A step-by-step guide for countries conducting a Technology Needs Assessment

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A step-by-step guide for countries conducting a Technology Needs Assessment[1]

[1] James Haselip, Rasa Narkevičiūtė and Jorge Rogat. This version was finalized on 10 September 2015.

Contents

Acronyms

BA	Barrier Analysis
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
EF	Enabling Framework
GHG	Greenhouse Gases
HEV	Hybrid Electrical Vehicles
ICE	Internal Combustion Engine
INDC	Intended Nationally Determined Contribution
LDC	Least Developed Country
MCA	Multi-Criteria Analysis
MDG	Millennium Development Goal
MSW	Municipal Solid Waste
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organisation
SME	Small and Medium Enterprise
TAP	Technology Action Plan
TMA	Technology Market Assessment
TNA	Technology Needs Assessment
UDP	UNEP DTU Partnership
UK	United Kingdom
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 document is to summarise the various steps in the implementation of a TNA, serving as the 'go-to' document for national coordinators and consultants. It also points to the various materials that are available to further guide and support project management and methodology. For this new TNA Phase II (2015-2017), we reflect upon experience from the 36 countries in the TNA Phase I (2010-2013) and offer country case-study examples to help illustrate how the project can be organised and implemented. Links to the full electronic (.pdf) versions of the guidance documents are provided in this guidance note and can be downloaded from the TNA project website www.tech-action.org under 'Publications'.

1.1. The origins of TNAs

The TNA process originates from the Poznan Strategic Programme on Technology Transfer established at the Fourteenth Conference of the Parties (COP 14) to the United Nations Framework Convention on Climate Change (UNFCCC), with the aim to scale up investment in technology transfer thus enabling developing countries to address their needs for environmentally sound technologies.

A TNA can be defined as a set of country-driven, participatory activities leading to the identification, selection and implementation of environmentally sound technologies to decrease CO_2 emissions (mitigation) and/or to decrease vulnerability to climate change (adaptation).[2] As a country-driven process it should not be conducted in isolation but rather integrated with other similar ongoing processes aiming to support national sustainable development.

[2] Subash Dhar, 2014. ClimateTechWiki Webinar, 25 February, 2014

The TNAs are also a participatory process and thus 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 through to farmers or households, if all stakeholders are involved throughout the TNA. However, it is important to understand that stakeholders are different 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 a 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). It can be downloaded from the TNA project website www.tech-action.org under 'Publications'.

1.2. Objectives and deliverables

The TNA process has three main objectives:

1) To identify and prioritise mitigation/adaptation technologies for selected sectors/sub-sectors

2) To identify, analyse and address barriers hindering the deployment and diffusion of the prioritised technologies including enabling the framework for the said technologies

3) To articulate, based on the inputs obtained from the two previous steps, a Technology Action Plan (TAP) with suggested measures/actions presented in terms of project ideas

For each of these steps, guidance and methodologies have been developed and are summarised in this guide note in sections 3, 4 and 5. The three objectives are in turn translated into three concrete outputs which are: 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 to be used by the countries for each of the reports have been developed by UNEP DTU Partnership and the Regional Centres.

1.3. Anticipated outcomes

Based on the experience from countries in TNA Phase I, but also based on the feedback on the TNA process that countries provided, it is clear the TNA process can and has helped participating countries in various ways, which can be considered as *outcomes* of the TNA process. For instance, several Phase I countries have directly used the inputs from their TAPs to develop NAMAs or to explicitly link outputs to other national processes, to develop the analysis and/or plans detailed in their TNA/TAP reports. Other countries have applied the TNA methodology to assess other local environmental needs, under separate processes or projects. Some countries have developed further and/or fine-tuned the project ideas articulated in the TAP in order to develop concrete project proposals, as a step towards investment-ready projects; targeted at either with national or international funding. These are some examples of what can be considered a desirable outcome from the TNA process.

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, under the leadership of a National TNA Coordinator, conduct the TNA process. The National TNA Team is an umbrella that refers to the TNA Committee, the sectoral working group and the national consultants. For a detailed guidance on how to set up the national organisational structure for the TNA process see: Organising the National Technology Needs Assessment (TNA) Process: An Explanatory Note, which is summarised in the following section. We encourage countries to use or build upon existing structures, not necessarily creating new structures for the sake of the TNA. 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 job of the TNA team is to **agree upon the prioritised mitigation and adaptation sectors** that the TNA process will focus on, consulting with relevant stakeholders where appropriate. In most countries it will be easy to identify the priority sectors, and we suggest that this process is completed relatively quickly, drawing directly from existing analysis and/or national planning or strategy documents. We suggest that 2-3 well-defined sectors are selected for analysis under both mitigation and adaptation, assuming that countries choose to dedicate an equal share of the budget to mitigation and adaptation-side technologies. The final selection of priority sectors should be done through a simple participatory process, assisted by the application of basic criteria, which should reflect wider development priorities and be in-line with other processes in the country. The table below summarises some of the criteria used in Lebanon to select the priority sectors.

