Analysis of policy options of the technical examination process on mitigation and identification of possible activities for the TEC to take these options forward

PREPARED FOR

TECHNOLOGY EXECUTIVE COMMITTEE (TEC)
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

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23 SEPTEMBER 2016

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EXECUTIVE SUMMARY

At the Conference of Parties (COP) 21 meeting in Paris in December 2015, Parties to the UNFCCC requested the Technology Executive Committee (TEC) enhance their efforts to facilitate and support implementation of mitigation policies, practices, and actions identified through the technical examination process (TEP). In response to this request, the TEC commissioned a research effort to examine the TEP policies and compare them with countries' submissions as contained in the Technology Action Plans (TAPs) and technical assistance requests submitted to the Climate Technology Centre and Network (CTCN). This report summarizes the findings of that research effort.

Energy efficiency – particularly for the industrial sector – is of great interest (as indicated by its frequent occurrence in country plans and intentions), but there is relatively little expertise on this topic in the TEP implemented policies. This points to an opportunity to engage with the private sector and others with a stake in industrial energy efficiency, and take other steps as well to support country interest in this climate change mitigation opportunity.

Various aspects of financing are the largest hurdles towards more widespread implementation of climate change mitigation efforts, as expressed in the databases of country needs, plans, and intentions. These financial hurdles point to a need for basic financial training, assisting countries in making early-stage decisions on financing, matching country plans and intentions with funding sources, and, in general, acting as a bridge between the policy and finance communities. The financing experience in the TEP implemented policies could be collected via surveys and/or interviews, and matched with country plans and intentions.

Case studies of successful TEP policies point to how *non-climate mitigation benefits* (such as local employment, increased income, and improved public health) often drive behavioral change and motivate programme and policy success. The TEC could work with stakeholders that value non-climate benefits to develop comprehensive policies and approaches.

All databases show *high interest in solar PV*, likely due to its rapidly dropping costs and flexibility in application. This finding suggests a role in country-to-country information sharing. Possible activities could include assembling a virtual network of country-level government expertise in solar PV policies, commissioning a report that summarizes lessons learned from the TEP solar PV examples, preparing a guidebook on solar PV finance, and organizing informal information-sharing venues such as webinars. These activities could build on existing formats for information sharing from previous Technical Expert Meetings.

Training – particularly of technicians and workers – is a frequently stated need, as is increased public and stakeholder awareness.

A TEC role in any of the above should be evaluated in the context of the official TEC mandate, and should start with a review of planned and ongoing activities by stakeholders in any of the respective fields, in order to avoid duplication.

OUTLINE

Chapter 1: Introduction and Overview

At the Conference of Parties (COP) 21 meeting in Paris in December 2015, Parties to the UNFCCC requested the Technology Executive Committee (TEC) enhance their efforts to facilitate and support implementation of mitigation policies, practices, and actions identified through the technical examination process (TEP). In response to this request, the TEC commissioned this study, which examines the TEP policies and compares them with countries' submissions as contained in the Technology Action Plans (TAPs) and technical assistance requests submitted to the Climate Technology Centre and Network (CTCN).

A short discussion of institutional background and setting will put this work in context. The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty, entered into force on 21 March 1994. The goal of the UNFCCC is, "to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system."[1]

As part of the process of achieving that goal, the UNFCCC established the Technical Examination Process (TEP) which, "explores high-potential mitigation policies, practices and technologies with significant sustainable development co-benefits that could increase the mitigation ambition of pre-2020 climate action."[2] This process yielded, among other outcomes, a database of 411 policy options that member countries are using to mitigate climate change.[3] This database, hereafter called the '**TEP policies**,'[4] provides valuable examples of what countries are *actually doing* – rather than plans or intentions – to mitigate climate change. An example of a TEP policy is South Africa's procurement process for new utility-scale renewables.

This report compares and contrasts the TEP policies to two additional databases that contain information on what countries would like to do, or are planning to do. The first of these contains the Technology Action Plans or '**TAPs**,' and is an outcome of the UNFCCC's technology needs assessment process (TNA). A TAP is, "an action plan containing a group of measures which address identified barriers to the development and transfer of a prioritized technology."[5] In other words, a TAP is a country plan or proposal for implementation of a climate change mitigation technology or action, and typically outlines steps to accomplishment. An example of a TAP is Mongolia's action plan for efficient lighting, which lays out a number of specific proposed actions (such as reduced import duties for efficient lamps) to increase lighting efficiency in Mongolia. As of July 2016, 146 mitigation-related TAPs have been proposed.[6] TAPs, by definition, have not yet been implemented and may or may not be, depending on finances, politics, and other factors.

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[1] Direct quote from http://climateaction2020.unfccc.int .
[2] Direct quote from http://climateaction2020.unfccc.int/tep/ .
[3] The TEP policies can be found at: http://climateaction2020.unfccc.int/tep/policy-options/ .
As of July 2016, there were 411 TEP policies.
[4] The term 'policies' is used broadly here to include programmes that have a large private sector presence.
[5] Direct quote from http://unfccc.int/ttclear/templates/render_cms_page?s=TNA_history.
[6] The TAPs can be found at http://unfccc.int/ttclear/pages/tech_portal.html .

The second database used here for comparison is the '**CTCN submitted requests**,' which contains formal requests from developing countries to the Climate Technology Centre and Network (CTCN) for technical assistance related to climate change mitigation, made through their national designated entities (NDEs). An example of a CTCN submitted request is Senegal's request for assistance in developing energy efficiency plans and programmes. As of July 2016, there were fifty mitigation-related CTCN submitted requests.[7] Similar to the TAPs, the CTCN submitted requests are intentions rather than operating projects.

Comparing policies that have already been implemented and for which results are available (TEP policies) to country intentions and ambitions (TAPs and CTCN submitted requests) can provide considerable insight into future opportunities for climate change mitigation. Where there is significant overlap – that is, where some countries have successfully implemented a policy, and other countries want to do the same – there is an opportunity for country-to-country learning on how to make that policy work successfully. In contrast, where there are gaps – that is, where some countries have successfully implemented a policy, but few others have proposed to do similarly – then that may be an opportunity to publicize that policy's potential. (Or it may indicate that the policy is not appropriate for other countries). The opposite gap can be revealing as well: If many countries are interested in implementing a policy or programme, but few have actually done so, then more research and pilot testing may be warranted.

This report is organized as follows:

- *Chapter 2* provides results from comparing the 411 TEP policies to the 146 mitigation TAPs. The focus is on commonalities (where there is overlap) and gaps (where the two markedly differ).

- *Chapter 3* provides results from comparing the 411 TEP policies to the 50 mitigation-related CTCN submitted requests. As with chapter 2, the focus is on commonalities and gaps.

- *Chapter 4* provides detailed case studies of six implemented TEP policies.

