TNA TECHNOLOGY NEEDS ASSESSMENT

TNA Step by Step

A guidebook for countries conducting a Technology Needs Assessment and Action Plan

UNEP DTU PARTNERSHIP

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Contents

List of boxes

List of tables

List of figures

Abbreviations

BAEF	Barrier Analysis and Enabling Framework
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
CV	Curriculum Vitae
DTU	Danish Technical University
GHG	Greenhouse Gases
HEV	Hybrid Electrical Vehicles
ICE	Internal Combustion Engine
INDC	Intended Nationally Determined Contribution
LDC	Least Developed Country
MCA	Multi-Criteria Analysis
MSW	Municipal Solid Waste
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contribution
NDE	National Designated Entity
NGO	Non-Governmental Organization
SME	Small and Medium Enterprise
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UDP	UNEP DTU Partnership
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention for Climate Change

1. Introduction: Understanding the TNA process

The purpose of this guidebook is to summarize the various steps in the implementation of a Technology Needs Assessment (TNA) and to be the 'go-to' document for national TNA teams, including TNA coordinators and consultants. It also points out the various materials that are available to guide and support project management and methodology further. We reflect upon the experiences of the more than sixty countries that have already drawn up TNAs and provide country examples to illustrate how the TNA project can be organized and implemented. A full overview of the TNA guidance documents can be found in section 7 and full electronic versions can be downloaded from the TNA project website[1].

A TNA can be defined as a set of country-driven, participatory activities leading to the identification, selection and implementation of climate technologies in order to reduce greenhouse gas emissions (mitigation) and/or vulnerability to climate change (adaptation). As a country-driven process, a TNA should not be conducted in isolation but rather integrated with other similar ongoing processes in order to support national sustainable development and, not least, the implementation of countries' Nationally Determined Contributions (NDCs).

As TNAs are also participatory in nature, it is crucial to involve all relevant stakeholders on the assumption that any given technology is more likely to be understood, accepted, supported and implemented at all relevant levels, i.e. from government ministries to farmers or households, if all stakeholders are involved throughout the TNA process. However, it is important to realize that stakeholders differ in nature because they represent different interest groups and should therefore occupy different roles, at different moments, in the TNA process; identifying them at an early stage is key to successful involvement and engagement. For detailed guidance on the stakeholder identification and engagement process, see 'Identification and Engagement of Stakeholders in the TNA Process: A Guide for National TNA Teams' (June 2015)[2].

Box 1. What is a climate technology?

The Intergovernmental Panel on Climate Change (IPCC 2000) defines technology as 'a piece of equipment, technique, practical knowledge or skills for performing a particular activity'. It is common to distinguish between three different components of technology:

1. *the tangible component, such as equipment and products, i.e. hardware.*
2. *the processes associated with the production and use of the hardware. This comprises know-how (e.g. manuals and skills) and experience and practices (e.g. agricultural, management, cooking and behavioural practices), i.e. software.*
3. *the institutional framework, or organization, involved in the adoption and diffusion process of a technology, i.e. orgware.*

These three components are all part of a specific technology, but the relative importance of each component may vary from one technology to another.

1
www.tech-action.org

2
To download the guidance document, please visit the TNA project website at www.tech-action.org/publications/tna-guidebooks

Rice terrace in China, saravutpics/Shutterstock.com.

1.1. The UN Climate Change Convention and the origins of TNAs

Commitments to promote technology transfers to developing countries have been renewed at every Conference of the Parties (COP) to the Convention. The TNA process originates in the Poznan Strategic Programme on Technology Transfer established at the Fourteenth Conference of the Parties (COP14) to the United Nations Framework Convention on Climate Change (UNFCCC), which had the aim of scaling up investment in technology transfers, thus enabling developing countries to address their needs for climate technologies.

In 2010, this level of commitment led to the establishment of the Technology Mechanism, in the form of the Technology Executive Committee and the Climate Technology Center and Network (CTCN), which aims to 'facilitate enhanced action' on technology development and transfer in order to support progress on climate change mitigation and adaptation. The Paris Agreement of 2015 highlights the importance of technology in implementing both mitigation and adaptation actions under the Agreement. The Technology Mechanism should facilitate and promote enhanced action on technology to help countries achieve the goals of the Paris Agreement, while at the same time recognizing the importance of rapidly accelerating transformational changes towards climate resilience and reduced greenhouse gas emissions. Based on a COP21 mandate, in December 2018 the parties at COP24 completed the drawing up of a new Technology Framework to guide the Technology Mechanism. The Technology Framework placed increased emphasis on TNAs and their role in promoting and facilitating enhanced actions on technology development and transfer. It also gave TNAs a central role in the implementation of climate mitigation and adaptation technologies.

1.2 Key challenges and opportunities in the 'post-Paris' era

It is more than ever important to plug the TNA process into existing sector-specific and ongoing plans and activities, such as those related to the NDCs, so as to maximize relevance and increase the chances of their making a difference. TNA teams should first consider the point at which their country has arrived in its policy and planning regarding investment in climate change technologies in order to determine the basic needs in respect of how best to design and implement the TNA in a way that helps the team achieve its objectives. Flexibility is key.

Ideally TNA teams will not need to spend too much time and resources on the technology prioritization stage. Rather, the emphasis should be on understanding the barriers to technology uptake and diffusion, identifying measures to overcome them and deciding the next steps in terms of international funding. Indeed, TNAs should be used to formulate actions that can be integrated into governments' own planning processes, as well as to create a pipeline of programmes and projects targeted at the Green Climate Fund (GCF) and other sources of multilateral and private finance. In parallel, or as an intermediate step, countries can approach CTCN. They can expect their requests to be 'favourably considered' provided they make explicit a connection with their TNA/TAPs, since the COP has mandated CTCN to build upon the TNAs.

Box 2. Mongolia: three proposals building on a TNA approved by the Green Climate Fund

Mongolia is opening new energy-efficiency and renewable-energy opportunities for its small companies at the same time as encouraging greater business participation by women, thanks to the country's TNA and GCF funding.

Mongolia's TNA found that high investment costs made it difficult for small businesses to access energy-efficient and renewable-energy technologies. To address this situation, XacBank, the first private-sector direct-access entity to be accredited by the GCF, put together a proposal to the GCF for a business loan programme. The country's TNA outputs, developed under the guidance of the UNEP DTU Partnership and Asian Institute of Technology, played a vital part in preparing the successful proposal. XacBank's program seeks to directly address financial barriers by lowering interest rates with co-financing of USD 19.5 million from the GCF to extend its existing USD 40 million business loan programme helping local companies cut their greenhouse gas emissions.

The project is expected to reduce greenhouse gas by almost 150,000 tons of CO_2 each year, resulting in cleaner air and reduced related health impacts from fossil fuel pollution. It will decrease total national energy consumption, with the aim of lowering energy prices for consumers.

In addition, the GCF has approved two other XacBank proposals, also building on Mongolia's TNA. One is for financing a 10MW solar photovoltaic power plant to support Mongolia's renewable energy transition, and one is an energy-efficient consumption loan programme.

1.3 Pursuing a gender-responsive approach

To ensure that men and women benefit equally from the actions set out in TNAs and that gender inequalities in activities and outcomes are reduced or eliminated, gender differences need to be taken into account throughout the entire TNA process and its outcomes. By systematically mainstreaming gender issues into the TNA, it will be possible to ensure that women and men have equal opportunities in relation to the Technology Action Plans (TAPs). To help TNA teams take gender issues into account when deciding their technology priorities and conducting their barrier analyses, and to integrate these issues into their TAPs and project ideas, guidance in producing a gender-responsive TNA has been drawn up[3].

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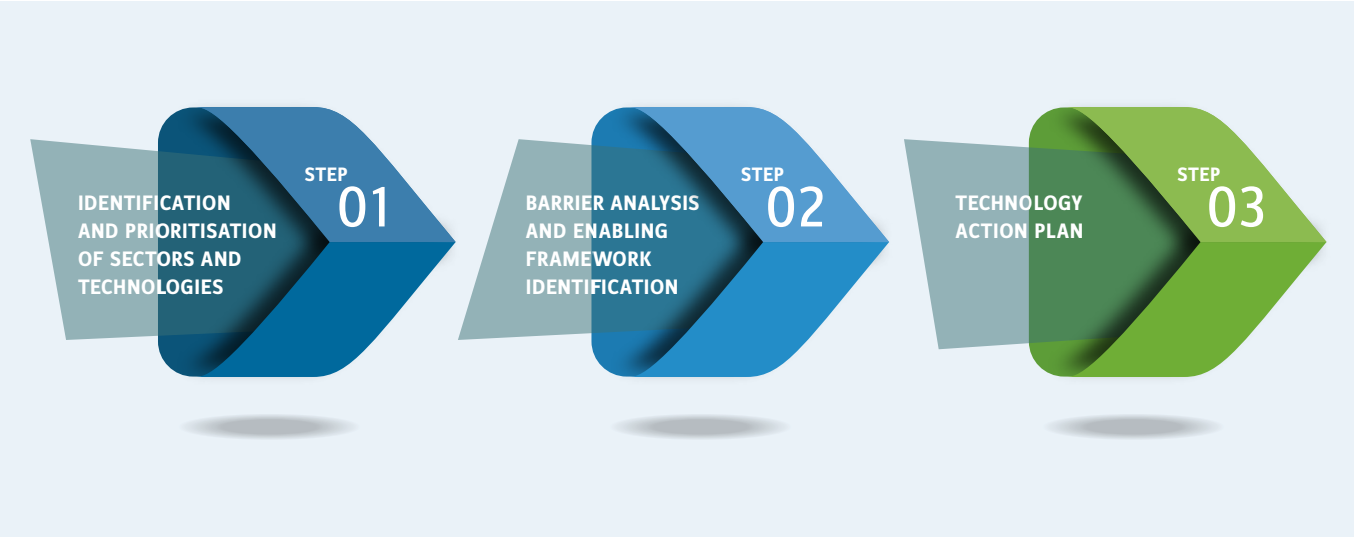
To download the guidance document, please visit the TNA project website at www.tech-action.org

Figure 1. The steps in a TNA process: from priorities to action



1.4 Objectives and deliverables

The TNA process has three main steps and related objectives:

1. To identify and prioritize mitigation/adaptation technologies for selected sectors/ sub-sectors
2. To identify, analyse and address the barriers hindering the deployment and diffusion of the prioritized technologies, including enabling the framework for the said technologies
3. Based on the inputs obtained from the two previous steps, to draw up a TAP with suggested actions presented in the form of project ideas.