Criteria
Vulnerability to climate change
Adaptive capacity
National priority
Socio-economic importance
Extent to which change can be inflicted

Once the sector prioritisation is done, the TNA team can identify 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:

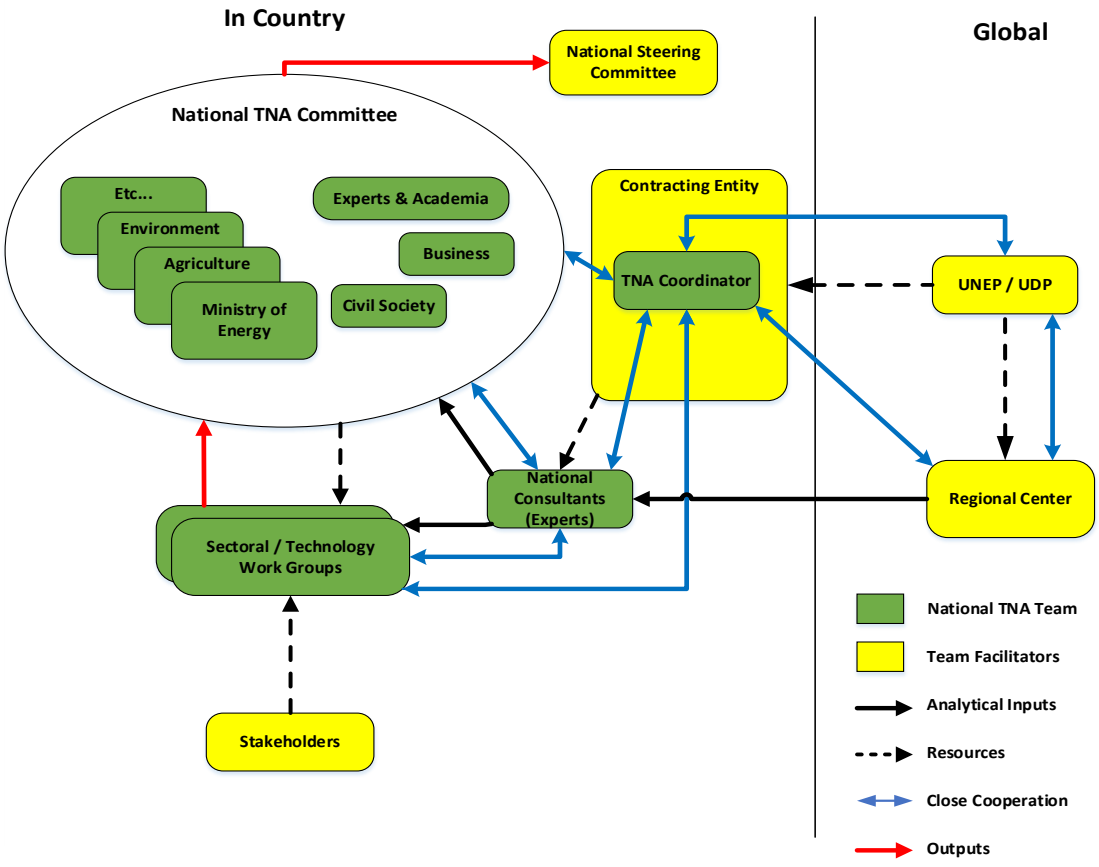
- An institutional structure, detailing responsibilities of key individuals and groups in the rest of the process

- Prioritised sectors for mitigation and adaptation, based on or coherent with national development priorities
- A detailed work plan, detailing the various steps of the TNA implementation and their corresponding completion dates
- Selected consultants for conducting the analysis for mitigation and adaptation
- A plan on how stakeholders will be engaged throughout the process
- An initial group of key stakeholders

Summary of the key preparation stages is shown in the table below.