- *Chapter 5* discusses the results of chapter 2, 3, and 4; with a focus on implications for the TEC.

Throughout this report, the underlying theme is as follows: **What can ongoing and planned mitigation actions tell us about how the TEC can best achieve one of its primary goals, which is to facilitate and support countries in their efforts to implement policies, practices, and programmes to mitigate climate change?** That is the intent of this report.

[7] The CTCN submitted requests can be found at: https://www.ctc-n.org/technical-assistance/data .

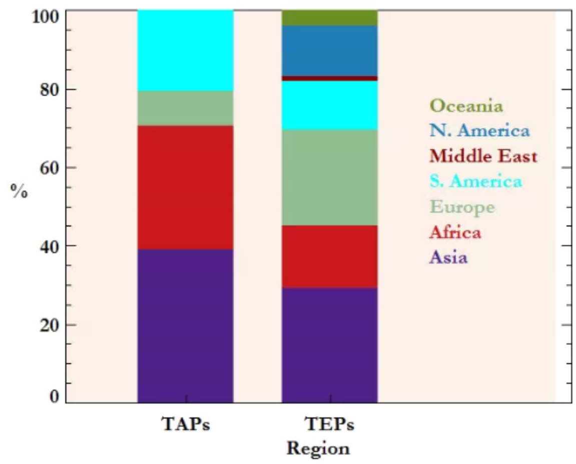
Chapter 2: Comparison of the TEP implemented policies and the TAPs

This chapter discusses results from a comparison of the 411 TEP policies to the 146 mitigation-related TAPs.

2A. Geographic representation

The TEP policies originate from a wide range of countries and regions, including a significant portion (~ ¼ of the total) from Europe. In contrast, the TAPs show a much stronger representation from Asia and Africa, as these two areas account for almost ¾ of the TAPs (and only 45% of the TEP policies). The TAPs are requests for assistance from developing countries, so the pattern shown in Figure 2A is not unexpected. Nevertheless, this figure does suggest the need to consider the specific country development status, as industrialized country policies may not be directly applicable to developing countries.

Figure 2A. Comparison of TEP and TAP geographical coverage.



2B. Thematic areas

Both the TEP policies and the TAPs focus on renewable energy and energy efficiency as areas for climate change mitigation – these two combined account for over half of the TEP policies and over 60% of the TAPs (Figure 2B). Noticeable for both databases is the large percentage – 33% and 38% respectively – on energy efficiency. This suggests that there is both considerable knowledge and experience on how to design and implement successful policies to implement energy efficiency, and great interest in expanding those policies to additional countries. (A more detailed discussion of energy efficiency is provided below in section 2C of this chapter).

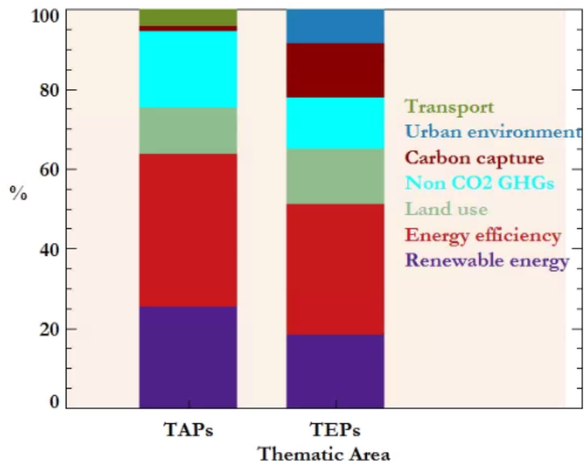
The majority of the renewables-focused TEP policies (73%) were on solar PV, likely reflecting the recent rapid price declines in this technology. Solar PV was the leading technology for renewables-focused TAPs as well, followed closely by wind and hydro.

Notable in Figure 2B is the relatively high occurrence of carbon capture (sometimes called CCS, for carbon capture and storage; or CCUS, for carbon capture, use, and storage) in the

TEP policies[8], in contrast to its very low occurrence in the TAPs. This disparity appears to indicate relatively little interest in carbon capture in the developing world – probably due to its relatively high cost and demonstration-phase technical status.

The thematic area of 'urban environment' is notable as well, for a pattern similar to CCS: it appears often in the TEP policies database, but rarely in the TAP database. (An example of an urban environment TEP is Mexico's sustainable cities program, which includes building large numbers of new, environmentally sustainable housing). The TEP policies reveal numerous examples of cities and regions taking innovative steps to lower the carbon footprint of their urban areas. This does suggest an opportunity for city and regional decision-makers in developing countries to lead sustainability efforts.

Figure 2B. Comparison of TEP and TAP thematic areas.

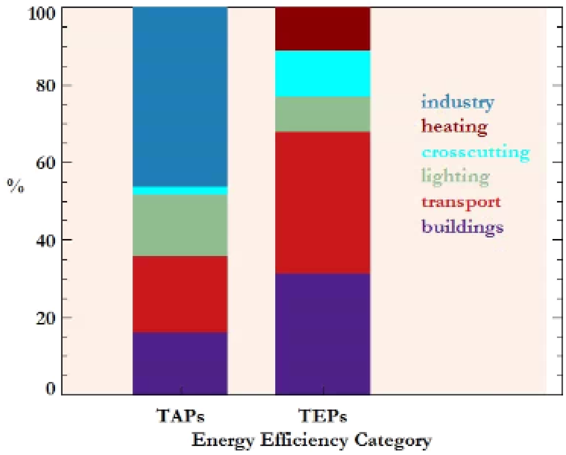


2C. A closer look at energy efficiency

The high occurrence of energy efficiency improvements in both TEP policies and TAPs suggests an opportunity for country-to-country learning, as those with experience (TEP policies) could guide those just beginning the process (TAPs). However, a breakdown of those efficiency policies and plans paints a more complex picture. As shown in Figure 2C, almost half the efficiency TAPs are for industrial efficiency, while few of the TEP policies directly address this sector. (Industrial energy efficiency includes, e.g., programmes to implement improved electricity generation technologies, industrial boilers, and other industry-specific technologies such as those for brickmaking). An example of a TAP related to industrial energy efficiency is Sudan's plan for improving the efficiency of industrial boilers in small- and medium-sized food, beverage, and textile industries.

[8] Most of these TAP CCSs were roadmaps or similar analysis documents, rather than in-the-ground physical projects.

Figure 2C. Comparison of TEP and TAP energy efficiency foci.



The prevalence of industry efficiency TAPs suggests that there is a recognized potential for improved energy efficiency in industry, at least in the countries that have prepared a TAP so far, and an interest in drawing on that potential. A closer look at these industrial energy efficiency TAPs provides further insight into country interests. Three-fourths of the industrial efficiency TAPs relate to fundamental and basic machinery for industry – turbines, boilers, burners, and furnaces (Table 2A). This is notable in that these technologies are widely applicable across industrial sectors – for example, improved boilers could improve energy efficiency in many types of industry, from food production to light manufacturing to agricultural processing.

