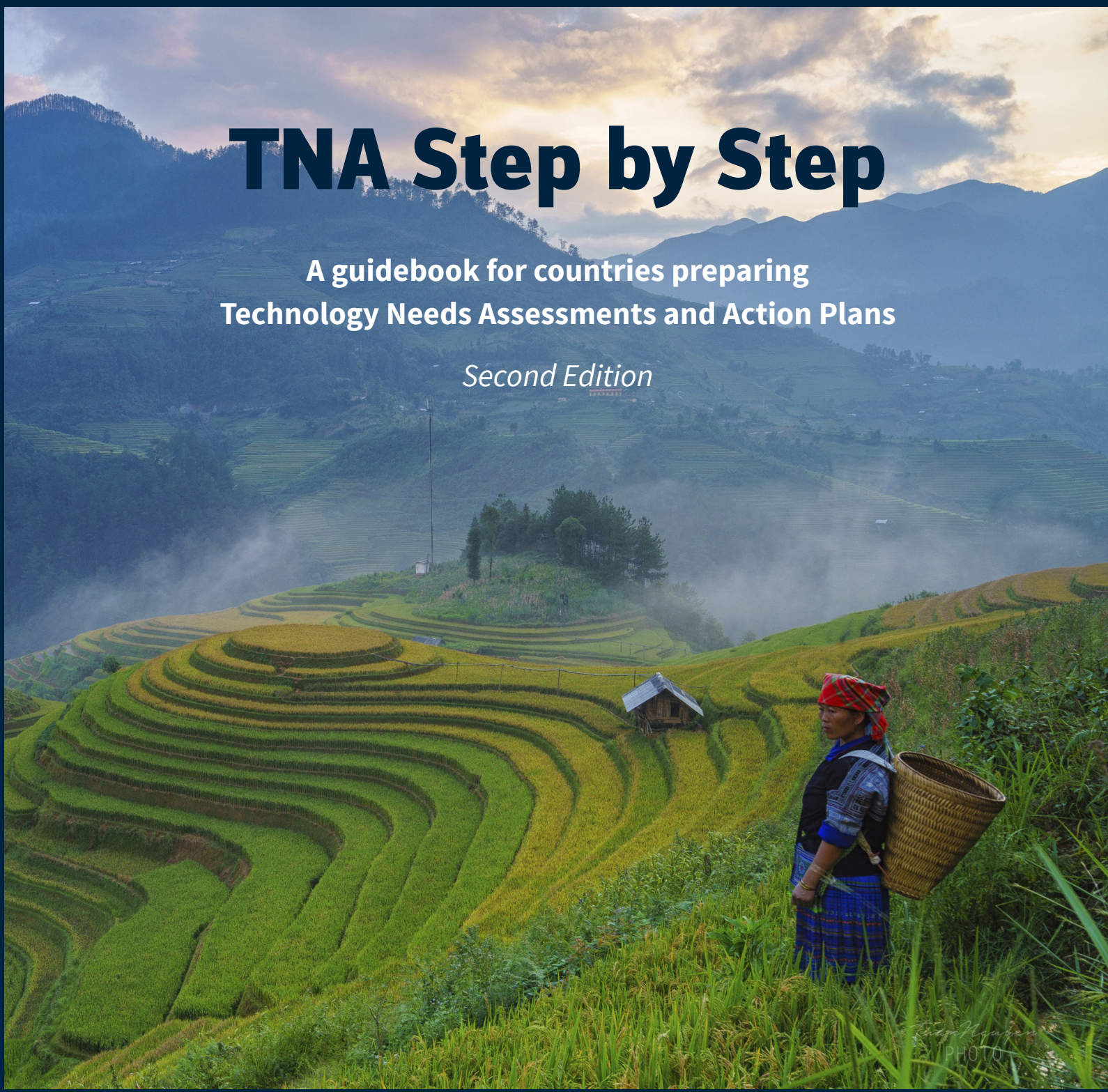
TNA TECHNOLOGY NEEDS ASSESSMENT

TNA Step by Step

A guidebook for countries preparing Technology Needs Assessments and Action Plans

Second Edition



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Citation

United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC); TNA Step by Step - A guidebook for countries preparing Technology Needs Assessments and Action Plans (2nd edition) (2024)

Acknowledgements

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UNEP-CCC would like to thank the UNFCCC Secretariat and the UNFCCC Technology Executive Committee for their contribution to the update of this guidebook. Thanks also to UNEP-CCC staff, TNA regional centres and partners for their valuable comments and suggestions.

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Abbreviations

BAEF	Barrier Analysis and Enabling Framework
BTR	Biennial Transparency Reports
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
DTU	Danish Technical University
GCF	Green Climate Fund
GHG	Greenhouse Gases
LDC	Least Developed Country
LT-LEDS	Long-Term Low Emissions Strategy(ies)
LTS	Long-Term Strategy(ies)
MCA	Multi-Criteria Analysis
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NDA	National Designated Authority
NDC	Nationally Determined Contribution
NDE	National Designated Entity
SDG	Sustainable Development Goal
SME	Small and Medium Enterprise
TAP	Technology Action Plan
TFS	Technology Factsheet(s)
TNA	Technology Needs Assessment
UDP	UNEP DTU Partnership (formerly URC)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-CCC	UNEP Copenhagen Climate Centre (formerly the UNEP DTU Partnership)
UNFCCC	United Nations Framework Convention for Climate Change
URC	UNEP Risø Centre

Glossary

Actions	Those measures which are taken into the TAP through a process of consultation and analysis
Activities	Components of the Actions that are implementable and with clearly defined responsibilities, costs and scheduling
Adaptation	Short for 'climate change adaptation', meaning adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities (IPCC, 2007). Adaptation is a process, not an outcome.
Adoption	The process by which a technology is selected for use by an individual, an organisation or a society.
Barrier	A reason why a target is adversely affected, including any failed or missing countermeasures that could or should have prevented the undesired effect(s).
Climate technology	Climate technologies are those that help us reduce greenhouse gases and/or adapt to the adverse effects of climate change. (See definition of technology below).
Deployment	The act of bringing technology into effective application, involving a set of actors and activities to initiate, facilitate and/or support its implementation (IPCC 2022a).
Diffusion	The process by which a technology is spread or disseminated through various channels over time in a society, where the technology is gradually adopted by more and more members of the society (people, institutions, companies, etc.).
Enabling environment	The set of resources and conditions within which the technology and the target beneficiaries operate. The resources and conditions that are generated by structures and institutions that are beyond the immediate control of the beneficiaries should support and improve the quality and efficacy of the transfer and diffusion of technologies (UDP 2015c).
Feasibility	The potential for a mitigation or adaptation technology to be implemented. Factors influencing feasibility are context-dependent, temporally dynamic and may vary between different groups and actors. Feasibility depends on geophysical, environmental-ecological, technological, economic, sociocultural and institutional factors that enable or constrain the implementation of an option. The feasibility of options may change when different options are combined and increase when enabling conditions are strengthened (IPCC 2022b).
Hardware	The tangible aspects of technology, such as equipment and machinery.
Incentive	Cf. 'Measure'.

Market/value chain	The chain of economic actors that own and transact a particular product as it moves from primary producer to final consumer.
Market mapping	An analytical framework for understanding market systems and an approach to market development that is both systemic and participatory, described in the BAEF Guidebook (UDP 2015c).
Measure	Any factor (financial or non-financial) that enables or motivates a particular course of action or behavioural change, or is a reason for preferring one choice over the alternatives. Often the word 'incentive' is used synonymously, sometimes with a slightly different interpretation. Neither this guidebook, nor the BAEF Guidebook, distinguishes between 'measure' and 'incentive'.
Mitigation	Short for 'climate change mitigation', meaning an action to decrease the atmospheric concentration of greenhouse gasses, either by reducing their sources or by increasing their sinks.
Orgware	The institutional framework, or organisational aspects, involved in the diffusion and uptake of a technology.
Resilience	Short for climate resilience, "the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure as well as biodiversity in case of ecosystems while also maintaining the capacity for adaptation, learning and transformation. Resilience is a positive attribute when it maintains such a capacity for adaptation, learning, and/or transformation." IPCC (2022c)
Software	The intangible elements associated with the production and use of the technological hardware. This comprises know-how (e.g. manuals and skills) and experience and practices (e.g. agricultural, management, cooking and behavioural practices).
Stakeholder	A person, group, organisation or system that affects or can be affected by an organisation's actions.
Technology	Technology is "a piece of equipment, technique, practical knowledge or skills for performing a particular activity" (IPCC 2000). It is common practice to distinguish between three different components of technology (Müller 2003): hardware, software and 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.
Technology transfer	The exchange of knowledge, hardware and associated software, money and goods among stakeholders, which leads to the spread of technology for adaptation or mitigation. The term encompasses both the diffusion of technologies and technological cooperation across and within countries (IPCC 2022a).
Transformative/ Transformational change	A system-wide change that requires the consideration of social and economic factors which, together with technology, can bring about rapid change at scale (IPCC 2018).
Vulnerability	Short term for 'climate change vulnerability'. It is the degree to which a system is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes (IPCC 2007). Vulnerability is a function of the nature, magnitude and rate of climate change and of the variation to which a system is exposed, its sensitivity and its adaptive capacity.

Bus Rapid Transit (BRT) system in

PAKISTAN

MITIGATION

TRANSPORT

Pakistan has the highest rate of urbanization in South Asia often characterized by unplanned and unmanaged growth resulting in informal settlements, environmental degradation, and poverty.

At the same time, Pakistan's public transport is characterised by slow commutes in vehicles that are mostly old and poorly maintained, leading to high fuel consumption, increased emissions, and higher operating costs.

In Pakistan's Technology Needs Assessment, the transport sector, and Bus Rapid Transit (BRT) in particular, is prioritized to address the climate and environmental challenges associated with rapid urban growth.

Pakistan's NDC emphasizes the essential role of climate technologies for both mitigation and adaptation, with specific attention to transportation and BRT, informed by insights from the Technology Needs Assessment.

Building on the Technology Needs Assessment and the action plans produced, the Government of Pakistan has received financial support to implement a BRT system in Karachi, Pakistan's main urban hub.

- Financial support totalling USD 583 million, incl. USD 49 million from the Green Climate Fund
- 2.6 million tonnes of emissions avoided

The Green BRT Karachi project is set to be completed by the end of 2024, having established a 30-kilometre, BRT system, fully separated from other transport modes, and operated with the "world's first" biomethane hybrid bus fleet.

Photo: Karachi @Usama Tayyab, Unsplash

1. Introduction: Understanding the Technology Needs Assessment process

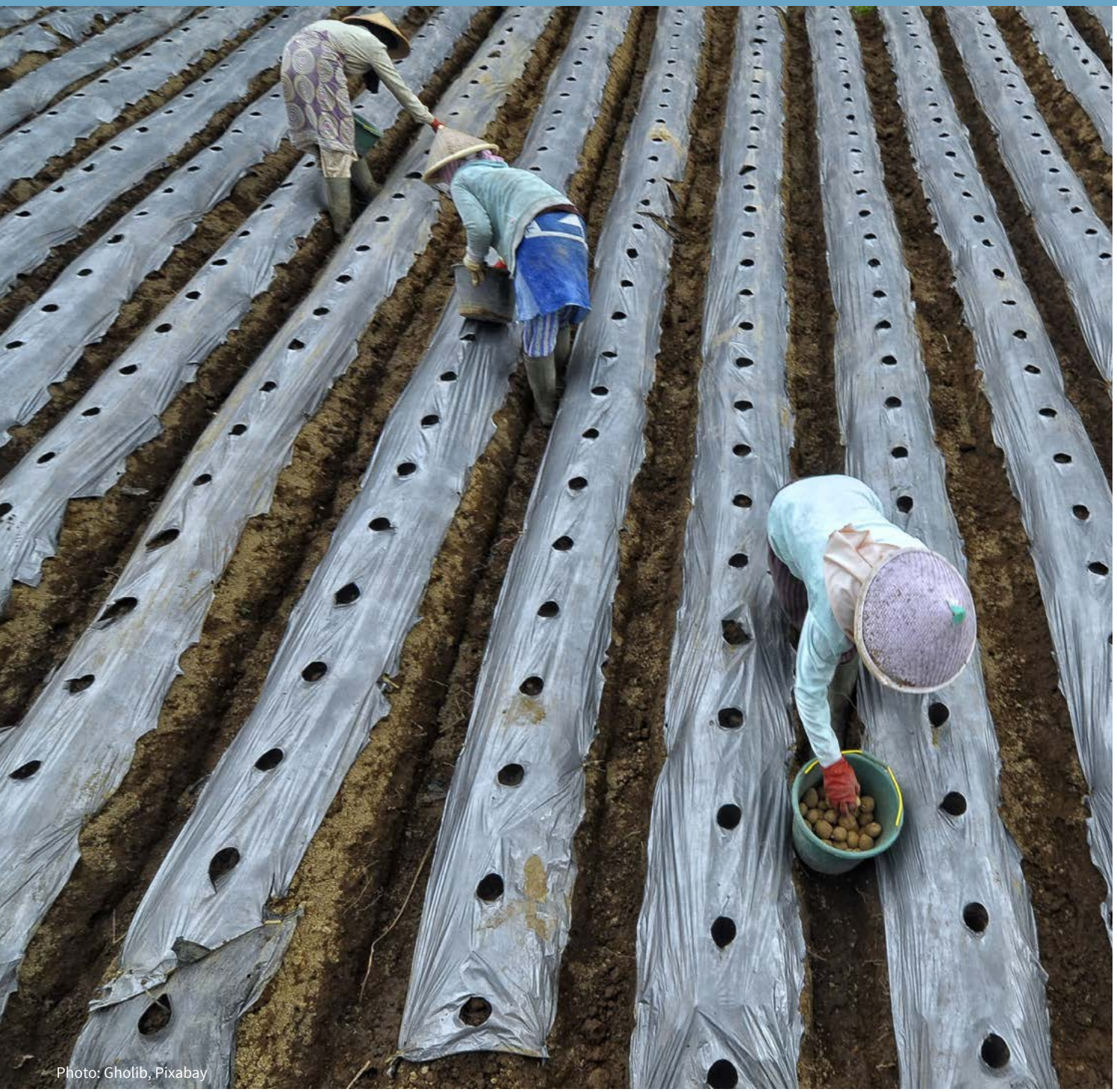


Photo: Gholib, Pixabay

The Technology Needs Assessment (TNA) process comprises a set of country-driven, participatory activities aimed at identifying, selecting, and planning for the implementation of climate technologies (See Box 1) to reduce greenhouse gas emissions (mitigation) and/or increase resilience to climate change (adaptation). The TNA process involves three distinct steps of 1) technology identification and prioritisation; 2) barrier analysis and enabling framework, and 3) technology action plan development, which are detailed further in Chapters 3, 4 and 5 of this guidebook. The steps build upon each other, where the technology action plans serve as roadmaps that can be integrated into the government planning process, as well as creating a pipeline of programmes and projects targeted at specific sources of multilateral (e.g. Green Climate Fund (GCF)) and private finance. Chapter 6 outlines the identification of Project Ideas, the process for elaborating Concept Notes for possible submission to financing entities, and the development of Policy Briefs, based on the Technology Action Plans.

