meet national climate and development priorities;
  3. Build strategic and coordination capabilities of play of national actors.
- **There is a need to conduct further assessment on the current state of NSIs in developing countries.** The Technology Mechanism and key stakeholders are encouraged to play significant roles in developing an enhanced understanding of the state of play of developing country NSIs with regard to climate technology innovation.
- **There is a need to enhance understanding of the effectiveness of initiatives supporting the strengthening of developing country NSIs.** The Technology Mechanism and other key stakeholders are encouraged to enhance efforts to share experiences, good practices and lessons learned.
- **Developing countries are encouraged to consider** how to strengthen their NSI when they undertake technology needs assessments (TNAs) and formulate technology action plans (TAPs), with a view to enabling them to achieve their specified climate technology goals and submit requests to the Climate Technology Centre and Network (CTCN).
- **Developed countries are encouraged to highlight to the CTCN, through their national designated entity (NDE), how they could support developing countries in strengthening their NSIs.**

1 National Systems of Innovation in Developing Countries

The key question of this brief is: *how can we support developing countries to build their technological capabilities and enhance their climate efforts?* As noted previously, to strengthen technological capabilities we need to strengthen our NSIs. In addition, to understand how we can together strengthen our NSIs, first we have to look at what needs to be strengthened, that is, what is the current situation in developing countries?

This question is difficult to answer. Firstly, there is little information on the current state of developing country NSIs. Most studies focus on developed countries, presumably because these countries have the greatest innovation activity and demands for such studies. There is some information on the larger developing countries (Brazil, China, India and South Africa), but little on the small- and medium-sized ones. Secondly, many aspects of NSIs are country-specific and thus vary widely among countries. These national characteristics can have a significant influence on shaping innovation outcomes, which might be why we see countries at similar levels of economic development with different innovation landscapes and trajectories. Thirdly, the key innovation activities that a country undertakes may depend on its size and income level. For example, small- and medium-sized developing countries may be focused on

incremental and adaptive innovation, while countries that are members of the Organisation for Economic Co-operation and Development (OECD), in addition to these activities, may also be focused on pushing the technological frontier.

However, there are a range of activities that are needed for successful innovation, irrespective of national characteristics (Edquist, 2011) and income levels. Moreover, while innovation is not a linear process and involves changes of many kinds – including cultural, organizational, behavioural and technological (Stirling, 2015) – we believe that there is merit in investigating NSI effectiveness by looking at activities along the traditional technology cycle (research and development (R&D), demonstration, market introduction and commercialization, and diffusion). Given the limitations noted above, and the limited space of this brief, we must emphasize that we do not provide a complete picture of the current state of NSIs. However, in this section, we will analyse some activities that help to build a general understanding of the state of developing country NSIs. Some of these activities are broader than climate change and are economy-wide. This is based on the notion that the NSI is the foundation for innovation in any technology area, including climate technologies.