Table 2A. Industrial energy efficiency interests by type as revealed in the TAPs.

Type/Category	%	Examples
Electricity generation	37	-High-efficiency combined cycle natural gas turbines -Supercritical coal technologies
Iron, steel, metals production	21	-Induction furnace -Waste heat recovery
High-temperature heat for industrial processes	17	-High-efficiency boilers -Regenerative burners
Other	25	-Variable speed drives for industrial motors -Combined heat and power (CHP)

Note: '%' refers to the percentage of industrial energy efficiency TAPs that are of that type.

2D. Policy instruments

Both databases contain data on 'policy instruments' – the overall policy approach or tool that is used (in TEPs), or intended to be used (in TAPs). As shown in Table 2B, a leading category for both is 'policy support' – a high-level category including policy frameworks, technology roadmaps, building networks with stakeholders, and feasibility analyses. However, for the TAPs, most (89%) indicated an interest in economic and financial policy instruments, while only one-third planned to pursue a regulatory approach. This suggests that market-based approaches and/or co-funding, rather than regulatory approaches, are of greater interest.

The relatively high (41%) occurrence of R&D in the TAPs is surprising. A closer look at the TAPs suggests that, in most cases, R&D is used to mean 'technology feasibility' or 'technical applicability' rather than research and development on the technology itself. In other words, R&D as used in the TAPs usually refers to determining how well a technology works in that specific country setting, rather than more fundamental questions of basic science or technology development. An example is Azerbaijan's small hydro TAP, which notes the need for R&D to collect improved streamflow data for hydro siting. In this example, the TAP includes environmental monitoring under the term R&D.

Table 2B. Comparison of TEP and TAP policy instruments.

	TEP policies- %	TAPs - %
Policy support	47	81
Economic and financial	24	89
Regulatory	15	33
R&D	7	41
Voluntary	6	0

Note: Most TAPs indicated the need for more than one policy instrument, so the percentages for the TAPs add up to more than 100%.

2E. Needs

The individual TAP submissions provide detail on what measures the requesting countries would need to accomplish in order to implement their proposals. An analysis and grouping of these stated needs, as shown in Table 2C, reveals some interesting patterns. First, note that 6 of the 9 highly-ranked needs (defined as those appearing in 20% or more of the TAPs) relate to *finance* – how the proposed plan is to be paid for. This suggests that various aspects of *finance are perhaps the most important issues for implementation*.

The TEP policies, in comparison, can all be said to have addressed the various financing issues as they are, by definition, implemented actions rather than plans. Of course, many do not require explicit up-front financing, or have only modest costs. Examples of these include Nicaragua's tax exemption for renewable energy equipment, Scotland's preparation of a CCS roadmap, and Chile's carbon tax.[9] Others do require up-front investment, examples include:

- The USA's 'SunShot' solar PV R&D effort is funded directly by the national government.
- The Ukraine's Sustainable Energy Funding Facility is funded by the Clean Technology Fund and the Global Environment Facility.
- Seoul's expanded bus transit system was largely paid for by the city government.

The need for financing to be tailored to the specific programme points to an opportunity for TAPs to learn from similar TEP policies that contain detailed financing information.

[9] Tax exemptions do have costs (in the form of reduced government revenues), and carbon taxes impose costs on carbon emitters, but these policy options do not require significant up-front monetary investment by the government.

Table 2C. TAP needs analysis reveals relevant keywords that appear in 20% or more of the TAPs.

Keyword	% of TAPs using that keyword	Examples of how that keyword is used in the TAPs
Train/training	45	-train technicians and workers -technical training courses -train stakeholders
Incentives	35	-create incentives -provide financial incentives -investment incentives
Awareness	32	-public awareness campaigns -promote awareness -stakeholder awareness
Loan/loans	32	-low-interest loans and grants -organize loans -long-term loans
Financial	27	-create financial fund -create financial incentives -establish financial mechanism
Fund	27	-create/establish fund -develop long-term funding policy -mobilize funding
Tax	26	-tax exemption -tax incentives -favorable tax policies
International	23	-international cooperation -apply for international funding -international experts
Invest/investment	22	-create financial mechanisms to generate investment -private investment -generate investment funds

The single most frequently stated need is *training* – it can be found in slightly less than half (45%) of the TAPs. There is clearly a significant perceived need for in-country expertise, largely related to technology. A closer look at the training needs, as shown in Table 2D, shows that training of technicians and workers was the most frequently-stated training need, noted by one-third of the TAPs. Stakeholder and public training, establishing training programmes and workshops, and creating formal courses and programmes were of considerable interest as well (table 2D).

Table 2D. Breakout of training needs in the TAPs.

Type/Category	% of TAPs noting this need
Train technicians and workers	33
Train stakeholders and/or the public	13
Establish training programmes, workshops, or centers	13
Establish university/vocational courses or programmes	12

Note: Some TAPs mentioned more than one type of training need.

Also of note is the interest in *public and stakeholder awareness*. In almost all cases, awareness raising in the TAPs are seen as an element of programme success, rather than a goal in and of itself. That is, when a TAP includes public and/or stakeholder awareness as an element of its proposal, it is in the context of building overall consensus, ensuring political support and public participation, and ensuring all stakeholders are supportive; awareness alone is not the goal of the proposal. An example is Senegal's plan for enhancing electricity production from biomass, which includes an awareness campaign among biomass producers and other stakeholders.[10]

2F. TEP policies and TAPs: Summary

The TEP policies and TAPs share a focus on energy efficiency and renewable energy. The TAPs, however, favor industrial energy efficiency, in contrast to the TEP policies' greater focus on buildings and transport. The two also differ markedly on CCS and urban environment – which are reasonably popular in policies in place (TEPs), but of almost no interest as revealed in the TAPs.

Various aspects of identifying and accessing finance are clearly the greatest needs as seen in the TAPs. This need is expressed as a variety of terms (e.g., loans, tax, investment), but all reveal the challenge of financing the ambitious TAPs.

Also notable are the needs for training, specifically training for workers and technicians, and for increased awareness by stakeholders.

[10] "Mener auprès des producteurs de biomasse, des autoproducteurs d'électricité et des concessionnaires d'électrification rurale, une large campagne de sensibilisation et d'information sur les avantages, le potentiel et le cadre réglementaire en vigueur…" Source is http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TTF_TEI/b0f1cb0f587f43e3b34276584e2d1f8a/d2b10e0753c14ee68a4a895ee7e88faa.pdf .