Guidance and methodologies have been developed for each of these steps and are summarized in Sections 3, 4 and 5 of this guidebook. The three objectives are in turn translated into three concrete outputs, namely: 1) the TNA report; 2) the Barrier Analysis and Enabling Framework (BAEF) report; and 3) the TAP report, including project ideas, with their costs and potential funding schemes. Templates for use by the countries for each of the reports have been developed by the UNEP DTU Partnership.

1.5 Anticipated outcomes

Based on the experiences of supporting countries in respect to their TNA processes, it is clear that the process can and has helped participating countries in various ways, which can be regarded as *outcomes* of the TNA process. For instance, in the previous rounds several countries have directly used the inputs from their TAPs to develop their NDCs, NAPs and NAMAs, link outputs explicitly to other national processes or develop the analysis and/or plans detailed in their TNA/TAP reports. Other countries have used the TNA methodology to assess other local needs under separate processes or projects. Some countries have further developed and/or fine-tuned the project ideas articulated in the TAPs in order to draw up concrete project proposals as a step towards implementing investment-ready projects with national or international funding.

2. Setting up and preparing for the TNA process

To achieve the objectives, outputs and expected outcomes of the TNA process, a national TNA team must be formed. This team will conduct the TNA process under the leadership of a National TNA Coordinator. The National TNA Team is an umbrella unit that refers to the National TNA Coordinator, the Sectoral Working Groups and the National Consultants. For detailed guidance on how to set up a national organizational structure for the TNA process, see Organising the National Technology Needs Assessment Process: An Explanatory Note, which is summarized in the following section. We encourage countries to use or build upon existing structures rather than create new structures just for TNA purposes. As such, the main challenge is to integrate the TNA process into existing national structures and networks, which the TNA team is in the best position to do.

The first task of the TNA Coordinator is to identify the priority mitigation and adaptation sectors on which the TNA process will focus, consulting with relevant stakeholders where appropriate. In most countries it will be easy to identify the priority sectors from the country's NDC. We suggest that this process be completed relatively quickly by drawing directly on existing analyses and/or national planning and strategy documents, not least the country's NDC. We suggest that two well-defined sectors be selected for analysis under both mitigation and adaptation, assuming that countries choose to dedicate an equal share of their budgets to mitigation and adaptation technologies.

Once the sectors have been selected, the TNA team can identify the relevant stakeholders, prepare a consultation and engagement plan, draft a detailed work plan, and select skilled and knowledgeable consultants. At the end of the setting-up and preparation stage, countries should have in place:

- An institutional structure detailing the responsibilities of key individuals and groups in the rest of the process
- Prioritized sectors for mitigation and adaptation, based on or coherent with national development priorities and the country's NDC
- A detailed work plan detailing the various steps in TNA implementation and their corresponding completion dates
- Selected consultants to conduct the analysis for mitigation and adaptation purposes
- A plan for how stakeholders will be engaged throughout the process
- An initial group of key stakeholders

2.1. Organizational structure of a TNA process

The TNA process should be conducted using a stakeholder-driven approach led by the national TNA Coordinator in collaboration with the National Consultants. A wide range of stakeholders should be consulted, including the working groups. The TNA team can come up with policy recommendations, but if these are to be implemented, they need to be vetted by policy-makers, who constitute the National Steering Committee.

As throughout the TNA process, it is important that gender is also mainstreamed into the composition of the national TNA team. Here two key aspects need to be considered in setting up and preparing the TNA process: first, the composition of the TNA team, to

Indian farmer checking growth of rice paddy farm with smart phone, singh_lens/Shutterstock.com.

Table 1. A summary of the TNA key preparation stages

Preparation stage	Responsibility	Additional Guidance
Institutional structure	TNA Coordinator, signing ministry	Explanatory Note for Organizing the National TNA Process
Sector prioritization	TNA Coordinator	UDP country coordinator and Regional Centre
Work plan	TNA Coordinator	UDP country coordinator and Regional Centre
Consultant selection	TNA Coordinator	UDP country coordinator
Stakeholder engagement plan	TNA Coordinator, consultants	Stakeholder guide note

ensure that it has a good gender balance; and secondly, the gender expertise present in the team. Selecting team members with knowledge of gender equality issues is crucial to mainstreaming gender into the TNA process. A more detailed description of the various national bodies and their corresponding role is given below.

National TNA Team

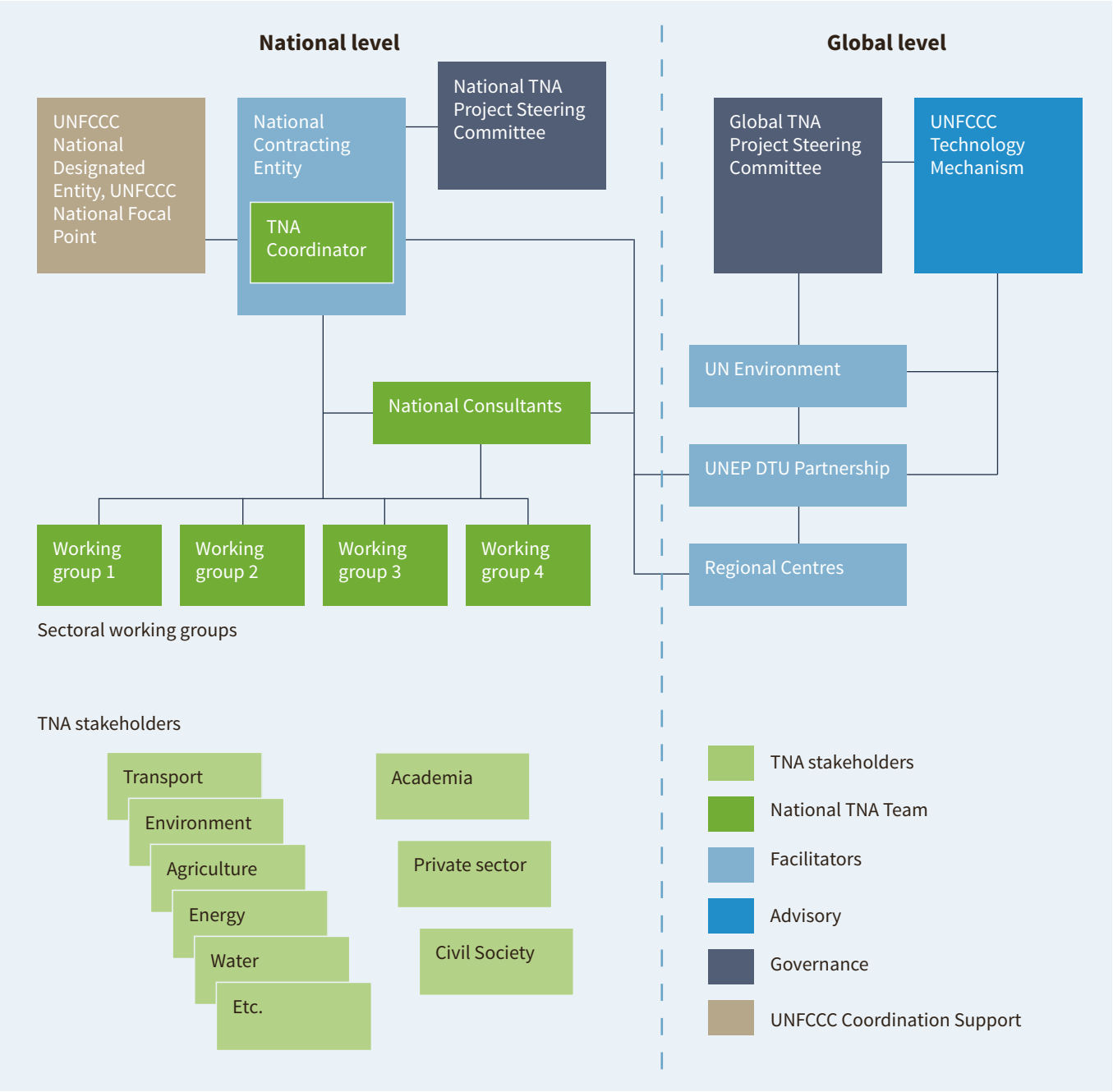
The national TNA team is made up of: 1) the National TNA Coordinator; 2) National Consultants; and 3) Sectoral Working Groups.

The National TNA Coordinator

The appointment of the National TNA Coordinator is the responsibility of the UNFCCC focal point. The National TNA Coordinator will be the focal point for the effort and management of the overall TNA process. In view of the role of National Designated Entities (NDEs) in respect of the UNFCCC Technology Mechanism, it is strongly recommended that countries select their NDEs as their National TNA Coordinators. This will involve providing vision and leadership for the overall effort, facilitating communication tasks with the National TNA Committee members, National Consultants and stakeholder groups, forming networks, information acquisition, and the coordination and communication of all work products. The leadership of the National TNA Coordinator is crucial for the success of the TNA in each country. It is therefore recommended that the TNA Coordinator's skills set includes facilitation skills, project management and some familiarity with the relevant technological aspects.

The National Coordinator is also the official TNA contact point for the country, communicating progress and/or any queries directly with the Country Coordinators at UDP and the Regional Centres. National Consultants should also communicate directly with UDP and the Regional Centres, and be copied in to all e-mails. Whichever way countries choose to organize and conduct their TNAs, it is recommended that a communications protocol be agreed so that the relevant individuals are always involved and at least kept informed.