ECONOMY-WIDE INNOVATION

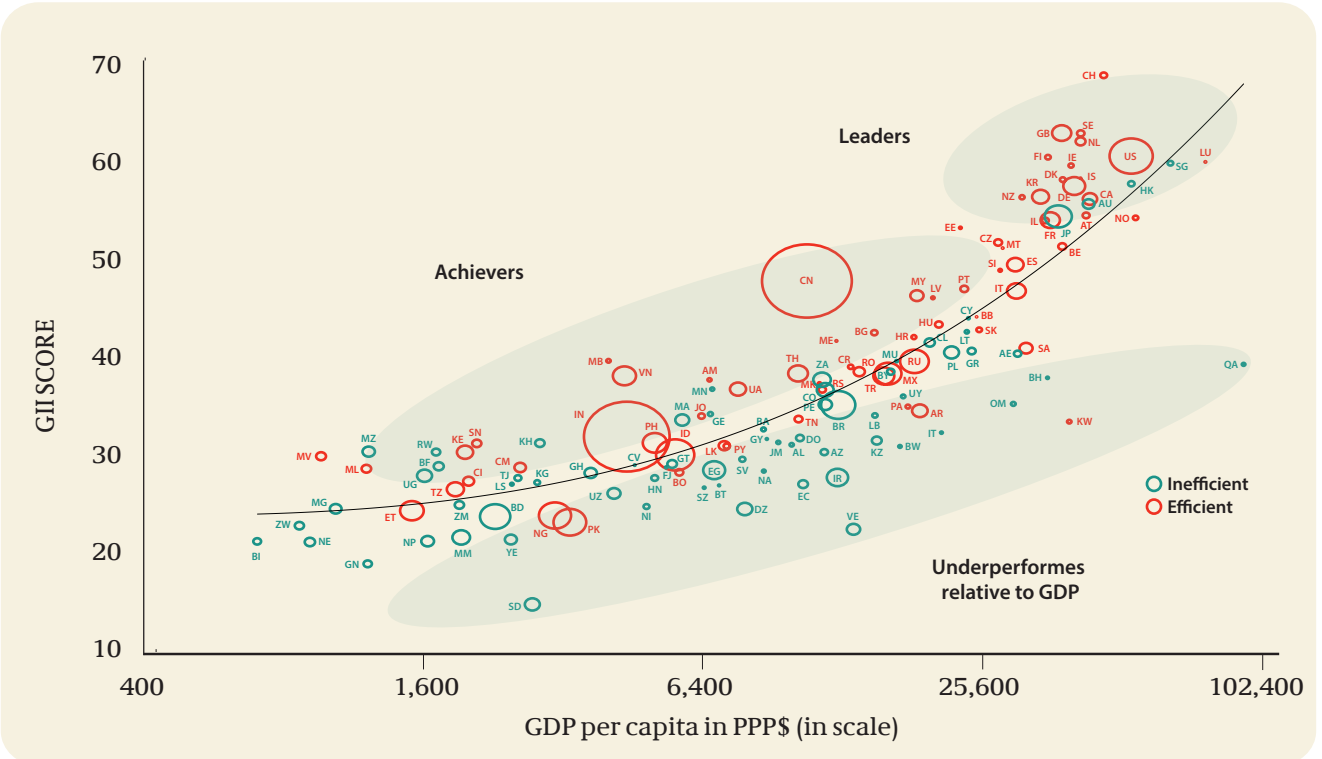
Innovation indices

One way to estimate a country's innovation effort is to consider indices that combine the analysis of various innovation activities into one measure. A commonly cited index of innovation performance is the global innovation index (GII), which contains 81 indicators that cover a variety of national innovation activities. Using this index, we find that innovative capability and performance vary with income level, with developed countries being the innovation leaders (see figure 1). Notably, however, many developing countries are seen as efficient innovators with regard to their innovation input/output. These countries are high achieving relative to their gross domestic product (GDP), with similar innovation efficiencies to high-income countries.

Gross expenditure on research and development

To approximate the level of activity in the early stages of the technology cycle, we can look at gross R&D expenditure. As with the GII, this indicator highlights the relative sparseness of developing country innovation activities (see figure 2). There is a clear correlation between income level and scale of R&D effort, although there are some variations among countries with similar GDPs.

Figure 1: Country global innovation index (GII) score versus gross domestic product (GDP) per capita in purchasing-power-parity adjusted dollars (PPP$) (Source: GII, 2014)



Research in universities

Another indicator used to assess the state of an NSI is university research. Universities provide the skilled workforce that is needed for innovation and are also the source of new knowledge and technologies that underpin innovation. With universities being critical actors in NSIs, it is striking that their concentration within developed countries is even more pronounced: of the 50 universities with the highest relative scientific impact across all disciplines in 2007–2011, only 2 were from outside the OECD member States (OECD, 2014). While the large developing countries (Brazil, China and India) are engaged in international collaboration, the normalized impact of their research output is below the world average. We note that there are many other research institutions that may also play a prominent role in building NSIs, including applied research institutions.