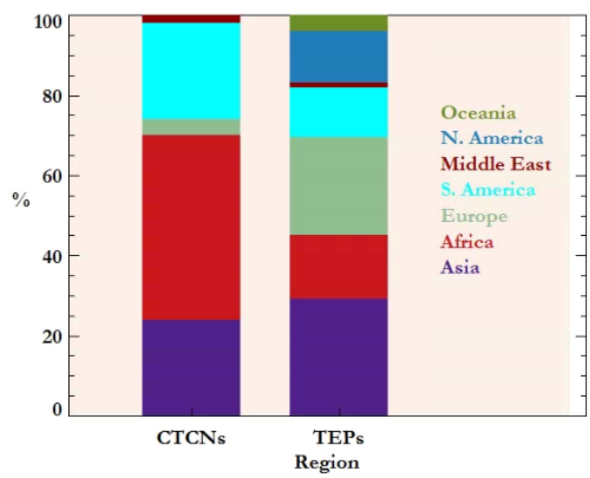
Chapter 3: Comparison of the TEP implemented policies and the CTCN submitted requests

This chapter discusses results from a comparison of the 411 TEP policies to the 50 mitigation-related CTCN submitted requests.

3A. Geographic representation

The overall distribution of the CTCN submitted requests is similar to that of the TAPs: they come largely from developing regions (Figure 3A). This is as expected, as developing countries are encouraged to formulate and submit CTCN requests. Nevertheless, as noted in chapter 2, this is a useful reminder of the need to keep country context in mind – that what works in an industrialized country may not work the same for another country that is developing its economy.

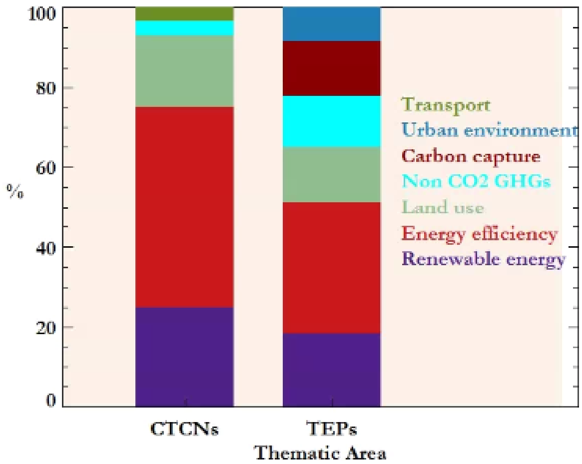
Figure 3A. Comparison of TEP and CTCN geographical coverage.



3B. Thematic areas

The CTCN submitted requests show a strong emphasis on energy efficiency, which accounts for 50% of the requests (Figure 3B). This reinforces the preliminary finding discussed in chapter 2, that energy efficiency is of great interest in some developing countries. A breakdown of the energy efficiency-focused CTCN's shows that interest in energy efficiency technologies for industry (including the electricity supply industry) and for buildings is the highest, followed by lighting and cross-cutting energy efficiency efforts.

Figure 3B. Comparison of TEP and CTCN thematic areas.



Note: CTCN submitted requests classified as 'cross-sectoral' and 'waste management' are not shown in Figure 3B, as there is no corresponding TEP category.

3C. Needs

Similar to the TAP analysis method, the CTCN submitted request keywords were analyzed to find out those that occurred most frequently. The results, summarized in Table 3A, largely reflect the CTCN's emphasis on technology (rather than policy), with frequently-stated needs for technology assessment, demonstration and pilot plants, and technical support. These technology needs fall under the general heading of 'technology applicability' – that is, they are not R&D in the sense of fundamental technology research or development, nor are they at the detailed level of specifying technologies for specific applications (e.g., manufacturer and model). Rather, they are at the level of seeking a better understanding as to what types of technologies fit what types of applications, and determining how or if a technology will function in a specific setting.

Notable as well however are needs related to people and institutions – capacity building, technical support, and workforce training (Table 3A).

Table 3A. CTCN submitted requests – keyword analysis.

Keyword	% of CTCN submitted requests using that keyword	Examples of how that keyword is used in the CTCNs
Assessment	24	-technology assessment
Capacity	18	-capacity building
Plant	18	-demonstration plant -pilot plant
Building	16	-capacity building
Efficiency	16	-energy efficiency
Waste	16	-waste management -waste disposal
Support	14	-technology guidance, support -technical support
Training	14	-workforce training
Business	12	-business plan/model -business development

3D. TEP policies and CTCN submitted requests: Summary

The CTCN submitted requests are, by definition, very technology-focused: the CTCN programme is intended to provide technical assistance on climate technologies. Energy efficiency technologies – particularly for industry (which includes the electricity supply industry) are of the greatest interest, followed by renewables. In contrast to the TEP policies, the CTCN submitted requests show little or no interest in CCS, non-CO_2 GHG mitigation, or urban environment development. The technology-related needs in the CTCN submitted requests are largely focused on 'technology applicability' – determining which technologies will fit their specific needs.

Chapter 4: Case Studies from the TEP implemented policies

Six case studies from the database of 411 TEP policies were selected for further analysis. The criteria for selection were:

1. Geographic and economic diversity. Case studies are drawn from India, the Philippines, South Africa, Niger, Bangladesh, and Cabo Verde; and thus represent a range of geographic areas and GDP per capita levels.

2. Technical diversity. Three case studies are on renewables (one on small-scale distributed, one on mini-grid, and one on large utility-scale), one on building energy efficiency, one on agricultural crops, and one on livestock. Thus, they cover a wide range of technologies and sectors that have climate change mitigation potential.

3. Potential for widespread application. Each selected case study illustrates a policy or approach that could be applied to other countries.

4. Uses and/or builds endogenous capacity. Although some of the case studies use international expertise or funding to start up, all include a focus on making use of, and/or building, endogenous capacity.

5. Imaginative, new approach. Each of the case studies illustrates a new and imaginative approach to climate change mitigation.

6. Success. All case studies can be considered successes in that they met their goals, demonstrated a new approach, and/or show promise as a method for climate change mitigation.

Each case study is first described, followed by a brief discussion of what principles, lessons learned, and/or implications that can be drawn from it.

4A. Case Study 1: Dairy cow productivity in India

Agriculture is a significant source of greenhouse gases: It is often an energy-intensive sector, due to its many high-energy inputs (notably nitrogen-based fertilizers), agricultural soil management is a primary source of nitrous oxide (a potent greenhouse gas), and it is directly responsible for significant methane emissions that come from livestock. Managing those emissions – while feeding the world's growing population – is a challenge.

An innovative programme in India nicely demonstrates how improved nutrition for livestock, delivered by village-based trained experts, can improve agricultural productivity and significantly reduce GHG emissions.

Dairy cow productivity (as measured by kg milk produced per day per cow) can be improved significantly if cows are fed an appropriate diet. Cows need the right mixture of minerals and other nutrients, without which their health and milk output suffers. In addition, cows' nutritional needs vary depending if they are producing milk, pregnant, or immature. And a further complication is that locally available feeds may vary seasonally as well depending on the season, rainfall, and other variables.