Preparation stage	Responsibility	Additional Guidance
Institutional structure	TNA Coordinator, signing Ministry	Explanatory Note for Organising the National TNA Process
Sector prioritisation	TNA Team	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, Consultant	Stakeholder guide note

2.1. Organisational structure for a TNA process

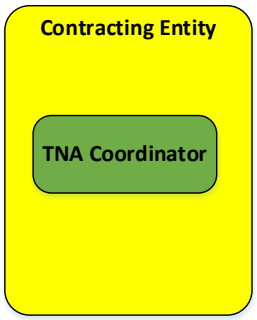


The various elements in the country structure are broken down and explained in the following sub-sections.

2.1.1. *National TNA Team*

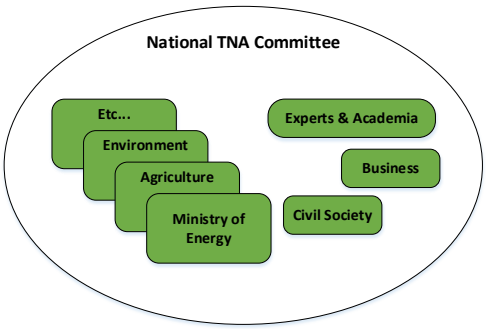
The national TNA team is made up of 1) the national coordinator; 2) the TNA committee; 3) National consultants; 4) sectoral working groups.

2.1.1.1. *The national TNA coordinator*



The National Coordinator is appointed by the contracting entity (ministry or state agency responsible for the TNA). Usually the coordinator is a civil servant employed by the contracting agency, ideally with a scientific or engineering background, familiar with the broader issues of climate change and the role of technologies in mitigating and adapting to climate change. Their job is to provide day-to-day leadership and vision for the TNA process, responsible for the overall management of the TNA. They are responsible for facilitating all relevant tasks, and ensuring communication among the national TNA Committee members, National Consultants and stakeholder groups. The National Coordinator is also the official contact point for the country, communicating progress and/or any queries directly with the Country Coordinators at UDP and the Regional Centres. National consultants are also able to communicate directly with UDP and the Regional Centres, though the National Coordinator should always be in email copy. Whichever way countries choose to organise and conduct their TNA, it is recommended that a communications protocol is agreed upon, so that the relevant individuals are always involved and/or informed.

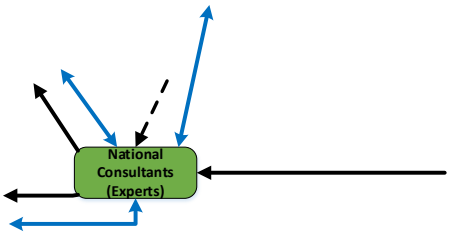
2.1.1.2. *The TNA committee*



The role of the National TNA Committee is to provide leadership to the project in association with the TNA coordinator. Specific responsibilities include identifying national development priorities, and priority sectors for technology needs; deciding on the constitution of sectoral / technological workgroups; approving the technologies and strategies for mitigation and adaptation recommended by sectoral workgroups. The committee should also provide feedback on the TAPs, though it is the national TNA coordinator together with UDP that

approves them. The TNA Committee should be composed of representatives from relevant ministries, civil society (NGOs), the private sector and experts or academics. The members should be familiar with national development objectives, sector policies, climate change science, the potential climate change impacts for the country, and adaptation needs. In order to simplify decision-making processes we recommend that the committee should have no more than 10 members.

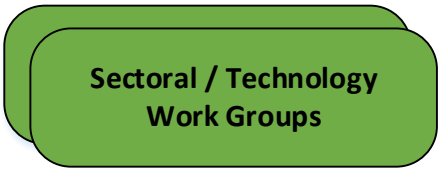
2.1.1.3. *National consultants*



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/TAP process. There are various ways to hire national experts as consultants, though experience indicates that two lead consultants, one responsible for mitigation and one for adaptation, creates clear lines of responsibility and communication with the National Coordinator. Other national experts can be hired later in the process to provide specific analytical inputs, as and when necessary. The lead national consultants should be selected by the National TNA coordinator in consultations with UDP (Regional Centres can be consulted when appropriate), 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 and candidates are rated according to some 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. Payments made to the National Consultants will constitute the majority of the TNA budget (the detail of which should be agreed between the National Coordinator and UDP). In exchange, they are expected to:

- Provide process-related and technical advisory services needed for conducting TNAs, BA&EF, and developing Technology Action Plans (TAPs)
- Lead and undertake activities such as research, analysis and synthesis in support of the TNA/TAP, delivering all project outputs
- Participate in capacity building workshops
- Work in close partnership with the National Coordinator to facilitate communication within the national TNA Team (consultants, sectoral working groups and the national committee), engage with stakeholders, form of networks, and coordinate and communicate all deliverables.