As a country-driven process, a TNA should not be conducted in isolation but rather integrated with other similar ongoing processes to support national sustainable development and, not least, the implementation of countries' Nationally Determined Contributions (NDCs). In this context, there is a direct linkage in both directions between the TNA and the NDC, with each potentially informing the other. Regarding linkage between TNAs and the SDGs, see UDP (2021a).

The purpose of this guidebook is to summarise the various steps in the preparation of a TNA, including associated Technology Action Plans (TAPs)[1], and to be the 'go-to' reference document for national TNA Teams, including TNA coordinators and consultants. It also points out the various materials that are available to guide and support the process. The revised guidance is based on the experience of the more than one hundred countries that have already conducted a TNA process and provide country examples to illustrate how the TNA project can be organised and implemented. A full list of the TNA guidance documents can be found in Annex 1 and full electronic versions can be downloaded from the TNA project website[2].

As TNAs are intended to be country-driven and 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 end-users such as farmers or households, if all stakeholders are involved throughout the TNA process. However, it is important to realise that stakeholders differ in nature because they represent different interest groups and should therefore occupy different roles, at different stages in the TNA process; identifying them at an early stage is key to successful involvement and engagement, and guidance is provided on stakeholder identification and engagement in the guidance document UDP (2015d).

1
The expressions TNA and TNA Process in this guidebook are generally assumed to include TAPs.
2
tech-action.unepccc.org

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 organisation, 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.

Climate technologies are those that help to address climate change: "Climate technologies are those that help us reduce GHGs include renewable energies such as wind energy, solar power and hydropower. To adapt to the adverse effects of climate change, we use climate technologies such as drought-resistant crops, early warning systems and sea walls" (UNFCCC 2016).

Thus, climate technologies serve to meet the objectives of the Paris Agreement, and particularly important COP Decisions (e.g. the Glasgow Climate Pact and the UAE Consensus on the Global Stocktake). Climate technologies also play a crucial role in moving towards affordable and fair clean energy transitions (IEA 2024).

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 concept of TNAs was introduced under the United Nations Framework Convention on Climate Change (UNFCCC) at COP-7, which defined TNAs as "a set of country-driven activities that identify and determine the mitigation and adaptation technology priorities af Parties, ..., particularly developing Parties". UNFCCC (2002). The present Global TNA project originated in the Poznan Strategic Programme on Technology Transfer, established at COP14, 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 (TEC) and the Climate Technology Centre and Network (CTCN), which aims to 'facilitate enhanced action' on technology development and transfer 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 recognising 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 significant role in the implementation of climate mitigation and adaptation technologies.

1.2 Key challenges and opportunities

It is more than ever important to align the TNA process and its outputs with existing sector-specific and ongoing plans and activities, such as those related to the NDCs, to maximise relevance and increase the chances of making a difference. Furthermore, as implementation of climate technologies is increasingly driven by private-sector models and moving from donor support to private investments, it is equally important to utilise the potential of the TNA process to strengthen and support private-sector led implementation as well as to increase the uptake of private-sector input into the policy process. TNA Teams are therefore encouraged to identify and tap into existing modalities of private-sector engagement. Sectoral multistakeholder platforms, if available, should be used for validation and generation of input from technology-solution providers and financiers at the various stages of the process. This will help increase the level of ambition and quality of the action plans as well as secure private-sector ownership at the stage of pursuing finance for implementation.

TNA teams should first assess their country's current policy and planning status regarding investment in climate change technologies. They should also consider the market maturity of prioritised climate technologies. This assessment will help determine the basic needs for designing and implementing the TNA to achieve its objectives. In parallel, or as an intermediate step, countries can approach the CTCN for support with further analysis, such as accessing data, developing baselines and conducting feasibility studies. Such supplementary analysis is often required to translate the outcomes of a TNA into fundable project concepts. Requests should be aligned with the CTCN prioritisation criteria for technical assistance.

1.3 Focus and role of the TNA

The TNA process is inevitably connected with other major climate change initiatives mandated by the UNFCCC, as well as other key nationally driven analyses, projects, and plans. Participating country teams should take responsibility for positioning and utilising the TNA process to identify and pursue synergies wherever possible. TNAs can be a national planning tool for identifying current and future technology needs for sustainable development, in combination with achieving mitigation and adaptation benefits. TNAs can thus serve as one of the starting points for countries that are developing or updating their NDCs, NAPs, BTRs and other national plans.

TNAs can help identify what technologies are most appropriate for achieving NDC targets and under which conditions these technologies can be transferred and diffused to where they are needed. To ensure their relevance for achieving the NDC targets, TNAs should a) explicitly analyse what is needed to implement existing NDCs so that the outlined targets can be achieved, and b) align the focus, scope, and validity of the TNAs to be consistent with priority sectors included in the NDCs. This will ensure that TNAs are able to support the implementation of the NDCs.

National Adaptation Plans (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. Therefore, a country that has a NAP can use the TNA process to address the issues identified in it. The TNA process can then result in a set of actionable conclusions that provide practical solutions to the climate risks and vulnerabilities detailed in the country's NAP.

1.4 TNAs and Long-term Low-emissions Development Strategies (LT-LEDS)

Countries increasingly use their TNAs and TAPs to inform the development and implementation of their NDCs and Long-Term Low-Emissions Development Strategies (LT-LEDS). LT-LEDS can also serve as a useful starting point for the TNA process, as illustrated in Figure 1.1.

The TNA process is guided by discussion and consensus on priority sectors and technologies, while the LT-LEDS process typically uses modelling to identify technologies that can achieve the desired GHG emission reductions.

The TNA process usually focuses on two sectors each for mitigation and adaptation, providing a detailed analysis of selected technologies. In contrast, the LT-LEDS process can cover the entire economy, but the focus is on GHG reductions as per the Article 4 of Paris Agreement.

> *"All parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies."*

However, some countries include an adaptation component (e.g., Bhutan, Chile, Bosnia & Herzegovina, Ethiopia, Indonesia), in terms of what is needed to enhance their climate resilience.

While TNAs consider technical feasibility, social and environmental benefits, and barriers, LT-LEDS often emphasises the GHG reduction potential of a technology, potentially overlooking social acceptance, economic readiness and other barriers beyond technical and financial requirements or legislative changes.

LT-LEDS call upon countries to define a long-term vision, typically for mid-century, promoting enhanced climate action and a pathway to whole-of-society transformation (Rocha & Falduto, 2019; WRI, 2020). In comparison, TNAs focus on near-term measures and actions for implementing NDCs, generally targeting two sectors for mitigation and two for adaptation.

LT-LEDS are voluntary, non-binding, and lack common guidance for harmonising country submissions. However, most LT-LEDS submissions by the end of 2023 included a low emission pathway with carbon neutrality or net-zero by mid-century. LTS also address sustainable development, sectoral strategies, monitoring plans, and revision processes (Abeysinghe, 2018; WRI, 2018).

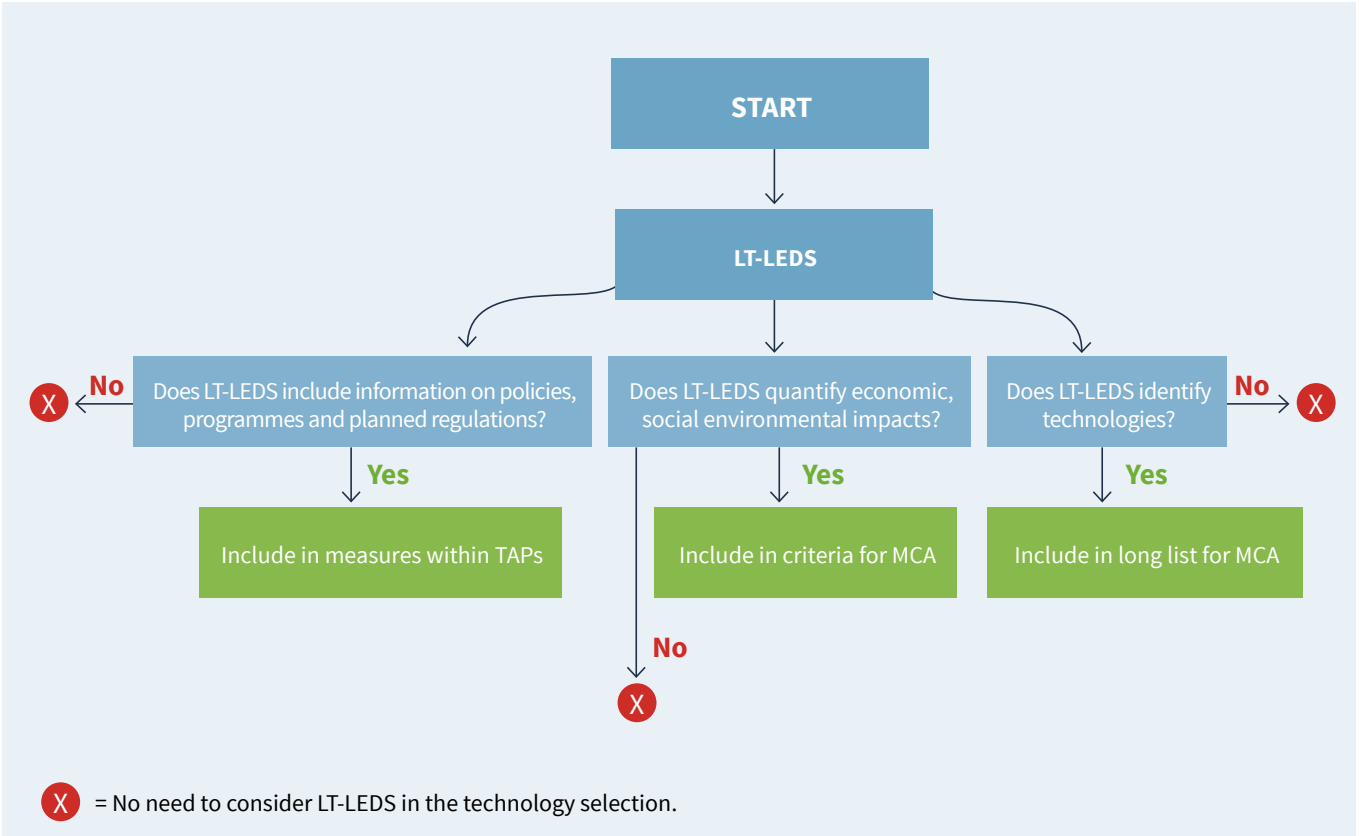
TNAs are also voluntary and non-binding but have followed a common structure since 2009. This includes a technology identification and prioritisation report for the selected sectors, a report on barriers and measures, and an action plan for technology implementation.

The LT-LEDS mapping of technologies that could lead to desired GHG emission reductions can serve as a starting point for the TNA process. The identified technologies may still require prioritisation for deeper analysis. See figure 1.1.

The TNA team may focus on specific LT-LEDS technologies without a detailed MCA analysis, based on the need for more information before policy decisions or the lack of available information on certain technologies. This approach depends on the government's strategy to maximise the TNA's role in the LT-LEDS process. LT-LEDS technologies can be supplemented with adaptation technologies not initially considered.

Once technologies are identified from the LT-LEDS, and the TNA's complementarity is established with stakeholders, the TNA can enhance the detail and analysis for these technologies. This helps create a more detailed action plan for deploying the technology to achieve the LT-LEDS objectives.

Figure 1.1. Decision chart for inclusion of LT-LEDS elements in TNA



1.5 Environmental and Social Safeguards

Environmental and Social Safeguards (ESS) refer to policies, principles, and procedures designed to protect the environment and society from potential negative impacts caused by development projects or other large-scale activities. These safeguards are typically implemented by governments, financial institutions, and international organisations to ensure that development initiatives are sustainable and do not harm the environment or vulnerable communities.

The projects and programmes developed by the TNA country teams, when they reach the stage of implementation, will be subject to the ESS principles of the respective funding agencies or governments. It is therefore important that TNA teams bear this in mind when developing project ideas to implement climate technologies, considering both:

(a) Environmental Safeguards with the objective to minimise or prevent environmental degradation and ensure that projects are environmentally sustainable, and
(b) Social Safeguards with the objective of protecting the rights, well-being, and livelihoods of people who may be affected by development projects.

These safeguards are generally a prerequisite for securing funding from major financial institutions like the World Bank, the Asian Infrastructure Investment Bank, African Development Bank, the International Monetary Fund, the Global Environment Facility, the Green Climate Fund and the European Commission. They are also integral to corporate social responsibility (CSR) initiatives and government regulatory frameworks for environmental protection and social justice[3].

1.6 Pursuing a gender-responsive and human-rights based approach

To ensure that all benefit equally from the actions set out in TNAs, and that gender inequalities in activities and outcomes are reduced or eliminated, gender-specific implications need to be considered throughout the entire TNA process and its outcomes. Gender considerations should be systematically mainstreamed into the TNA process. In keeping with this principle, sections on gender are integrated into this step-by-step guidance at every stage, with reference to the more detailed and specific recommendations in the 'Guidance for a gender-responsive Technology Needs Assessment' (UDP, 2018a).

Because gender realities differ across countries, regions, sectors and types of technologies, a systematic gender analysis of technologies assessed in the TNA process will reveal gender-differentiated climate change needs and priorities. This also highlights gender inequalities in access to opportunities and outcomes, providing a pathway for addressing such disparities within the broader context of climate change. By mainstreaming gender into the TNA process, these challenges can be addressed.

The need to address gender inequalities is tightly bound to the universal human rights principles. The United Nations has been steadfast in its mission to promote and protect fundamental human rights on a global scale. Through the adoption of over 70 human

3 For more information on Environmental and Social Safeguards, see UNEP (2024), GEF (2019), GCF (2024), EC (2024).

rights treaties, these rights have gained universal recognition and application at both global and regional levels. Almost all members of the international community have ratified resolutions and declarations obliging states and governments to uphold essential human rights, including access to an adequate standard of living, food, housing, as well as rights to participation and information.

The ramifications of climate change, however, present an existential threat to human rights and the overarching social and international framework essential for their realisation. Climate change is already undermining universal human rights such as the right to life, water and sanitation, health, food, housing, development, and a clean and sustainable environment.

The impacts of climate change affect individuals and communities belonging to marginalised groups disproportionately due to factors such as gender, age, indigenous or minority status, displacement, and ethnicity. Climate technologies have varied effects on different populations, potentially empowering or restricting their access to basic human rights. Like a gender-responsive approach, it is imperative to consider human-rights implications throughout the TNA process.

A human rights-based approach can guide meaningful climate action, echoing the principles of the TNA process, which emphasise country-driven and participatory methodologies rooted in broad stakeholder consultation across society. To ensure a comprehensive approach, the following guiding questions and considerations are recommended.

- **Inclusivity of Stakeholder Engagement**: Were diverse stakeholder groups actively engaged in the consultation process, including civil society, academia, and businesses?
- **Equitable Participation**: Have measures been implemented to address disparities in capacity, resources, socio-cultural circumstances, and economic or political influence among the public?