Figure 2. TNA institutional set-up



National Consultants

National mitigation and adaptation experts can be hired from independent consultancy companies, universities or research institutes based in each country. These experts will be the National Consultants, hired to conduct the substantive analytical work that informs the TNA process. There are various ways of hiring national experts as consultants. The lead National Consultants should be selected by the National TNA Coordinator in close consultation with UDP and the Regional Centres, following an open and transparent selection process whereby candidate CVs are gathered by the National Coordinator and shared with UDP. Ideally, interviews will be conducted during the inception missions, candidates being rated according to simple criteria agreed between the National Coordinator and UDP. Once hired, the National Consultants should work closely with the National Coordinator, reporting to him/her. The consultants will be responsible for:

- organizing consultative stakeholder meetings
- identifying and prioritizing technologies for the specific sector through a participatory process with the broad involvement of relevant stakeholders
- leading the process of analysing, along with the stakeholder groups, how the prioritized technologies can be implemented in the country and how implementation conditions can be improved by addressing the barriers and developing an enabling framework based, inter alia, on undertaking local market and other assessments, as may be required
- preparing deliverables, including the TNA, BAEF and TAP reports
- preparing working papers and other TNA-related documents as may be required to ease the consultative process
- harnessing inputs from stakeholders during meetings and workshops, among others
- participate in capacity-building workshops
- work in close partnership with the National Coordinator to facilitate communication within the national TNA Team (coordinator, consultants, sectoral working groups), engage with stakeholders, form networks, and coordinate and communicate all deliverables.

Sectoral Working Groups

The Sectoral Working Groups are intended to allow stakeholders to play an active role in the TNA. They can be set up on either a sector-specific or a technology basis in a way that makes sense to local needs and conditions. The typical composition of these groups includes representatives of government departments with responsibility for policy formulation and/or regulation; private- and public-sector industry representatives; delegates from utilities and regulators; and representatives of technology suppliers, finance, technology end-users (e.g., households, small businesses, farmers) and technology experts (e.g., from universities, consultants, etc.). These working groups should contribute their technical expertise and input into technology prioritization, the barrier analysis, and ideas or inputs for the enabling framework for a given technology and/or sector (see Section 4).

The National Steering Committee

The National Steering Committee is the key body guiding of the project. The National Steering Committee should be comprised of members responsible for policy-making from all the relevant ministries, as well as key stakeholders from the private sector. In most countries there is an existing inter-ministerial National Climate Change Committee, which could also be utilized as a steering committee for the TNA project. Their role is to provide high-level guidance to the national TNA team and help secure political acceptance for the TAP. As such, it is envisaged that the National Steering Committee should only meet two or three times, first when the TNA team has been established and the priority sectors have been selected, and then again towards the end of the process, once the TAP has been finalized. However, as with all aspects of the TNA process, the exact composition, role and responsibilities of the Steering Committee should reflect existing structures and make sense within each national context. Flexibility is key. Thus, there may be overlaps between this and the national TNA committee, and it might even be decided that this higher-level committee is redundant.

Box 3. Top-10 must-do activities to engage stakeholders: a Lebanese perspective

By Lea Kai, Ministry of Environment, Lebanon

Lebanon started work on its TNA project in September 2011, only six months after the publication of its Second National Communication (SNC). This was a logical progression of the climate change activities initiated in 2007 by the SNC and strengthened by the government's high-profile participation in Copenhagen back in 2009. The TNA project was timed perfectly to sustain the momentum created at the national level. Nevertheless, engaging stakeholders has always been a major challenge to be overcome. Here, we share with you some practical tips that helped the TNA team in Lebanon mainstream the project within other national projects.

1. *Conducting background work. We carried out all the necessary research and mapped out 'who's doing what' in terms of adaptation and mitigation in the country. We also made sure to review all the existing and planned strategies within ministries and government agencies.*
2. *Joining up the circle. We accessed the 'circle' of people working on climate change in Lebanon, which was an important step, as people working on climate change usually operate as a small community where symbiotic relations link everyone together. So becoming one of them facilitated contacts and the acquisition of rare data.*
3. *Identifying friends, befriending foes. We made sure not only to involve obvious friends (like the scientist or a colleague at the Ministry), but also to reach out to the pessimistic journalist, the unreachable sceptic and the highly placed director. This was based on the principle that the final work is less likely to be criticized if the criticizer himself is involved throughout the process!*
4. *Meeting the right people. Instead of waiting for people to reach out to us, we decided to contact officials ourselves and arrange meetings with them. Most of the decision-makers cannot find the time in their packed agenda to participate in workshops, and most government employees need the permission of a dozen supervisors to leave work. So taking the initiative to meet over coffee or lunch was the way to proceed.*
5. *Knowing what to share…and sharing it. Summarizing a 100-page technical report in a simple, reader-friendly, straight-to-the point paper is an art by itself. We opted for this approach and shared the right documentation to facilitate discussion and encourage information-sharing.*
6. *Knowing what to ask…and asking. This was an important factor, as it is essential to be well informed about the field of work of each stakeholder so that awkward or irrelevant questions are not raised. And we tried to ask them only a minimum of questions, realizing that everyone is already overcrowded with work.*
7. *Joining hands and events. We recognized that our project is not the only project dealing with climate change in Lebanon, so we explored the possibility of holding joint events with other partners. As a consequence, stakeholders did not have to repeat the same idea twice and only had to make the trip once.*
8. *Being out and about. We tried our best to participate in most events related to climate change and to be vocal about what our project is doing. This enabled the TNA results and related upcoming activities to be shared with a wider group of people.*
9. *Taking the lead. We took initiative in organizing coordination meetings between all the adaptation and mitigation actors in the country and shared precious data and information as a proof of our commitment and cooperation.*
10. *Spreading positive energy. We worked in a manner that would make us known for our approach, encouraging attitude and team spirit, and thus allowing for more collaboration to follow!*

2.2. Identifying and engaging the relevant stakeholders

This is a fundamental aspect of the TNA process. Sufficient time should be set aside and effort made by the National Coordinator and National TNA Committee to ensure that the TNA process is a truly stakeholder-driven process. Everybody who has an interest in or is affected by the TNA process or by its results should be considered a relevant stakeholder. It is important to ensure that the stakeholder consultation process is gender-sensitive in both process and content. This means that the perspectives of both women and men need to be sought during consultation to ensure that both have an opportunity to voice their opinions. As a result, we have prepared a specific guidance document on how best to identify and engage the relevant stakeholders, entitled Identification and Engagement of Stakeholders in the TNA Process: A Guide for National TNA Teams[4]. National TNA teams are encouraged to read this document and follow the recommended procedures.

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To download the guidance document, please visit the TNA project website at www.tech-action.org/publications/tna-guidebooks

3. Identification and Prioritization of Technologies

The prioritization of technologies within the selected priority sectors is the first analytical step in the TNA process. The conclusions of this step should be reported in the first of the deliverables (referred to as 'the TNA report'), as stated in the MoU. All members of the National TNA Team should be involved in this step under the direction of the TNA Coordinator working closely with the National Consultants, who will have a firm grasp of how to conduct a Multi-Criteria Analysis (MCA). As with all steps in the TNA process, inputs should be sought from relevant stakeholders. A summary of inputs, roles and responsibilities in respect of technology prioritization is shown in Table 2.

Table 2. Preparing for the MCA.

Decision-making	National TNA committee/team, TNA Coordinator
Technical support	National Consultant
Information, consultation	Relevant, well-defined stakeholder groups
Main tool / methodology	Multi-Criteria Analysis (MCA)
Activities involved	Consultation, data-gathering, analysis, reporting

3.1. Overview of the process of identifying and prioritizing climate technologies

The process of identifying and prioritizing technologies presented in this guidebook follows the approach for conducting multi-criteria analyses described in Dodgson et al. (2009) and more detailed guidance provided for TNA countries as two separate guide notes on adaptation (UDP, 2015a) and mitigation (UDP, 2015b). The steps involved are shown in Figure 3.

The following sections will go through each of the steps in the above schematic, pointing to further sources of guidance where available.

