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Draft final paper

Good Practices of Technology Needs Assessments

Executive Summary

1. This paper:

(a) Describes experiences with technology needs assessments (TNAs) conducted in 36 countries between 2009 and 2013;

(b) Presents good practice lessons for organising and conducting the step-wise TNA process, as well as for preparing a successful implementation of prioritised technologies for mitigation and adaptation;

(c) Provides recommendations for improving the TNA process and for enhancing implementation of TNA results.

2. In the TNA process, technologies for climate change mitigation and adaptation are prioritised in light of a country's development priorities, in order to achieve the highest possible combined climate and development benefits. After technology prioritisation, barriers to these technologies are identified, technology action plans (TAPs) with measures to address barriers are prepared, and concrete project ideas for technology implementation are proposed. All steps and outputs of the TNA are reported, to communicate the process and main results and serve as reference material for other processes.

3. The decision on the institutional and organisational structure of the process is one of the first tasks of the TNA. Most TNAs have been coordinated by ministries closely related to environment and climate change topics. As the TNA should be linked to a country's national strategic planning processes, it is good practice to also actively involve key ministries responsible for national development planning (such as Finance, Economic Affairs, Energy, Agriculture and Transport).

4. A TNA should be a participatory process, so that needs and preferences of stakeholders are taken into account. To enhance implementation of TNA results it is good practice to actively engage high-level policy makers and financial experts in the technology prioritisation process, to provide reality checks on feasibility of technology choices and investments. It may be helpful to engage development banks early in the process.

5. Criteria for the prioritisation of sectors and technologies in a TNA are derived from countries' national development goals. With these criteria, technologies are assessed in terms of their adaptation or mitigation potential and their economic, environmental and social benefits and costs. Multi-criteria decision analysis (MCDA) supports this by facilitating a dialogue among stakeholders, for a broader understanding of technologies and their contribution to development and climate goals.

6. Several approaches can be used in TNA process to identify barriers, such as expert interviews, market mapping and root cause analysis. Barriers can be categorised in, for instance, financial, regulatory, capacity and technical barriers, and subsequently specified in terms of what are their main causes and possible causal relationships with other barriers. Finally, barriers can be prioritised so that the most important barriers can be addressed first.

7. For the removal of barriers, enabling measures are identified as input for TAPs. These measures are often described in TNAs in terms of: why are the measures important, who will be responsible for the measures, within what time frame will the measures need to be implemented, what costs are required and what are possible sources of funding?

8. In the recent round of TNAs, most countries have developed project ideas. Countries are asked to include in project ideas detailed information on projects' objectives, measurable outputs, relationships to sustainable development priorities, activities, timelines, specified budget requirements, responsible organisations and potential financiers.

9. TAPs and project ideas in the recent TNAs often lack information about the business case for technology projects and programmes. It is therefore recommended to include benefit-to-cost ratios of a technology-related programme and/or project. This would facilitate judgements by governments and other potential funder of a technology investment's internal rate of return (in case of a project) or economic rate of return (in case of technology programme at sector or country level).

I. Introduction

A. Background

10. One of the functions of the TEC is to provide an overview of technological needs and analysis of policy and technical issues related to the development and transfer of technologies for mitigation and adaptation;

11. The work plan of the TEC for 2014-15 contains the following activities related to TNAs including:

(a) Review of technology needs assessments (TNAs), technology action plans (TAPs) and project ideas, and progress in the implementation of the results of TNAs, and

(b) Further work on possible ways to establish linkages between TNAs and nationally appropriate mitigation actions, national adaptation plans and national communications, and involve national designated entities in the process.

B. Objectives of the paper

12. The objectives of the report are to:

(a) Describe, based on the 31 TNAs conducted during 2009-2013 and interviews held with TNA practitioners and technology transfer experts, **experiences, lessons and challenges** related to conducting TNAs, by analysing organisational, participatory and analytical aspects of TNAs;

(b) Identify possible options for **further strengthening the TNA process**, including institutional aspects and organisation of TNA teams, which is crucial for the success of a TNA project, and

(c) Analyse ways **for enhancing the implementation of prioritised technologies** in practice, including how Technology Action Plans (TAPs) and project ideas emanating from the TAPs could result in actual technology implementation.

C. Scope and approach

13. Good practice lessons presented in this report have been distilled from the previous TNA phase, with 31 countries have delivered final TNA reports[1]. Another important source of information for this report has been the Third Synthesis Report on TNAs (3SR).[2] Good practice from an earlier Good Practice report has been considered,[3] as well as the main findings of the TNA Experience Sharing Workshop of September 2012 (Bangkok).

[1] These reports are posted on the TNA Project website <http://tech-action.org>.
[2] UNFCCC, 2013. Third synthesis report on technology needs identified by Parties not included in Annex I to the Convention, FCCC/SBSTA/2013/INF.7, <http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf>.
[3] UNFCCC, 2007. Best practices in technology needs assessments, Technical paper, FCCC/TP/2007/3, <http://unfccc.int/resource/docs/2007/tp/03.pdf>.

14. The approach for the report has been the following:

(a) The TNA reports have been studied and examples of good practice have been distilled from these. The main criterion for considering good practice is whether a method, approach or tool has been considered efficient or effective in reaching a predetermined goal. Good practice examples from different country reports have been compared and, to the extent possible, aggregated across countries for drawing more generic conclusions. It has been acknowledged throughout the analysis that good practice is related to a country's context and culture, so that good practice in one country does not necessarily lead to success in another;

(b) In order to substantiate the good practice lessons distilled from TNA reports, interviews have been held with the TNA practitioners about their experiences with conducting TNAs, what they consider good practice, and how the TNA process could be further improved;

(c) Additional interviews have been held with technology transfer experts from international organisations, development cooperation organisations, financial institutes and knowledge institutes.

D. Possible action by the Technology Executive Committee

15. The TEC will be invited to agree on the paper on good practices, including how to channel the outcome of this work to a wider audience.