2.1.1.4. *Sectoral work groups*



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

2.1.2. *The National Steering Committee*

The National Steering Committee should be composed of members from all relevant ministries responsible for policy making, plus key stakeholders from the private sector. Their

role is to provide high-level guidance to the national TNA team and help secure political acceptance for the TAP. As such, it envisioned that the National Steering Committee only meets 2 or 3 times, once the TNA team is established and the priority sectors are known, and towards the end of the process, once the TAP has been finalised. However, as will 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, and there may be overlaps between this and the national TNA committee, that may even deem this higher-level committee to be redundant.

2.1.3. *Identifying and engaging relevant stakeholders*

This is a fundamental aspect of the TNA process, and significant time and effort should be 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. As such, we have prepared a specific guidance document on how to best identify and engage relevant stakeholders, entitled Identification and Engagement of Stakeholders in the TNA Process: A Guide for National TNA Teams. National TNA teams are encouraged to read this document and follow the recommended procedures.

3. Identification and Prioritisation of Technologies

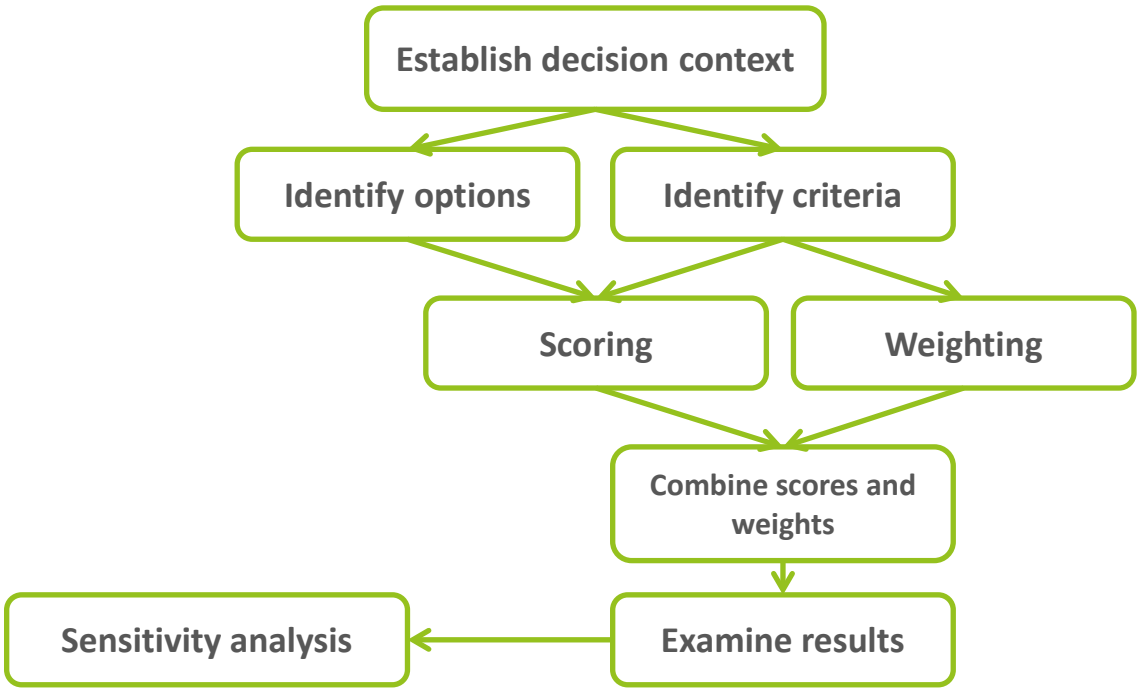
The prioritisation of technologies, within the selected priority sectors, is the first analytical step in the TNA process. The conclusions of this step shall be reported in the first of the three deliverables, (referred to as 'the TNA report'), as stated in the MoU. All members of the National TNA Team 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. Summary of inputs, roles and responsibilities for the technology prioritisation are shown in the table below:

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 prioritising climate technologies

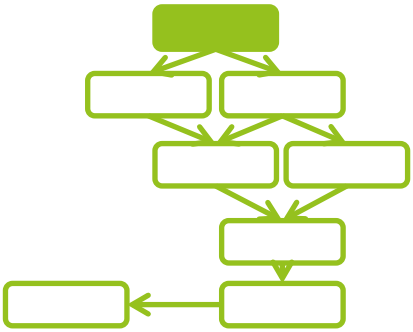
The process for identifying and prioritising technologies presented in this guidenote follows the approach for conducting Multi-Criteria Analysis described in Dodgson et al. (2009) and more detailed guidance provided for TNA countries as two separate guide notes on adaptation (UDP, 2015a) and mitigation (UDP, 2015b). The steps involved are shown in the figure below.