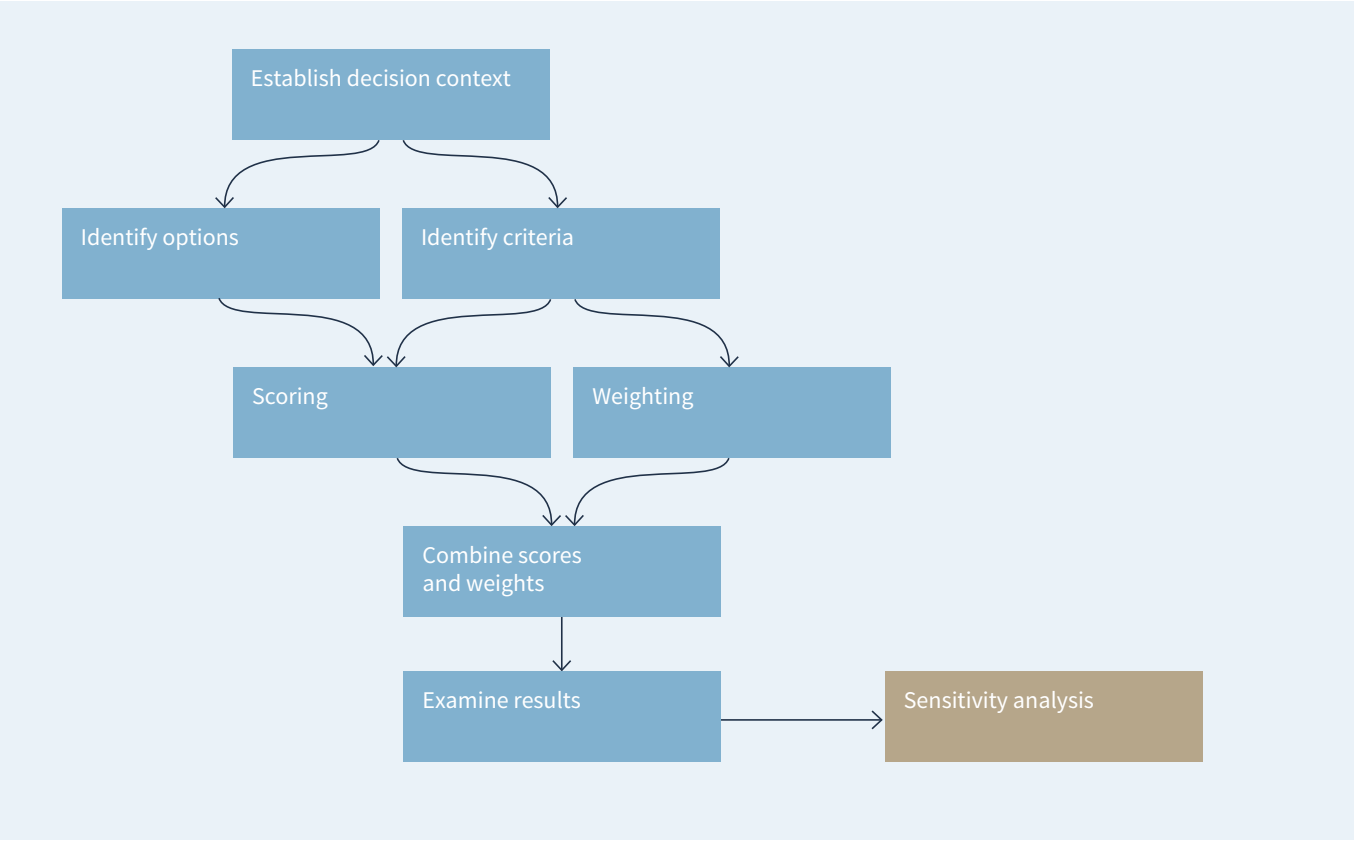
Decision context

Parties involved: Consultant, national TNA team

Activities: to analyse the current situation, assess the context in which the TNA is being carried out and establish a decision-making body. How does the TNA process relate to other national processes and/or analyses, and what goals can it help achieve? Here, it is useful to bear in mind the key national status and development priorities, including the NDC, national GHG inventories, national sectoral plans and policies, poverty-reduction strategy papers, five-year National Plans (or similar documents), Nationally Appropriate Mitigation Actions (NAMA), country-specific SDG reports and other relevant initiatives. The MCA Guide note on Adaptation and Mitigation (UDP, 2015a; UDP, 2015b) provides examples from existing TNAs.

Passengers waiting for the bus in Bangkok, Thailand, matthew25/Shutterstock.com.

Figure 3. Prioritization process



Outputs: 1) a succinct account of the national context, in the form of a written summary of development priorities and goals, intended for distribution to stakeholders; and 2) the constitution of Sectoral Work Groups.

Identifying options

Parties involved: National Consultants and Sectoral Working Groups

Activities: To undertake a review of existing planning documents (past TNA, NDC, NAPA, NAP, Energy Plans, National Communications, etc.), and prepare technology factsheets and other information for input into the MCA template. Relevant sources of information include the Climate Techwiki[5] and guidebooks published by UNEP DTU[6] which cover the transport sectors, building and agriculture (for mitigation) and coastal zones, and water and agriculture (for adaptation). The Regional Centres can also be contacted to provide sector- and technology-specific information. All options should be presented to and discussed with the relevant stakeholders to ensure a high level of 'buy in'.

Output: a list of technologies (suggested ten to twelve technologies) to be analysed, with technology factsheets for each one. Factsheets produced by countries[7] from earlier TNAs may be used to form the basis of new factsheets, but each country should create new ones, tailor-made to fit their particular circumstances and contexts.

5
For more information on Climate Techwiki, please visit www.climatetechwiki.org

6
For more information on TNA guidebooks please visit www.tech-action.org/publications/tna-guidebooks

7
For more information on Technology Factsheets please visit http://database.tech-action.org.

Identifying criteria

How can the different technology options be compared? What makes one technology better or more appropriate than another and more worthy of implementation? To help assess this, the criteria used in evaluating each technology option have to be defined. The final selection of criteria will depend on the national context and priorities, and will differ between adaptation and mitigation technologies.

Parties involved: Consultants, Sectoral Working Groups

Activities: to organize consultation with stakeholders, clarifying what key issues and considerations were expressed by stakeholders when choosing technologies for TNA purposes. Alternatively, the consultants (working with the TNA Coordinator and the Sectoral Working Groups) can suggest criteria that reflect the country's development priorities and organize a validation workshop with stakeholders. The criteria can be organized into sub-criteria at different levels to help link them to development priorities, for which readers can refer to the adaptation guide note (UDP, 2015a) and the mitigation guide note (UDP, 2015b). For a general understanding of the criteria parties are referred to the Multi- Criteria Analysis Manual (Dodgson et al., 2009). An Excel-based template for calculation purposes can also be downloaded from the website.

Outputs: a list of criteria and/or a criteria tree for assessing adaptation and mitigation technologies which will be inputted to the MCA template.

Table 3. Example: criteria for mitigation, energy sector, Sri Lanka

Category		Criteria
Costs		Cost of energy conversion facility
Benefits	Economic	Local economic benefits
		Local share of technology
	Social	Direct employment
		Skill and capacity development
		Energy security
	Environmental	GHG emissions reduction
		Positive local environmental impacts

Table 4. Example: criteria for adaptation, water sector, Lebanon

Criteria, water sector
Cost of technology (capital-maintenance)
Capacity to increase water supply
Capacity to increase water-efficient use
Extent of application
Need for knowledge and human resources
Need for required infrastructure
Acceptance of technology
Negative environmental impact

Scoring

Technology options are evaluated on the basis of the selected criteria. First, a performance matrix is constructed, in which the scale of evaluation can be different for each criterion. For example, the capital cost may be entered directly in monetary units and GHG reduction in tonnes of CO_2, while qualitative criteria can be evaluated using a Likert or similar scale. Qualitative descriptions of consequences can accompany the scores in this matrix. Secondly, the performance matrix is converted into a scoring matrix, in which the scales for all criteria are the same, for example 0-100. The most preferred option is assigned a score of 100, while the least preferred is given a score of 0. The scores for the remaining options should reflect differences in the strength of each preference. If no detailed data are available, a scoring matrix can be constructed directly. Table 5 presents a simple example in which four technologies are assessed against two criteria (cost and GHG emissions reduction). The best-performing options are marked in bold, the worst in red.

Table 5. Prioritization example

	Cost (US$)	GHG Reduction (tonne CO_2e)
Technology A	1200	250
Technology B	**1100**	100
Technology C	1500	400
Technology D	1700	**550**

In the Table 6, the best option is given a score of 100 and the least preferred option a score of 0. The remaining technologies are, in this case, assigned values proportionate to the performance, e.g. for technology C, where GHG reduction is 400 tCO_2e, this is normalized with respect to the best and worst performing options:

$$\frac{400-100}{550-100} = 0.67.$$

Table 6. Prioritization example

	Cost (US$)	GHG Reduction (tonne CO_2e)
Technology A	83	33
Technology B	100	0
Technology C	33	67
Technology D	0	100

A more exhaustive explanation of the performance matrix and scoring along with an example from one of the countries in the first round is presented in the mitigation guide note (UDP, 2015b).

Parties involved: Consultant, Sectoral Working Groups. The Consultant should conduct the desk study, organize stakeholder consultations, summarize stakeholder views, fill in the performance matrix and build the scoring matrix. The stakeholders provide their views and opinions on the performance of each technology option and suggest scores for discussion.

Activities: to conduct a desk or field study of the quantifiable options (e.g. GHG reductions) followed by consultations with stakeholders on the performance of technology options, or the validation of quantitative values. This information should be inputted into the MCA template.

Output: a matrix with a score for each technology option.

Weighting

The criteria selected for evaluating the usefulness of each technology option may not be equally important to the decision, nor to the achievement of the overall goal. Therefore, the weights given to each criterion should reflect their relative importance in the choice of technology options. Is cost more important than GHG reduction when choosing a new technology for the energy sector? If so, by how much? Is vulnerability reduction seen as an essential criterion for adaptation measures in the agricultural sector, much more so than any other? This step aims to assign quantitative values to the relative importance of the different criteria. There are different ways to assign weights, both participatory and statistical. However, in the context of the TNA process, it is essential that the weights reflect the views and priorities of stakeholders, meaning that weights are best determined by participatory methods. The simplest way to do this is through a process of budgetary allocation, whereby the total number of criteria can be represented in a pie chart (with a total value of 100), the pie being split into slices of varying sizes. Since scores are normalized for all criteria between 0 and 100, weights should also reflect the performance swings between the most preferred and least preferred options. Readers can refer to the MCA manual for more information on this procedure (Dodgson et. al., 2009). The question of how weights are assigned when the criteria are organized into sub-criteria is explained in the mitigation guide note (UDP, 2015b).

Parties involved: Sectoral Working Groups, Consultant, TNA Coordinator. The TNA Coordinator and the Consultant need to have a clear understanding of the framework in order to facilitate the discussion about specific technologies and be aware of what is required as the end result. The stakeholders should consider how important each of the criteria is for a given objective (development, GHG reduction, etc.), and assign weights to them so that they reflect their relative importance.

Activities: organize a stakeholder discussion, facilitate discussion to obtain decision on weights, and input this information into the MCA template.

Output: a list of weights for the previously selected criteria.

Table 7. Example: criteria weights for mitigation, energy sector, Sri Lanka

Category		Criteria	Weigth
Costs		Cost of energy conversion facility	20
Benefits	Economic	Local economic benefits	20
		Local share of technology	8
	Social	Direct employment	12
		Skill and capacity development	8
		Energy security	12
	Environmental	GHG emissions reduction	8
		Positive local environmental impacts	12

Results and Sensitivity Analysis

All the information and views collected in the previous steps are now consolidated, with a few technologies having been selected for further detailed analysis. Calculating the total scores for these options can be performed using the MCA template provided by UDP. The technology options are then ordered according to their total score, and the two or three best-scoring technologies can be selected for further analysis. Sensitivity analysis can help assess whether, and how much, the ordering of the options will change depending on the chosen weights or the preference allocation. This can be very helpful in building a consensus if, for example, different groups of stakeholders have very different views on the criteria weights or on the qualitative scores given to a specific technology. In this case an extra exercise to calculate the total scores and the ordering of the options should be conducted. The results can then be compared and acted upon accordingly.

Parties involved: Sectoral Working Groups, Consultant

Activities: to calculate the overall scores of each technology option and rank them accordingly. If there are significant discrepancies among stakeholder views, then a sensitivity analysis should be performed. The main tool to be used here is the MCA template.

Output: a shortlist of technologies for further analysis.