Matching cows' nutritional needs with varying locally available feeds is a complex problem – one largely solved, however, with software developed by the National Dairy Development Board (NDDB) of India. This user-friendly software runs on laptops and small handheld devices, and tells animal owners how to make optimal use of available feeds to keep their cows healthy and productive.

A primary challenge is getting that tool into the hands of users. To accomplish this task, a local resource person is selected and hired. They are then provided with a two-week training program, which includes training on how to use the software. Once trained, the person is provided with a handheld computer, which is linked to a central server. That person is initially paid ~USD 30/month initially, however that salary is gradually replaced with commissions from sales of minerals and related supplements. The local resource person then works directly with farmers and animal owners to devise a least-cost feed mix for the cows.

Field testing of the programme has found a number of benefits: Improvement in milk production, increase in daily net income, reduction in parasites, and improvement in overall cow health. From a climate change perspective, a particularly notable result is a 15-20% reduction in enteric methane emission per kg of milk produced (FAO, 2012).

This programme nicely illustrates three principles of successful programme design:

- The critical role of a knowledgeable and trained community-level person, who understands the culture and is trusted by local decision-makers.
- The importance of locally-valued benefits. Reduction in methane emissions is of great value for climate change mitigation, however the increased milk production (and resulting increased income) are what drives farmer's participation.
- The potential of information technologies and knowledge to change behavior. In this example, a small and inexpensive hand-held device – in the hands of a trained and trusted individual – allowed for dramatic improvements in food production and income.

4B. Case Study 2: Green buildings in the Philippines

Buildings are responsible for a significant share of global GHGs. Keeping the world's buildings heated, cooled, and lit is energy-intensive; and new building construction adds to the burden. Fortunately, technologies and construction practices are available that allow buildings to be comfortable, well-lit, and low-cost, as well as energy efficient. These technologies are commercially available and cost-effective.

The challenge, as is often the case, is *implementation*. How does one design institutions, policies, and incentives, such that buildings are energy-efficient? A public-private effort in the Philippines, driven largely by industry and having only a small but essential policy role, illustrates the possibilities.

The Philippines Green Building Council (PHILGBC) is a non-profit organization that promotes and facilitates ‘green’ buildings – buildings that minimize their environmental impact. This includes water use, waste reduction, landscaping, and – perhaps most importantly – energy efficiency. One of the PHILGBCs’ main activities is the development and promotion of the Philippines’ national voluntary green building rating system (BERDE). Determining a building’s overall energy efficiency and environmental impact is a challenging task, yet without some measure of this, potential building buyers and renters have no basis on which to make informed decisions. Similarly, any future policy preference for green buildings (such as tax breaks or regulations requiring green construction) hinges on the availability of a credible, analytical, and widely recognized measure or indicator.

The Philippine’s BERDE rating system was developed through a multi-stakeholder consultation process, and represents a consensus on how to best represent a building’s energy and environmental footprint. Once a building earns a high rating, that rating can then be used to attract tenants and investors who see value in their building being green. That perceived value can take many forms, such as lower energy and other operational costs, consistency with the tenant’s mission and culture, or a higher market value for the property. BERDE is available for new construction, retrofits, and building operations. In addition, the PHILGBC offers training for those seeking to become certified BERDE assessors.

The government’s role in BERDE is modest, yet critical. The Philippines Department of Energy (DOE) officially recognizes BERDE as the national voluntary green building rating system, partners with PHILGBC on training and capacity building, and gives public recognition to BERDE certified buildings.

The combined efforts of the DOE and the PHILBGC to produce the BERDE was composed almost entirely of in-country resources and expertise. The PHILGBC is a member of the World Green Building Council, and some of the DOE’s energy efforts have been supported by the Asian Development Bank, but BERDE is Philippine-designed and implemented.

It remains to be seen whether the market will choose the BERDE rating or the LEED rating system. In any case, the BERDE story does show how the private sector can lead on an important mitigation component such as building energy efficiency. This effort also illustrates several generalizable aspects of policy efforts to promote energy efficiency:

- There is a market for energy efficiency, and the private sector will – if it sees market potential – take the lead in efforts to tap that market. The government role in BERDE is modest; it is largely a private sector effort.
- Governments can certify and participate in labelling and measuring systems, but there can be advantages in maintaining some distance from such efforts, including reduced costs to the government and greater private sector engagement.
- Public-private partnerships, with governments taking a minor yet well-designed role, are a critical tool for addressing climate change.

- The private sector can tap into international expertise (the World GBC, in this case); when that expertise is demand-driven (that is, based on direct in-country requests) it may be a better fit with in-country needs.

4C. Case Study 3: Bangladesh home solar program

Over one billion people in the world do not have reliable access to electricity. Providing electricity improves quality of life, public health, income, and also mitigates climate change by replacing inefficient use of traditional fuels (such as wood, crop wastes, and dung) with efficient and potentially renewable sources.

In much of the world, electricity is provided by large electric power plants that deliver electricity via an extensive transmission and distribution system (a.k.a. 'the grid'). However, in rural areas, such a system may not be feasible. Interest in distributed electricity systems – in which electricity is generated at or near where it is consumed – is growing, due to the need to provide electricity in areas not served by the grid and by sharp decreases in the costs of distributed generation technologies.

Bangladesh has an electrification rate (the percentage of the population with reliable access to electricity) of just 60% (World Bank, 2014), and is in dire need of solutions that can provide reliable, low cost, and environmentally-friendly electricity. Distributed renewables can be part of the solution for Bangladesh.

Bangladesh has had considerable success with an innovative programme that provides households with small solar electricity systems. The programme provides low-cost, small solar PV systems for residences. The households typically make a down-payment of 10-15%, and the remainder is financed over 2-3 years at market interest rates. (The average cost of a 40 W_p peak system is USD 300). Due to a fortuitous confluence of factors (notably improved appliance efficiency allowing for smaller PV systems and sharp drops in PV prices), residents can pay less than they were paying for kerosene and, in addition, all but the smallest systems are built and financed without subsidy.

This programme started out small, with installations of just 11,000 systems in 2003, however, fine-tuning of the programme with particular attention to financing led to installations approaching one million by 2013. A key to its success was the establishment of a government implementing agency, IDCOL (Infrastructure Development Company Limited), with a mandate to provide financing for private infrastructure projects. IDCOL's role includes setting technical specifications, certifying products, and selecting partner organizations.

The benefits of the programme go beyond saving households money and providing higher-quality light, refrigeration, and other end-use services. A programme evaluation showed that participants increased food expenditures by 10% - as scarce household income was freed up from kerosene and moved to food (World Bank, 2014). Reductions were seen in respiratory ailments, due to reduced or eliminated in-residence burning of kerosene. There have been considerable macro-economic benefits as well: All the system components are made in Bangladesh, providing domestic employment in a growing industry. Bangladesh has, by one estimate, 127,000 jobs in solar PV (IRENA, 2016, p.17), many of which are a result of the solar home program.