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

3.1.1. *Decision context*

Parties involved: Consultant, national TNA team

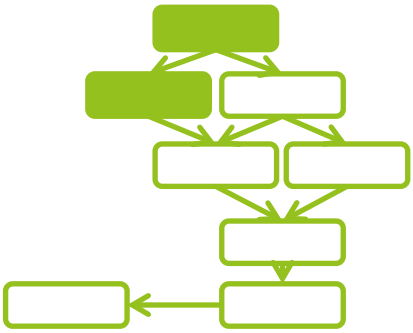


Activities: to analyse the current situation, assess the context in which TNA is conducted and establish a decision making body. How does the TNA process relate to other national processes and/or analyses, what goals can it help achieve? Here, it is useful to bear in mind the key national status and development priorities, including national GHG inventories; national sectoral plans and policies; poverty reduction strategy papers; 5-year National plans (or similar documents), Nationally Appropriate Mitigation Actions (NAMA); country-specific MDG reports, INDCs and other relevant initiatives. The MCA Guide note on Adaptation and Mitigation (UDP, 2015a; UDP, 2015b) provide examples from TNA Phase I.

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 workgroup.

3.1.2. *Identifying options*

Parties involved: National consultants and Sectoral Work Groups

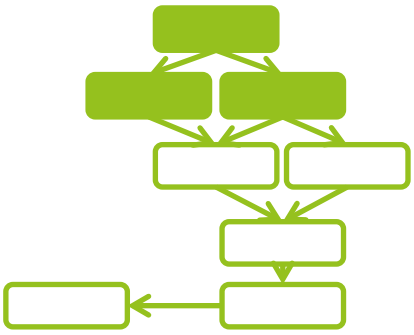


Activities: To undertake a review of existing planning documents (Past TNA, NAPA, Energy Plans, National Communications, etc.), preparing technology factsheets and other information for

input into the MCA template. Relevant sources of information include the Climate Techwiki and guidebooks published by UNEP DTU which cover the transport sectors, building and agriculture (for mitigation) and coastal zones, 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 relevant stakeholders, to ensure a high level of 'buy in'.

Output: A list of technologies (suggested 10-12 technologies) to be analysed including technology factsheets for each one. Fact sheets produced by countries from the previous phase can form the basis of new factsheets, however each country should create new ones, tailor made to fit their circumstances / context.

3.1.3. *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, criteria for 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: Consultant, sectoral working groups

Activities: to organise a stakeholder consultation, clarifying what are the key issues / considerations expressed by stakeholders when choosing technologies. Alternatively, the consultants (working with TNA coordinator and the sectoral working groups) can suggest criteria that reflect country's development priorities, and organise a validation workshops with stakeholders. The criteria can be organised into sub criteria and organised into different levels to help in linking to development priorities, for which

readers can refer to the adaptation guide note (UDP, 2015a) and mitigation guide note (UDP, 2015b). For a general understanding of criteria we refer parties to the Multi-Criteria Analysis Manual (Dodgson et. at., 2009). An Excel-based template for calculations 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.

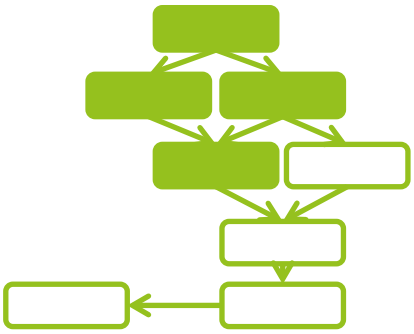
Example: Criteria for mitigation, energy sector, Sri Lanka

Category		**Criteria**
Costs		Cost of Energy Conversion Facility (C)
Benefits	Economic	Local Economic Benefits (LEB)
		Local Share of Technology (LST)
	Social	Direct Employment (DE)
		Skill and Capacity Development (SCD)
		Energy Security (ES)
	Environmental	GHG Emission Reduction (GHGR)
		Positive Local Environmental Impacts (PLEI)