II. Background

A. What is a TNA?

Key points
- In the TNA process, technologies are prioritised in light of a country's development priorities with the aim of achieving the highest combined development and climate benefits.
- After technology prioritisation, barriers to prioritised technologies are identified and ways to address these evaluated.
- Technology Action Plans (TAPs) are prepared containing a set of measures to address identified barriers to the development and transfer of prioritised technologies.
- Finally, concrete project ideas for the implementation of prioritised technologies are proposed.

16. Development priorities to guide a TNA can be derived from a country's national strategic document(s) or based on a specific problem that the country wants to address. For example, a national development strategy could contain a vision with objectives for the future development of the country. The **TNA could then support the formulation of a national pathway** towards that vision. Alternatively, TNAs could be based on a more focused problem identified by high-level policy makers in the country, such as energy security of supply problems, or a vulnerable agriculture sector due to climate change.

17. In light of these national development needs a TNA then **identifies sectors** in a country where the strongest development and climate benefits are expected to be achieved, which is followed by a prioritisation of technologies within these sectors. These portfolios with prioritised technologies per sector for mitigation and adaptation form the first deliverable of a TNA.

18. A next step in a TNA is **to identify barriers to successful implementation of prioritised technologies** in the country and to assess how these barriers can be addressed, so that an enabling framework results within the country for technology development and transfer. The barrier analysis and enabling framework report form the second deliverable of a TNA.

19. Measures identified for addressing technology barriers are subsequently described in **Technology Action Plans (TAPs)**, which form the third deliverable of a TNA. Actions included in TAPs could be specific for each priority technology or identified across technologies at the sector level.

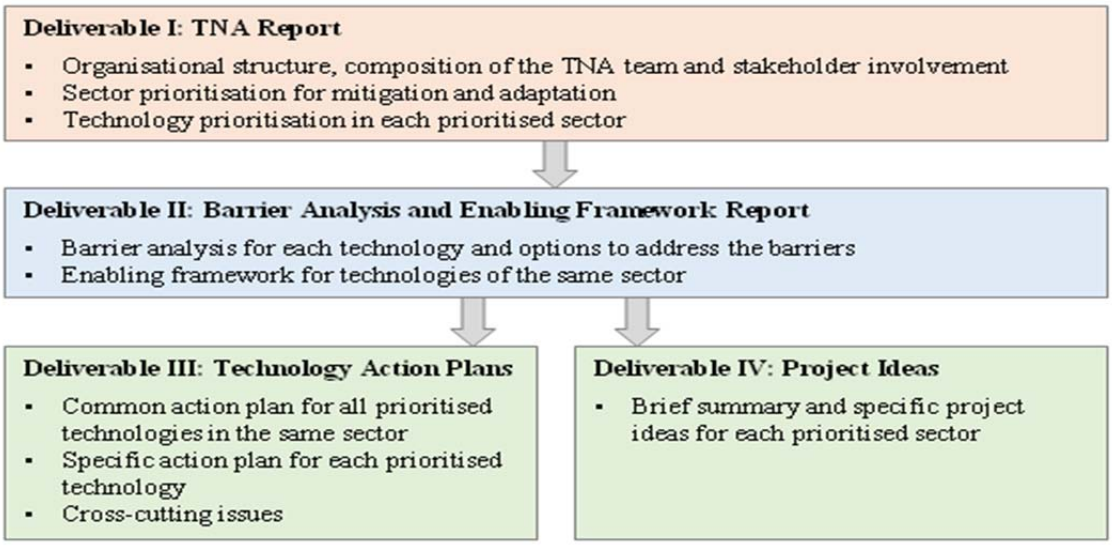
20. Finally, in their TNAs, countries formulate **project ideas as concrete actions for the implementation** of their prioritised technologies. The project ideas form the fourth deliverable of a TNA.

21. The relationships between these four TNA deliverables and their reporting outputs are shown in Figure 1. Guidance on the content of each deliverable (steps and reporting outputs) was provided by URC in the form of report templates with reporting suggestions per section.[4]

22. A step-wise guidance to the TNA process and its organisation is provided by the **TNA Handbook**[5] and the explanatory note by URC on organising the national TNA process.[6] Both guidance documents lay out the key steps, decisions, methods and resources needed for conducting TNAs, taking into account that national circumstances and needs vary among countries.

23. In addition to this guidance, countries could consult the **series of guidebooks prepared to support the TNA process** (on barrier analysis and identification of finance opportunities for technology investments) and to provide content support (information about technology options within sectors).[7] Countries have received operational and technical support from URC and from the regional collaborating centres: Asian Institute of Technology (AIT, Thailand), Environment and Development Action in the Third World (ENDA, Senegal), Fundación Bariloche (Argentina) and Libelula (Peru).

Figure 1. Relations and contents of the main country deliverables from the TNA project.[8]



B. Overview of conducted TNAs

24. The second synthesis report of TNA (2SR), which was prepared in 2009, presented an overview of the TNA reports of the 69 countries that had conducted a TNA process until then.[9] The third synthesis report (3SR), which was prepared in 2013, presents an overview of the results of 31 TNA processes that were conducted between 2009 and 2013. **The countries with TNAs included in the second and third synthesis reports** are shown in Figure 2.

[4] URC, 2012. TNA and TAP Report Template for Mitigation/Adaptation, Version 2, 16 February 2012.
[5] Handbook for Conducting Technology Needs Assessment for Climate Change, <http://unfccc.int/ttclear/sunsetcms/storage/contents/stored-file-20130321154847356/TNA_Handbook_Nov2010.pdf>.
[6] Dhar, S., J. Painuly and I. Nygaard, 2010. Organising the National TNA Process: An Explanatory Note, UNEP Risoe Centre, Denmark. <http://tech-action.org/media/k2/attachments/OrganizingNationalTNAprocess_13.pdf>.
[7] These guidebooks can be downloaded from: <http://tech-action.org> (under Publications).
[8] This structure has been applied by the 32 Parties which have recently submitted their TNA reports. It may be changed for the planned next round of TNAs (see section I) as, e.g., deliverables II and III may be integrated.
[9] UNFCCC, 2009. Second synthesis report on technology needs identified by Parties not included in Annex I to the Convention, <http://unfccc.int/resource/docs/2009/sbsta/eng/inf01.pdf>.