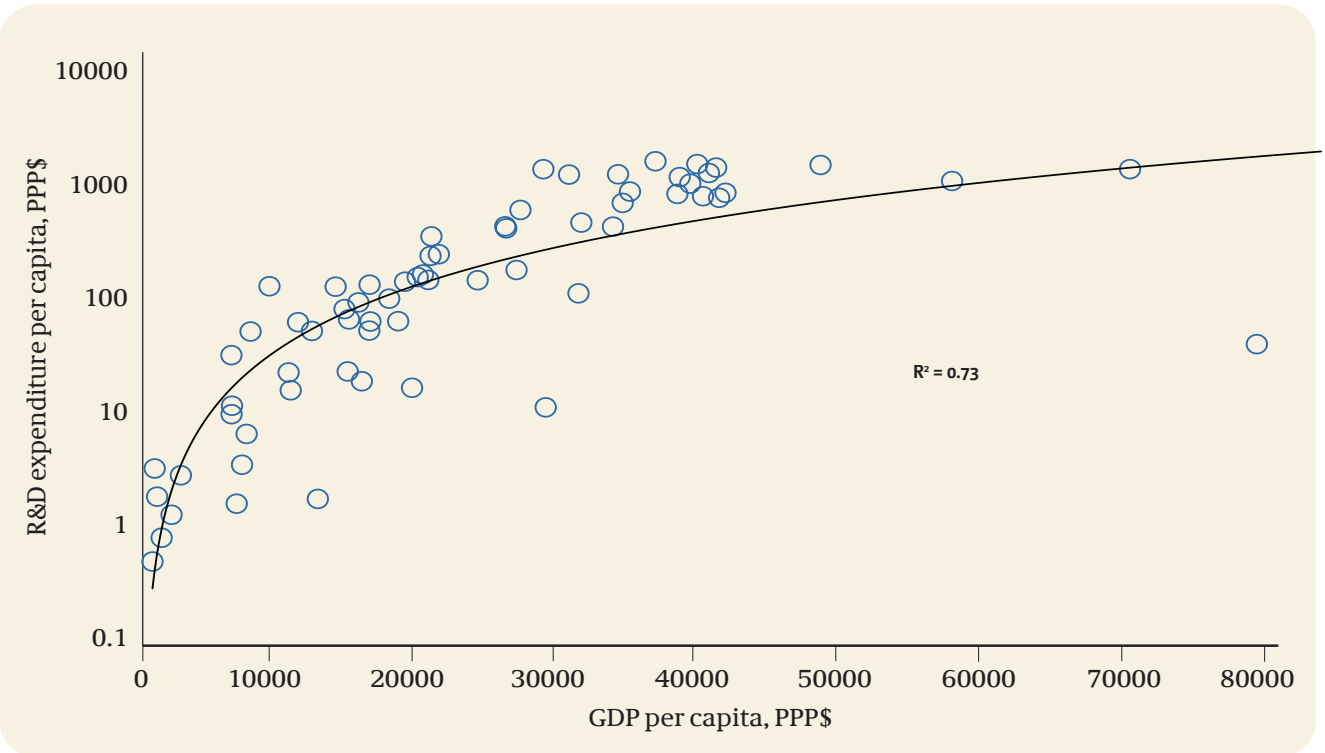
CLIMATE TECHNOLOGY INNOVATION

In terms of climate technology innovation, again nearly all studies focus on OECD countries since these have traditionally undertaken most of the climate technology innovation activities. For developing countries, existing studies focus only on the large countries. Here, we look briefly at two ways of estimating NSI capacity for climate technology innovation. We consider innovation inputs (i.e. a country's efforts to stimulate innovation) and then also the innovation outputs and outcomes (i.e. the outcomes of these efforts). As noted previously, in this section we provide only a snapshot of some of the activities that may highlight climate technology innovation activity.

Climate technology innovation inputs

With regard to inputs, a country's level of RD&D is seen as a key indicator because it is expected to reflect the pipeline of new and improved technologies entering the national market. Investments in RD&D also attract and stimulate other national investments and efforts in innovation. However, there are limited data about climate-mitigation RD&D in countries other than the government energy RD&D (ERD&D) investment data collected by the International Energy Agency (IEA). These data can still serve as a useful measure of climate technology innovation activities because the energy sector is a key contributor to greenhouse gas emissions. It is estimated that in 2013, non-IEA country government investments in ERD&D were a small fraction of the 17.3 billion purchasing-power-parity adjusted dollars (PPP$) invested by IEA country governments in that year. A study examining ERD&D investments in large developing countries found that direct government investments in these countries in 2008 were about 1.4 billion PPP$ (Kempener et al., 2010).[1] There is even less understanding of innovation inputs such as RD&D for adaptation, in part because adaptation technologies are more difficult to define (and

Figure 2: Gross research and development (R&D) investments per capita versus gross domestic product (GDP) per capita in purchasing-power-parity adjusted dollars (PPP$) (Source: World Bank DataBank)



[1] The study also found that state-owned enterprises in these countries invested more than 12 billion PPP$ in ERD&D that same year, indicating that they are an important component of the climate-related NSIs in developing countries (Kempener et al., 2010).

may often be 'soft technologies') but also because adaptation activities are often more local than those of mitigation.