3.2. Reporting

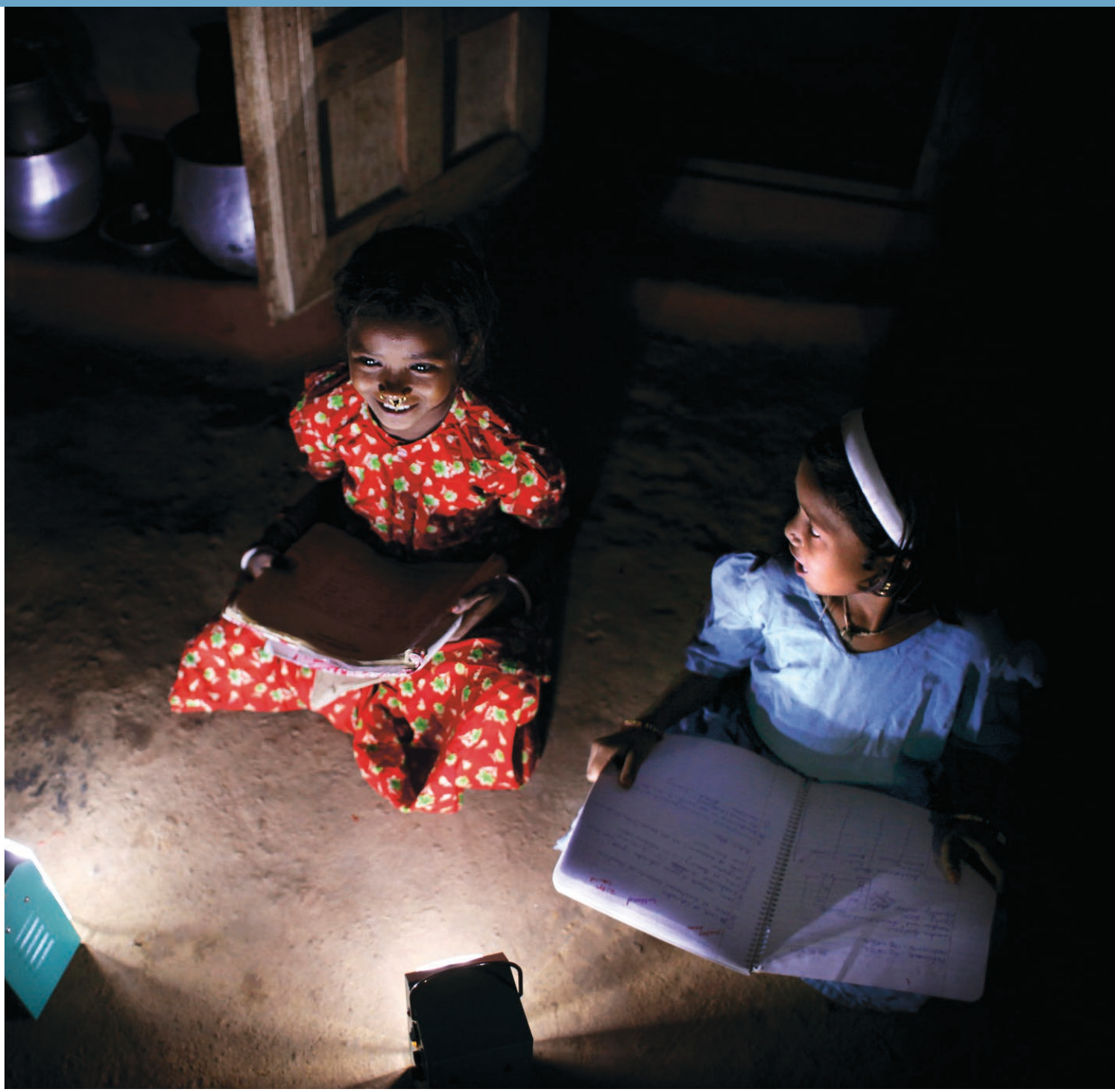
Each country should submit a report detailing the technology prioritization process and its results, referred to as the 'TNA report'. This should contain a detailed description of how the prioritization has been conducted for the sectors and subsectors in need of mitigation and adaptation technologies, and which methodologies have been used in drawing up the prioritization list. UDP provides reporting templates which include

sections describing the country context, a description of the institutional arrangement, sector selection and technology prioritization for each selected sector. In addition, a list of the stakeholders involved and the technology factsheets used should be added as appendices. The report will be subjected to a maximum of two rounds of review by UDP and the Regional Centre, though if the first draft is deemed to be inappropriate or of very poor quality, then it may be rejected without comments (so as to avoid a potential third rounds of comments). After submission of the first and second drafts, UDP and the Regional Centre will have one month in which to provide their comments. The countries will then have another month in which address each round of comments. After the second round, the final report will be submitted and published on the TNA Website. The delivery of this report is primarily the responsibility of the National Consultant, but it must also be approved by the National TNA Coordinator.

3.3. Support and guidance to technology prioritization

- Regional capacity-building workshops
- Regional Centre help-desk and technical supports missions
- TNA Website (www.tech-action.org)
- MCA Guidebook (published by the Government of the United Kingdom)
- MCA calculation template and examples
- Adaptation and mitigation-specific guides to technology prioritization process
- Technology guidebooks

4. Barrier Analysis and Enabling Framework (BAEF)



In the preceding sections this guidebook has emphasized the importance of countries identifying their climate change technology needs *per se* and updating these needs frequently through a transparent and participatory process of prioritization. However, experience indicates that the emphasis should be placed on providing a detailed understanding of the barriers facing these technologies in each country, followed by a clear analysis of what rules, regulations and incentives are required to overcome them, collectively referred to as the 'enabling framework'. TNAs should therefore focus on understanding the various barriers and constraints to the uptake and diffusion of the technologies prioritized by participating countries.

4.1. Conducting the barrier analysis

The objective of the barrier analysis is to analyse the market conditions for each of the selected technologies and to identify the barriers to their introduction, use and diffusion. Detailed guidance is provided in the document '*Overcoming Barriers to the Transfer and Diffusion of Climate Technologies: Second Edition*' (Nygaard and Hansen, 2015), published by UDP. The key steps in the barrier analysis are as follows:

1. Identify all possible barriers through a literature survey, interviews and/or workshop brainstorming
2. Screen the long list of barriers to select the most essential ones
3. Classify the selected essential barriers into a hierarchy of categories

These steps are completed by the National Consultants working in consultation with stakeholders in the Sectoral Working Groups. The issues, ideas and justifications required for each step should come from the stakeholders themselves, not just the expert opinions of the consultants. As such, the main task of the consultants is to *facilitate* these sectoral working groups, i.e. to present all relevant information for discussion, structure the discussions, and clarify and document the main conclusions. In terms of written analytical outputs, the barriers should be prioritized and grouped into relevant categories, for example, economic, financial, institutional, legal, technical, social and cultural barriers.

4.2. Example of a barrier analysis from Moldova

In Moldova the TNA/TAP process was split evenly between mitigation and adaptation technologies. For mitigation technologies, three sectors were selected: agriculture, transport and energy. A total of six well-defined technologies were prioritized across these three sectors, enabling a focused analysis of the barriers and the measures to overcome them. In the case of adaptation, the analysis was divided between two sectors – agriculture and human health – spanning a total of five technologies (see summary in Table 8).

Arrival of solar panels in rural Orissa, Abbie Trayler-Smith/Panos Pictures/Department of International Development.

Table 8. Climate change technologies prioritised in Moldova.

Adaptation		Mitigation	
Agriculture	Conservation system of soil tillage without herbicides for winter wheat	**Energy**	Electricity supply: combined heat and power plants based on internal combustion engines of up to 500kW (ICE CHP)
	Applying 50 t/ha of manure with bedding to agricultural soils once every five years		Heat supply: gasification of municipal solid waste for electricity heat/ production (G-MSW)
	Introduce vetch field as green fertilizer into five-year crop rotation	**Transport**	Hybrid electric vehicles (HEV). A hybrid car combines an internal combustion engine with technologies used in fully electric vehicles
Human health	Provisional posts for medical emergency care during heat waves	**Agriculture**	No-till soil cultivation system with preliminary positive recovery of the post-arable layer and use of vetch as intermediate crop for green fertilizer
	Supply rural population with drinking water of guaranteed quality		Mini-Till soil cultivation system with preliminary positive recovery of the post-arable layer and use of vetch as intermediate crop for green fertilizer
			Classic tillage, by including a vetch field (two yields per year, autumn and spring) as a 'green fertilizer field' into a five-year crop rotation scheme

First of all, it is important to have clear and well-defined technologies. The more specific and well-defined they are, the better the barrier analysis will be. In the final report submitted by Moldova, an average of five thousand words of analysis (including tables) was dedicated to the barrier analysis and enabling framework for *each technology*. This level of detail is required in order to provide a meaningful depth of understanding of and insight into the key challenges facing specific technologies. The most common mistake that countries make at this stage is to offer only a superficial analysis of the most obvious barriers, such as 'high capital costs', without going on to explain at greater depth what exactly are the cost differences and why they arise. It is useful to take the example of just one technology, for example, 'conservation system involving soil tillage without herbicides for winter wheat'. Below is the summary table (Table 9) of the key barriers that were identified through stakeholder consultation and then taken forward for further analysis for that specific technology.

Taking this example further, by focusing on one particular category of barrier, the text box below summarizes the analysis of the key economic and financial barriers to the uptake of conservation systems involving soil tillage without herbicides for winter wheat in Moldova. The detailed analysis can be placed in an annex, but it is nonetheless

Table 9. Example of barriers for Agricultural Conservation System technology

Category of barrier	Conservation system of soil tillage without herbicides for winter wheat
Economic and financial	High up-front investment
	Inadequate access to financial resources
	Inappropriate financial incentives and disincentives
	High interest rates
	Small farm size
Institutional capacity	Limited institutional capacity
Network	Main stakeholders show lack of willingness to cooperate
	Weak connectivity between actors favouring the new technology
Market	Poor market infrastructure
Policy, legal and regulatory	Inadequate sources of increasing returns
	Insufficient legal and regulatory enforcement
	Policy intermittency and uncertainty
Social, cultural and behavioural	Low confidence in new climate technologies among farmers
Informational	Inadequate information

needed in order to explain and justify the summary list of barriers and to show that they have not been chosen arbitrarily. However, the summary tables or lists of barriers are necessary in order to present them in a schematic format, which helps link them to other barriers and thus builds up a picture of how they interact and what measures can be designed to overcome them.