Although not all of aspects of this programme is necessarily replicable in other countries (for example, Bangladesh's high population density allowed for vibrant market competition, driving down costs), this story does point to several findings for future efforts to mitigate climate change:

- It is not always necessary for distributed renewable electricity systems to be subsidized. Such systems can be financially self-sustaining, depending on local conditions.
- Innovative finance is a critical component for distributed renewable electricity systems.
- Ensuring technical quality is critical for building consumer trust. Rigorous and enforced technical standards, with strong government backing, are a necessity.
- Governments have an essential role to play, even in programmes that are privately financed and implemented. In this case, that role included technical specification-setting and certification.

4D. Case Study 4: Re-greening Niger

Agricultural lands stressed by drought, inappropriate use of fertilizers, and overproduction will require greater and greater inputs (water, fertilizer, and seed) but yield less and less. This vicious circle can result in barren lands, sharply reduced income for farmers, and – in the worst-case scenario – starvation.

A thoughtful and imaginative programme in Niger has put a halt to this deadly pattern, and has resulted in the restoration of approximately five million hectares of degraded farmland. This case study is partly one of climate change mitigation, as the need for energy-intensive agricultural inputs (notably fertilizer and water) has been sharply curtailed. However, it is also a story of climate change adaptation, as the restored lands will be more resilient to the coming changes driven by climate change.

In the 1960s and 1970s, demand for firewood and wood products in Niger resulted in many of its large trees being cut down. The lack of trees left the soil vulnerable to drought, winds, and over-use. Add this to a growing population, and the tragic result was widespread malnutrition and starvation. There were periodic replanting efforts, however these were largely unsuccessful due in part to a lack of local engagement: Local decision-makers were not engaged in decisions as to where new trees should be planted, what kind of trees were appropriate, and who should take care of them.

Beginning in the 1980s, however, careful observation by researchers found that underneath the degraded soils remained a network of living roots – remnants of the trees that formerly occupied the lands. Careful nurturing of these roots (in contrast to the then-common practice of 'cleaning' the soil by hacking them away) showed that allowing trees and shrubs to co-exist with harvested crops dramatically increased yields and reduced the need for fertilizers and other energy-intensive inputs. The practice of "farmer-managed natural regeneration" spread quickly from farmer to farmer, due to clear and direct economic benefits for farmers. According to a local authority, when referring to a plot of land surrounded by three large trees, “it would give you about 60 kg millet for one harvest. A plot of land the same size in a field with no trees might yield 15 kg at most.” (WAC, 2013, p.11). The science behind this is well-known, the trees ‘fix’ nitrogen in the soil and make it available for the harvested crops.

Satellite imagery reveals that approximately five million hectares have been re-greened, and the practice appears to be well-entrenched in local decision-making. Farmers in other parts of the Sahel are adopting the practice as well (WRI, 2013).

This success story points to several lessons learned:

- In contrast to the expensive, and largely unsuccessful, large-scale replanting effort (funded primarily by international donors), the farmer-managed natural regeneration was low cost, had modest international involvement, and no “hardware”; it was simply a smarter way of doing things.
- Farmers changed their behavior because they could see the immediate and direct benefits of doing so: increased yields and reduced inputs. The climate change mitigation and adaptation benefits are significant, but since they accrue to society overall, they may not be effective drivers for individual behavioral change.
- Good ideas with direct benefits can spread by themselves.

4E. Case Study 5: South Africa’s competitive bidding process

Large-scale renewable electricity is growing rapidly, as costs come down and the technologies mature. The policy challenge is how to design market mechanisms that yield low cost, reliable, and appropriate installations of new renewables. South Africa’s renewables procurement programme has emerged as a successful model, and provides valuable lessons on policy innovation.

South Africa set national goals for renewables in 2003, and in 2011 launched a process of competitive bidding to get utility-scale renewables in place. The resulting program, known as REIPPP (Renewable Energy Independent Power Procurement Program), was designed in close collaboration with the private sector. The first request for proposals (RFP) was issued in 2011. The Department of Energy (DOE) managed the process, and instead of receiving an expected 12 bids, had 53 bids submitted, 28 of which were identified as preferred. Contracts were signed in November 2012, and the first project came online in November 2013. Subsequent bidding rounds saw reduced prices and robust bidding. By the third round, wind prices were down to 7.5 US cents/kWh and PV to 10 US cents/kWh - dramatically lower than for the first round. Overall, the first three rounds of the programme attracted USD 1.5 billion of private investment and resulted in new renewables totaling almost 4 GW. This programme was very successful in getting low-cost renewables in place and operational, with minimal delays.

The programme not only had renewables as a goal, but economic development as well. Thirty percent (30%) of total bid value was based on economic and social development factors. This was controversial, due in large part to the difficulty in quantifying these factors, yet by one measure, the RE projects under this programme generated 20,000 temporary construction jobs and 35,000 operational jobs. (Eberhard et al., 2014, p. 28).

A comprehensive review of the programme (Eberhard et al., 2014) identified several lessons learned, including:

- Adopt a business-friendly approach, which includes offering at least the potential for profit, and appropriate minimization of risk.
- Define and maintain the arguments for renewables. In this case, the economic development benefits of renewables helped maintain public and political support for the program.
- Find a programme champion. In this case, a high-level management team was created – one that had credibility with potential investors. This helped minimize investors' perceived risk.
- Programme procedures need to be professional. Competitive bidding is a complex process, and REIPPP placed great emphasis on making the process transparent, on-schedule, and credible.

4F. Case Study 6: Cabo Verde's hybrid mini-grid

Small island developing states (SIDS) typically use diesel for electricity production, which is expensive and subject to price volatility. Solar PV appears to be an ideal replacement technology, but suffers from its own challenges – notably intermittency and high (although rapidly falling) costs.

The Republic of Cabo Verde, a volcanic archipelago off the coast of West Africa, has had some success with an innovative solar PV mini-grid. Their experience provides some insight into how low-carbon technologies can provide multiple benefits, but also demonstrates that finding the right financial model is a continuing challenge.

Monte Trigo, a remote fishing village of 450 people on one of the Cabo Verde islands, used a 40 kVA diesel generator to provide electricity. Electricity was available only about 5 hours per day, and obtaining a reliable supply of diesel fuel to this remote location was expensive and problematic.

In 2012, the diesel system was replaced with a 40 kW_p solar PV mini-grid with battery storage. This new system provides electricity 24 hours/day, and has allowed for the installation of two ice making machines. This has in turn boosted residents' income, as they can now freeze their daily catch – frozen fish commands a much higher price than dried fish. The ice makers are a deferrable load, which increases system flexibility.