Figure 2. World map of countries included in the second and third synthesis reports.

III. Synthesis of good practices of conducting and reporting TNAs

A. Organising the TNA process

Key points

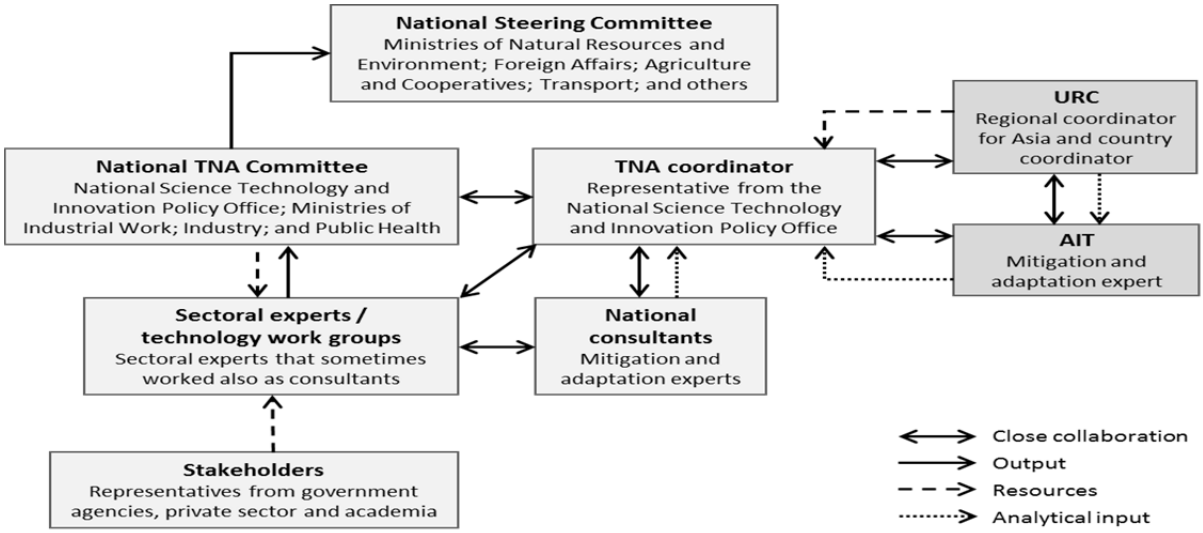
- Among the first tasks in a TNA is to decide on the institutional and organisational structure of the process. The decision on the leadership of a TNA is an important step to determine the 'ownership' of the process.
- The national TNA team usually consists of a TNA coordinator, a National TNA Committee, a National Steering Committee, sectoral/technology working groups, relevant stakeholders and national consultants.
- Successful engagement of stakeholders supports knowledge building in a TNA and informs stakeholders about technology opportunities. High-level policy makers should be among the stakeholders, in order to obtain political commitment and financial experts can inform TNA teams about criteria for funding and provide reality checks on feasibility of technology investments.
- A detailed work plan should be developed with clearly defined tasks, schedules and budgets.
- The TNA process usually requires approximately 24 months.

1. Organisational structure

25. Based on the previous experiences from countries, TNA generally requires around 24 months to be completed.[10] Such time extensive project requires a **solid organisation structure** and commitment to the process by participants in the project team. Therefore, among the first tasks in a TNA is to set up the organisational structure. Guidance on that has been provided by URC in a note on institutional arrangement. Figure 3 shows a practical example of organising a TNA and how 'team members' collaborate within the TNA structure.

[10] Some TNAs have taken fewer months and some of the interviewed TNA practitioners indicated that part of the 24 months was spent on organisation of the process itself, including signing a Memorandum of Understanding.

Figure 3. Example of the organisation structure of a TNA, including involved ministries (Thailand[11]).



26. The decision on the leadership of a TNA is an important step to determine the 'ownership' of the process. Most TNAs have been co-ordinated by representatives of ministries which are closely related to climate change mitigation and adaptation topics, such as the Ministry of Environment. This has in most cases also been the contracting entity for TNAs (via a Memorandum of Understanding agreed with URC). An alternative option for leadership, as seen in some TNAs, is to form an **interministerial committee with experts from relevant ministries**. Involvement in such committee may create an active ownership of the TNA.

27. Experts interviewed for this report highlighted that important factors contributing to the success of a TNA and implementation of its results are: (a) the existence of a **climate change strategy** in a country and how it has been institutionalised, and (b) the extent to which a TNA has been linked to a country's **national planning processes**.

28. The National Steering Committee (NSC) for TNAs can support the linking of TNAs to national development planning processes. In most TNAs, **NSC has functioned as an advisory committee** to ensure political support for the process. It usually consists of representatives from several ministries, notably the Ministry of Environment. In some countries membership was supplemented with representatives of **academia and/or NGOs**.

29. The TNA process is carried out by the National TNA Team. This team typically consists of:

- The **TNA coordinator** who provides vision and leadership to the overall process, thereby facilitating the communication with the Team members, supporting stakeholder network formation, collecting information for the TNA steps, and supporting outreach of TNA results;
- The **National TNA Committee** which is the TNA's core group (usually at most 10 people) and which ideally consists of representatives from ministries and other experts on climate and development issues in the country. Its composition could remain flexible, so that additional expertise can be invited during different TNA stages;
- **National consultants** to support the work of the National TNA Committee. They are selected, based on CVs, by the National TNA Committee in collaboration with URC. The consultants support, through their research, analysis and synthesis of information, the activities of the National TNA Committee and the stakeholder working groups;
- **Sectoral/technology working groups**, which were established by most countries for mitigation and adaptation or for each sector.

30. The organisation and methodology of the TNA process can be summarised as in Table 1.

[11] Thailand, Technology Needs Assessment Report for Climate Change – Mitigation, July 2012, section 2, pp. 21-22.

Table 1. Organisation and methodology of the TNA process.