4.3. Identifying measures to create an enabling framework for climate technologies

Chapter 6 in the Barrier Analysis Guidebook describes how the identified barriers can be tackled by measures to overcome them. The detailed analysis should have clarified the nature of the barriers and their interrelations, which itself helps indicate what measures may be necessary. Chapter 6 in the Guidebook also offers examples of how a set of complementary measures may be used to enhance their impact, and how different sets of measures to achieve the same goal may have different economic and other impacts. It is therefore recommended to discuss the measures at the highest political level before selecting a set of measures to be included in the TAP (Nygaard and Hansen, 2015).

Box 4. Economic and financial barriers to the uptake of conservation systems involving soil tillage without herbicides for winter wheat in Moldova

Commercial banks in Moldova have relatively high capitalization, but lending is based on the principle of economic profitability. Thus, the interest rate on loans provided to entrepreneurs for operational activities is 20-24% annually, including commission rates. This implies that economic activity should have a return of at least 40-45% in order to be able to repay the loan on time, which is a significant demand for the agriculture sector. Moreover, currently no commercial banking institution in the country favours lending to agricultural enterprises without having the support of international credit lines (RISP, SIDA, and DFID). This is often the biggest impediment for small producers.

Another challenge arising from the farmers' limited access to the available financial resources is the refusal of commercial banks to accept agricultural land as collateral. This is due to the absence of a legal framework in this area. In the Republic of Moldova only 4-5% of agricultural land is secured, resulting in increased risk to economic profitability. This is the case when land is affected by rain, droughts, etc. The lack of banking institutions or Land Banks that could provide finance to farmers by accepting land as collateral explains the lack of interest from foreign investors in the country's agricultural activities. Another barrier to the adoption of this technology is the required change in equipment; this increases the initial cost and makes adoption more difficult.

The capital market is not sufficiently developed in Moldova. Financial instability does not allow the promotion of long-term credits at lower rates of interest. Credit is released through commercial banks which are interested in short-term lending only. The issue of credit is very complex and supposes financial stability and less dependence on the international market for inputs (oil, fertilizers, pesticides, agricultural equipment, seeds etc.). High prices for inputs and relatively low prices for agricultural products further limit access to credit. In order to improve the existing situation for financing agriculture of Moldova and thus for the implementation of climate technologies, it would be advisable to:

- *Establish criteria for the evaluation of farm activities, which should include not only economic parameters (profit, yields), but also ecological and social parameters, which usually are externalized.*
- *Farmers who implement environmentally friendly technologies should be supported by the state through subsidies and reduced taxes for imported equipment used for climate technologies.*

What is an Enabling Framework?

We understand an enabling framework as something broader than just a set of specific policies, as it should also include the country-specific circumstances that encompass existing market and technological conditions, institutions and practices. While the nature and success of any given enabling framework varies between countries, an effective framework for scaling up investment in climate change mitigation and adaptation technologies can be constructed through the implementation of specific policies and activities, drawing upon, and adapting, successes from other countries. Therefore, establishing an enabling framework means thinking primarily about creating and/or regulating markets for climate technologies, not just specific projects. That said, the analysis of markets and incentives is more relevant to technologies such as drip irrigation or solar home systems, which are sold on the mass market, than for large infrastructure projects such as metros, hydropower dams, dykes, seawall defences, coastal zone and flood management technologies, which may require state-financed investment.

To enable the uptake and diffusion of 'climate technologies', markets may need to be freed, created or stimulated, as well as supported and regulated by governments and wider stakeholders (Haselip et al., 2011). Developing stable market conditions for renewable energy, for example, is an inherently more sustainable means of achieving a transition to a low-carbon economy than a series of externally financed projects. However, the enabling environment can be viewed as something broader than just the relevant policies and incentives etc., also including an understanding of the capacities of the various actors and agencies in each country.

Identifying specific measures

Each analysed barrier should be 'answered' with a series of proposed measures, which make up the substantive content of the enabling framework analysis. As with the barrier analysis, we have simplified the approach to designing an enabling framework. Possible solutions to the prioritized barriers can be classified under economic incentives (where the barriers are economic or financial), including targeted tax exemptions and/or subsidies, access to finance at preferential rates and government-based financing schemes. Where the barriers to technological uptake can be classified as 'institutional', then measures to address them could include the introduction of funding agencies to provide grants for retro-fitting buildings in order to increase energy efficiency, or regional authorities rolling out low-tech coastal-zone management practices. A weak capacity somewhere in the market chain may be identified as a key barrier, for example, in business management and entrepreneurship for clean energy. In such cases targeted capacity-building for entrepreneurs and managers operating in, or planning to develop, climate technology SMEs may be one proposed measure, or a network of SMEs innovators or 'start-ups' that can share ideas and facilitate access to markets and investors. Some barriers may be defined as 'legal', for example, a lack of clarity regarding the rules or a lack of minimal required standards that act as a drag on changing incumbent 'dirty' technologies. In such cases, well-designed standards, building codes, waste and fuel-blending targets, and power-purchasing agreements are examples of measures that can enable and incentivize investment in low-carbon or climate-resilient technologies.

Who identifies the measures and how?

The first steps in identifying and describing specific measures would ideally be taken during a facilitated workshop with the group that has been involved in the barrier analysis. During this workshop, various inputs, tools and approaches may be used to identify measures to overcome the identified barriers. These may include:

- The TNA Consultant's own experience, supplemented by documented experience of policy measures from other countries. The Consultant should therefore be well prepared for the workshop. There is considerable sector-specific information available online, published by various development institutions, including the World Bank. To provide examples for the TNA process, UDP has published two issues in the Technology Transfer Perspectives Series that provide case studies of enabling frameworks for renewable energy technologies in various developing countries (Haselip et al., 2011) and for adaptation technologies (Christiansen et al., 2011).

Table 10. Descriptions of barriers and measures categories. Source: Nygaard and Hansen (2015).

Barrier or measure category	Barrier description	Measure description
Economic and financial	High cost of capital, investment in technology considered risky (e.g. due to few prior local reference examples), low expected rate of return	E.g. subsidies, standard power-purchasing agreements (feed-in tariffs), loan guarantees, green marketing (e.g. a premium tariff on 'green' electricity), etc.
Market conditions	Few local suppliers of auxiliary goods and services, uneven playing field (e.g. due to subsidies on competing technologies), market control by industry incumbents	Market liberalization (e.g. by introducing competition with incumbent fossil-based monopolies)
Legal and regulatory	Technology opposing incumbent actors (such as utilities), insufficient legal framework, highly controlled sector, conflicts of interest, political instability, bureaucracy, rent-seeking behaviour	Obligations to generate or purchase 'green' electricity, public investment policies, regulation of financial-sector institutions
Network	Weak connectivity between actors, incumbent networks being favoured, limited distribution networks	Promotion of industry associations, networks, organizations and alliances
Institutional and organizational capacity	Few professional institutions, limited institutional capacity, limited management and organizational skills	Initiatives to enhance efficiency in government procedures and processes, capacity-building programmes of governmental agencies and institutions
Human skills	Unskilled technical personnel and inadequate training	Education policies, publicly funded research and development and training programmes
Social, cultural and behavioural	Consumer preferences and social biases, traditions, dispersed settlements	Involving local communities and civil society, targeted assistance to support early adopters and technology front-runners, promotion of public–private partnerships
Information and awareness	Inadequate information, lack of feedback, lack of awareness	Research, information dissemination, outreach and awareness-raising campaigns
Technical	Poor technology quality/performance, few local reference examples	Improved access to the grid, support for testing and demonstration facilities (including training programs), technical standards, certification, and codes
Other	I.e. environmental impacts, physical infrastructure conditions	Improved infrastructure

- Measures already touched on during the barrier analysis may be another important input. Although the barrier analysis and the identification of measures are in theory distinct processes, practice shows that it is difficult for participants to think of barriers without at the same time thinking of measures or solutions. Although measures are not part of the barrier analysis, it may be practical at that stage to take notes that can be used as input to the identification of measures. This can lead to a discussion among stakeholders of what can be done about barriers.
- In cases where the market-mapping tool has been used to identify barriers, it will also be used to identify measures.

Table 11. Example of measure to overcome economic barriers.

Barriers identified	Measures identified to overcome the barriers
Economic and financial	To decrease the interest rate for credit released by commercial banks. To encourage the creation of agricultural banks with a low rate of interest.
	To reduce or avoid taxes on profit for farmers investing in good agricultural practices, including procurement of equipment.
	To ask for higher discount rates for climate technologies from companies producing agricultural equipment
	To release subsidies for farmers implementing climate technologies
	To take into consideration the negative externalities (pollution, soil degradation) of the conventional farming system relative to the conservation farming system
	To reduce taxes for the importation of climate technologies.

Example from Moldova

It makes sense to look again at Moldova, following the example of the adaptation technology described as a 'conservation system involving soil tillage without herbicides for winter wheat'. Below is a summary table of the measures proposed to address only the economic and financial barriers previously identified for this technology. Note that the measures are specific, clear, and correspond to each barrier, and are accompanied by some more detailed analysis of each measure (placed in an annex), which should describe how each measure can realistically be implemented, i.e. who are the key actors and agencies involved, and what do they have to do.

4.4. Reporting for the barrier analysis and enabling framework

The report for the BAEF is the second of the three deliverables that participating countries are expected to submit, the one for which countries are encouraged to dedicate the most resources in preparing and finalizing it, given the analytical requirements. Countries are given the opportunity to submit full first drafts of the BAEF report for critical review by staff at UDP and the Regional Centres. Templates are provided, and the overall length of the report is not expected to exceed eighty pages. As always, quality is more important than quantity, though sufficient detail should be provided on each barrier analysed and the proposed measures to overcome it, offering analytical insights that go beyond simple description and prescription.

4.5. Training and more information

Detailed training on how to conduct the barrier analysis and design the enabling framework will be provided by UDP and the Regional Centres during the second regional capacity-building workshop. However, technical support is provided throughout the project's lifetime by means of a 'help desk' facility operated by the Regional Centres. National Coordinators and/or the lead consultants are encouraged to contact them with any questions or queries they may have, at any stage of the project.