The system is operated and maintained by the local municipality and the local water company, which partnered to establish a new organization. This new organization involves local users as system caretakers and fee collectors, building endogenous capacity and providing further local economic benefits.

The original tariff scheme had users paying a flat rate for an agreed-upon amount of electricity. This would have provided a predictable income level, and was designed to produce sufficient revenue to cover both O&M expenses as well as to establish a fund for longer-term equipment replacement. (First costs for the system were covered by an ACP-EU grant [75%] and the local government [25%]). However, this scheme was not approved at the national government level, and is still under discussion.

Lessons learned include:

- 100% PV with storage is technically feasible, although not inexpensive.
- Innovative tariff structures may require high-level approval, which takes time.
- Local institutions can play essential roles in system operation and maintenance.

4G. Summary and Conclusions

These six case studies are quite diverse, covering a range of technologies, approaches, and settings. However, they all share the important trait of providing in-country economic benefits, building in-country capabilities, and using mostly in-country resources (expertise and capital) as inputs. Overall lessons learned include:

- Private sector investment is critical, and can be encouraged by appropriate risk reduction and the lure of profit.
- Both renewable energy and energy efficiency can be profitable; they do not necessarily require continuing subsidy.
- Governments clearly have a role, notably in ensuring and enforcing technical quality and standards.
- Immediate, visible, and highly-valued benefits will change individual behavior.
- Local champions are essential for projects implemented at the local level.

The following chapter discusses these findings and their implications for possible activities for the TEC.

Chapter 5: Implications for the TEC

The analyses of the three databases, detailed in chapters 2, 3, and 4, yielded a number of diverse findings. This chapter summarizes these findings and discusses their implications for the TEC.

5A. Summary of findings from the TEP, TAP, and CTCN databases

Energy efficiency is of great interest in the TAPs – even more so than renewable energy. Industrial energy efficiency is of the highest interest, yet other sectors (buildings, transport, lighting) show up as well. There are very few examples of successful industrial energy efficiency programmes in the TEPs however. This is clearly a 'gap,' with high interest and low experience. Taking a closer look at industrial energy efficiency, the TAPs show that most (75%) are targeted at the fundamental heavy machinery of industry – e.g. turbines, boilers, and burners.

Renewables are not far behind efficiency as a tool for climate change mitigation, and solar PV is the renewable technology showing both the highest interest (TAPs and CTCN submitted requests) and the highest level of experience (TEP policies). This is a 'commonality' – an area in which there is both interest and experience.

The area of 'urban environment' (sustainable development plans and programmes at the city level) is a 'reverse gap' – with high experience and low interest to date. This apparent low interest may be due to limited applicability in many developing countries (perhaps because many cities lack funds and credit ratings that would support such an effort), or it may simply be that the TAPs and CTCN requests focus on national rather than regional or city-level efforts.[11]

The needs expressed in both the TAPs and the CTCN requests are diverse, but do fall into three groupings. In the TAPs, finance is clearly the greatest need. This is expressed in several different terms (e.g. financial incentives, tax policies, funding), but is all referring to the challenging and fundamental issue of how to secure the funds for the proposed plan. Also highly ranked as TAP needs are training (as in training technicians and workers) and awareness (such as building awareness in stakeholders). The CTCN requests make clear the need for technology applicability support, meaning assistance in determining a technology's applicability to a specific country.

The case studies add a richness of detail to the above, with some important additions. Chief among these are (1) local benefits (such as employment or increased income) drive local participation, (2) efficiency and renewables can be profitable investments, and thus can attract private capital, and (3) governments play a critical role in technology certification, standard-setting, and enforcement.

[11] The NAZCA effort tracks efforts by cities and others to address climate change – see http://climateaction.unfccc.int .

5B. Implications for the TEC: TEC functions

Possible TEC activities, based on the above findings, need to be considered in the context of the TEC functions – that is, the mandate and purpose of the TEC (Figure 5-1).

Figure 5-1. TEC functions.

TEC functions

1. **Overview and analysis**
   Provide an overview of technology needs and an analysis of policy and technical issues
2. **Promotion**
   Recommend actions to promote technology development and transfer
3. **Guidance**
   Recommend guidance on policies and programmes, with special consideration to the least developed country Parties
4. **Collaboration**
   Promote and facilitate collaboration between technology stakeholders
5. **Addressing barriers**
   Recommend actions to address barriers to technology development and transfer
6. **Cooperation**
   Seek cooperation with technology stakeholders and promote coherence across technology activities
7. **Technology road maps and action plan**
   Catalyse the development and use of technology road maps or action plans

Source: TEC 2016-2018 rolling work plan, available at http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEC_column_M/0fb1009f2d3b4f43b7ebcb16bbb60c8d/dcdf79ce412d46159ba7311252c9be18.pdf

It's also useful to consider the functions of the CTCN, which is (along with the TEC) a body of the TEC Technology Mechanism. The CTCN:

> …facilitates the transfer of technologies through three core services: providing on climate technologies; fostering collaboration among climate technology stakeholders via the Centre's network of regional and sectoral experts from academia, the private sector, and public and research institutions.[12]

The two entities' defined functions are quite high-level, and appear to give the TEC considerable leeway in scope and focus. Nevertheless, any proposed TEC activity should fall within the TEC functions, and should not duplicate existing or planned CTCN activities.

5C. TEC option: Industrial energy efficiency

One option for the TEC is to focus on energy efficiency, and in particular energy efficiency opportunities in industry. This identified 'gap', which includes policies and technical issues related to climate technology development and transfer in the field of industrial energy, is of high interest in many developing countries. Industrial energy efficiency expertise does exist (see e.g. Goldberg et al. 2014), but it is not as widely held or recognized as it is in other sectors, such as buildings or transport. This is due in part to each type of industry having its own technical needs and characteristics, and because most governments play a very limited role in industrial energy efficiency.

[12] Direct quote from http://unfccc.int/ttclear/templates/render_cms_page?TEM_ctcn .

However, as noted above, three-fourths of the industrial efficiency TAPs relate to fundamental and basic machinery for industry – turbines, boilers, burners, and furnaces. Many of these technologies are similar across industrial sectors, suggesting an opportunity: efforts to enhance take-up of efficient boilers, for example, could be applicable to many types of industry.

TEC activities in industrial energy efficiency could involve, for example:

- Commissioning a study or technical paper that documents and breaks down the industrial energy efficiency potential by industry sector and technology. This would allow for pinpointing the industrial areas that appear most promising for future climate change mitigation efforts.
- Holding a kick-off meeting or thematic dialogue with stakeholders. These stakeholders could include industry groups that share an interest in energy efficiency, as well as government officials with responsibility for industrial energy.
- Assembling a team of industrial energy efficiency experts, and having that team give a series of workshops or seminars in how to implement industrial energy efficiency. Such a team should have expertise in both technologies and financing, and should include individuals with industry experience.