By integrating these considerations into the TNA process, technology development and adoption that respects and upholds human rights principles can be promoted. A robust human rights and gender-responsive approach will enhance the enduring impact and validity of the TNA. It is crucial to recognise that climate action should not solely aim to protect the environment or mitigate climate change effects. It also represents a means for states to fulfil their human rights obligations as enshrined in ratified treaties.

1.7 Objectives and deliverables

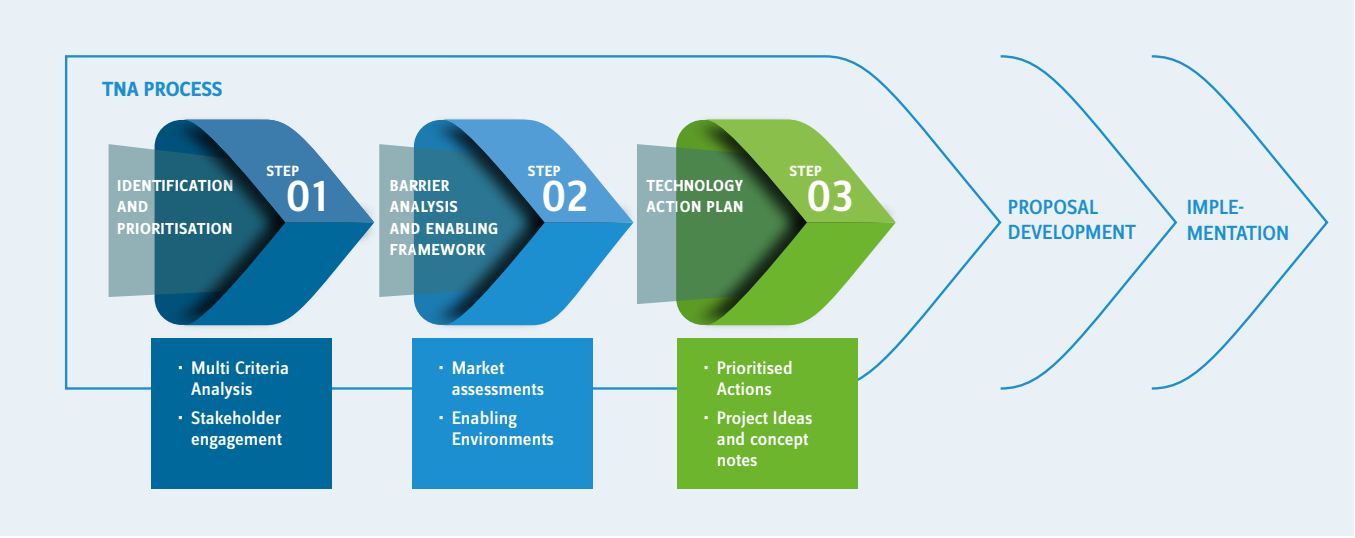
The TNA process has three main steps and related objectives (Figure 1.2):

- Step 1: To identify and prioritise mitigation/adaptation technologies for selected sectors/sub-sectors, resulting in the delivery of TNA[4] reports for Adaptation and Mitigation.

- Step 2: To identify, analyse and address the barriers hindering the deployment and diffusion of the prioritised technologies, including enabling the framework for the said technologies, resulting in the delivery of Barrier Analysis and Enabling Framework (BAEF) reports.

- Step 3: Based on the inputs obtained from the two previous steps, to draw up a Technology Action Plan (TAP), resulting in the delivery of the TAP reports, with suggested actions presented in the form of project ideas. This step also includes developing policy briefs for each of the prioritised technologies, to be followed by development of one or more concept notes for submission to a climate financing entity.

Figure 1.2 The steps in a TNA process: from priorities to action



4
For historical reasons, the first of the three main deliverables is referred to as the TNA Report, describing the technology identification and prioritisation process referred to in Figure 1.2.

Development of full-scale proposals for implementation of TAPs, and the actual implementation *per se*, lie beyond the scope of the TNA project. Nevertheless, it is important that mechanisms are put in place to track the implementation of the TAPs. Mechanisms for tracking are suggested in section 5.7.

The overall focus of the TNA process is on *climate technologies*, not climate risks or strategies *per se*, and the TAPs are intended to focus on what can be done to scale up investments in low-carbon or climate-resilient technologies. This should be the starting point for considering how the methodology and outputs of the TNA process should relate to other national processes.

Indeed, the TNA, BAEF and TAP Reports (including project ideas) are a key source of information for National Designated Entities (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 to the CTCN from countries with a TNA and a TAP could, for example, focus on further technical support in implementing their TAP 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.

Guidance and methodologies have been developed for each of these steps[5] and are summarised in Chapters 3, 4, 5 and 6 of this guidebook.

Box 2. Anticipated outcomes of the TNA

Based on the experience of supporting countries in respect to their TNA processes, 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 to draw up concrete project proposals as a step towards implementing investment-ready projects with national or international funding.

See UNEP-CCC (2023) and references therein for examples of success stories from earlier TNAs.

5
See Annex 1 for a list of the available guidance documents.

Sustainable livestock management in

MONGOLIA

MITIGATION ADAPTATION

AGRICULTURE CITIES

Mongolia has seen average temperatures going up by 2.1°C over the past 70 years, as a result of climate change. Average rainfall is declining, and extreme weather events are becoming more frequent creating challenges for livestock production and the country's vast pasturelands.

In response to this, Mongolia prioritized the agricultural sector in its Technology Needs Assessment, with special attention given to the husbandry and livestock production and sustainable pasture management.

Building on these priorities, Mongolia's Aimags and Soums Green Regional Development Investment Program promotes low-carbon, climate-resilient development, and more efficient urban-rural linkages, addressing the technological needs identified and aligning with NDC targets.

It is a comprehensive investment programme which also directly supports herder groups to manage the rangelands sustainably and is designed for replicability across the country.

- Financial support totalling USD 735 million, incl. USD 175 million from the Green Climate Fund
- 112 million tonnes of emissions avoided

The project received final approval in January 2024, and will directly benefit more than half a million people. Due to its cross-sectoral nature and inclusive design, it is estimated that it will indirectly benefit Mongolia's population of more than three million people.

Photo: Altai mountains, Western Mongolia @Bolatbek Gabiden, Unsplash

2. Setting up and preparing for the TNA process

Photo: Abhilash Jacob, Pixabay

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 TNA Consultants[6]. Countries are encouraged to use or build upon existing structures rather than create new structures just for TNA purposes. Thus, the TNA process can be better integrated into existing national structures and networks.

The first task of the National TNA Coordinator is to facilitate identification of the priority mitigation and adaptation sectors on which the TNA process will focus, based on the priorities defined in their countries' NDCs, LTS, NAPs, and other relevant policy documents and consulting and validating it with relevant stakeholders and authorities as appropriate. This process can be completed by drawing directly on existing analyses and/or national planning and strategy documents, including the country's NDC. The TNA process should focus on a maximum of two sectors each for mitigation and adaptation if countries choose to dedicate an equal share of their budgets to mitigation and adaptation technologies. In other words, a total of no more than four sectors for analysis.

Once the sectors have been selected, the TNA Team can identify the relevant stakeholders, prepare a consultation and engagement plan, and draft a detailed work plan[7]. At the end of the setting-up and preparation stage, countries should have in place:

- An institutional structure detailing the responsibilities of key actors throughout the national TNA process
- Prioritised 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
- A plan for how stakeholders will be engaged throughout the process (see the Stakeholder Guidebook (UDP, 2015d)
- An initial group of key stakeholders (See Box 3)

Box 3. The initial group of key stakeholders may include:

- *Climate change experts who provide technical support to reach the objectives in adaptation and mitigation*
- *Technology producers or providers (private sector) who provide technical support and will open the market to new technologies*
- *Government representatives from ministries of sectors related to the request (political decision makers)*
- *NGOs that promote social or environmental objectives, and or technologies*
- *Institutions that provide technical support to both government and industry*

See UDP (2015d), Table 1

6
The National TNA Consultants are national experts, selected by the national signing entity with support and guidance from the TNA National Steering Committee, the Regional Centres and UNEP-CCC. The consultants will work in close collaboration with the various working groups, and will report directly to the National TNA Coordinator. The Consultants' overall task is to support the entire TNA process and to prepare the analytical inputs.

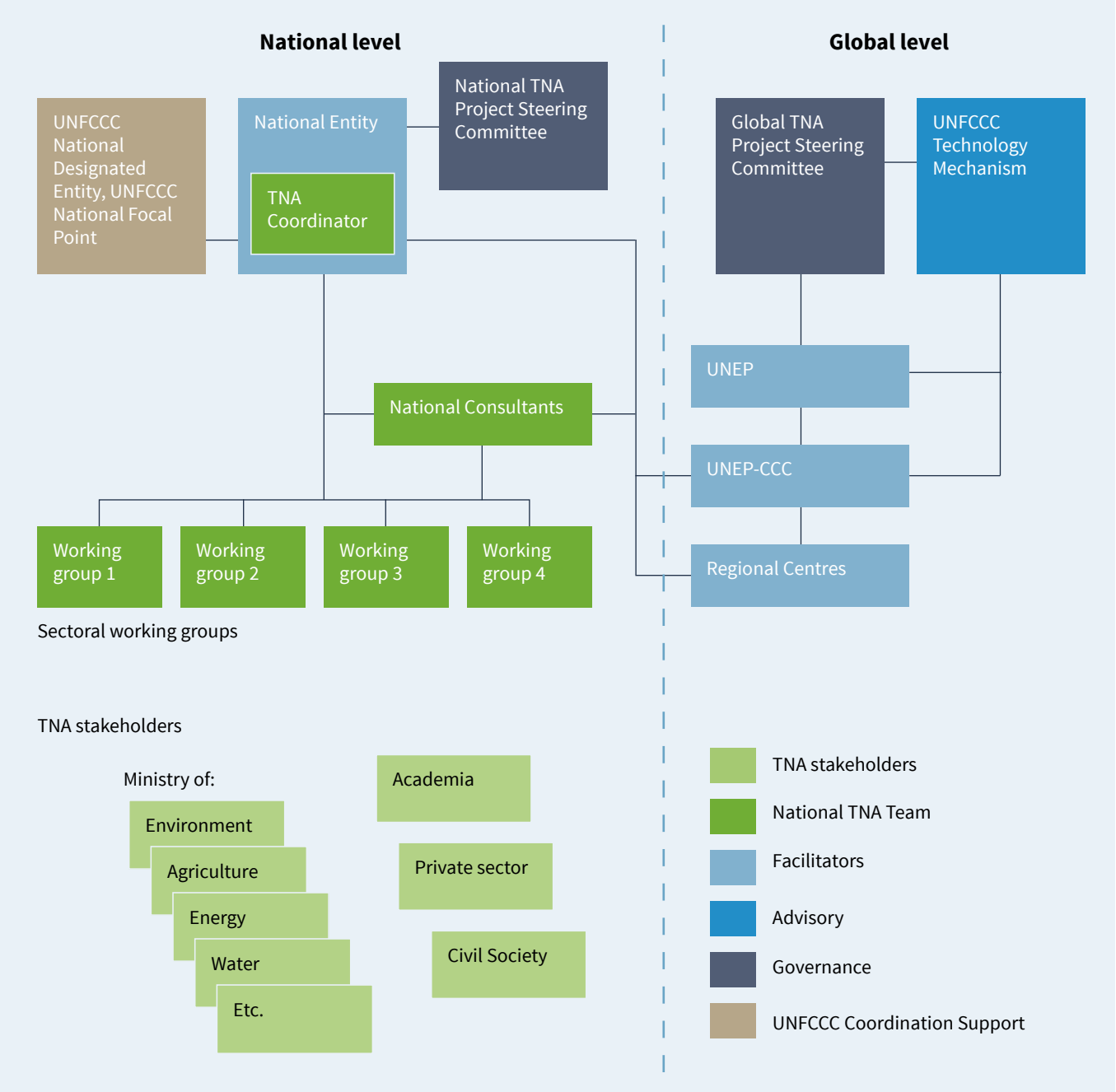
7
The detailed work plan is the first formal deliverable of the TNA project.

2.1. Organisational 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 make policy recommendations, but if these are to be implemented, they need to be vetted by high level policymakers, who constitute the National Steering Committee.

A more detailed description of the various national bodies and their corresponding role is provided below, and a schematic structure of the institutional set-up is shown in Figure 2.1.

Figure 2.1. TNA institutional set-up for the Global TNA Project



National TNA Team

The National TNA Team is the active core of the project with the National TNA Coordinator acting as a focal point. The National TNA Team includes the National TNA Coordinator, the National Consultants, and the Working Groups. The National TNA coordinator will play a key role and coordinate amongst the separate groups to ensure that they work together as a team.

National TNA Coordinator

The National Entity (normally a Ministry or Department) responsible for the TNA process in the country, and the host institution of the National TNA Coordinator, is appointed by the UNFCCC focal point in the country. The National TNA Coordinator will be the focal point for the effort and management of the overall TNA process. NDEs serve as national entities for the development and transfer of technologies. They are also focal points for interacting with the Climate Technology Centre and Network (CTCN). It is therefore 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 Steering 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 process in each country. The Coordinator's skills set should include facilitation skills, project management, convening power to bring diverse relevant authorities and stakeholders into the process, as well as general familiarity with the relevant technological aspects.

The National TNA Coordinator is the official TNA contact point within the country, communicating progress and/or any queries directly with the assigned contact point at UNEP-CCC and the Regional Centres. Whichever way countries choose to organise and conduct their TNAs, it is recommended that a communications protocol be agreed so that the relevant individuals are always involved and kept informed.

National Consultants

The main substantive analytical work at country level in the Global TNA Project is conducted by national mitigation and adaptation experts, hired as consultants through modalities to be agreed between UNEP-CCC and the National Entity.

Sectoral Working Groups

Sectoral Working Groups SWGs are established to draw on the specific expertise and experience of key national stakeholders. The SWGs should be set up by the National TNA Coordinator in collaboration with the relevant National Consultant, and should include representatives of government departments with responsibility for policy formulation and/or regulation; private- and public-sector industry representatives; delegates from utilities and regulators; associations representing technology suppliers, finance, technology end-users (such as households, small businesses, farmers) and technology experts (such as from academia and consultants). Membership should focus on sectoral and technological experts for the specific sectors, sufficiently broad to cover relevant aspects of the sector or technology, but sufficiently limited in size to allow an effective work process.

If national sector expert groups already exist, these can be used with advantage and may also facilitate linkages and synergies with other national processes. Sub-groups may also be formed to focus on technologies or groups of technologies within the sectors, for example solar energy or irrigation. These working groups should contribute their technical expertise and input into technology prioritisation, the barrier analysis, and ideas or inputs for the enabling framework for a given technology and/or sector, as described in the following sections.