TNA process step	Organisational elements		Methodological elements	Database supports	Training
	Decision-making entity	Technical support			
Prioritisation of sectors	• National TNA Committee	• TNA Coordinator	• TNA Handbook		Regional Capacity Building Workshop – 1 on Multi-criteria spreadsheets
Prioritisation of technologies	• National TNA Committee • Sectoral work groups	• National consultants	• TNA Handbook • MCDA tool	• Guidebooks • Regional centres • ClimateTech-Wiki	
Barrier analysis	• Work groups	• National consultants	• Guidebook on barriers • Policy fact sheet	• Perspectives Mitigation • Policy database	Regional Capacity Building Workshop – 2 on Market / Barrier Analysis & Template for TAP
TAP and project ideas	• National TNA Committee • Project Steering Committee	• National consultants • Work groups	• TAP and project ideas templates • Financing guidebooks		
Source: URC, personal communication					

2. Organising stakeholder involvement

31. It is considered good practice that a core team of stakeholders **is active in most of the TNA steps** and that they exchange information with and collect feedback on TNA results from their 'wider groups'. The core stakeholders may be assigned to sectoral or technology working groups as mentioned above (see Figure 3).

32. Stakeholders in a TNA may come from governmental entities, industries, the finance community, consumer organisations, research institutes, labour unions, international organisations, and other NGOs (see Box 1). According to an interviewed expert from a development cooperation organisation, stakeholders can also **support the outreach of TNA results** to a broader audience in a country.

Box 1. Example of stakeholders involved in TNA of Dominican Republic.

In the TNA process in the Dominican Republic,[12] a wide range of stakeholders have been involved, such as:

- **National government**: Ministries of Agriculture; Economy, Planning and Development; Finance; Higher Education, Science and Technology; Industry and Trade; Public Health; Environment and Natural Resources; Foreign Affairs; Tourism. Central Bank; National Council on Climate Change and CDM; National Energy Committee; Development Fund for Land Transport; National Office of Meteorology; *etc*.
- **International Organisations**: USAID; FAO; UNEP Small Grants Programme, UNDP
- **Business and business associations:** Biogen bio energy; Bosquesa S.R.L.; Dominican Agribusiness Board; National Association of Hotels and Restaurants; *etc*.
- **Environmental and development NGOs**: Climacción climate change platform; Dominican Environmental Consortium; Foundation for Nature, Environment and Development; National Network of Business Support for Environmental Protection; The Nature Conservancy; *etc*.
- **Academics**: Autonomous University of Santo Domingo; Technological Institute of Santo Domingo; National Evangelical University; University of Organisation and Methods; *etc*.

33. According to most interviewed experts, implementation of TNA results will be enhanced by **active engagement of high-level policy makers and financial experts** throughout the entire TNA process. In order to obtain their attention and 'commitment' for TNA result implementation, these stakeholders need a clear TNA goal.

[12] Dominican Republic, ENT RD – Síntesis ENT y reporte de plan de acción para la transferencia de tecnologías priorizadas – mitigación, December 2012, section 2.2, p. 21.

34. Interviewees have the impression that, in recent TNA processes, **financial experts have played only a limited role** in the formulation of TAPs and project ideas. It was considered good practice to involve financial stakeholders, such as commercial banks, development banks and international donors, from the beginning of the TNA process (see Box 2 for examples).

35. **Involvement of financial experts with development cooperation and multilateral organisation** background was considered particularly important when prioritised technologies are new to a country and their development and transfer surrounded by unknown risks. Financial experts were considered able to offer their expertise with mitigating such risks and analyse whether technology choices and investments plans reflect the 'flavour of the market' and are financially and economically feasible.

Box 2. Examples of financial stakeholders involved.

Colombia[13]: One of the stakeholders involved in the Colombian TNA process was BANCOLDEX, the business development bank of Colombia. BANCOLDEX manages three pension trust funds and is seen as a high-influence actor. Although it does not fund projects directly, including this development bank in the process has the advantage of generating capacity and knowledge on the financial sector and processes. Colombia states that this is of great importance to guide the process of financing energy efficiency projects.

Ghana[14]: In the Ghanaian TNA process, the Agricultural Development Bank and regional commercial bank Ecobank have been involved.

Kenya[15]: For its technology needs assessment for adaptation, Kenya has involved a wide range of 'development partners' from the finance and investment community. These include the World Bank, the African Development Bank, the Japan International Cooperation Agency and the Swedish International Development Agency, amongst others.

3. Establishing a work plan

36. The work plan for a TNA contains of roughly three main stages:

- the preparatory stage,
- the sector and technology prioritisation stages, and
- the stage of preparing priority technologies for implementation.

37. During the **preparatory stage** the above organisational structure is determined with the first step, after project approval with a Memorandum of Understanding, being the appointment of the TNA co-ordinator. This is followed by the composition of the TNA Committee. Usually, this core TNA team formulates the scope for the TNA, which is then discussed with country stakeholders, mostly at a national TNA workshop.

38. During the **sector and technology prioritisation stages**, the National TNA Committee organises the knowledge exchange with stakeholders on climate and development characteristics of the country's sectors and possible technologies within these sectors. Sector experts may be appointed to do preparatory work. URC and the regional consultants provided training on the use of methods. The work plan contains, for instance, a timetable for meetings, achievement of milestones and delivery of results. Interviewed TNA practitioners indicated that the sector and technology prioritisation work plan could cover about a year.

39. According to interviewed TNA practitioners, the work plan for the **implementation preparatory stage** of the TNA, mainly aiming at formulating the TAPs and project ideas, could take approximately half a year. Box 3 shows an example of what a TNA process could look like in terms of what activities to organise, when and how. It also shows that the above indications of time required for each TNA stage can differ between countries and that the work during the stages can overlap so that the total time required for the full TNA could be less than two years.

[13] Republic of Colombia, Evaluación de Necesidades Tecnológicas y Planes de Acción Tecnológica para Mitigación al Cambio Climático, April 2013, p. 27.
[14] Ghana, Technology Needs Assessment Report, August 2012, appendix 1, pp. 46-49.
[15] Republic of Kenya, Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation, March 2013, annex 2.4.4, p. 57.