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

3.1.4. ***Scoring***



Technology options are evaluated based on the selected criteria. Firstly, a performance matrix is constructed, in which the scale of evaluation can be different for each criterion. For example, capital cost may be input directly in monetary units, GHG reduction in tonnes CO_2, qualitative criteria can be evaluated on a Likert (or similar) scale. Qualitative descriptions of consequences can accompany the scores in this matrix. Secondly, the performance matrix is converted to a scoring matrix, in which the scales for all criteria are the same: 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 preference. If no detailed data is available, a scoring matrix can be constructed directly. The table below presents a simple example where 4 technologies are assessed against 2 criteria (cost and GHG emissions reduction). The best-performing options are marked in bold, worst in red.

	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 following table, the best option is given a score of 100 and the least preferred option a score of 0. The remainder 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 normalised with respect to the best and worst performing options: $\frac{400-100}{550-100} = 0.67$.

	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 on performance matrix and scoring along with an example from one of the countries from TNA phase I is presented in the mitigation guide note (UDP, 2015b).

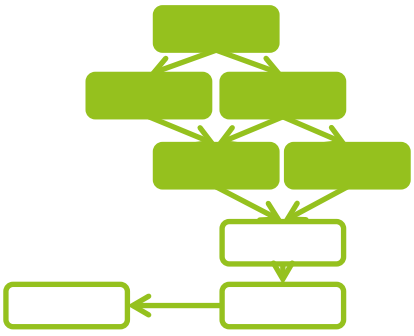
Parties involved: Consultant, sectoral working groups. The consultant should conduct the desk study, organise stakeholder consultations, summarise the stakeholder views, fill in the performance matrix and build the scoring matrix. The stakeholders provide their views and opinions on the technology options performance and suggest scores for discussion.

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

Output: A matrix with a score for each technology option

3.1.5. ***Weighting***

The criteria that are selected for evaluating the usefulness of each technology option may not be equally important to the decision, or 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 technology in energy sector? If so, by how much? Is vulnerability reduction seen as an essential criterion for adaptation measures in agricultural sector, much more so than any other? This step aims to assign quantitative values to the relative importance of 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. This simplest way to do this is via a process of budget allocation, whereby the total number of criteria can be viewed as a cake (with a total value of 100), split up into slices of varying sizes. Since scores are normalised for all criteria between 0 to 100, weights should also consider how the performances swing between most preferred and least preferred option. Readers can refer to the MCA manual for this (Dodgson et. al., 2009). Regarding how weights are assigned when the criteria are organised 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, to facilitate the discussion about specific technologies and be aware of what is required as an 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 the relative importance of the criteria.

Activities: Organise a stakeholder discussion, facilitate discussion to obtain decision on weights. Input this information into the MCA template.

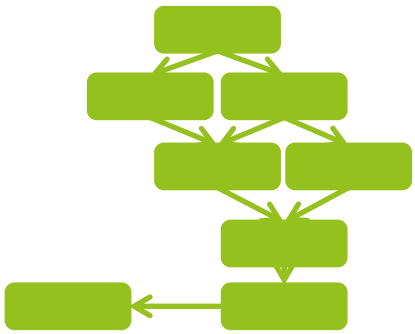
Output: A list of weights for the previously selected criteria

Example: criteria weights for mitigation, energy sector, Sri Lanka

Category		Criteria	Weight
Costs		Cost of Energy Conversion Facility (C)	20
Benefits	Economic	Local Economic Benefits (LEB)	20
		Local Share of Technology (LST)	8
	Social	Direct Employment (DE)	12
		Skill and Capacity Development (SCD)	8
		Energy Security (ES)	12
	Environmental	GHG Emission Reduction (GHGR)	8
		Positive Local Environmental Impacts (PLEI)	12

3.1.6. ***Results and Sensitivity analysis***

All the information and views collected in the previous steps are now consolidated, with a few technologies 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 2 or 3 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 for consensus building, 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 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 it is recommended to perform a sensitivity analysis. The main tool to be used here is the MCA template.

Output: a shortlist of technologies for further analysis

3.2. Reporting

A report detailing the technology prioritisation process and its results (referred to as the 'TNA report') is to be submitted by each country. This should contain a detailed description of how the prioritisation has been conducted, for the sectors and subsectors in need of mitigation and adaptation technologies, and which methodologies have been used for the prioritization of technologies. UDP provides reporting templates which include sections describing the country context, a description of the institutional arrangement, sector selection, and technology prioritisation for each selected sector. In addition, a list of stakeholders involved and the technology factsheets used should be added as appendices. The report will be subject to a maximum 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 three rounds of comments). After the 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, approved by national TNA coordinator.