National TNA Project Steering Committee

The National TNA Project Steering Committee is the key guiding body of the project. The Committee should be comprised of members responsible for policy making from all key ministries and stakeholders from the private sector relevant to the sector selection. The role of the Committee is to provide high-level guidance to the TNA Team, and to help secure political acceptance for the TNA process within the country and the endorsement of the Technology Action Plans. In most countries, an inter-ministerial National Climate Change Committee already exists, and this could also function as a steering committee for the TNA project, ensuring coherence and linkages between national climate change activities.

2.2. Gender considerations in setting up the TNA

As with the entire TNA process, it is important that gender is also mainstreamed into the composition of the National TNA Team. Two key aspects should be considered in setting up and preparing the TNA process:

- **Gender balance in the TNA Team**: What roles are fulfilled by men and women respectively in the TNA process, and how might this affect outcomes? During stakeholder consultations or interviews, some women may not feel comfortable responding to questions from men, and vice versa.

- **Gender expertise present in the country team**: Selecting team members with gender expertise is a crucial first step to mainstreaming gender in the TNA process to ensure that gender targets are met nationally.

As with the selection of the TNA Team, it is important that the stakeholders have a good gender balance, and that gender expertise is represented in the sectoral working groups. Box 4 provides guidance on the criteria that can be used in selecting members of the TNA Team and sectoral working groups.

Box 4. Examples of gender-specific criteria to be considered in selecting TNA Teams and/or national consultants (adapted from UNIDO (2015) and Meyers and Jones (2012))

Diversity, skills, and expertise of relevance to the TNA process	*Familiarity with gender analysis tools and processes.:*
	Effective communication skills and the ability to consult with various stakeholders, including government officials.
	Familiarity with gender analysis tools and methodologies in the specific area of intervention.
	A minimum of five years practical experience in the fields of gender equality and gender mainstreaming.
	Formal training in gender analysis and planning and demonstrated expertise in mainstreaming gender into projects and programmes, especially in the specific area of intervention.
	A thorough understanding of the gender context in the country concerned, and experience working with government institutions and international or non-governmental organisations supporting gender and development work in the specific area of intervention.

2.3. Identifying and engaging the relevant stakeholders

Stakeholder engagement is a fundamental aspect of the TNA process. Sufficient time should be set aside, and effort made by the National Coordinator and National Team to ensure that the TNA process is a truly stakeholder-driven process. National TNA Teams are encouraged to read the Stakeholder Guidebook (UDP, 2015d) and to follow the recommended procedures and consider the experience presented in Box 5 from a previous TNA. Key factors for the National Coordinator and the consultants to bear in mind are:

- **Relevant stakeholders**: Everybody who has an interest in or is affected by the TNA process or by its results should be considered a relevant stakeholder, and their involvement should be encouraged and valued.
- **Stakeholder ownership**: Stakeholders may need to be convinced of their relevance to the TNA process and the key part that they can play, thus encouraging a feeling of ownership.
- **Workshop fatigue**: Repeated meetings and consultations over an extended period, with few tangible results can be frustrating, discouraging and counter-productive, not least for people with busy time schedules. Coordinators and consultants should exercise good judgement in requiring stakeholders' time to gain the maximum useful information and keep them updated on the progress in the TNA process and the importance of their involvement.

It is important to ensure that the stakeholder consultation process is gender-sensitive in both process and content. See the Gender Guidance (UDP, 2018a) page 15 for more details. As with the selection of the TNA Team, it is important that the relevant stakeholders have a) a good gender balance, and b) that there is gender expertise in the sectoral working groups.

Key questions for the TNA Team to consider in stakeholder consultation are:

- What measures and actions need to be put in place to ensure the equal participation of people with diverse gender identities in stakeholder consultations? How should inputs and insights from both women and men be sought out, listened to, considered, addressed, and documented?
- Should specific arrangements be made to ensure that all constituencies are engaged in the consultation, for example, speaking to women and men separately, having focus groups for women and focus groups for men before gathering them together to ensure their meaningful participation, and adapting the timing of consultation activities to men's and women's respective work schedules (Global Goals, 2022).

Box 5. 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 at COP 15 in Copenhagen 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 some practical tips that helped the TNA Team in Lebanon mainstream the project within other national projects.

- ***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.*
- ***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.*
- ***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 criticised if the criticiser himself is involved throughout the process!*
- ***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.*
- ***Knowing what to share…and sharing it**. Summarising 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.*
- ***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, realising that everyone is already overcrowded with work.*
- ***Joining hands and events**. We recognised 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. Therefore, stakeholders did not have to repeat the same idea twice and only had to make the trip once.*
- ***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.*
- ***Taking the lead**. We took initiative in organising 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.*
- ***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!*

2.4. Capacity building of TNA Teams

When the country TNA Teams have been formed and priority sectors finalised, representatives of the teams are invited to participate in training workshops, normally in regional groups, with participation of the respective Regional Centres and UNEP-CCC. Participation is supported for three members of each team, for example the TNA Coordinator and two National Consultants. The three three-day regional training workshops each address in succession the three steps of the TNA process:

- **First Regional Workshop - Step 1:** Technology identification and prioritisation – leading to the TNA Report
- **Second Regional Workshop - Step 2**: Barrier analysis and enabling framework – leading to the BAEF Report
- **Third Regional Workshop - Step 3**: Technology action plan – leading to the TAP Report

Each regional workshop is scheduled so that the participating teams have completed the previous stage and are ready to embark on the following step. Thus, after completion of Step 1, teams can focus on the BAEF for the prioritised technologies, learning the techniques for barrier analysis and identification of measures for overcoming the barriers. Likewise, on completion of Step 2, teams are ready to work on the technology action plans and the details and consultations required to transform the measures into plans for action and activities.

Collaboration is encouraged between the different country teams, providing inspiration and cross-fertilisation as they address the country-specific, but often similar, challenges of supporting the enhanced diffusion of climate technologies in their countries. Additional online targeted training is provided in the latter stages of the project period for consultants selected to develop concept notes, based on project ideas from the TAPs, for eventual submission to a funding agency.

The regional training workshops are supplemented by online e-learning modules available from the TNA website, as well as targeted ad hoc support from UNEP-CCC and the Regional Centres.

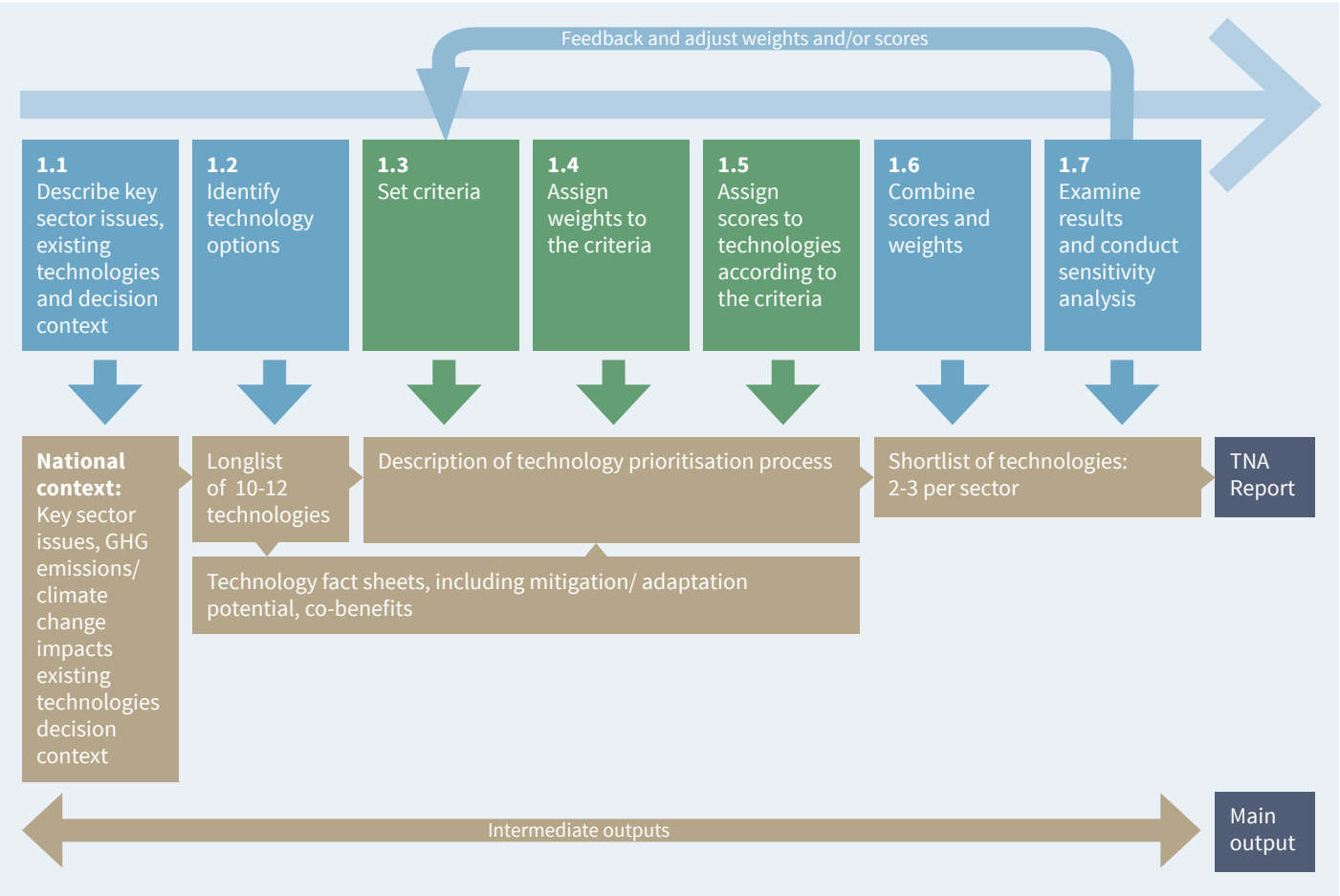
3. Identification and Prioritisation of Technologies

Photo: Quang Tuấn Nguyễn, Pixabay

The first analytical step in the TNA process is the prioritisation of technologies within the selected priority sectors. The results of this process are reported in the first main deliverable of the project, 'the Technology Needs Assessment (TNA) Report.' All members of the National TNA Team should be involved in this step under the direction of the National TNA Coordinator collaborating closely with the National Consultants. The technology prioritisation process, in-turn, consists of seven component steps, labelled 1.1 to 1.7, as shown in Figure 3.1, and uses a multi-criteria analysis (MCA) approach that is described in the following sections 3.3 to 3.7.

The choice of technologies to take forward into the detailed analysis and action planning is important, ensuring that the technologies selected are relevant and useful for the country, and have support from the stakeholders. TNA Teams are encouraged to complete the technology prioritisation step as efficiently as possible, with judicious choice of selection criteria and well-focussed discussion and consultation. The main emphasis should be on the next main steps of the TNA: understanding the barriers to technology uptake and diffusion, identifying measures to overcome them, and incorporating these into national plans and project funding ideas and proposals.

Figure 3.1. Seven steps in the technology prioritisation process



Countries that have already conducted a TNA, for example in the earlier phases of the Global TNA project, may choose an alternative approach to prioritising technologies. Instead, they can review the previous assessment and update it, considering new market conditions, new strategies and plans, or relevant technologies that were not included previously. In these cases, they can speed up the process and move on to the Barrier Analysis and Enabling Framework (TNA Step 2) described in the next chapter. Likewise, countries that have already developed their Long-term Low Carbon Development Strategies (LT-LEDS) may explore the possibility of leveraging the identified technologies for further work under the TNA process. It is important to note, however, that adaptation technologies may be underrepresented in the modelling work informing these strategies.

3.1. Summary of the national context

Following the establishment of the TNA Team, a first task is to prepare a summary of the relevant national context in which the TNA process is being conducted, to be incorporated as an introductory chapter in the TNA Report. The review should consider how the TNA process relates to other national processes, and what goals it can help to achieve. The review should refer to key national issues 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 (NAMAs), National Adaptation Plans (NAPs), country-specific SDG reports and other relevant initiatives.

Building further on the review of the national context, the National Consultants, in consultation with the relevant sectoral working groups, should go on to describe the context in the prioritised sectors by addressing the following points:

- For mitigation: What is the current level and growth of GHG emissions in the chosen sectors?
- For adaptation: What are the key vulnerabilities in the sectors?
- What will be the focus areas of the TNA analysis?
- What are the current objectives and challenges in the sector?
- What are the existing efforts (projects, programmes, policies, etc.) to reduce GHG emissions in the key focus areas?
- How are these key focus areas linked to existing climate and development efforts in the country?
- What are the existing technologies within the key focus areas of each sector?

The process of identifying and prioritising technologies for the selected sectors will take place based on this national context, including the situations in each sector. This process is described in sections 3.2 to 3.7.

- Intermediate output: A draft introductory chapter for the TNA Report describing key sector issues, decision context and existing technologies.

3.2. Identify technology options in the sectors

The next step in the process is to identify and prioritise potential new mitigation or adaptation technologies, or technologies whose deployment should be significantly increased, within each prioritised sector. All members of the National TNA Team should be involved in this step, focussing on their respective sectors, under the direction of the National TNA Coordinator collaborating closely with the National Consultants, and engaging with relevant stakeholders to obtain specific information on technology requirements, experience, and technical details.

The starting point for the prioritisation of technologies is to draw up long lists of potential climate technologies for each selected sector. Information on relevant technologies can be obtained from a review of existing planning documents (past TNAs, NDC, NAP, Energy Plans, National Communications, Long-term Low-Emission Development Strategies (LT-LEDS) etc.), from the guidebooks published by UNEP-CCC covering the sectors, from data sources such as the Green Database (WIPO 2024a) and the Green Technology Book (WIPO 2024b), and from relevant stakeholders with detailed knowledge of the sectors and key issues. All options should be discussed with the relevant stakeholders to ensure an elevated level of 'buy-in'. The technology identification is concluded with a long list of 8 to 12 technologies, each with technology factsheets and other information that will provide input for the subsequent prioritisation step, described in the next section, in which the long list of technologies for each sector must be reduced to 2 or 3 technologies per sector for in-depth analysis.

The TNA Report should describe how the potential technologies for climate change mitigation or adaptation in the sectors were selected in the country. The national mitigation/adaptation consultants are expected to prepare technology factsheets (TFS) for several pre-selected technology options for each sector. These TFS should include brief technology description, costs of the technology, the application potential in the country, technical aspects (geographical applicability range, maturity), potential for reduction of GHG emissions or enhancing climate change resilience, as well as any other social, economic, and environmental benefits. The TFS will be used by the stakeholders in selecting the technologies for further analysis. Factsheets produced by countries from earlier TNAs may be used to form the basis of new factsheets, but these should be adapted to fit the national circumstances and contexts. The TNA Technology Guidebooks (listed in Annex 1), cover key sectors for both adaptation and mitigation, and provide useful source material for the TFS.

The available resources (time and labour) in any TNA project are limited, while there is a need for in-depth analysis of the technologies. For this reason, the longlist of identified technologies must be reduced to a smaller number (normally 2 or 3) that will be carried further into the Barrier Analysis and Enabling Framework (BAEF) step, and subsequently into development of the Technology Action Plans (TAPs).