Climate technology innovation outputs and outcomes

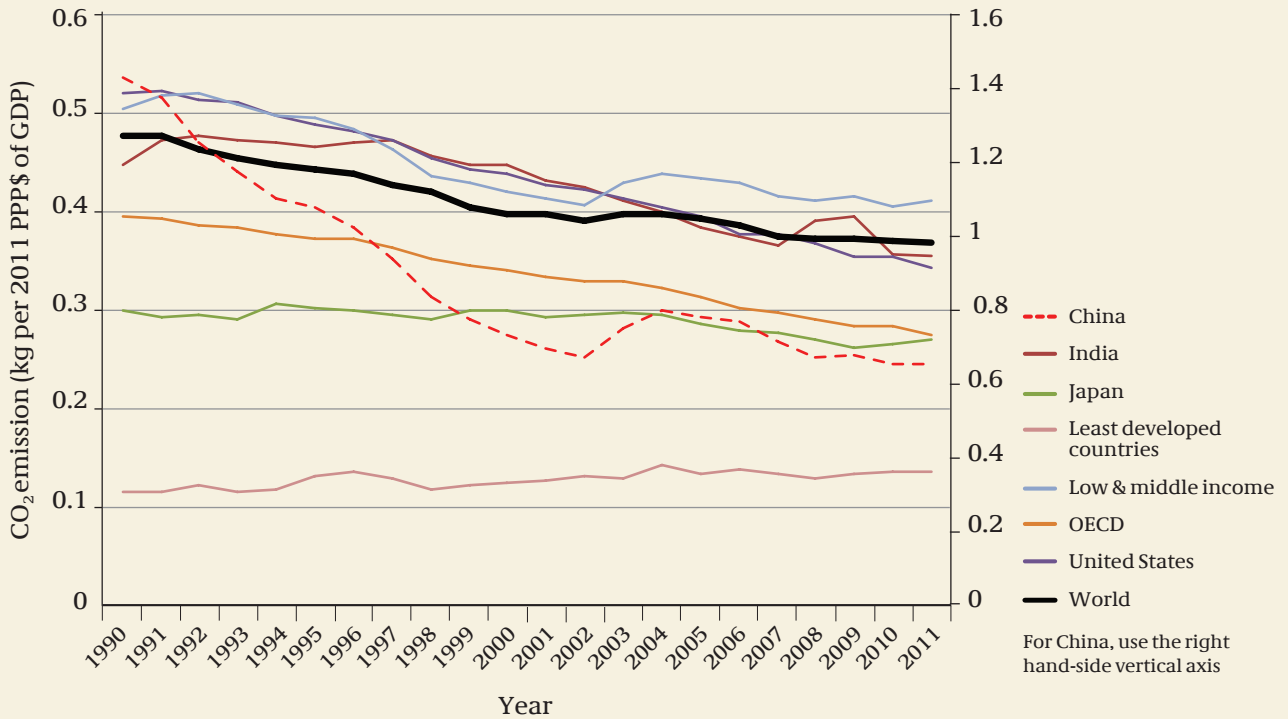
In terms of innovation outputs, patents are often used as an indicator of innovation as they are noted to be an approximate measure of technological progress and activity. In addition, there are data available on energy-related patenting in large developing countries. An analysis of patenting data on climate technologies between 2000 and 2011 suggests that patents from China account for 13.7 per cent of the global total, with India, Brazil and South Africa each accounting for less than 1 per cent (IEA, 2013). There is little aggregated information on patenting data from small- and medium-sized developing countries. Additionally, we note that patents may be a less effective measure of innovation in countries where little patenting activity occurs. We also note that one of the issues in examining patent applications by country of origin is that the applications could be made by local R&D centres of multinational corporations (IEA, 2013).

With the NSI playing a key role in driving technological changes, it is also interesting to observe if such changes lead to reduction in a country's carbon intensity. It can be observed that the low- and middle-income developing countries and the large developing countries are reducing their carbon intensities. This may be taking place by moving to low-carbon energy sources as well as enhancing the energy efficiency of their economies. Only the least developed countries and some low- and middle-income countries are experiencing increases in the carbon intensities of their economies (see figure 3); this occurs mainly as a consequence of structural changes to the economies.

OVERALL STATE OF NATIONAL SYSTEMS OF INNOVATION

In general, developing country NSIs tend to be less developed, less dynamic and much less analysed than those of developed countries. The limited studies that exist show that the large developing countries have visible innovation-related activities and outputs. China is an outlier among the developing countries in terms of the scale of its R&D investments, its ERD&D investments, and its performance in patenting and deploying renewable energy technologies. In fact, China is now seen as the world's largest investor in renewable energy (REN21, 2015). With China, India and other major developing countries recently making significant investments in renewable energy deployment, there needs to be a greater understanding of developing country contributions to climate technology innovation. On the whole, our understanding of NSIs in developing countries – especially in relation to climate challenges – remains very limited.