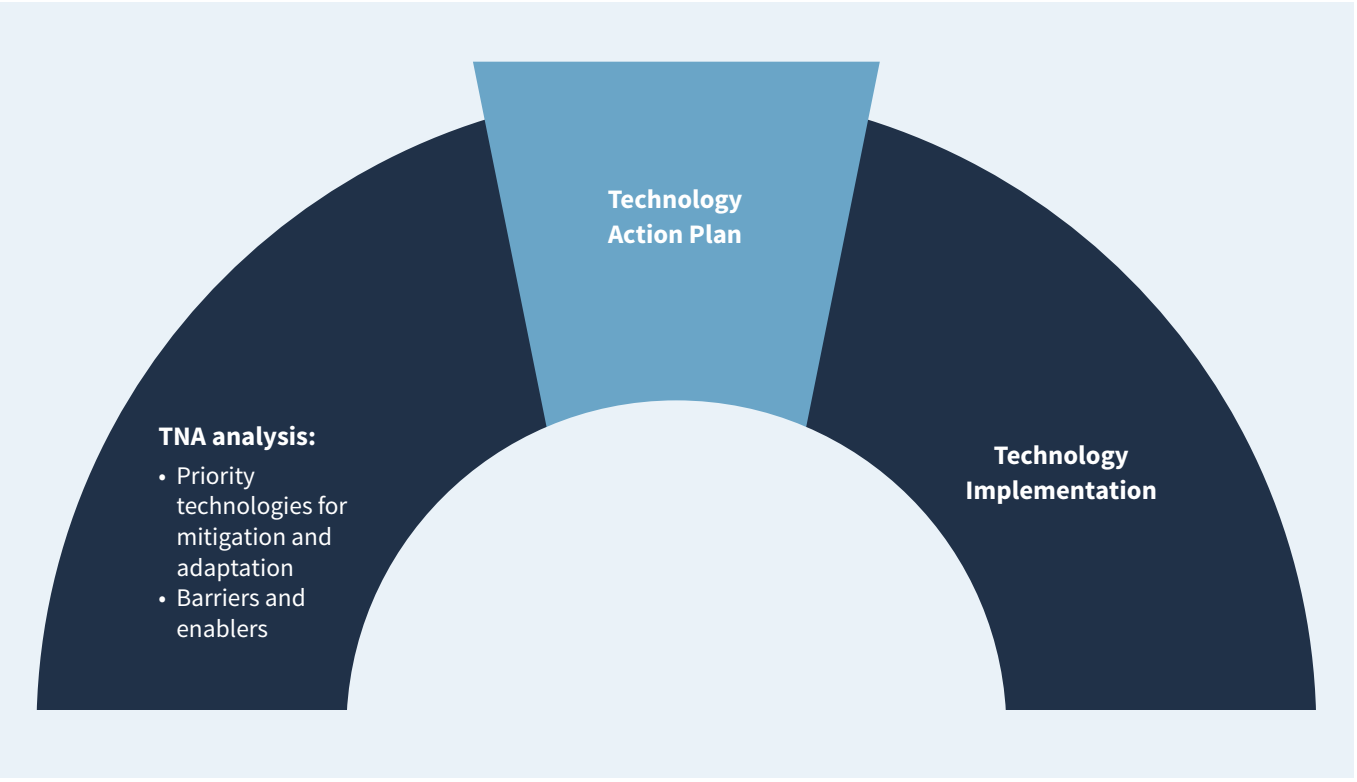
5. Technology Action Plans (TAP)

The final step in the TNA process is the preparation of a TAP to support the implementation of the prioritized technologies on the desired scale within the country to achieve the climate and development benefits as identified earlier in the TNA. Concretely, the TAP should be based on the measures identified in the TNA for overcoming the barriers to technology implementation, and it specifies how to implement these measures, including who is responsible, when and from where for securing funding. As such, a TAP serves as a bridge between the analysis of the prioritized technologies and their implementation.

The actions in a TAP can take different forms. For example, an action can be a technology demonstration project, with the aim of overcoming public opposition to that technology. Another example of an action could be a programme to train local engineers in order to address the barrier of a lack of the skills needed to operate a specific technology. An action could also aim to overcome indirect barriers to technology uptake or diffusion, with associated co-benefits, such as the provision or upgrading of infrastructure. Each TAP should contain:

- A set of concrete actions needed for the successful implementation of technology in the country
- An indicative investment proposal for each technology, to be taken into account when it comes to funding by potential public and/or private funders

Figure 4. TAPs as the 'keystone' between TNA analysis and technology implementation (UNFCCC and UNEP DTU 2015)



Female engineer and wind turbines, bannafarsai/Shutterstock.com.

Box 5. Smart Water Meters in Tanzania

In Tanzania, Non-Revenue Water – water that is produced for consumption and lost before it reaches the customer – is a serious challenge. On average 37% of the water supply in urban areas is lost as Non-Revenue Water, while in a large city like Dar es Salaam it is estimated to be up to a 50% loss. The challenges that the national water authorities in Tanzania face with Non-revenue Water results in water supplies that do not meet demand. The consequence of water loss is reduced the financial viability of water utilities, which again results in poor service and inadequate water access, availability and affordability.

Tanzania's TAP for the water sector identified Smart Water Meters as a key priority to address this problem. The plan identifies and analyses barriers and the enabling framework conditions, which are required for introducing water leakage management through smart water metering systems, and thereby to start the digitalization of the water sector in Tanzania. Introducing a smart water-metering programme is a huge challenge and involves extensive planning, training of personnel, a customer information system and management.

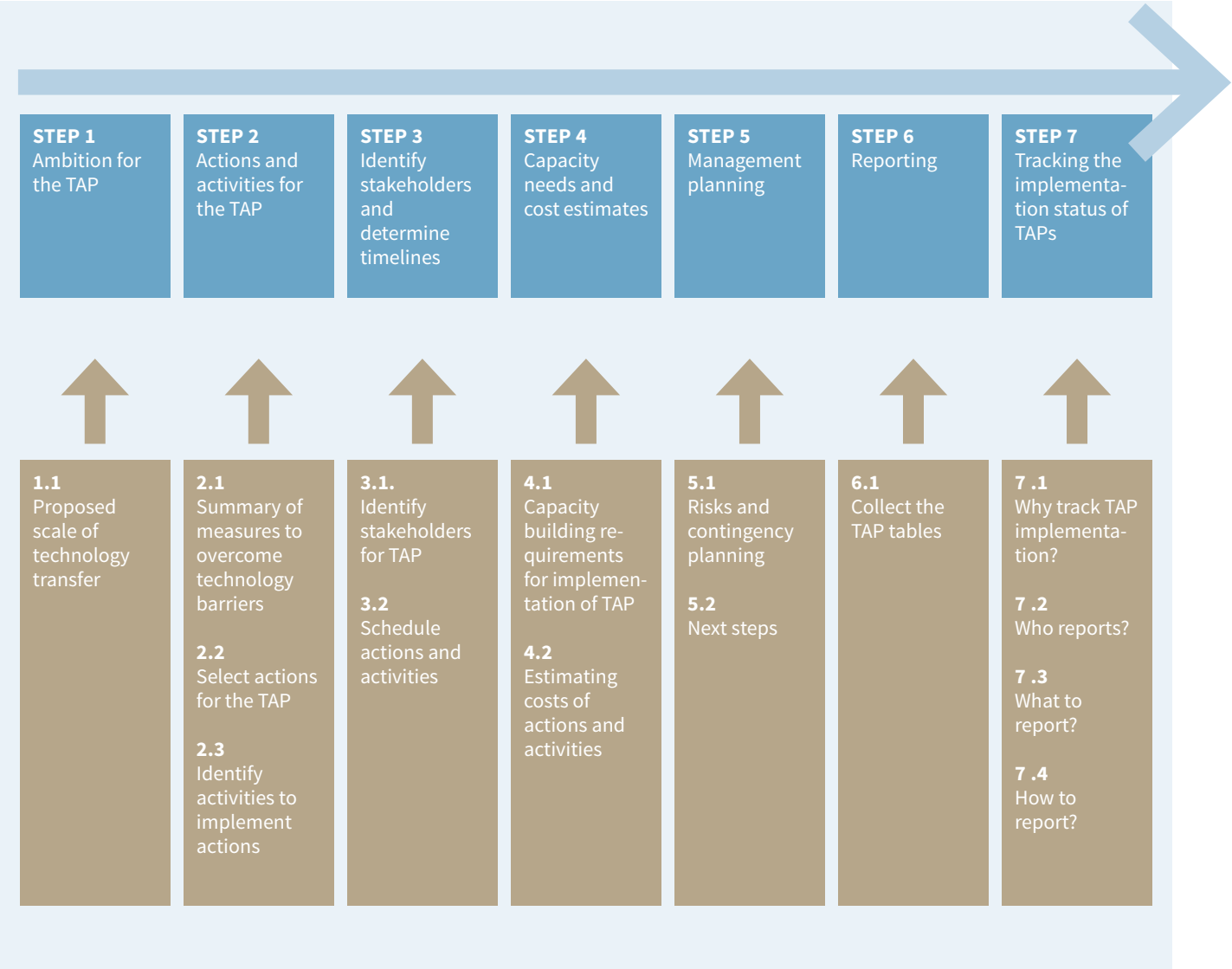
A higher awareness of water consumption is a key contribution of smart water meters, but digitalization will also have a significant impact on preserving the country's water resources in general. Initiatives like this will contribute to alleviating the climate change-induced impacts on the water sector, which threaten people's livelihoods, infrastructure and ecosystems. It is imperative to integrate sustainable management technologies into the local water infrastructure.

It is important to bear in mind that the funding requests prepared as part of a TAP are unlikely to be fully in line with the information needs of potential funders. This is because different funders have different proposal requirements, which a TAP, given the limited resources available, cannot meet. Therefore, the TAP should include proposals that are sufficiently detailed and informative for a 'pre-assessment' or 'first screening' of, for example, their suitability with regard to the funders' own criteria. However, it will be necessary to refine the funding proposal further so it is tailored to the formats and expectations of specific sources.