This does not mean that the remaining technologies are not important, or the list is discarded. Rather, it indicates that, for the TNA process, the 2 or 3 have been identified as having a higher priority to analyse in depth and incorporate in national plans for implementation. The long list of technologies, with the corresponding technology factsheets presented in an annex of the report, remains an important sectoral technology portfolio that may be considered for further investments, beyond the immediate scope of the present TNA project.

The prioritisation process uses the multicriteria analysis (MCA) technique that involves assigning a numerical score to each potential option (technology) based on well-defined criteria, summing the scores with weights assigned to each of the criteria, examining the results and performing sensitivity analysis. This process can follow a "comprehensive" approach, or the "simple" approach outlined in section 3.3. For most country cases the simple approach is adequate and strongly recommended. Detailed instruction is provided to country teams in the first regional training workshop.

- Intermediate output: (a) A longlist of technologies (8 to 12 technologies per sector is recommended) to be analysed (b) Technology factsheets for each longlisted technology.

3.3. Setting Criteria

After completing Step 2, two questions may come to mind: 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 team uses a set of criteria to evaluate each technology option. In the simple approach described here, using the Simple MCA Tool, it is recommended to have 8 to 10 criteria while still allowing stakeholder priorities regarding climate change impacts, and other social, economic, and environmental characteristics of the technologies, to be expressed. Nine example criteria, shown in Table 3.1, are provided in the Simple MCA Tool, available for download from the TNA website[8]. Criteria definitions may be changed to reflect other priorities, and additional criteria may be added, but teams are encouraged to keep the number of criteria to a maximum of ten. A prominent issue that should be considered in setting criteria for technology choice is the concept of "just transition". See Box 6.

Table 3.1. Criteria for the Simple MCA Tool applied to a simple adaptation example[9].

Criteria		Scoring scale
Costs	1. Cost to set up and operate the technology per beneficiary/year	0=very high cost --> 100=very low cost
Economic	2. Improving farmer income and ability to reinvest	0= very low --> 100= very high
	3. Trigger private investment	0= very low --> 100= very high
Social	4. Poverty reduction potential	0= very low --> 100= very high
Environmental	5. Contribution of the technology to protect and sustain ecosystem services	0= very low --> 100= very high
Climate-related	6. Improvement of resilience to climate change	0=very low-->100=very high
Institutional/ Other	7. Ease of implementation	0=very low -->100=very high
	8. Replicability	0=very low -->100=very high
Political	9. Coherence with national development policies and priority	0= very low --> 100= very high

8 https://tech-action.unepccc.org/tools/ The process of identifying and prioritising technologies follows, in principle, the approach for conducting multi-criteria analysis described in Dodgson et al. (2009). A Simple MCA Tool and a Comprehensive MCA Tool are available. For most purposes, the Simple Tool is recommended. More detailed guidance is provided for TNA countries as two separate guidenotes on adaptation (UDP, 2015a) and mitigation (UDP, 2015b).

9 Note that the example here is for an adaptation case, consistent with the Simple MCA Tool template shown in Annex 2, where criterion 9 represents "improvement in climate change resilience". In a mitigation-only case, this criterion would be used to represent the mitigation potential. If both adaptation and mitigation are relevant for the group of technologies, then criteria for each would be used.

The criteria are expressed so that a positive fulfilment of each criterion represents a positive reason to select the technology, in other words, increasing scores against all criteria indicate a more favourable result.

Box 6. Consideration of "Just Transition" in setting criteria

The importance of the concept of "Just Transition" is widely being recognised amidst global efforts to transform economies towards low-carbon sustainable development pathways, to mitigate climate change, adapt to its impacts and build resilience. Just Transition considers the management of potential negative impacts of climate action on people and societies and ensures that the transition will maximise the economic development outcomes for all. A just transition can drive economy-wide transformation that delivers poverty reduction, generates decent work, and acts as driver of inclusion and equality, but this requires a conscious approach and inclusive policies with the intent of bridging climate and development goals. Deliberate strategies to produce positive social and economic outcomes are needed. This recognition is at the heart of the notion of a just transition. Further, it is evident that social and just considerations need to be mainstreamed into policies, decision-making criteria, and reflected in the country's development and climate plans, including TNAs and TAPs, as well as in the implementation. Therefore, it is important that such considerations are considered during the TNA process.

3.4. Assigning Weights

The criteria selected for evaluating the benefits of each technology option may not be equally important to the decision, nor to the achievement of the overall goal. Therefore, weights are assigned to each criterion to reflect its relative importance in the choice of technology options. For example, is the technology 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, more than any other characteristic? This step aims to assign quantitative values to the relative importance of the different criteria. For the Simple MCA Tool, pre-defined weights are assigned as shown in Table 3.2. These weights are provided for illustrative purposes only and should be changed by the TNA Team to reflect the national and sectoral priorities. Note that the weight "19" assigned in this example to "climate-related", is only very slightly higher than the other criteria. Since the accent in the TNA process is on "climate technologies", TNA Teams may be advised to assign a higher weight to emphasise the importance of the climate impact in this analysis. This may also be the subject of sensitivity analysis described in section 3.7, where the effect of putting more emphasis on the climate criterion, or indeed any of the other criteria, can be investigated.

Table 3.2. Example criteria and weights for the Simple MCA Tool

Category	Criteria	Weight
Cost	1. Cost to set up and operate the technology per beneficiary/year	11
Economic	2. Improving farmer income and ability to reinvest	10
	3. Trigger private investment	8
Social	4. Poverty reduction potential	16
Environmental	5. Contribution of the technology to protect and sustain ecosystem services	17
Climate related	6. Improvement of resilience to climate change	19
Institutional/ Other	7. Ease of implementation	8
	8. Replicability	6
Political	9. Coherence with national development policies and priority	5
	Sum	100

3.5. Scoring

Each technology is evaluated for each criterion by the Sectoral Working Group, with the TNA Consultant acting as facilitator. In the simple approach[10], all technologies are awarded scores from 0 to 100, with 100 being the highest, according to how well the technology performs against the respective criteria. An example of a Scoring Matrix, based on a fictitious case, is shown in Annex 2, Table A2.1 with arbitrary scores following the above scheme and criteria and weights as shown in Tables 3.2 and 3.3.

- Intermediate output: Draft description of technology prioritisation process, incorporating Steps 1.3, 1.4 and 1.5.

3.6. Combining scores and weights

The next stage is to apply the criterion weights by multiplying the scores in each column by the respective weight. Thereafter, an overall score is calculated for each technology. The technology that has the highest overall score has the top priority, and so on. The result of this is shown in Annex 2, Table A2.2 with the technologies ordered to show the priority ranking one to nine.

10
If an absolute value is available for a specific criterion, e.g. CO_2 reduction in tonnes, the score can be normalised into a value between 0 and 100. The methodology for doing this, along with an example, is available in the MCA mitigation (UDP, 2015b).

3.7. Result examination and sensitivity analysis

The technology options are ranked according to their total score and the two or three best-scoring technologies can be selected for further analysis in the next step of the TNA process. Before moving on, the technology prioritisation should be examined for two issues:

(a) The best-scoring technologies may be ones that are already receiving attention in the country through other activities, or already under increased implementation. Since there may be limited value added in conducting the full barrier analysis and enabling framework process, the technology may be omitted, and a next best technology prioritised.

(b) The final scores of technologies often lie very close to each other, and it can be difficult to identify the top two or three with any confidence. There may also be differences of opinion among stakeholders regarding the weights that have been assigned. Sensitivity analysis is therefore recommended in all cases to establish the robustness of the selection, and to resolve any differences of opinion among the team regarding weights or the scores given to technologies.

- Intermediate output: Description of results and conclusions of technology prioritisation process, incorporating Steps 1.6 and 1.7.

- Final output: Incorporating descriptions of Steps 1.1 to 1.7, following the TNA Report template.

Technology standards and legal frameworks in

ECUADOR

MITIGATION

ENERGY

In its Technology Needs Assessment, Ecuador has prioritized energy efficiency to ensure energy security and reduce energy consumption and emissions from energy production. This also aims at reducing energy costs, to benefit users and increase competitiveness.

The Technology Needs Assessment identified lack of information and of capacity on energy efficiency, as well as inadequate regulations, as barriers for energy efficient technologies.

As a result, the Securing Energy Efficiency in the Ecuadorian Residential and Public Sectors (SECURE) project was started to address these barriers. SECURE responded directly to climate technology priorities and to Ecuador's NDC targets of creating incentives for efficient use and saving of energy through the use of efficient technologies.

SECURE was supported with USD 25.8 million through the Global Environment Facility, and became a key instrument in boosting energy efficiency policies leading to a significant reduction in electricity consumption nationwide:

- A reduction in peak demand of 362 MW
- USD 720 million in savings due to avoided infrastructure investments

The project also included capacity-building and guidelines for enforcing energy-efficiency standards to stimulate increased use of energy-efficient appliances in the residential and public sectors.

Photo: Ecuador @Lynn Friedman

4. Barrier Analysis and Enabling Framework (BAEF)

Photo: Vietnguyenbui, Pixabay

The next step in the TNA process is to achieve a detailed understanding of the barriers that the prioritised technologies face in the country, followed by a clear analysis and selection of the measures that may be required to overcome them. The collection of measures is collectively referred to as the 'enabling framework'.

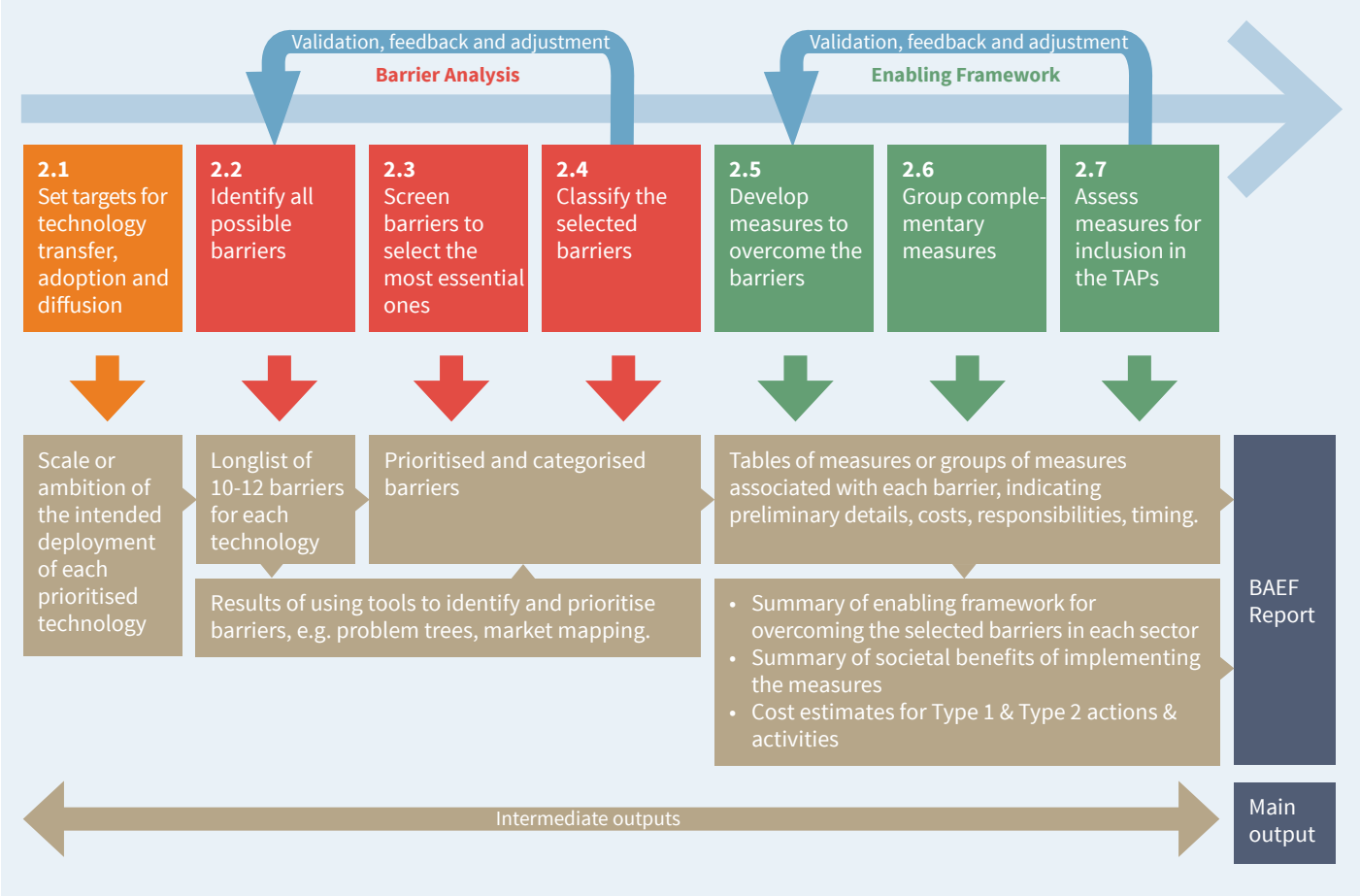
An enabling framework, or enabling environment, refers to the overall set of requirements, regulations, and political conditions that support and make it easier for the transfer and spread of technologies (IPCC, 2000). This involves specific factors in a country, like the existing market and technology conditions, institutions, resources, and practices, which can be changed through government actions.

The objective of the barrier analysis is an understanding of the conditions that each of the selected technologies face about their availability and adoption, and thereby to identify the barriers that may hinder their more widespread introduction, use and diffusion. Detailed guidance is provided in UDP (2015c)[11] (also referred to as the BAEF Guidebook), Chapters 3, 4 and 5. The National TNA Consultants play a leading role in this process, by facilitating the sectoral working groups, presenting all relevant information for discussion, structuring the discussions, and clarifying and documenting the main conclusions. The key steps 2.1 to 2.4 in the barrier analysis are illustrated in Figure 4.1 and described in sections 4.1 to 4.4, with intermediate outputs indicated at each step. The barrier analysis is completed by the National TNA Consultants producing a draft report that elaborates the most essential barriers, grouped into categories, and ready for scrutiny and validation by the relevant national stakeholders.

The barrier analysis is followed by the development of measures to overcome the barriers and hence the enabling framework, steps 2.5 to 2.7, and described in sections 4.5 to 4.7.

11
UDP (2015c) "Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. Second Edition. UNEP DTU Partnership, Copenhagen.

Figure 4.1. Seven steps in the BAEF process for all sectors and prioritised technologies in the sectors.



4.1. Targets for technology transfer, adoption, and diffusion

Barriers and enabling measures are closely related to the amount of technology transfer, adoption, and diffusion to be achieved. In other words, the scale or ambition of the intended deployment[12] of the technology will have an important bearing on the factors that may hinder it, and on the measures required to overcome the barriers. Before embarking on the barrier analysis step, it is therefore important to decide on the extent to which each prioritised technology is envisaged to be rolled out in the country. The TNA Team should set a preliminary target for the deployment of the selected technologies in each sector, so that appropriate barrier and enabling measures can be identified. This need not be limited by the current target set in national policy. Rather it should reflect an ambitious but realistic increase in deployment, given that the proposed measures and enabling frameworks are in place.