B. Prioritising sectors and technologies for mitigation and adaptation

Key points

- Criteria for the prioritisation of sectors and technologies in a TNA are mostly derived from national development priorities, which can be based on existing national plans.
- Criteria for sector prioritisation may be more of a high-level nature, whereas criteria for technologies are often more at the technology-level such as technology costs.
- To keep the TNA process manageable, it is good practice to keep the list of sectors that are considered relatively short and to prioritise two or three sectors for both mitigation and adaptation.
- Technology familiarisation is an important step before prioritising technologies within priority sectors.
- Multi-criteria decision analysis (MCDA) helps to assess benefits and costs of potential technology options. MCDA facilitates a dialogue between stakeholders for a broader understanding of technologies' contribution to development and climate goals in a TNA country.
- For both sector and technology prioritisation it is good practice to make these steps participatory.

1. Deriving criteria for sector and technology prioritisation

40. An important goal of a TNA is to prioritise technologies for mitigation and adaptation in light of a country's development priorities. The link between TNAs and countries'development priorities is reflected by often detailed descriptions in TNA reports of existing strategies for climate change mitigation and adaptation, enhancing energy security, redusing poverty, reduction of negative domestic environmental impacts, etc.

41. Although most Parties formulated criteria in light of national development priorities, they often used **different sets of criteria for sector selection and technology prioritisation**. For example, several countries applied in their TNAs mainly macro-level development priorities (economic, environmental, social) as criteria for sector prioritisation, but added more pragmatic technology-level criteria for technology prioritisation (e.g. market potential or costs).

42. Moreover, it could be observed from TNA reports that **many countries further specified macro-level criteria** into more detailed criteria. For instance, environmental benefits as main criterion could be specified into: biodiversity protection, local air quality improvement, forest conservation et.

Box 3. Clustering of development priorities and criteria in Lao PDR[16].

Lao People's Democratic Republic has, for sector and technology selection, based its criteria on the national development priorities (structured among three categories), as well as GHG reduction potential (for mitigation) or vulnerability reduction potential (for adaptation) and costs.

Category	Criterion
Costs/investments	• Costs in the implementation, operation and maintenance
GHG reduction	• Potential for GHG emission reduction or enhancement of sequestration
Adaptation potential	• Potential for adaptation including reduction of vulnerability and impacts, while enhancing adaptive capacity
Economic benefits	• Yield/income: enhance economic growth • Enhance micro, small and medium-sized enterprises
Environmental benefits	• Reduce negative environmental impacts • Reduce air pollution
Social benefits	• Employment: creation of new jobs and improved working conditions • Gender equality • Socioeconomic equality: addressing gaps between urban and rural development • Enhance adaptive capacity: health, safety, infrastructure, education and organisational strengthening

43. Some criteria for next TNA stages were based on more pragmatic aspects such as optimisation of time and resources available for a TNA, knowledge needs, interlinkages between sectors, as well as development benefits (see Box 4). For instance, if sectors have clear interlinkages, such as improving

[16] Lao People's Democratic Republic, Technology Needs Assessment Report Climate Change Adaptation, April 2013, chapter 3, pp. 22-30; Technology Needs Assessment Report Climate Change Mitigation, April 2013, chapter 3, pp. 24-36.

waste management and enhancing production of energy from waste, then this could be a criterion for prioritising the sectors energy and waste.

Box 4. Criteria determined for sector prioritisation – TNA for adaptation in Argentina[17].

In the TNA for adaptation in Argentina (similar to the TNA for mitigation) the National TNA Coordinator, jointly with the Ministry of Science, Technology and Innovative Production in Argentina, first, determined general guidelines for sector selection, thereby taking into account current national plans and programmes. Criteria were identified to optimise the available resources for conducting the TNA and the usefulness of the TNA results for the various agencies. The suggested criteria were subsequently discussed and validated by relevant TNA stakeholders for use in the sector prioritisation and other TNA stages.

Selected criteria for Argentina's TNA for adaptation are:
- Optimisation of economic resources and time available for a TNA,
- Ensure that results are applicable for the future,
- Interlinkages between sectors,
- Coordination with existing plans and programs,
- Possible synergies between mitigation and adaptation,
- Potential for local technology development in Argentina,
- Additional development benefits, and
- Information requirements in sectors.

2. Sector prioritisation for mitigation and adaptation

44. Based on the criteria identified, sectors for mitigation and adaptation in TNAs are prioritised. From the TNA reports and interviews, the following (non-exhaustive) approaches for sector prioritisation can be distinguished (see also Box 5 for examples):

- **Mainly climate benefits**: sectors are selected based on alignment with national climate change strategies;
- **Climate first, then development**: sectors are selected in terms of GHG emissions and vulnerability profile (e.g. first identify sectors with high GHG emissions and high vulnerability) and then assessed in terms of potential economic, social and environmental development benefits;
- **Equal climate and development weight**: sectors are scored against climate and development criteria, as well as costs; and
- **Applying specific criteria for the country's context**: sectors are selected against criteria such as knowledge needs within a sector, interlinkages between sectors, potential for local technology development, *etc*. (see the example of Box 5).

Box 5. Examples of sector selection processes in TNAs.

In **Bangladesh**[18], power generation and use, industry and agriculture were identified as **main sectors** with high GHG reduction potentials and which complement the country's development priorities. These three sectors have then been further sub-divided into sub-sectors and these sub-sectors have been scored against criteria for economic, environmental and social criteria (simple MCDA as in the TNA Handbook).

In **Bhutan**[19], sectors have been identified based on the National Communications (2000) as major emitting or vulnerable sectors/areas. Sub-sectors were scored against GHG reduction potential as well as economic, environmental and social criteria with equal weighting. The scoring took place through an iterative process by e-mail with 20 members of the TNA Task Force. After round 1 a first conclusion was calculated which was then sent back to members for reconsideration. A few revisions were received in round 2, which then became the final round.

Indonesia[20] selected three main sectors in its TNA for mitigation: forestry (including peat), waste and energy The selection was solely based on a description of their GHG emission profiles and trends.