A TAP can focus on a single technology with larger-scale potential within a country or sector, or on a portfolio of technologies to which common actions apply (e.g. a bus-rapid-transit system together with cycling lanes and pedestrian footpaths). Based on the portfolio of priority technologies within sectors and/or the identified barriers, the TNA team may decide whether or not commonalities exist across multiple prioritized technologies, and whether these justify a TAP that covers a whole portfolio of technologies.

The target audience for a TAP consists of in-country public- and private-sector stakeholders that are likely to be involved in the implementation of the proposed actions detailed in the TAP. These stakeholders can be decision-makers from governments, where actions involve, for instance, regulatory measures or incentives or infrastructural

Figure 5. Overview of TAP preparation process



improvements, and private investors when actions concern concrete business proposals and/or investment opportunities. This guidance emphasizes the need to clarify the responsibilities of the organizations and individuals involved in implementing the TAPs.

The process of developing a TAP can be broken down into seven steps. The first task is to describe the scale and context for the deployment and diffusion of technology, referred to as the 'ambition'. Secondly, it is necessary to summarize the barriers to deployment and diffusion for each technology, as well as possible measures for addressing them. These first two aspects of a TAP should draw on the work completed in the previous steps of the TNA process. For a TAP, the previously identified measures are turned into a List of Actions, which are then expanded into a set of specific activities, i.e. the specific things that need to be done to realize an Action. Once the activities have been defined, the relevant stakeholders, i.e. those who will be directly involved in implementing the TAP, should be identified. Here, it is also important to estimate a timeframe for

each activity. Following the identification of stakeholders, the TAP should estimate the human and financial resources needed for each activity, including the type of financing required and potential sources of funding. The TAP should include a management plan for reporting, risk management, corrective measures and contingency plans. The figure below also includes a Step 6 on reporting and a final Step 7 on how to track the future implementation of TAPs. Figure 5 presents an overview of the content of a TAP, broken down into seven steps.

Box 6. Solar Farms in Guyana

An important target outlined in Guyana's NDC is that Guyana will develop 100% of its power supply as renewables 'as far as possible' by 2025. Guyana has committed itself to developing an energy mix consisting of wind, solar, biomass and hydropower to supply grid-connected and off-grid connected systems. Therefore, Guyana's new TAP focuses on actions to overcome barriers to the implementation of technologies in three key areas, namely solar farms to service urban centers and supply the national grid, large-scale hydropower plants (over 5MW) to support national energy demands, and stand-alone wind farms to service urban centers and supply the national grid.

Guyana's national expert working groups under the TNA project identified the lack of a robust policy framework to promote technology transfer, diffusion and uptake in the energy sector as the key barrier. The working group stakeholders identified an urgency to develop the institutional and technical capacities of the key institutions responsible for deploying, regulating and managing the technology applications. On this basis, it was recommended to integrate elements of the Public Awareness and Education Programme into Guyana's Human Resources Development Plan to allow for continuous or sustained education and development at the tertiary level. Stakeholders also identified the economic and financial incentives as the next priority action. The rationale behind the selection of this action was that incentives serve as the stimulus for the development of renewable energy in the energy sector. It was also suggested that for any investment opportunity incentives are critical.

6. Linking the TNA to other processes

It is important to understand how the TNA process is connected with, or relates to, other major climate change initiatives mandated by the UN Climate Change Convention, as well as key nationally driven analyses, projects and plans. Overall, it is the responsibility of participating countries to position and utilize the TNA process in a way that makes sense to them, identifying and pursuing synergies wherever possible. While there are numerous relevant initiatives to consider, this section offers an analysis of the complementarities and potential overlaps between TNAs and Nationally Appropriate Mitigation Actions (NAMAs), National Adaptation Plans (NAPs) and Nationally Determined Contributions (NDCs) in an effort to highlight the need for meaningful interaction between these Convention-inspired processes.

Countries often ask if and how the TNA feeds into NDCs, NAMAs and/or NAPs, and what comes first. When thinking about TNAs, it should be remembered that the overall focus is on *climate technologies*, not climate risks or strategies per se, and that the TAPs should really focus on what can be done to scale up investments in low-carbon or climate-resilient technologies. That is the overall objective and starting point for working out how the methodology and outputs of the TNA should relate to other national processes.

Indeed, TNA and TAP reports and project ideas are a key source of information for NDEs in their capacity as the focal points of the UNFCCC Technology Mechanism so that quality requests for CTCN and for other donors and financiers can be generated. Requests from countries with a TNA and a TAP to the CTCN could, for example, focus on further technical support in implementing their TAP in order to: 1) strengthen business cases for implementing technology actions; 2) remove some of the identified capacity, policy and regulatory barriers; and 3) assess the feasibility of technology choices and investments.

On the adaptation side, NAPAs provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change, i.e. those for which further delay would increase vulnerability and/or costs at a later stage (UNFCCC, 2015). In addition, NAPs are used as a means of identifying medium- and long-term adaptation needs and of developing and implementing strategies and programmes to address these needs. It therefore makes sense for LDCs that have already conducted or are close to completing their NAPs and NAPAs to use the TNA process as a means to address the issues identified in the NAP and/or NAPA. As such, the TNA/TAP process should result in a set of actionable conclusions that provide practical solutions to the climate risks and vulnerabilities detailed in the country's NAP and/or NAPA.

For NAMAs the situation is reversed: the mitigation project concepts detailed in the TAP report have the potential to be formally registered as NAMAs by participating countries, thus improving their chances of securing external financial support from various international climate funds, including the Green Climate Fund and the Climate Investment Funds, as well as other multi-lateral funding agencies.

Building terraces to prevent soil erosion in Rwanda, Sam Thompson/Department for International Development/Flickr.

Since COP20 in 2014, there has been much discussion about the Intended Nationally Determined Contributions (INDCs) and how TNAs can and should relate to them. In short, on the mitigation side INDCs are detailed post-2020 emissions reduction pledges, intended to feed into the new international climate agreement mandated by the UNFCCC at COP21 in Paris in December 2015. As such, it makes sense for countries conducting a TNA to link this process explicitly to their INDC commitments (which must be communicated prior to COP21), including a focus on the same priority sectors, and using the quantified emissions reduction targets as an input when clarifying the context in which the decision was taken (see Section 3.1 – Decision Context).

Box 7. Sustainable Livestock NAMA: Honduras

Honduras prioritized sustainable livestock production as part of its TNA for the agricultural sector. This was in response to the country's policy to increase the cattle population, which has seen a decline in the past two decades following a series of hurricanes and the growing trend to convert pasture into palm-tree plantations. However, in order to scale up the livestock sub-sector sustainably and in line with greenhouse gas emissions targets, Honduras included the ambition to develop a Sustainable Livestock Nationally Appropriate Mitigation Action as one of the actions in its Technology Action Plan, which should include different practices considered important for greenhouse gas emission reductions.

The Nationally Appropriate Mitigation Action for livestock in Honduras is now in the process of being designed. It focuses on improving animal feed through pastures and fodder banks, genetic improvements, veterinary programs and better farming systems that include incentives in finance and marketing structures as strategies for livestock repopulation. These strategies were initially identified in the TNA for Honduras, which was still under development as work began on the Nationally Appropriate Mitigation Action.

This example demonstrates not only how the TNA can inform other planning tools, but how planning tools can develop in tandem, with feedback from each other.

7. Further reading

Listed here are the detailed TNA guidance documents upon which this guidebook is based. All reports are available to download from http://www.tech-action.org

Nygaard, I. and Hansen, U. (2015). *Overcoming Barriers to the Transfer and Diffusion of Climate Technologies: Second edition.* UNEP DTU Partnership, Copenhagen.

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Rogat (Ed.) (2017) *Identification and Engagement of Stakeholders in the TNA Process: A Guide for National TNA Teams.* UNEP DTU Partnership, Copenhagen.

Trærup, S. and Bakkegaard, R. K. (2015) *Evaluating and prioritizing technologies for adaptation to climate change: a hands on guidance to multi criteria analysis (MCA) and the identification and assessment of related criteria*. UNEP DTU Partnership.

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UDP (2014). *Organising the National TNA Process: An Explanatory Note. Revised Edition.* UNEP DTU Partnership, Copenhagen.

UDP (2015a). *Evaluating and prioritizing technologies for adaptation to climate change: a hands-on guidance to multi-criteria analysis (MCA)*. UNEP DTU Partnership, Copenhagen.

UDP (2015b). *Identifying and prioritising technologies for mitigation: a hands-on guidance to multi-criteria analysis (MCA)*. UNEP DTU Partnership, Copenhagen.

UDP and Libélula (2015). *Identification and Engagement of Stakeholders in the TNA Process: A Guide for National TNA Teams.* UNEP DTU Partnership, Copenhagen.

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UNFCCC (2015). *National Adaptation Programmes of Action (NAPAs).* http://unfccc.int/national_reports/napa/items/2719.php

URC (2010). *Technologies for Climate Change Adaptation – Coastal Zones and Flooding.* TNA Guidebook Series. UNEP Risø Centre, Roskilde.

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URC (2011c). *Technologies for Climate Change Mitigation – Transport Sector.* TNA Guidebook Series. UNEP Risø Centre, Roskilde.

URC (2012a). *Technologies for Climate Change Mitigation – Agriculture Sector.* TNA Guidebook Series. UNEP Risø Centre, Roskilde.

URC (2012b). *Technologies for Climate Change Mitigation – Buildings Sector*. TNA Guidebook Series. UNEP Risø Centre, Roskilde.

TECHNOLOGY NEEDS ASSESSMENT

This guidebook is produced as part of the GEF-Funded Global Technology Needs Assessment Project, which is implemented by UN Environment and UNEP DTU Partnership. The guidebook is intended for national TNA teams, which consist of stakeholders from government, non-government organisations, private sector and others.

The guidebook walks through the steps in preparing a Technology Needs Assessment (TNA) and Technology Action Plan (TAP). As such it is the 'go-to' document for national TNA teams. It is based upon, and refers to, various in-depth guidance materials that are available to inform and support TNA project management and technical analysis. It draws upon numerous country examples to illustrate how the TNA project can be organized and implemented, and how it can enable countries to secure public and private sources of investment in strategic and priority climate technology projects, both for mitigation and adaptation.

More information about the global Technology Needs Assessment Project can be found at:

www.tech-action.org

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