Figure 3: **Trends in carbon intensity for selected economies and groups (1990–2011) (Source: World Bank DataBank)**



2 Strengthening Key Elements of National Systems of Innovation

With developing country NSIs being less effective than desired, what can be done to strengthen them? This is a formidable task. It involves strengthening a range of actors, enhancing the institutional context in which they are operating and catalysing the linkages between actors and the institutional context. Importantly, the national government (along with state and province level administrations, and even city administrations, in countries where they play an important role) is the central NSI stakeholder that leads efforts to strengthen the NSI. To achieve this, the following three complementary actions may be considered.

ACTION 1: START WITH FUNDAMENTALS

While countries such as the Republic of Korea stand out for transforming their NSIs in recent decades, success stories of large-scale transformation are rare. What are the key policy actions that successfully transform an NSI? Firstly, these countries had a strong national focus on developing foundational capabilities. Policies that build a strong technical higher education and training system are key, because these serve both as a research base and as a training ground for skilled **actors** at the heart of the innovation system. In this context, it is important to have strong collaboration among government bodies involved in the national innovation process, including those responsible for education, legal and regulatory issues.

For the **institutional context**, the focus is on creating a general enabling environment (e.g. creating stable macroeconomic conditions and facilitating competition and entrepreneurship) and building demand through market formation. Emphasis is also on creating an environment that encourages investment in: (i) building skills and technological capability, (ii) technology adoption and (iii) innovative activity. These activities may catalyse the involvement of the private sector, which is another key actor in the innovation process. Governments also strive to ensure that institutional contexts facilitate and promote learning by various actors within NSIs. Finally, equally important is to strengthen **linkages** between key actors, such as those between firms, universities, research institutes, quality or productivity organizations and technology transfer or extension bodies.

Ultimately, the process of developing strong indigenous innovation capabilities is a long and arduous process. It generally starts with learning to introduce and master existing and newly developed technologies and engaging in incremental innovations. Later, it leads to being able to develop 'new to the world' innovations based on new knowledge. Historically, governments have played an active and key role in driving and enabling such progress up the innovation ladder (see Box 1).

Box 1. Republic of Korea: Building a dynamic national system of innovation

The Republic of Korea is a prominent example of a country that has successfully built a strong and dynamic innovation system in just a few decades. In the initial stages, government policies promoted the importation and assimilation of technologies and their improvement over time by learning-through-manufacturing as well as reverse engineering. The policies also promoted a focus on specific industries such as steel, shipbuilding and automobile. The Government: (i) introduced an export-oriented strategy that ensured competition and (ii) encouraged significant investments in R&D that developed competitive national firms. Government investments in education and human resource development also supported this capability-building. Notably, the Government's policies evolved over time in response to the evolving perceived needs of the economy. The Government's role also changed: at first, it set targets and helped firms to meet these targets through suitable policies and provision of finance; later, it became more of a facilitator and coordinator of policies and programmes. (Based on Chung, 2007.)

Photo: "Irrigation sprinklers", Vstock LLC/VStock/Thinkstock

ACTION 2: FOCUS ON SPECIFIC CLIMATE TECHNOLOGIES

Strengthening NSIs broadly is an objective to aspire to for all developing countries. However, given the enormity of that task and the timescale for success, a country may consider beginning with strengthening its NSI to meet specific climate and development challenges. In this way, a country can efficiently allocate its resources to strengthen innovation system elements that are most relevant to successful implementation of its priority technological pathways in the climate arena. To strengthen its NSI using this focused approach, a country might prioritize specific sectors and technologies, and identify the stages of the technology cycle that might require most support. We note that focused NSI strengthening is somewhat nuanced and subject to the particularities of a country's climate technology choices.

Even for a given technology, different actors, institutional contexts and linkages may come into play at different stages of the technology cycle. During the research stage, **actors** such as universities and research laboratories play a central role in the technical arena, and government agencies are the primary source of policy action and direction, and play the largest role in funding. The **institutional context** is focused on providing an environment that nourishes research, invention, experimentation and the transfer of knowledge and know-how. As Box 2 highlights, the government may also undertake direct state investment to support innovation of the prioritized area, providing a base upon which private actors may later build. **Linkages** are centred on exchanging scientific and technical information and financing opportunities.

At the development stage, the private sector becomes the key **actor**: it generally has the greatest incentives to collect information about how and under what conditions the technology will be used, which affects product specification. Private-sector entities may also engage in demonstrating the technology in order to test it and obtain user feedback. At this stage, funds from private-sector entities or risk-capital providers are more relevant. Important **linkages** here include public–private partnerships, which may support the transition from applied research to technology demonstration and avoid the 'valley of death' of the technology cycle.