[17] Argentina, Evaluación de Necesidades Tecnológicas ante el Cambio Climático – Informe Final sobre Tecnologías para Adaptación, section 3.1, pp. 39-40.
[18] Bangladesh, Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation, December 2011, chapter 4, pp. 25-29.
[19] Kingdom of Bhutan, Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation, March 2013, chapter 3, pp. 9-13.
[20] Republic of Indonesia, Indonesia's Technology Needs Assessment for Climate Change Mitigations 2012, February 2012, section 1.3, pp. 11-14.

Viet Nam[21] first characterised sectors in detail and then followed the TNA Handbook guidance to identify sectors for mitigation based on shares in national GHG emissions and potential for feasible GHG mitigation options, sector capacity to employ low-emission technology and contribution to overall national development goals.

45. In order to **keep a sector prioritisation process manageable**, the TNA Handbook suggests that the 'long' lists of sectors for mitigation and adaptation are kept relatively short. This could be done, for example, by taking the highest emitting or most vulnerable sectors, until a critical value has been reached. For instance, consider only sectors for mitigation which cover above 75% of the country's GHG emissions.

46. In most countries, **scoring of benefits** has been done with a light version of multi-criteria decision analysis (MCDA) with scores ranging from, *e.g*., 'very low' to 'very high' benefits (often on 5-point scales). It is good practice that scoring and the justification of scores stimulate a dialogue among stakeholders.

47. Finally, **prioritised sectors were ranked** according to the highest benefits. Because of time and budgetary constraints, it has become good practice in TNAs to 'shortlist' no more than two to three sectors each for mitigation and adaptation, so that the TNAs remain manageable.

3. Technology prioritisation for mitigation and adaptation

48. After the identification of strategic sectors for mitigation and/or adaptation, technologies are prioritised within these sectors. As explained above, **criteria for technology prioritisation** can be derived from countries' national development priorities, but also be more focussed on technologies' market potential, implementation aspects and costs (see Box 6 for an example).

49. When assessing technology options, it is of key importance to first make a **long list of potential technologies to be considered within each priority sector for mitigation and adaptation**. Such a list can consist of currently existing technologies within the sector and potential new technologies. Sector experts could then analyse which technologies are potentially suitable for the country.

50. A crucial step in a TNA is that country **stakeholders familiarise themselves with identified technologies**. It is good practice to also engage potential technology users and decision makers in this familiarisation process. This enables informing them about technologies and removal of possible negative perceptions early in the prioritisation process.

Box 6. Criteria for the prioritisation of technologies for adaptation (El Salvador[22]).

The following criteria were used in El Salvador for the prioritisation of technologies for adaptation. Technologies are scored for each criterion on a scale from 1 (hardly desirable) to 5 (extremely desirable).

- Adaptation potential or contribution to vulnerability reduction
- Creation of green employment
- Increase of human and institutional capacity
- Use of local human and natural resources for the technology
- Favourability to the environment or reduction of environmental damage: biodiversity, soil conservation, watershed management, air quality, water conservation
- Consistency with other public policies
- Intersection with other priority sectors
- Capital and operating costs, relative to the alternatives
- Scale of investment required
- Possibilities for replication: adaptability to different geographic, cultural and socio-economic areas
- Access to the technology (readiness), commercial availability

51. Following the familiarisation, **technology options are assessed** against climate and economic, social and environmental development benefits for a country (see Box 8 for an example of criteria used). In order to determine benefits of a potential technology option, the new situation with the technology can be compared with the situation in a sector without the technology.

[21] Viet Nam, Technology Needs Assessment for Climate Change Synthesis Report, June 2012, chapter 3, pp. 11-22.
[22] El Salvador, Síntesis de la Evaluación de Necesidades Tecnológicas (ENT) y Plan de Acción para la transferencia de tecnologías priorizadas en adaptación al cambio climático, February 2013, section 3.2, pp. 19-23.

52. In a TNA, estimated **improvements of technology options are subsequently valued** ('scored') by stakeholders. It has become good practice to use a detailed MCDA methodology for that. For instance, technology options can be scored in terms of delivering low or negative (low score), medium (medium score) or large benefits (high score). It is also a good practice to **weight the scores across criteria** as, due to the scores, some criteria may have become less important than others.

53. It is important that the **scores and weights are justified** and that the justification is recorded. This facilitates a sensitivity analysis of the prioritisation results and also forms a source of information for decision makers as it informs them about the underlying reasons for the prioritisation.

54. A common output of a technology prioritisation process are **technology portfolios for priority sectors** with information about climate and development benefits and costs, thereby assuming a certain scale of technology R&D, deployment and diffusion.

IV. Synthesis of good practice of implementing TNA results

A. Good practices of formulating Technology Action Plans (TAPs)

- For TAPs, it is good practice to revisit sector plans and strategic long-term documents to ensure that prioritised technologies are in line with already agreed objectives.
- For prioritised technologies barriers are identified and characterised, using problem tree/root cause analysis and market mapping.
- Barriers are categorised and ranked, so that the most important barriers can be addressed first
- For the removal of barriers, measures are identified as an input for a TAP.
- Identified measures are categorised (economic measures, capacity building, infrastructure investments, etc.) and characterised (who, when, what, how, how much, etc.).
- Measures may be aggregated, to formulate TAPs at a sector or national level.
- It is good practice to engage financial experts in the TAP preparations and make the process receptive to their inputs.
- It has been recommended that TAPs contain information about the benefit-to cost ratio of a technology-related programme and/or project, so that policy makers and investors obtain a good overview of economic benefits of a technology at a project, programme or national economy level.

1. Preparing TAPs and project ideas

55. This chapter focuses on good practice of preparing Technology Action Plans (TAPs) and project ideas in a TNA for implementation of prioritised technologies.[23] This section describes good practice of TAP formulation, while the next section (B) focuses on project ideas. Section C contains views and options for enhancing implementation of TNA results, as expressed in interviewed with TNA practitioners and technology transfer experts.

56. In a TNA, the steps towards the formulation of TAPs are generally the following:

(a) Placing **implementation** of priority technologies in a **sector or national context**;

(b) Assess **barriers** to technology transfer;

(c) Identify **measures to address barriers**; and

(d) **Formulate** TAPs.