These proposed activities appear to fall under TEC functions 4 (collaboration) and 6 (cooperation) (see figure 5-1). Nevertheless, if the TEC were to pursue any of these, the next step would be to review existing and proposed activities by other groups to ensure there is no duplication of efforts.[13]

5D. TEC option: Finance

Climate change mitigation technologies are widely available, technologically mature, and – in most cases – more capital-intensive than the technologies they need to replace. One estimate is that annual global investment in renewables alone must double from its current levels, to reach USD 500 billion per year (IRENA 2016) in order to limit global mean temperature rise to below 2° Celsius. And most of this must come from the private sector, as public investment funds are simply not available at this level.

The financing issue, overall, is not just one of insufficient funds. Funds, when available, need *investable projects* – those that offer an acceptable level of risk and return to potential investors. So the challenge is not just to find funds, but to ensure that climate change mitigation projects are available and appropriate for investment.

As clearly evidenced in the TAPs, decision-makers are well-aware that financing of climate change mitigation efforts is critical. What's rather striking, however, is that most of the TAPs and CTCN requests show very little depth in the area of finance. Most merely note that financing will be necessary, but go no further.

[13] See e.g. Copenhagen Centre on Energy Efficiency (2016), http://www.iipnetwork.org .

This suggests an opportunity for the TEC to have a closer look on financing issues, e.g. identifying which existing initiatives are involved in providing basic financial training, assisting countries in making early-stage decisions on financing, matching country plans and intentions with funding sources, and in general acting as an essential bridge between the policy and finance communities. Specific TEC activities could include:

- Identifying and liaising with organizations that offer web-based tutorials that explain the basics of project financing, and outlines the major financing options.
- Identifying and liaising with organizations that offer finance decision trees (or similar online tools) that help countries choose financing approaches.
- Holding a thematic dialogue, jointly with the Standing Committee on Finance, that brings together government officials and representatives of large financial institutions, with the goal of each better understanding the others' goals and perspectives.
- Reaching out to existing alliances of the finance industry.
- Reaching out to alliances of development banks and similar international organizations.

Additionally, there is an opportunity to enhance relationships between government decision-makers, and private sector investors in some countries. The TEC is well positioned to act as an "honest broker" between these two stakeholders, which share many goals and need to work together.

Since the TEP policies are, by definition, funded (as they are currently in operation), the body of knowledge on how this was accomplished could be tapped and made available. One way to do this would be to survey those who direct or manage the TEP policies, and/or conduct interviews with selected TEP policy option managers or directors. That information could then be compiled into a 'how to' manual on financing climate change mitigation programmes. Another option would be to work with the CTCN to support finance-focused content offered at the CTCN forums.[14]

These proposed activities appear to fall under TEC functions 4 and 5 (*collaboration* and *addressing barriers*, see figure 5-1), however they may also fall under the CTCN umbrella, and, in addition are closely related to the activities of the Global Climate Fund (GCF). Therefore, as for all the proposed activities in this paper, a first step for the TEC would be to review existing and planned activities by other organizations, to ensure there is no duplication of effort. Resources (time, funding, political will) are finite, and care must be taken to make optimal use of them.

5E. TEC option: Leveraging non-climate benefits

The case studies point to how non-climate mitigation benefits (such as local employment, increased income, and improved public health and agricultural productivity) often drive behavioral change and motivate programme and policy success. Most climate change mitigation efforts provide numerous and significant non-climate benefits (Table 5A). Energy efficiency, in particular, has numerous such benefits, ranging from reduced energy costs to

[14] Information on the CTCN forums can be found at: https://www.ctc-n.org/capacity-building/regional-fora .

improved energy security to poverty alleviation. Recent work by the IEA (IEA, 2014) identified 15 separate such co-benefits (also called 'ancillary benefits' and 'non-energy benefits).

Table 5A. Climate change mitigation benefits and stakeholders.

Example benefits of climate change mitigation programmes and policies	**Examples of interested stakeholders**
Increased local and regional employment	Local and regional decision-makers
Improved air quality and resulting public health improvement	World Health Organization (WHO)
Reduced energy costs	Industry and manufacturing groups
Economic development	Development banks
Reduction of energy imports	National economic agencies

One potential activity for the TEC is to cultivate relationships with those stakeholders that value those non-climate benefits, and work together to develop comprehensive policies and approaches. This goes beyond involving stakeholders once a policy or programme is underway – rather, this would be a re-framing of climate change mitigation efforts into, for example, public health *and* climate change mitigation efforts.

5F. TEC option: Solar PV

All databases show high interest in solar PV, due largely to its rapidly dropping costs and flexibility in applications – it can work at the household or utility scale. This is a 'commonality,' meaning expertise exists in the TEP policies and there is interest in the TAPs and the CTCN requests. The topic of renewable energy has been largely discussed in the course of the TEP during several Technical Expert Meetings.[15] The TEC could suggest another round with a focus on solar PV for the future, enhancing a country-to-country information sharing. The TEC could organize, in partnership with the CTCN, a web conference in which those involved in the solar PV related TEP policies give short presentations, with those pursuing solar PV (as evidenced in solar PV-related TAPs and CTCN requests) as the intended audience. Further steps could include commissioning a report that summarizes lessons learned from the TEP solar PV examples, preparing a short guidebook on solar PV financing, or assembling a virtual network of country-level government expertise in solar PV policies.

5G. TEC option: Training

Education, as an overall discipline, is in the midst of dramatic changes due to the growing availability of high-quality courses and training resources on the internet. The TEC could leverage this by paying attention to training elements in their next thematic dialogues/in-session workshops.

5H. TEC option: Support for urban-level actions

As noted above, the TEP policies reveal a number of interesting and innovative urban-level actions to mitigate climate change, yet there is very little interest in such activities as

[15] http://unfccc.int/focus/mitigation/technical_expert_meetings/items/8179.php

revealed by the TAPs and CTCN submittals. Given the rapid urbanization in many developing nations, there exists an opportunity to promote and encourage urban-level actions. Currently, most TEC activities and connections are with country (national-level) decision-makers. The TEC could consider extending its reach, and including city and regional-level decision makers in any efforts to assist, support, or network with policy-makers. Similarly, the TEC could reach out to existing global initiatives with a focus on sub-national action, seeking entry points for a collaboration.

5I. Summary

Technology advances, policy innovation, and recent political agreements have made climate change mitigation an attainable vision. The options presented in this report, based on analysis of the three databases, are intended to provide guidance for the TEC in its critical efforts to assist countries in implementing policies for climate change mitigation. This analysis points to industrial energy efficiency, financing, solar PV, ancillary benefits, and training as particularly promising topics for the TEC to consider.   This analysis does not explicitly assess cost-effectiveness of these topics, nor does it rank them by greenhouse gas reduction potential. These could be considered as next steps for future analyses.

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