3.3. Support and Guidance for the technology prioritisation

- Regional capacity building workshops
- Regional Centre help desk and support missions

- TNA Website (www.tech-action.org)
- MCA Guidebook (published by the UK Government)
- MCA calculation template and examples
- Adaptation and mitigation-specific guides to technology prioritisation process
- Technology guidebooks

4. Barrier Analysis and Enabling Framework (BAEF)

This guidebook has explained, in the preceding sections, that it is important for countries to identify their climate change technology needs *per se*, often updating these needs through a transparent and participatory process of prioritisation. However, experience indicates that emphasis on providing detailed understanding of the barriers facing these technologies in each country, followed by a clear analysis of what rules, regulations and incentives, is required to overcome these barriers, collectively referred to as the 'enabling framework'. Therefore, the TNAs focus on understanding the various barriers and constraints to the uptake and diffusion of the technologies prioritised 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 of the barrier analysis are:

1. Identify all possible barriers through literature survey, interviews and/or workshop brainstorms

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 opinion 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 prioritised and grouped into relevant categories, for example: economic, financial, institutional, legal, technical, social and cultural barriers.

4.2. Example barrier analysis from Moldova

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

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 per five years		Heat Supply: gasification of municipal solid waste for electricity heat/ production (G-MSW)
	Vetch field as green fertilizer into 5 year crop rotation	**Transport**	Hybrid electric vehicles (HEV). A hybrid car combines an internal combustion engine with technologies used in full electric vehicles
Human health	Provisional posts of 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 intermediary crop for green fertilizer
	Rural population supply 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 intermediary crop for green fertilizer
			Classic tillage, including a vetch field (two yields per year - autumn and spring), as a "green fertilizer field" into a 5-fields crop rotation

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 5,000 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 and insight of 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 deeper to explain what exactly are the cost differences and why does this occur. It is useful to take the example of just one technology, for example "conservation system of soil

tillage without herbicides for winter wheat". Below is the summary table of the key barriers there were identified via stakeholder consultation, and taken forward for further analysis, for that one specific 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

Taking the example further, focusing down on one particular category of barriers, the text box below summarises the analysis of the key economic and financial barriers to the uptake of conservation systems of soil tillage without herbicides for winter wheat in Moldova. The detailed analysis can be placed in an annex but is required in order to explain and justify the summary list of barriers, i.e. that they haven't been chosen arbitrarily. However, the summary tables or lists of barriers are necessary in order to present these in schematic format, which helps to link them to other barriers to build up a picture of how they interact and what measures can be designed to overcome them.

Economic and financial barriers to the uptake of conservation systems of 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 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 with the farmers' limited access to 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 a banking institutions or Land Banks that would provide finance to farmers by accepting land as collateral explains the lack of interest from foreign investors for 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 doesn't allow promoting long-term credits at lower rates of interest. Credit is released through commercial banks which are interested in short-term crediting. The issue of crediting is very complex and it supposes financial stability and less dependence from the international market on inputs (oil, fertilizers, pesticides, agricultural equipment, seeds etc.). High prices for inputs and relatively low prices for agricultural products further limit the access to credit. In order to improve the existing situation for financing agriculture of Moldova, 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 which are implementing environmentally friendly technologies should be supported by the state through subsidies, reduced taxes for imported equipment used for climate technologies.

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

Chapter six in the barrier analysis guidebook describes how the identified barriers can be translated into measures to overcome the barriers. The detailed analysis should have clarified the nature of barriers and their interrelations, which itself helps indicate which measures may be necessary. Chapter six in the guidebook offers examples of how a set of complementary measures may be used to enhance their impact, and how different sets of measures achieving 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 technology action plan (Nygaard and Hansen, 2015).

4.3.1. *What is an Enabling Framework?*

We understand an enabling framework as something broader than just a set of specific policies, to 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 in a 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 uptake and diffusion of 'climate technologies', markets may need to be freed, created or stimulated, 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., but also include an understanding of the capacities of various actors and agencies in each country.