2. Placing implementation of priority technologies in a sector or national context

57. It is generally considered good practice to **revisit a country's existing sector plans and/or strategic long-term documents** before identifying technology barriers and measures to address these. As such, actions for development, deployment and diffusion of priority technologies can be identified in line with a country's already agreed objectives and goals.

[23] In order to support countries in those steps, guidance has been provided by the TNA Handbook (chapter 6) and by URC in the form of templates for reporting as presented in the form of training presentations: e.g., <http://orbit.dtu.dk/files/10144594/TNA_TAP_Template_9_Sept_rev_2_.pdf>.

58. Revisiting the sector situation and trends enables TNA stakeholders, among others, to:

- **develop an understanding of financial and other constraints** within the sector, which could also be used for other processes within a country, such as updating strategic development documents and the National Communication (see also above under sector prioritisation); and
- more clearly assess at what would be a **scale of technology implementation** within a sector, in order to optimally contribute to national and sector goals.

3. Assessing barriers to technology transfer

59. After having determined the potential role of priority technologies to meet national and/or sector goals, the TNA process considers **barriers to successful development and transfer of technologies.** From the TNA reports, it can be concluded that most countries consider the barrier analysis as a first step in the formulation of TAPs, which are often seen as a package of measures or actions to address these barriers.

60. For the assessment of barriers, the following approaches have been used by countries:[24]

- **interviews with country experts and stakeholders** to explore barriers and enabling measures (80 per cent of the TNAs);
- tools such as '**market mapping**' and '**problem trees**' (70 per cent of TNAs);
- **dedicated workshops** (60 per cent of TNAs);
- **desk study** (50 per cent of TNAs); and
- **logical problem analysis** (27 per cent of TNAs).

61. When assessing barriers, countries have often acknowledged that barrier analysis should not be limited to the technology itself, but also **focus on its broader market or system context**. Therefore, several countries have distinguished between:

- **an enabling environment** for a technology (*e.g*. existing legislation, culture, habits, *etc*.);
- **the market chain** through which a technology moves towards application (including market actors), and
- **the supporting services** for technology application (*e.g*. financial, technical or legal services).

62. Such a '**market map**' describes the broader market system for technology transfer, including assessment of where in the system blockages or inefficiencies exist. Market maps can be detailed descriptions of interactions between market actors or simply a collection of post-it notes on a flip-over, which then forms a basis for further stakeholder discussions. Market mapping has generally been applied by TNA countries for technologies that are in the process of deployment and diffusion in a market.

63. Another tool which most countries have successfully applied, sometimes in combination with market mapping, is **problem tree analysis** to identify the root cause of a barrier. For instance, an observed barrier is lack of skilled persons to operate a technology. Through problem tree analysis, the identified underlying reason for that is insufficient education, which has been caused by budget limitations for education in the country.

64. In some countries, a first assessment of barriers was made by expert teams based on **desk review**, which was then reviewed and validated at stakeholder workshops. Other countries have identified and categorised barriers with stakeholders straight from the beginning.

65. Based on the TNAs conducted between 2009 and 2013, it is considered good practice **to group identified barriers in categories** so that similar or comparable barriers can be addressed.

66. Finally, once barriers have been identified, categorised and described, it is good practice to strengthen the barrier analysis by:

[24] The percentages shown in this paragraph describe how many of the TNA country reports (completed between 2009 and 2013) applied one or more of the listed approaches. It may well be that countries have used multiple approaches, *e.g*. interviews, market mapping and dedicated workshops. Therefore, the percentages mentioned in this paragraph do not have to add up to 100%.

- **Prioritising which barriers need to be addressed first**, or which of the barriers identified are the most relevant for a prioritised technology;
- **Exploring causal relationships between barriers**, as one barrier may be affected by the existence of other barriers.
- **Distinguishing between different stages of technology development and transfer**, as each stage (*e.g*. technologies in R&D or diffusion stage) has different (types of) barriers.

4. Towards TAPs: identify measures to address barriers

67. Next to the identification of barriers to technology development and transfer, it has been common practice in TNAs to **identify measures for the removal of the barriers**. **These measures subsequently form inputs for TAPs**.

68. Often in TNAs, as suggested by the TNA Handbook, identified **measures are grouped in categories**, such as economic and financial support, capacity building, infrastructure investments, networking activities and international cooperation.[25] Within these categories, TNA countries have often specified measures by describing, for instance:

- **why is the measure important** in light of the identified barrier;
- **what institution will be responsible** for the measures and what type of private-public cooperation is recommended;
- **within what time frame** will the measure be needed (whereby usually for technologies that are in the stage of diffusion to commercial application a shorter time frame is envisaged than for technologies that are in an R&D stage[26]);
- **what costs are required** for the measure, and
- what are possible national and international **sources of funding**?

69. A number of TNAs have aggregated measures across technologies and **formulated their TAPs** at the level of a sector or even at the national level. This aggregation can take place in different ways, such as:

- At the level of a **technology**, but assuming that multiple units of the technology will be implemented within a sector or the country for reaching sector or country goals;
- At the level of a **sector**, whereby options for multiple priority technologies within the sector are grouped into a TAP for the sector, such as, for instance, a training programme for domestic engineers for priority technologies or a feed-in tariff for prioritised energy generation technologies;
- At the level of a **country**, whereby similar options identified for multiple sectors are aggregated at the national level for a national strategy.

70. In addition to the above examples of good practice, from the TNA reports and based on interviews with TNA practitioners and technology transfer experts areas for improvement of TAPs can be considered, such as:

- **Cost information:** Generally, the cost information provided in TAPs, if included at all,[27] is limited to a rough estimate of costs of actions for technology implementation;
- **Information about the benefit-to cost ratio of a technology-related programme and/or project:** For instance, an economic internal rate of return could be used to explore the broader economic benefits an investment could bring to the economy by assigning best estimates of economic values to benefits that may not have direct financial return (*e.g*. better air quality, reduced congestion, *etc*). With such information, technology investments can be screened for prioritization and allocation of resources in countries;
- **Clarity about funding sources:** Most TAPs do not make clear how estimated costs are foreseen to be covered. TNA technology investments could be funded by private sector financing, public

[25] TNA countries have generally followed such a categorisation, but the categories sometimes differ, also in terms of interpretation. For instance, several TNA countries mention under 'international cooperation action' handling of intellectual property rights, whereas other countries foresee the need for international cooperation in terms of funding acquisition, training, *etc*.