As the technology is commercialized, the focus shifts to establishing technology production. Efforts are made to ensure that producers and consumers successfully adopt the technology and that it is quickly and widely diffused. Private-sector entities are again the central **actors**. However, in the case of climate technologies, governments can also be critical in defining and shaping

the **institutional context** that creates markets and demand through appropriate policies and regulations. Different kinds of **linkages** are important here, such as those between manufacturing firms, financiers, users and governments. For low-income countries and least developed countries, and those in the early stages of technological development, an important area of focus will be on supporting the organizations that promote the adoption and diffusion of these technologies in high-priority areas.

ACTION 3: DEVELOP NATIONAL STRATEGIC CAPABILITIES

Finally, perhaps the most important set of capabilities are strategic and coordination capabilities (Chaudhary et al., 2012). These elements – which form a key part of policy capabilities – are urgently needed in developing countries to allow national and subnational (state or province level) governments to spearhead and accelerate the climate action needed. This action is focused on building the capacity of national **actors** so that they have the ability to develop priorities based on a country's mitigation and adaptation options and development needs. It also involves developing the countries' ability to: (i) identify road maps to meet these priorities, (ii) identify the innovation gaps to be addressed for the countries to successfully progress on these road maps and (iii) coordinate activities across the innovation cycle. Such capabilities not only help to increase the probability of successfully undertaking actions 1 and 2, but also help to do so faster and more efficiently. Box 3 illustrates such an action.

Box 2. China: Developing the wind sector

At the end of 2014, China had the largest installed wind power capacity in the world, and 4 of the 10 biggest global wind power manufacturers were Chinese. This outcome is the culmination of a sustained effort by China to develop its wind sector. The first phase, from the mid-1980s to the mid-1990s, consisted of R&D projects that encouraged national wind farms and universities to demonstrate and test the wind technology in local conditions. From the mid-1990s to the early 2000s, the second phase focused on technology transfer, localization, establishment of manufacturing facilities and market exploration, with manufacturing firms becoming the central actors. The third phase focused on significant expansion of the wind turbine market and deepening of innovation capacity, with the objective of achieving technological leap-frogging. At each stage, the Government employed a suite of suitable policies to achieve the desired outcomes. (Based on Dai and Xue, 2015.)

Box 3. India: Enabling change through strategy and coordination

The Indian Bureau of Energy Efficiency (BEE) has played a central role in the recent past in enhancing energy efficiency programmes in India, with significant savings in energy and avoided generation capacity. To do so, it has taken a careful and strategic approach, identifying and prioritizing areas of highest impact through consultations with a variety of stakeholders. As a result, it began with a focus on appliances, lighting, buildings and industry. In each area, a pathway for implementation of energy efficiency programmes was identified, taking into account the gaps (e.g. availability of technology, finance, human resources and suitable policies) and actors for different stages of the technology cycle. BEE also helped to coordinate various actors and activities to enable effective implementation of the programmes. In that sense, it is a 'systems operator' that is able to prioritize areas, spot key gaps, help address the gaps and tweak the programmes over time, based on learning from experiences in implementation. (Based on Chaudhary et al., 2012.)

3 Possible Actions by Key Stakeholders

There are two major information gaps with regard to supporting developing countries to strengthen their climate technology NSIs. Firstly, there is a lack of understanding of the current state of developing country NSIs. Secondly, our understanding of how to effectively strengthen NSIs is still limited, as is our understanding of the scope and effectiveness of programmes to support developing countries in undertaking the three key actions of NSI building.

Both of these gaps lead to the need to develop a more systematic assessment of good practices, experiences and lessons learned in undertaking and supporting such efforts. It is only through this assessment that we can learn what works, what does not work and what we can improve. In addition, the outcomes of such assessments are applicable to the country strengthening its NSI and to the actors supporting such efforts. To achieve accelerated NSI strengthening, we need to do more than build the national capacities of developing countries. We also have to build the capabilities of those who support such capacity-building. Table 1 outlines the key elements of NSI strengthening at each stage of the technology cycle.

DOMESTIC ACTORS

Section 2 outlined the possible actions that the national government, the central NSI actor, may undertake. Other domestic **actors** can contribute importantly to strengthening climate technology NSIs by better targeting their own capabilities and efforts towards climate-relevant innovation. These actors – for example, private-sector entities, civil society and academia – can also build **linkages** with other actors to strengthen the country's technical, financial and policy activities. For example: (i) civil society and academia can engage in debate on national priorities and pathways to meet climate challenges; (ii) private-sector entities can develop consortia to address specific technical challenges, and they can also participate in public–private collaborative efforts to define national priorities, develop national strategies and action plans, and undertake technology foresight exercises; (iii) government agencies and private-sector entities can collaborate with finance providers to develop instruments that meet funding needs; and (iv) public agencies that support technology adoption and diffusion (e.g. technology extension services) can prioritize the provision of relevant information, advice and support for the diffusion of useful existing and newly developed climate technologies.