It is useful to express the targets in terms of the following characteristics:

- Action word(s)
- How much/how many?
- What?
- Size/extent
- By when?

12 "Deployment" is here taken to mean the technology being installed or used, while "diffusion" refers more to the process of spreading the use or deployment of the technology.

For example, in Pakistan's BAEF (Adaptation) Report[13], the team defined targets as follows:

- "To construct 1000 community and public-run surface rainwater harvesting reservoirs each with a capacity between 15,000 - 50,000 m^3 by 2025".
- "Modernise and upgrade urban stormwater drainage infrastructures of 10 major towns by 2022."

In Uganda's BAEF (Mitigation) Report[14], the targets were expressed (along with estimates of required investment, economic benefits, environmental benefits and expected lifetime) as follows:

- Preliminary targets for solar rooftop systems
  - Health Centres: 200 (units)
  - Education institutions: 300 (units)
  - Households: 140,000 (units)
- Preliminary targets for efficient institutional cook stoves:
  - 1,000 efficient institutional cook stoves built in schools saving 10,481 tonnes of firewood in a period of 8-10 years.

The preliminary targets may be adjusted based on the results of barrier analysis and enabling framework process. These envisaged deployment targets will be revisited in the third step of the TNA process when the Technology Action Plans (TAPs) are developed for each technology, described in the next chapter. Clearly the ambition for deployment will play a significant role in the formulation of these plans.

- Intermediate output: Scale or ambition of the intended deployment of each prioritised technology

4.2. Identify barriers

All relevant barriers should be identified through a literature review and expert[15] interviews: The preparatory stage should be completed by the National Consultant responsible for the sector, with input from the SWGs (or their specialised technology subgroups) and external experts. The National Consultant compiles a long list of barriers based on secondary review as well as on expert consultations. (Section 3.2 of the BAEF Guidebook). Various tools may be used to facilitate the process of identifying and understanding barriers, see Box 7 and annexes A, B and C of the BAEF Guidebook.

- Intermediate output: Longlist of 10-12 barriers for each technology

13
Pakistan: Technology Needs Assessment for Climate Change Adaptation Report II Barrier Analysis and Enabling Framework (December 2016) https://tech-action.unepccc.org/wp-content/uploads/sites/2/2017/01/tna-baef-adaptation-pakistan-dec-2016.pdf

14
Uganda: Technology Needs Assessment Report, Barrier Analysis and Enabling Framework for Climate Change Technologies – Mitigation (November 2020) https://tech-action.unepccc.org/wp-content/uploads/sites/2/2021/01/mitigation-report-baef-uganda-1.pdf

15
Relevant experts with knowledge of the technology and/or its application in the national context.

Box 7. Tools for identifying barriers and measures

The process of identifying barriers can be significantly enhanced by using tools to analyse the essential cause and effect relations. This can also facilitate the next stage, identifying suitable measures to address the causes. Several tools are available that can be used individually or in combination.

The most widely used tool in past TNAs has been the ***problem tree****, utilising the logical problem analysis approach as described in Annex A of the BAEF Guidebook. The problem tree method is a visual tool that provides a simple method to identify the problem and to order and prioritise the most important causes and effects. It can be applied both to market and non-market goods, and hence to most mitigation and adaptation technologies. The problem tree is readily transformed into a solution or objective tree for the identification of measures.*

Market mapping *is an analytical framework for understanding market systems. The tool helps to identify who the market actors for a technology are, what support services are available to them and the nature of the enabling business environment. It is useful for identifying weak links in the market chain corresponding to barriers to the efficient functioning of the market. The market mapping approach is only useful for market goods, where there is a well-defined market and where a market chain can be illustrated, showing the monetary transactions between the actors in the chain. For more information on market mapping and how to use the tool, see the BAEF Guidebook , Annex B.*

4.3. Screen barriers

Screen the longlist of barriers to select the most important barriers that hamper technology diffusion (Section 3.3 of the BAEF Guidebook), for example sorting the barriers according to their level of significance or importance:

- killer (non-starter)
- crucial
- important
- less important
- insignificant (easy starter)

Following this, exclude the insignificant barriers and rank the remaining barriers in order of importance. This may be conducted in a workshop setting with the sectoral working group and relevant stakeholders, with agreement by consensus or majority vote. The process is illustrated in figure 4.2.

Figure 4.2. Ranking of barriers in order of importance: example of mini-hydropower plants

4.4. Classify the selected barriers

The barriers identified in the previous step should be classified into a hierarchy of categories. Typical categories for the barriers are economic and financial, market conditions, legal and regulatory, institutional, and organisational capacity, human skills, social, cultural, behavioural, information and awareness, and technical (table 4.1). For more details, see Section 3.4 of the BAEF Guidebook.

Table 4.1 Examples of barrier categories, adapted from the BAEF Guidebook.

Barrier category	Barrier description
Economic and financial	High cost of capital, technology considered risky, low expected rate of return
Market conditions	Few local suppliers, market control by incumbents
Legal and regulatory	Over-bureaucratic procedures, corruption, rent seeking
Human skills	Unskilled technical personnel
Social and cultural	Consumer preferences and social biases, traditions, dispersed settlements
Information	Limited awareness of technology, missing feedback
Technical	Few local references, low product quality.

The draft barrier analysis should be discussed with the broader stakeholder group, including private-sector actors, culminating in the validation of the identified barriers at the technology level. This step is facilitated by the National Consultants, involving the working groups as well as broader technology-specific stakeholders including relevant policy makers/regulators, technology solution providers and potential financiers. Input from these consultations will be incorporated into the final barrier analysis report. The aim of this consultation is to ensure that the main barriers have been captured and retained in the analysis for each prioritised technology. The stakeholder discussions also serve to kickstart the process of identifying measures to be addressed in the next section.

- *Intermediate output: Validated set of prioritised and categorised barriers for the selected technologies in each sector*

4.5. Develop measures to overcome the barriers

Having established a thorough understanding of the barriers to the transfer, adoption, and diffusion of technologies, the next step is to analyse how these barriers can be removed or overcome. The term 'measure' is used as a general concept for any factor (financial or non-financial) that enables or motivates a particular course of action or behavioural change with the objective of overcoming a barrier. There is therefore a perceived causal and logically consistent link between the barriers that have been identified, the measures adopted to overcome them and the resulting impact of the measures in terms of barrier removal.

The process of identifying and describing the measures should ideally be conducted among the same group of stakeholders that participated in the barrier analysis, in a separate facilitated workshop. See the BAEF Guidebook section 6.1 for further details.

Various tools and approaches may be used to identify measures to overcome the identified barriers:

- The TNA consultant's own experience, supplemented by documented experience on policy measures from other countries.
- Measures already suggested by the working group during the barrier analysis process.
- If a logical problem analysis (problem tree) has been used to identify barriers, the same tool should be used to move from problems to solutions (see Annex A of the BAEF Guidebook).
- For technologies classed as consumer goods and capital goods, the market mapping tool may have been used to identify barriers. In this case the market mapping tool should also be used for the identification of measures (see Annexes B and C of the BAEF Guidebook).

The measures should be grouped by category, using the same categories as those used when identifying the barriers as shown in Table 4.2 and described in the BAEF Guidebook section 3.2.

Table 4.2 Suggested measures grouped with the barriers that they address, adapted from the Barrier Guidebook.

Barrier and measure category	Barrier description	Possible measures
Economic and financial	High cost of capital, technology considered risky, low expected rate of return	Subsidies, power-purchasing agreements, loan guarantees, green marketing, etc.
Market conditions	Few local suppliers, market control by incumbents	Market liberalisation (e.g. by introducing competition)
Legal and regulatory	Over-bureaucratic procedures, corruption, rent seeking.	Obligations to generate or purchase 'green' electricity, public investment policies, regulation of financial-sector institutions
Human skills	Unskilled technical personnel	Education policies, publicly funded research and development, training programmes
Social and cultural	Consumer preferences and social biases, traditions, dispersed settlements	Greater involvement of local communities and civil society, support to early adopters and technology front-runners, promotion of public–private partnerships
Information	Limited awareness of technology, missing feedback	Information dissemination, outreach, and awareness-raising campaigns
Technical	Few local references, low product quality	Support for testing and demonstration facilities, training programmes, technical standards, certification, and codes

4.6. Group complementary measures

Experience shows that, to achieve a significant impact on the transfer, adoption, or diffusion of a specific technology, it is necessary to apply a broad set of complementary measures addressing barriers at various levels, combined to form a programme of measures[16]. Measures are often classified as financial or non-financial, as it is of importance to policymakers to have a clear idea of which need to be financed (nationally or externally), and which can be implemented by legal or other interventions.

The proposal for groups of measures should include consideration of the timing of the specific measures, since the effectiveness of the measures to remove barriers to the diffusion of a technology will depend on whether the technology in question is at the early stage or close to broad-scale market diffusion, or somewhere intermediate. In many cases, in addition to combining different measures into a comprehensive programme, the creation of synergies by including more than one technology in a technology diffusion programme should be considered.

16 The BAEF Guidebook refers to a group of complementary measures as a "programme". Together, these can comprise the enabling framework.

Conditions in the enabling environment can address both the supply and demand sides of the transfer, adoption, and diffusion of climate technologies. Distinct aspects of political influence, when combined, form the larger enabling environment. Table 4.3 presents these elements, showing the key areas where governments can introduce changes to enhance the conditions for promoting technology transfer, adoption, and diffusion.

Typically, an enabling framework is associated with the national level, but certain components (such as regulations or subsidies) may be tailored for a specific region within the country. The focus of the enabling framework could be on a set of technologies (e.g., renewable energy) or a specific technology, like wind turbines.

Table 4.3 Elements of enabling environments for the transfer, adoption, and diffusion of technologies

Enabling environment elements	Relevant government policies (examples of areas of influence)	Barriers addressed (examples)
National macroeconomic conditions, financial/fiscal and policy frameworks	• Trade policies and laws • Tax, subsidies, and tariff regime policies • Regulation of financial sector institutions • Public investment policies • Commercial law and practices	• High cost of capital and interest rates • High inflation rate and high price fluctuations • Balance of payment problems • High import duties • Unstable currency and uncertain exchange rates
Human, organisational, and institutional capacity	• Capacity-building programmes of governmental agencies and institutions • Initiatives to enhance efficiency in government procedures and processes • Promotion of industry associations, networks, organisations and alliances	• Human resource-constrained legal entities • Ineffective coordination between governmental agencies • Prevailing culture of the disengagement of civil society in public affairs • Under-specialised governmental agencies
Research and technological capacity	• Technical standards, certification, and codes • Publicly funded research and development and training programmes • Support for testing and demonstration facilities (including training programmes) • Monitoring capacity enhancement programmes • Property rights regimes policies	• Few technology-nurturing sites • Limited capacity to install, implement, operate, and maintain technology • Insufficient specialised expertise in technology, practice, or organisational system • Low technology and product quality
Social and cultural	• Information dissemination, outreach, and awareness-raising campaigns • Targeted assistance to support early adopters and technology frontrunners • Promotion of public–private partnerships • Education policies	• Limited awareness, trust in, or acceptance of the suitability/reliability of the technology • Aesthetic considerations by users of technology (e.g. products lack appeal) • Community resistance to technology or practice • Tradition, social esteem, pride, comfort, and religious belief discouraging adoption of technology

For further details and examples of grouping and programmes of measures, see Section 6.2 of the BAEF Guidebook.

- *Intermediate output: Tables of measures or groups of measures associated with each barrier, indicating preliminary details, responsibilities, and timing.*

4.7. Assess measures and sets of measures to be included in the TAP

Several competing sets of measures may have been identified, each of them leading to a similar outcome, but with different costs and benefits. For an optimum selection of measures for policymakers, they should each be assessed in terms of their impacts and their costs, estimating:

- the effect of each measure and the combination of measures (programme)
- the societal benefit of the programme
- the cost of the measures included in the programme
- the feasibility that the responsible for the measure implements it

Effect of the measures

The effect of a measure is the difference in the number of installations or extent of a system or technology with the measure applied, compared with a business-as-usual scenario (baseline) without the measure. For each technology, this requires answering questions such as:

- What is the effect of a subsidy on investment, and how does this depend on the size of the subsidy?
- What is the effect of a new low-cost financing scheme, and how does this depend on the interest rate?
- What is the effect of a tax exemption?
- What is the effect of an awareness campaign, and how does this depend on the size and cost of the campaign?
- What is the effect of a supported networking initiative among equipment producers and suppliers?

To estimate the effect of economic incentives on market technologies, it is necessary to revisit the barrier analysis (described in detail in Chapter 4 of the BAEF Guidebook) and use the results of the economic assessment applied in the barrier analysis to assess the level of economic incentives needed to make the technology economically competitive compared to the incumbent technology.

Societal benefits of measures

When the effect in terms of the increased deployment of a technology compared to the baseline is established, it is possible to estimate the societal benefits (impacts) of the increased diffusion of the technology, such as the CO_2 reductions, reduced vulnerabilities, environmental benefits, use of local resources, employment, fiscal balance, trade balance and other impacts.

Costs of measures

Finally, the cost of each measure should be estimated. For example, the cost of a subsidy scheme, a tax exemption scheme or a financing scheme is dependent on the number of installations diffused and can be calculated by estimating the subsidy element per unit sold. The costs of information campaigns, test centres and institutional support are independent of the numbers of installations diffused and need to be estimated by evaluating the costs of similar interventions in other sectors.

For further details of how to assess the measures, including an example, see Chapter 6 of the BAEF Guidebook.

- Intermediate output: Summary of the effect of implementing the measures including their societal benefits, and the estimated cost of applying the measures.
- Main Output: BAEF Report following the BAEF Report Template

5. Technology Action Plans (TAPs)

Photo: Herbert Biese, Pixabay

The last step in the TNA process is the preparation of Technology Action Plans to support the implementation of the prioritised technologies to achieve the climate and development benefits identified earlier in the process. The TAPs draw heavily on the previous Step 2 (BAEF), focussing on the measures for overcoming the barriers to technology diffusion and deployment, and specifying how to implement these measures, who is responsible, the timing of the measures, the detailed costs and where to secure funding. As such, the TAPs form a bridge between the analysis of the prioritised technologies and their implementation. A dedicated guidance document is available[17], referred to here as the TAP Guidebook.

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 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.

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 commonalities exist across multiple prioritised technologies, and whether these justify a TAP that covers a whole portfolio of technologies.