4.3.2. *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 prioritised barriers can be classified as 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 these could include the introduction of funding agencies to provide grants for retro-fitting building to increase energy efficiency or regional authorities to roll-out low-tech coastal zone management practices. 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 a proposed measure, or a network of SMEs innovators or "startups" that can share ideas and facilitate access to markets and investors. Some barriers may be defined as 'legal', referring to a lack of clarity regarding the rules or lack of minimal required standards that stand to benefit incumbent 'dirty' technology. In such cases, well designed standards, building codes, waste or fuel blending targets and power purchase agreements are example of measures that can enable or incentivise investment in low carbon or climate resilient technologies.

4.3.3. ***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 which 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 on 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 published two issues of 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).

- 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 to take notes at that stage, which 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 the cases where the market mapping tool has been used for identifying barriers it will also be used for the identification of measures.

Source: Nygaard and Hansen (2015)

4.3.4. ***Example from Moldova***

It makes sense to look again at Moldova, following the example of the adaptation-side technology "conservation system of soil tillage without herbicides for winter wheat". Below is a summary table of proposed measures 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.

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

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, and the one for which it is encouraged that countries dedicate most resources to preparing and finalising 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 80 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 them, offering analytical insights that go beyond simple description/prescription.

4.5. Training and more information

Detailed training on how to conduct the barrier analysis and design the enabling framework is provided by UDP and the Regional Centres during the second regional capacity building workshop. However, technical support is provided throughout the project lifetime through a 'help desk' facility operated by the Regional Centres and

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)

Guidance of the TAPs is currently being updated, in consultation with the UNFCCC. It will be included in a revised version of this guidance note, to share with countries later in 2015.

6. Linking the TNA to other processes

It is important to understand how the TNA process connects with, or relates to, other major climate change initiatives mandated by the UNFCCC Climate Change Convention, as well as key nationally-driven analyses, project and plans. Overall, it is the responsibility of participating countries to position and utilise the TNA process in a way that makes sense for 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 Programmes of Action (NAPAs), National Adaptation Plans (NAPs) and Intended Nationally Determined Contributions (INDCs), 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 NAMAs, NAPs or NAPAs and what comes first. When thinking about TNA it should be remembered that the overall focus is on *technologies*, not the climate risks or strategies per se, and that the TAPs should really focus on what can be done to scale up investment 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 UNFCCC initiatives, including the CTCN.

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 - 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 developing and implementing strategies and programmes to address those needs. It therefore makes sense, for LDCs that have already conducted or are close to completing the 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.

Since COP20 in 2014 there has been much discussion about the Intended Nationally Determined Contributions (INDCs), and how TNAs can and should relate to INDCs. In short, INDCs are (on the mitigation side) detailed post-2020 emissions reduction pledges, intended to feed into a new international climate agreement mandated by the UNFCCC at COP21 in Paris, December 2015. As such, it makes sense for countries conducting a TNA to explicitly link this process to their INDC commitments (which must be communicated prior to COP21), including to focus on the same priority sectors and use the quantified emissions reduction targets as an input into clarifying the decision context (section 3.1.1.).

References

Christiansen, L., Olhoff, A. and Trærup, S. (eds.): *Technologies for Adaptation: Perspectives and Practical Experiences*, UNEP Risø Centre, Roskilde, 2011

Dodgson, J.S., Spackman, M., Pearman, A. and Phillips, L.D. (2009). Multi-criteria analysis: a manual. Department for Communities and Local Government: London.

Haselip, J., Nygaard, I., Hansen, U., Ackom, E. (2011). *Diffusion of renewable energy technologies: case studies of enabling frameworks in developing countries*. Technology Transfer Perspectives Series, UNEP-Risø Centre, Denmark, pp. VII-XIV

Nygaard, I. and Hansen, U. E. (forthcoming in 2015). *Overcoming Barriers to the Transfer and Diffusion of Climate Technologies: Second Edition*. UNEP DTU Partnership, Roskilde, Denmark.

Republic of Moldova (2012). *Technology Needs Assessment for Climate Change Adaptation. Report II: Analysis of Barriers and Enabling Framework*. http://www.tech-action.org/Participating-Countries/Phase-1---Asia-and-CIS/Republic-of-Moldova

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

UNDP (2010). *Handbook for conducting Technology Needs Assessment for Climate Change*. United Nations Development Programme, New York

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

URC (2011a). *Technologies for Climate Change Adaptation – Agriculture Sector.* TNA Guidebook Series. UNEP Risø Centre, Roskilde

URC (2011b). *Technologies for Climate Change Adaptation - The Water Sector.* TNA Guidebook Series. UNEP Risø Centre, Roskilde

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