INTERNATIONAL ACTORS

International actors can play an important role in complementing, catalysing and accelerating national efforts on strengthening NSIs. These actors may include: national governments, international organizations, bilateral and multilateral agencies, R&D agencies, private-sector entities, philanthropies, non-governmental organizations and civil society. International collaboration may take many forms, including strategic alliances, foreign direct investment, formal joint ventures, contracts, trade, joint development of technology and licensing (Gallagher, 2014). It should be noted that there are a number of ongoing activities undertaken by international public actors to support climate NSI strengthening, one of which is outlined in Box 4. These actors can contribute in many different ways, including by strengthening:

Box 4. International: The Climate Innovation Centres

The Kenyan Climate Innovation Centre (CIC) is the first of a series of CICs being set up by a World Bank infoDev initiative in partnership with Denmark and the United Kingdom of Great Britain and Northern Ireland. The CICs aim to support climate technology innovation in developing countries by providing seed financing, network linkages, technical facilities, business training and support for the design of specialized policy interventions. The Kenyan CIC was seeded with a contribution of USD 15 million in Nairobi, Kenya, in 2012, and focuses on three priority areas: water management, agribusiness and renewable energy. Key activities undertaken by this CIC are: services to help entrepreneurs accelerate their businesses; financing designed to meet business needs across their growth cycle; and market intelligence, matchmaking, and policy advice and advocacy.

- Technical aspects of NSIs, by collaborating on scientific, engineering and other technical R&D, and facilitating the transfer of knowledge and know-how.
- Financial aspects of NSIs, by providing finance to undertake technology demonstration and deployment and help overcome other barriers to innovation, for example, through risk mitigation for early adopters. They can also provide financial support to help build linkages between domestic and international actors.
- Policy and business-model design and development, by providing advisory services or developing good-practice approaches.
- Local capacities of actors, especially in the least developed countries, by training engineers and scientists, entrepreneurs, financial actors (in risk evaluation and financing of climate technology projects), technology extension services and policymakers.

Table 1: Key elements for strengthening the national system of innovation (Source: Ambuj Sagar)

Technology stage	Cross-cutting: strategic analysis and coordination	Basic and applied research	Technology development/ adaptation (including demonstration)	Market-focused product and delivery-model development/ adaptation	Commercialization	Large-scale diffusion
Strengthening of national systems of innovation	· Develop priorities based on mitigation and adaptation options · Identify needs, local capabilities and resources · Identify implementation pathways and innovation gaps · Coordinate activities across innovation cycles	Build scientific research capabilities	· Build scientific, engineering and design capabilities · Understand users and markets and the linkages between the two		· Build manufacturing capabilities · Create early markets · Mitigate risks for early adopters	· Refine the business model · Encourage large-scale deployment · Develop policy review and feedback systems
National-level activities	Identify strategic and coordination agencies	· Provide domestic research and development funding · Support higher education and skills training · Encourage experimentation	Provide financial and technical support for: · Technology adaptation · Product development and demonstration		· Provide finance for scale-up of manufacturing · Mitigate risks of early adopters	· Support diffusion · Create demand
International activities	· Analyse climate and development opportunities · Analyse technology options landscapes and local capabilities · Support implementation pathway design · Identify innovation gaps	· Support scientific research collaborations · Train human resources · Collaborate in joint technology development/adaptation		Technology adaptation	· Provide support for manufacturers · Provide technical support for financial institutions and policymakers for market and risk-mitigation instrument design · Share good practices	· Provide technical support for policymakers · Share good practices · Support diffusion

4 Possible Actions by the Technology Mechanism

The Technology Mechanism can play an important role in strengthening NSIs in developing countries to support and accelerate their efforts to address climate challenges. The Technology Mechanism could carry out the following actions.

OVERARCHING

- Undertake analytical studies that deepen the understanding of the current state of developing country NSIs with regard to climate technology innovation.
- Prepare case studies and synthesize experiences from developing countries to help identify the challenges, good practices and lessons learned in strengthening NSIs with regard to climate technology innovation and executing climate technology implementation plans.
- Communicate and share key findings, good practices and lessons learned to the Conference of the Parties and other key stakeholders.
- Support developing countries to build their NSIs with regard to climate technology innovation in a way that facilitates technology leap-frogging (use of new technologies) and takes into account national priorities and development plans.
- Support the strengthening of developing country NSIs, in accordance with decision 1/CP.16, paragraph 123(c)(ii).
- Encourage developing countries to consider how to strengthen their NSIs when they undertake TNAs and formulate TAPs, and involve their NDE in developing and implementing their TAPs.