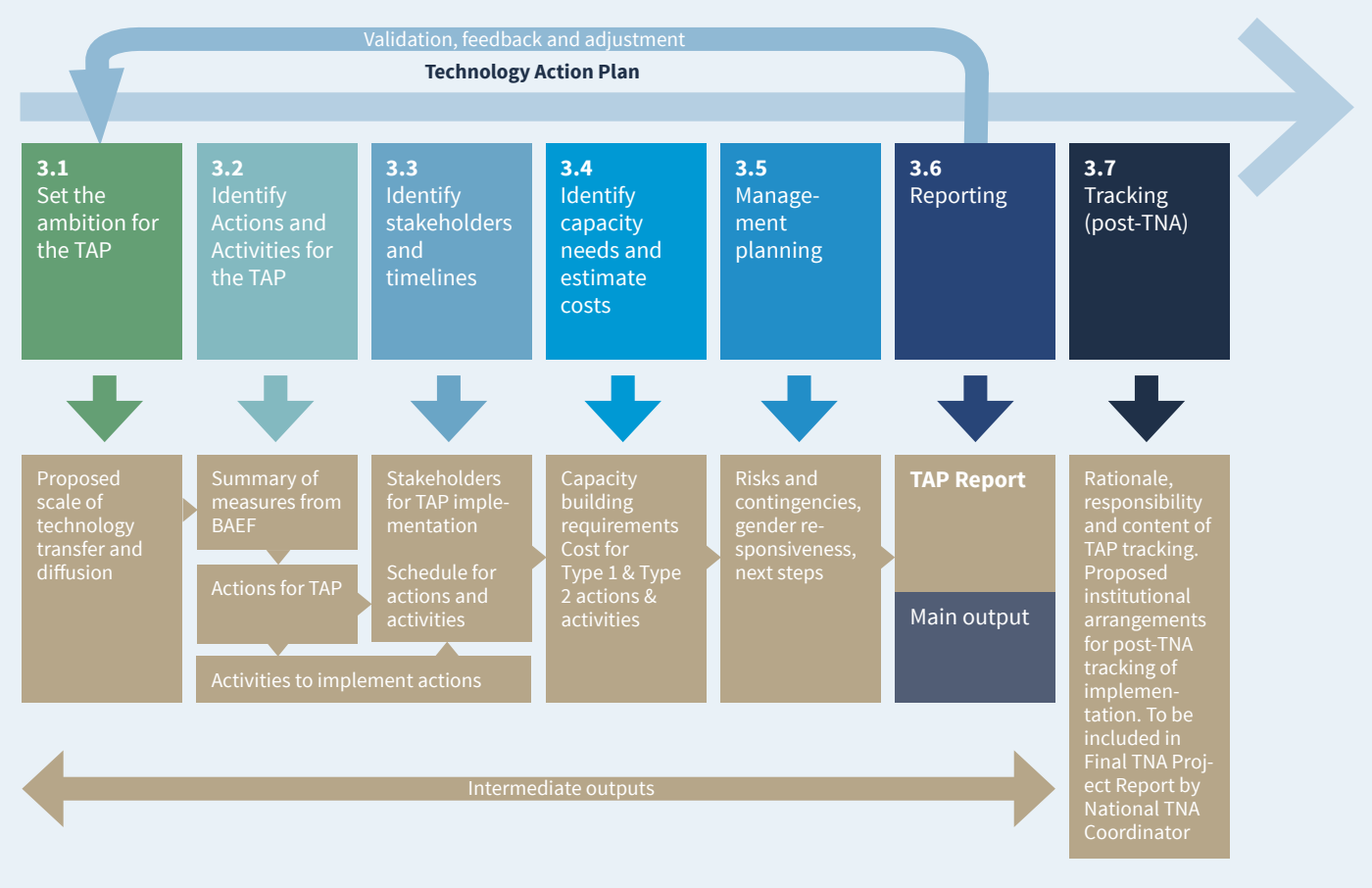
The target audience for a TAP consists of the in-country public- and private-sector stakeholders that are likely to be involved in the implementation of the proposed actions detailed in the TAP. These stakeholders may be government decision makers, where the Actions involve regulatory measures, incentives or infrastructural improvements, or private investors where the Actions comprise concrete business proposals or investment opportunities. In all cases, it is essential to clarify the responsibilities of the organisations and individuals involved in implementing the TAPs and involve them in the development of the TAP actions. See recommendations in the Stakeholder Guidebook for involvement of stakeholders at this stage.

The process of developing a TAP can be broken down into seven steps, as illustrated in Figure 5.1 and outlined in sections 5.1 to 5.7.

Transformational change is a critical concept integral to the TNA process, particularly in the development of Technology Action Plans (TAPs) and Concept Notes. This significance is underscored by the necessity to identify components of transformational change, often referred to as paradigm-shift potential, as it plays a vital role in justifying financial support for projects from climate change funding agencies. (See Box 8.)

17
UNFCCC and UNEP DTU (2017)

Figure 5.1 Seven steps and outputs in the TAP preparation process. Step numbers 3.1 to 3.7 refer to sections 1 to 7 in the TAP Guidebook.



Box 8. Transformational change and paradigm shifts

Within the realm of climate change mitigation and adaptation, transformational change denotes a profound and foundational shift in how societies, economies, and ecosystems function to effectively confront and address the challenges posed by climate change. This shift necessitates comprehensive and systemic alterations across diverse sectors, encompassing energy, transportation, agriculture, and urban planning.

Going beyond mere incremental adjustments, transformational change demands a reassessment of existing structures, policies, and behaviours. Implementation often involves innovative technologies, novel governance models, and widespread societal engagement. This type of change is imperative to achieve substantial reductions in greenhouse gas emissions, bolster resilience to climate impacts, and foster a sustainable and equitable future. Transformational change requires bold, holistic, and enduring adjustments to ensure a resilient and low-carbon future amidst the challenges of climate change.

Further details are provided in the TNA Transformational Change Guidebook (UNEP-CCC, 2022). TNA teams are advised to consider these drivers in their TNA processes, so that the technology choices and eventual deployment can contribute to achieving transformational change associated with GHG emission reductions, climate resilience and sustainable development.

5.1. Setting the ambition of the TAP

When setting the ambition for the TAPs, the focus will likely be on the short- to medium-term vision, as outlined in the NDCs. However, the TNA Team and stakeholders may also consider the long-term vision for the technology, such as a net-zero target by 2050 (see Section 1.4 on Long-Term Strategies (LTS)).

The initial target for the technology roll-out, as suggested in the first step of the BAEF, can now be revisited and reconsidered in light of the BAEF findings. This review should align with national climate change policies and consider the balance between short- to medium-term goals and the long-term vision.

Intermediate output:

- *Proposed scale of technology transfer, adoption, and diffusion*

5.2. Identify Actions and Activities to include in the TAP

The BAEF process identified various **Measures** to address key barriers, assessing them for their effects, costs, and societal benefits. This provides the foundation for selecting the most appropriate **Measures** and grouping them into **Actions** for inclusion in the TAP. The selection of these Measures should be based on the assessment outlined in section 4.7, through analysis and consultation with relevant stakeholders and policy-makers, forming the **Actions** in the TAP.

Once selected, the **Actions** can be broken down into **Activities**, specifying objectives, responsibilities, costs, and scheduling. It is essential to involve the entities responsible for implementing these **Activities** to ensure ownership and accuracy. Definitions of the terms **Measures, Actions**, and **Activities** can be found in the Glossary.

When selecting **Measures** to be included as **Actions** in the TAP, the following criteria should be considered:

- **Effectiveness** of the Measure in implementing the technology—i.e., the degree to which it is successful in achieving the result
- **Efficiency** of the Action in achieving this effectiveness—i.e., achieving the desired results with minimal use of human and financial resources.
- **Interactions or conflicts** with other Measures that could affect effectiveness or efficiency.
- **Suitability** of the Action in the specific country or sector context.
- **Costs and benefits** of the Measures, as previously identified in the BAEF Report (see Section 6.3 of the BAEF Guidebook).
- **Feasibility** of implementation by the assigned responsible entities.

Additional country-specific criteria may also be added to ensure that the selected **Actions** align with national policy and strategy. **Measures** addressing economic and financial barriers may also be evaluated using models that analyse alternative financial proposals (see Box 1 in the TAP Guidebook). If a TAP is expected to be implemented in the short or mid-term, the proposed **Actions** and **Activities** should align with sectoral and national planning processes. Similarly, long-term **Actions** should align with the strategic vision of LT-LEDS. An example of the process of selecting **Measures**, defining **Actions**, and decomposing them into **Activities** is provided in the TAP Guidebook (Step 2, page 9). The example uses Solar Home Systems (SHS) and demonstrates how the most suitable and effective **Measures** are chosen through stakeholder and technology sub-group consultations, tailored to the country's context.

The selected **Measures** then become the **Actions** in the TAP. The final selection between different sets of **Measures** is a political decision. These proposed **Measures** must be discussed, negotiated, and agreed upon by relevant stakeholders at country level, ensuring alignment with domestic objectives. The final selection is then confirmed by the highest level of ministry involvement before inclusion in the TAP.

The TAP should also include a detailed plan of action to implement the proposed policy measures, estimating the need for external assistance to cover additional implementation costs. This plan may follow a programmatic approach, including information on responsibilities, specific targets, and milestones for TAP implementation. For more details on decomposing measures, refer to the TAP Guidebook.

The gender dimension should also be considered when selecting **Actions** for the TAP, ensuring that these **Actions** achieve desired gender outcomes. Key questions from the Gender Guidebook (UDP 2018a, p. 26) include:

- How will women and men be targeted and reached?
- Does the Action address gender-differentiated labour patterns, wage gaps, etc.?
- How will the Activities and services benefit both women and men?
- Could the Action have adverse effects on women or men?

Are there policies, cultural, or social factors that either support or hinder women's participation in or benefits from the Action?

Intermediate outputs:

- Identified **Actions** to include in the TAP based on BAEF Measures.
- Defined **Activities** needed to implement the **Actions**.

5.3. Identify stakeholders and determine timelines

Stakeholder engagement is crucial in developing the TAP. It ensures national buy-in and ownership of the plan's elements and helps identify the individuals and institutions responsible for various Activities. A lead institution, such as the Ministry of Energy or Agriculture, should be assigned responsibility for each Action. Within this lead institution, specific individuals or teams should be tasked with implementing the Activities.

If the country's NDE has not yet been involved, they should now be brought into the process to help stakeholders identify elements that could be supported by the CTCN. For more guidance on stakeholder involvement in the TAP stage, refer to the TAP Guidebook (Step 3, p. 17), the Stakeholder Guidebook (p. 15), and the TEC brief on planning activities and assigning responsibilities (TEC 2013).

With stakeholders identified and their roles in TAP implementation agreed upon, the scheduling of Activities can proceed, defining:

- Start and completion dates for the Activities.
- Sequence of Activities.
- Nature and scale of the Activities.
- Whether the Activities are national or regional programmes.
- Whether they are stand-alone or involve multiple small projects/programmes.

Intermediate outputs:

- Identified stakeholders for TAP implementation.
- Detailed schedule for Actions and Activities.

5.4. Determining capacity needs and estimating costs and funding needs

This step in TAP development requires detailed information on each technology's implementation needs. It builds on the BAEF analysis by adding specifics such as timing, responsibilities, and locations for implementing the technologies in the country. The costs associated with achieving the ambition set out in section 5.1 must also be estimated, along with the funding requirements and potential sources. Extensive consultation with stakeholders—both government entities and private sector actors—is essential to develop realistic, implementable plans that command ownership and can attract financing.

Capacity needs

The TNA process does not provide funding for capacity building or the implementation of **Actions** and **Activities** in the TAP. Instead, it identifies the capacity and funding needs for future TAP implementation. These needs can be communicated to the country's NDE, which can then formulate requests for technical support or advice through the CTCN. For further discussion of capacity building needs, see the TAP Guidebook, page 21.

Cost of Actions and Activities

Two types of **Actions** and **Activities** must be considered:

- **Type 1**: **Actions** and **Activities** aimed at preparing a full programme of implementation, which will largely rely on public sector and international donor funding.
- **Type 2: Actions** and **Activities** aimed at fully implementing a prioritised technology programme.

Specifying these cost types helps identify appropriate public or private funding sources, such as public grants, commercial loans, cost-sharing agreements, subsidies, or revenues from goods and services (private). Methods for estimating the costs of these **Actions** and **Activities** are provided in the TAP Guidebook (page 22).

After estimating costs, the need for subsidies or external funding should be determined, and potential funding sources identified. The most applicable funding source depends on factors such as the scale of the investment, the technology (whether market or non-market), and whether the focus is on mitigation or adaptation. Distinguishing between potential public and private funding in this step also helps indicate which parts of the TAP are commercially viable and which require public support. For more guidance on financing TAP implementation, refer to the Finance Guidebook (UDP, 2020b).

Finally, the TNA Team should ensure that capacity building is gender-responsive by conducting a gender analysis of budget lines and **Activities**, as recommended in the Gender Guidebook.

Intermediate outputs:

- Capacity building requirements
- Cost estimates for Type 1 & Type 2 **Actions & Activities**

5.5. Management Planning

This step covers risk management, contingency planning, gender responsiveness, and next steps. Regardless of the type of **Action** or **Activity**, effective project management, monitoring, evaluation, course correction, and contingency planning are necessary.

Despite careful planning—covering responsibilities and costs—there will always be uncertainties in implementing the TAP. For example, key stakeholders may become unavailable, or costs may exceed initial estimates.

Such uncertainties pose the risk that the TAP may be less effective than anticipated. To mitigate these risks, it is important to identify potential risks and formulate contingency plans. Each **Action** and its associated **Activities** will have its own uncertainty and risk profile, so risk and contingency planning should begin at this level. However, it is also advisable to treat the TAP as an overall strategic document, assessing where common risks exist across **Actions** and **Activities**. This allows for shared monitoring, evaluation, and contingency planning.

As part of TAP management planning, it is critical to ensure equal participation of women and men in project management, as well as among project beneficiaries, partners, and key stakeholders. Women and men should have equal voices in decision-making. Efforts to enhance gender mainstreaming and promote gender equality

or women's empowerment may be necessary. For further guidance on risk identification and management, see the TAP Guidebook and the TNA Gender Guidebook.

Intermediate output:

- Description of risks and contingencies, gender responsiveness of the TAP, and next steps.

5.6. Reporting

The TAP report should follow the template provided by UNEP-CCC and offer a comprehensive description of the action plan for mitigation or adaptation technologies. It should be concise, but structured in a way that allows it to be read and understood as a standalone document.

To ensure strong national ownership and alignment with national policy, the draft TAP Report should undergo scrutiny and validation by the National TNA Steering Committee. This review process will cover the steps described in sections 5.1 to 5.5, with feedback provided as necessary for adjustments by the TNA Team, facilitated by the National TNA Coordinator.

Final output:

- Final TAP Report following scrutiny and validation by the National TNA Steering Committee, with revisions as required

5.7. Tracking the implementation status of TAPs

The final step of the TAP process includes activities that must be carried out and continued beyond the completion of the TNA project. Details on how the tracking process will be institutionalised in the country should be outlined in the Final TNA Project Report, which is submitted by the National TNA Coordinator at the conclusion of the project. Tracking should be done using a simple table format for each TAP, focusing on:

- Problem identification
- Initiatives
- Linkages
- Status updates
- Contact information
- Future steps

This information should be submitted annually to the UNFCCC and UNEP-CCC, and compiled into a publicly accessible summary table to streamline the reporting process. A designated entity, such as the legal entity overseeing the TNA project or the NDE, should be responsible for overseeing TAP tracking. Stakeholders in charge of TAP activities will report to this entity. Further recommendations on tracking implementation can be found in the TAP Guidebook.