ACTORS

- Support developing countries to identify national priorities and implementation pathways for climate technology development/transfer and deployment. These actions will help the country to identify relevant actors and innovation gaps that need to be addressed. This process may be assisted by supporting and encouraging developing countries to undertake TNAs and prepare TAPs. While TNAs have not focused specifically on NSI building, they play a key role in building the capacity of national actors to determine a country's climate technology priorities.
- Support the strengthening of relevant local actors by supporting human resource training, development of technical infrastructure, implementation of good practices, and collaborations and partnerships with international counterparts.
- Support the building of national analytical capabilities of NSI actors with regard to climate technology innovation.
- Encourage developing countries to consider the importance of strengthening their NSIs, including their NDE, when submitting requests to the CTCN.
- Invite developed countries to highlight to the CTCN, through their NDE, how they could support developing countries to strengthen their NSIs. Developed countries could be invited to list relevant national-level:
  - Areas of expertise;
  - Private-sector actors;
  - Research institutions;
  - Development cooperation agencies.

INSTITUTIONAL CONTEXT

- Support the design, strengthening and implementation of policies that facilitate the implementation of national climate technology plans, including by:
  - Holding stakeholder workshops;
  - Facilitating the sharing of experiences, lessons learned and good practices;
  - Providing policy recommendations;
- Support the development of climate technology markets for strategic new technologies.

LINKAGES

- Build on good practices and lessons learned, and undertake focused activities (e.g. workshops, forums or webinars) to promote the strengthening of linkages and collaboration between actors at the local, national and international levels.
- Support the creation or strengthening of geographical innovation clusters.

5 Way forward

A developing country can strengthen its NSI with a concerted national strategy, sustained policy efforts at the national level and effective international support. This will primarily require actions by the national government. However, international support can play an important role in helping to strengthen an NSI by drawing on wide-ranging experiences and expertise. Given the time that may be required to broadly strengthen NSIs, it may be useful to focus on national and international actions that can help to accelerate prioritized climate technology innovation. To do so, a focused approach should be taken that emerges from identified climate priorities and implementation pathways and which concentrates on supporting the strengthening of specific NSI elements. In addition to learning from programmes that aim to strengthen NSIs, greater efforts to build the science, technology and innovation capabilities of developing countries are critical for accelerating their climate actions.

References

- Chaudhary A, Sagar AD and Mathur A. 2012. Innovating for energy efficiency: a perspective from India. Innovation and Development. 2(1): pp. 45–66.
- Chung S. 2007. Excelsior: the Korean innovation story. Issues in Science and Technology. 24(1): pp. 62–69.
- Dai Y and Xue L. 2015. China's policy initiatives for the development of wind energy technology. Climate Policy. 15(1): pp. 30–57.
- Edquist C. 2011. Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). Industrial and Corporate Change. 20 (6): pp. 1725–1753.
- Gallagher K. 2014. The Globalization of Clean Energy Technology: Lessons from China. Massachusetts: Massachusetts Institute of Technology.
- Global Innovation Index (GII). 2014. The Global Innovation Index 2014: The Human Factor in Innovation. Ithaca, Fontainebleau and Geneva: Cornell University, INSEAD and WIPO.
- International Energy Agency (IEA). 2013. Tracking Clean Energy Progress 2013. Paris: IEA.
- International Energy Agency (IEA). 2015. Energy Technology Perspectives 2015. Paris: IEA.
- Kempener R, Anadon L and Condor J. 2010. Governmental energy innovation investments, policies, and institutions in the major emerging economies: Brazil, China, and South Africa. Energy Technology Innovation Policy Discussion Paper 2010-16. Massachusetts: Belfer Center for Science and International Affairs, Harvard Kennedy School, Harvard University.
- Organisation for Economic Co-Operation and Development (OECD). 2014. Science, Technology and Industry Outlook 2014. Paris: OECD.
- Renewable Energy Policy Network for the 21st Century (REN21). 2015. Renewable 2015: Global Status Report. Paris: REN21.
- Stirling A. 2015. Towards innovation democracy? Participation, responsibility and precaution in the politics of science and technology. STEPS Working Paper 78. Brighton: STEPS Centre.
- World Bank DataBank. <http://databank.worldbank.org/>.

Acknowledgements: The Technology Executive Committee extends its appreciation for the expertise and inputs provided by representatives of observer organizations in the development of this TEC Brief.

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About the Technology Executive Committee

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