A brief description of the planned national TAP implementation tracking process should also be included in the Final TNA Project Report.

Rainwater harvesting in

MOZAMBIQUE

ADAPTATION

WATER

Climate change in Mozambique threatens the country on several fronts, as heavy storms and severe droughts hit the country with increasing regularity.

Due to high intensity and frequency, drought is the most devastating for the agriculture sector which employs more than 80% of the economically active population. The impacts are exacerbated by the limited availability of water for irrigation and livestock watering.

In its Technology Needs Assessment, Mozambique identified conservation agriculture and rainwater harvesting as key technologies for adaptation to climate change in the agriculture sector. Both technologies have the potential to improve production and strengthen resilience, benefitting a large portion of the population.

Informed by the Technology Needs Assessment and based on Mozambique's Intended Nationally Determined Contribution (INDC), a comprehensive water-sector action plan was introduced in 2018 to increase water storage capacity by 30%.

This was followed by a successful national water programme that has so far:

- Provided clean drinking water to 1.7 million people, with
- 3.9 million additional people benefitting by 2024

Mozambique is also receiving support to further explore rainwater harvesting technologies based on the Technology Needs Assessment to help vulnerable communities living in southern and inland Mozambique.

Photo: Rainwater harvesting @Shutterstock

6. Project ideas, concept notes and policy briefs

Photo: Pongsakorn Shangkajantee, Shutterstock

6.1. Project ideas

Responsibility: National TNA Consultants and National TNA Coordinator

An important additional part of the Technology Action Plan Report is the description of Project Ideas associated with the sectors and prioritised technologies. These are concrete actions supporting the realisation of the overall targets indicated in the Technology Action Plan for each sector. They provide the starting point for the development of concept notes or proposals for funding the implementation of the Actions embodied in the TAP. The project ideas also provide a basis for choosing the topics for one or more concept notes that will be supported in the final part of the TNA process, described in section 6.2. As specified in the TAP Report template, a section under each sector should indicate how the project ideas for that sector were identified and developed, and how they can contribute to the transfer, adoption, and diffusion targets of relevant mitigation/adaptation technologies.

Outline of project idea for a sector/technology

A project idea should be developed for each prioritised technology in the TAP and included in the TAP Report chapter dedicated to the relevant sector. The description of each project idea should fill no more than two pages in the TAP Report, be presented in the form of a table and cover the following items:

- Introduction/Background (Brief description of the project and how it was developed)
- Objectives (What will the project accomplish?)
- What are the outputs and are they measurable?
- Relationship to the country's sustainable development priorities (How does it relate to the mission and key strategies? Is it a new development?)
- Project Deliverables e.g. value/benefits/messages (Why is it important and necessary?)
- Project Scope and Possible Implementation (How broad is the project? How feasible is it? Is it linked to current or past projects?)
- Project activities
- Timelines (What are the timelines e.g. one quarter, one-year, multiple years?)
- Budget/resource requirements (What is the budget? How is the project to be funded? /staff, engaging consultants, partnership, etc.)
- Measurement/evaluation (What tangible evaluation of accomplishments will be conducted? How will success be measured?)
- Complications or challenges
- Responsibilities and coordination (Who does what, when and how?)

18 Sometimes countries combine more than one technology in a proposal e.g., drip irrigation and solar powered irrigation pumps with net metering for a climate smart agriculture proposal

19 https://www.greenclimate.fund/sites/default/files/document/gcf-concept-note-user-s-guide.pdf

20 https://www.greenclimate.fund/document/concept-note-template

6.2. Concept notes

The Global TNA Project for each country includes an allocation to prepare one or more project concept notes for submission to a funding agency or an accredited entity associated with a funding institution. These concept notes may address climate change adaptation, mitigation or a combination of each, and represent the first steps to take forward the TAPs towards implementation. They are also helpful in raising funding for the next stages of proposal development. Experience shows that to secure funding, early engagement with donors in the country and the donor coordination group is advantageous.

The topics for concept notes may be selected from project ideas produced in the context of the TAP. Alternatively, the TNA technology priorities may be taken as a starting point. These possible topics can be discussed with the government focal points for GEF, GCF, Adaptation Fund and others, with Accredited Entities in the country, such as UNEP, UNDP, FAO, multilateral banks, bilateral donors, and EU, to ascertain which of these technologies (or project ideas) are of interest to the funding community and aligned with the priorities of the country. Based on these discussions the countries should decide on the specific technology or technologies[18] to be included, and the funding entity to which the concept note should be submitted.

The development of the concept note will normally be conducted by a dedicated and experienced consultant, specially contracted for the task, or by one of the existing TNA consultants with the necessary qualifications. Targeted training will be provided to the respective concept note consultants by UNEP-CCC and the relevant Regional Centres. Specific guidance on developing concept notes is provided by the targeted funding entity. For example, the GCF provides a user's guide[19] to accompany the Concept Note Template[20].

Irrespective of the targeted funding entity, it is essential that concept note developers have a clear understanding from the outset of the objectives of the proposed project and the expected climate change impacts (whether mitigation, adaptation, or both), for example in terms of reduced GHG emissions or increased resilience, number of beneficiaries, etc. Concept note development then involves identifying and quantifying the possible co-benefits, specifying the various activities, outputs, and outcomes of the project, explaining the logic of the project in terms of a Theory of Change, and the role of the various participants in the project. Climate change financing institutions such as GCF also increasingly require that the proposed project leads to transformational change or a paradigm shift (See Box 8 and UNEP-CCC (2022)).

Finally, a key component of the concept note is the identification of the financing needs for the different cost components: grant, loan, equity, co-financing, guarantees, etc. Guidance on climate change finance is available from UNEP-CCC in e-learning/webinar modules, as well as in the Finance Guidebook (UDP, 2020b).

6.3. Policy briefs

Participating countries in the Global TNA Project, represented by the National TNA Co-ordinator, are encouraged to engage with relevant actors, including donors, investors, policy makers and planners, at an early stage and throughout the entire process. As part of these efforts, key results and findings of the TNA process will also be summarised into targeted technology policy briefs to close the process and make the findings of the TNA process accessible and user-friendly, and to be shared with policy makers. The policy briefs thus provide a supplement to the TAP Report, presenting concise descriptions of the proposed plans for each technology taken forward to the TAP.

The policy brief should give balanced information for policymakers for moving forward with the preparation of programmes and policies to support TAP implementation. The key purpose of the policy brief is to:

- provide enough background for the policymaker to understand the problem.
- convince the policymaker that the policy / programme is needed.

The policy brief should therefore:

- be short and to the point. The brief should focus on a particular problem or issue, without going into too much detail. It should provide sufficient information for the reader to understand the issue and to reach a decision.
- be based on firm evidence drawing from the TNA/TAP process.
- focus on project findings and recommendations, without details of the methodology.
- relate to the big picture, building on context-specific findings, but facilitating more generally applicable conclusions.

The National TNA Consultants are expected to elaborate the policy briefs, with guidance from the TNA Coordinator and in close collaboration with UNEP-CCC, based on a template to be supplied.

Development of a renewable energy investment framework in

LIBERIA

MITIGATION

ENERGY

Liberia is highly vulnerable to the impacts of climate change. 70% of the population work in the agriculture sector and with the country's dependency on agricultural goods, the increased frequency of extreme weather events threatens the livelihoods of millions.

In its Technology Needs Assessment, Liberia prioritized renewable energy technologies for both mitigation and adaptation in the agriculture sector. With the right climate technologies, the significant availability of biomass generated by the sector can help both reduce emissions and improve climate resilience.

Building on the Technology Needs Assessment and related Technology Action Plan, a Green Climate Fund Readiness project is helping develop a renewable energy investment framework as part of the efforts to achieve Liberia's NDC commitments to generate 30% of its energy from renewable energy sources by 2030.

To reach the NDC target, Liberia estimates a need of:

- A total of 100 MW of renewable energy generation
- Investments of about USD 242 million by independent power producers

The renewable energy investment framework will support Liberia in developing policy, regulatory, and investment frameworks to translate these targets into action through financially sound investment opportunities.

Photo: Solar power, Monrovia, Liberia @UN Photo/Christopher Herwig

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Annex 1.

Table A1.1 TNA guidance materials available at www.tech-action.unepccc.org

Guidance type	Reference
Main process guidebooks	• **UDP (2015c)** Overcoming Barriers to the Transfer and Diffusion of Climate Technologies (BAEF Guidebook) • **UDP (2018a)** Guidance for a gender-responsive Technology Needs Assessment (Gender Guidebook) • **UDP (2019)** TNA Step by Step (first edition) • **UNEP-CCC (2024)** TNA Step by Step A (second edition) • **UNFCCC and UDP (2017)** Enhancing Implementation of Technology Needs Guidance for Preparing a Technology Action Plan (TAP Guidebook)
Other process guidebooks	• **UDP (2015a)** Evaluating and prioritising technologies for adaptation to climate change: a hands-on guidance to multi-criteria analysis (MCA) • **UDP (2015b)** Identifying and prioritising technologies for mitigation: a hands-on guidance to multi-criteria analysis (MCA) • **UDP (2015d)** Identification and Engagement of Stakeholders in the TNA process: A Guide for National TNA Teams • **UDP (2017)** Evaluating Measures for Inclusion in a Technology Action Plan • **UDP (2018b)** Organising the National TNA Process: An Explanatory Not • **UDP (2021a)** Achieving the Sustainable Development Goals: exploring linkages with the Technology Needs Assessments • **UNEP-CCC (2022)** Transformational Change Guidance for Technology Needs Assessment
Technology guidebooks	• **UDP (2021b)** Climate Technologies in an Urban context. • **UDP (2021c)** Indigenous Peoples and Climate Technologies • **URC (2010)** Technologies for Climate Change Adaptation - Coastal Erosion and Flooding • **URC (2011a)** Technologies for Climate Change Mitigation: Transport Sector • **URC (2011b)** Technologies for Climate Change Adaptation: Agriculture Sector • **URC (2012c)** Technologies for Climate Change Mitigation: Agriculture Sector • **URC (2012d)** Technologies for Climate Change Mitigation: Building Sector • **URC (2012d)** Technologies for Climate Change Mitigation: Building Sector
Finance guidebooks	• **UDP (2020b)** Finance Guide for Implementation of Technology Action Plans • **URC (2012a)** Accessing International Financing for Climate Change Mitigation • **URC (2012b)** Accessing International Funding for Climate Change Adaptation
TNA briefs	• **UDP (2020a)** Regional Technology Brief Latin America and Caribbean • **UDP (2020c)** Regional Technology Brief Africa • **UDP (2020d)** Regional Technology Brief Asia Pacific

Annex 2. Multicriteria Analysis (MCA) example matrices

Table A2.1 Prioritisation example – Simple MCA Tool – ***Scoring Matrix***

	Costs	Benefits					Other		
		Economic		Social	Environmental	Climate related	Institutional/Implementation		Political
	Cost to set up and operate the technology per beneficiary / year	Improving farmer income and ability to reinvest	Trigger private investment	Poverty reduction potential	Contribution of the technology to protect and sustain ecosystem services	Improvement of resilience to climate change (i.e. to what extent the technology will contribute to reduce vulnerability to climate change impacts)	ease of implementation	replicability	Coherence with national development policies and priority
Reforestation of the water catchment area of the main Reservoirs of Mauritius	100	40	60	100	100	100	100	80	100
Up-scaling of locally proven IPM technologies for control of pes	76	80	40	100	100	60	80	60	100
Micro irrigation (gravity fed drip & mini and micro sprinkler irrigation)	20	80	80	100	60	100	80	70	100
Decentralised rapid pest and disease diagnosis service (plant clinic)	98	60	60	80	80	60	80	80	80
Reinforce breeding and conservation programme for crop adapted to change in climate	90	100	40	60	60	100	60	40	100
Education and awareness raising among farming community to promote adaptation to climate change	92	80	40	60	60	80	80	80	100
Low cost postharvest technology (crates and evaporative cooling chambers)	72	100	40	60	100	60	60	60	60
Improving Agro-meteorology Information network for forecasting and Early Warning System	98	80	20	80	60	80	40	40	60
Index based weather disaster subsidised agricultural insurance scheme for food crops	52	80	20	80	20	80	80	40	100
Scoring scale	0=very high cost --> 100=very low cost	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0=Very Difficult -->100=Very Easy	0=Very Difficult -->100=Very Easy	0=Very Difficult -->100=Very Easy	0= Very low --> 100= Very high
Criterion weight	11	10	8	16	17	19	8	6	5

Table A2.2 Prioritisation example - Simple MCA Tool - ***Decision Matrix***

	Costs	Benefits					Other			
		Economic		Social	Environmental	Climate related	Institutional/Implementation		Political	
	Cost to set up and operate the technology per beneficiary / year	Improving farmer income and ability to reinvest	Trigger private invest-ment	Poverty reduction potential	Contribution of the technology to protect and sustain ecosystem services	Improvement of resilience to climate change (i.e. to what extent the technology will contribute to reduce vulnerability to climate change impacts)	ease of implementation	replicability	Coherence with national development policies and priority	**Total Score**
Reforestation of the water catchment area of the main Reservoirs of Mauritius	1100	400	480	1600	1700	1900	800	480	500	8960
Up-scaling of locally proven IPM technologies for control of pes	836	800	320	1600	1700	1140	660	360	500	7896
Micro irrigation (gravity fed drip & mini and micro sprinkler irrigation)	220	800	640	1600	1020	1900	640	420	500	7740
Decentralised rapid pest and disease diagnosis service (plant clinic)	1078	600	480	1280	1360	1140	640	480	400	7458
Reinforce breeding and conservation programme for crop adapted to change in climate	990	1000	320	960	1020	1900	480	240	500	7410
Education and awareness raising among farming community to promote adaptation to climate change	1012	800	320	960	1020	1520	640	480	500	7252
Low cost postharvest technology (crates and evaporative cooling chambers)	792	1000	320	960	1700	1140	480	360	300	7052
Improving Agro-meteorology Information network for forecasting and Early Warning System	1078	800	160	1280	1020	1520	320	240	300	6718
Index based weather disaster subsidised agricultural insurance scheme for food crops	572	800	160	1280	340	1520	640	240	500	6052
Scoring scale	0=very high cost --> 100=very low cost	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0= Very low --> 100= Very high	0=Very Difficult -->100=Very Easy	0=Very Difficult -->100=Very Easy	0=Very Difficult -->100=Very Easy	0= Very low --> 100= Very high	
Criterion weight	11	10	8	16	17	19	8	6	5	

This guidebook is produced as part of the GEF-Funded Global Technology Needs Assessment Project, which is implemented by UN Environment Programme and UNEP Copenhagen Climate Centre. 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 ex-amples to illustrate how the TNA project can be organised and implemented, and how it can enable countries to secure public and private sources of investment in strategic and priority cli-mate technology projects, both for mitigation and adaptation.

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

tech-action.unepccc.org