[26] In general, distinguishing different technology development stages can be considered good practice as each stage requires different actions towards successful implementation.

[27] 19 countries included budget estimates for actions specified in TAPs for adaptation and 18 countries specified costs for TAPs for mitigation.

funding or a combination. For example, energy, water, and transport sector technologies could be attractive for commercial funding (in some cases through public-private partnerships), while adaptation technologies may often rely on public funding thus making it all the more important to conduct a robust analysis on what technologies provide the best value for money;

- **Measure success:** Although TAPs clearly identify actions and characterise these, only a few TNAs include in their TAPs indicators **to measure future success after implementation**. Absence of such indicators makes it difficult to measure the impact of an action after implementation.

B. Good practice of developing project ideas

Key points

- 262 project ideas have been prepared by 26 TNA countries, using a template provided by URC.
- It is good practice that project ideas describe goals and objectives, with quantified targets in order to assess project outcomes.
- To reach project targets, it is good practice that project ideas contain detailed timelines (such as Gantt charts), specified budget details, and an indication of responsible organisations for each project activity. It is good practice to include a detailed project plan with project milestones, as well as benefit-to-costs ratios for well-informed decisions.
- It is considered good practice to choose a timeframe for project ideas depending on, among others, the technology characteristics and the local context (*e.g*. whether the technology is in R&D or technology diffusion stage).

71. In the latest round of TNAs, between 2009 and 2013, 26 countries developed **more than 260 project ideas** in total, using a reporting template provided by URC.[28] This template encourages countries to include detailed information on projects' objectives, measurable outputs, relationships to sustainable development priorities, activities, timelines, specified budget requirements, responsible organisations and financiers. Based on the presented project ideas the following good practice can be observed.

72. Some 95 per cent of the project ideas contained descriptions of **goals and objectives**, albeit with different levels of detail. Generally, the objectives specify a project's final goals and how the project plans to achieve these.

73. For over 60 per cent of the project ideas **project activities** have been described, again with varying levels of detail. Good practice examples contain detailed descriptions of activities, including timelines, budgets and responsible organisations per activity.

74. Almost all project ideas contain an indication of the **project duration.** 80 per cent of the project ideas are planned to take no longer than five years. Determining good practice in choosing the timeframe depends on the technology and local context: project ideas for technologies in an R&D phase or requiring infrastructural investments or country-wide system improvements usually have longer timeframe than projects supporting near-commercial technologies towards market diffusion.

75. It is considered good practice to **specify timeframes and duration for each project activity**. One out of four project ideas in TNAs conducted during 2009-2013 included a project plan with a Gantt chart, which is helpful to obtain an overview for all stakeholders of what activities are to be conducted and when, possibly with mentioning of project milestones.

76. It is considered good practice to **include a budget specification for project ideas**, including investment, operational and maintenance costs. Almost all project ideas of the latest TNA phase contain a budget. However, the majority of these budgets are not or only roughly specified in further detail for an example of a budget specified per activity. A shortcoming for almost all project ideas is that merely investment costs are given, without clarification of operational and maintenance costs, as well as the expected returns on investment.

77. Similar to the recommendations made for TAP, interviewed technology transfer experts recommended that project ideas contain basic information about their benefits in relation to costs. Such information could be in the form of **a financial internal rate of return or an economic rate of retur**n,

[28] See footnote 6.

whereby, for instance, economic values have been assigned to benefits which may not have a direct financial return. With such information, policy makers and investors would be better able to screen investments for prioritisation and allocation of resources.

C. Enhancing implementation of TNA results and the role of TAPs and project ideas

Key points

- TNAs lack information about how to prepare proposals with technologies. For instance, for a government to decide on how to allocate resources for technology implementation, information is needed about the benefit-to-cost ratio of a technology-related programme and/or project
- It is good practice to actively engage high-level policy makers and financial sector stakeholders in TNAs from the beginning, and to make TNA processes more receptive to their inputs
- For engaging high-level policy makers and financial sector stakeholders in TNAs, it is good practice to be clear from the beginning how the TNA outputs could support national planning processes
- It may be helpful to engage development banks earlier in the TNA process
- TAPs and project ideas could be more credible for potential funders if technology prioritisation and TAP/project idea preparations were done by sector or technology experts

78. The main objective of TAPs and project ideas is to **support implementation of technologies** prioritised in a TNA. On the basis of the experience with TNAs conducted between 2009 and 2013, interviews were held with TNA practitioners and technology transfer experts on how technology implementation can be enhanced by focussing on:

- **What information** should be included in TAPs and project ideas?
- **Who should take part in the formulation** of TAPs and project ideas?
- **What sources for funding** could be considered for inclusion in TAPs and project ideas?
- **What could be the role of the CTCN** to support implementation of TNA results?

79. Some TNA practitioners have suggested that TAPs and project ideas may **acquire a higher quality and gain more financial sector credibility if prepared by sector and technology exper**ts. In their view, the technology prioritisation and TAP and project idea formulation can be done by smaller groups with sector experts and/or engineers using their professional knowledge (supported by iterative consultation with wider stakeholder groups for discussion, questions, modifications, and eventually acceptance).

80. Moreover, it has been suggested that instead of having TAP and project ideas compiled by national TNA teams with broad stakeholder consultation, a TNA could publish a **call for proposals** to invite technology owners and/or developers to submit TAPs and/or project ideas for prioritised technologies. Submitted plans can then be evaluated by the national TNA teams and the 'winning' plans can be shared with potential investors.

81. Most interviewees, both TNA practitioners and technology transfer experts, emphasised, that involvement in TNAs of key ministries for national development planning can **support the implementation of TNA results**. Without their involvement, there is a risk that TAPs are not endorsed as inputs for national planning as they are considered a result from 'outside' the ministries.

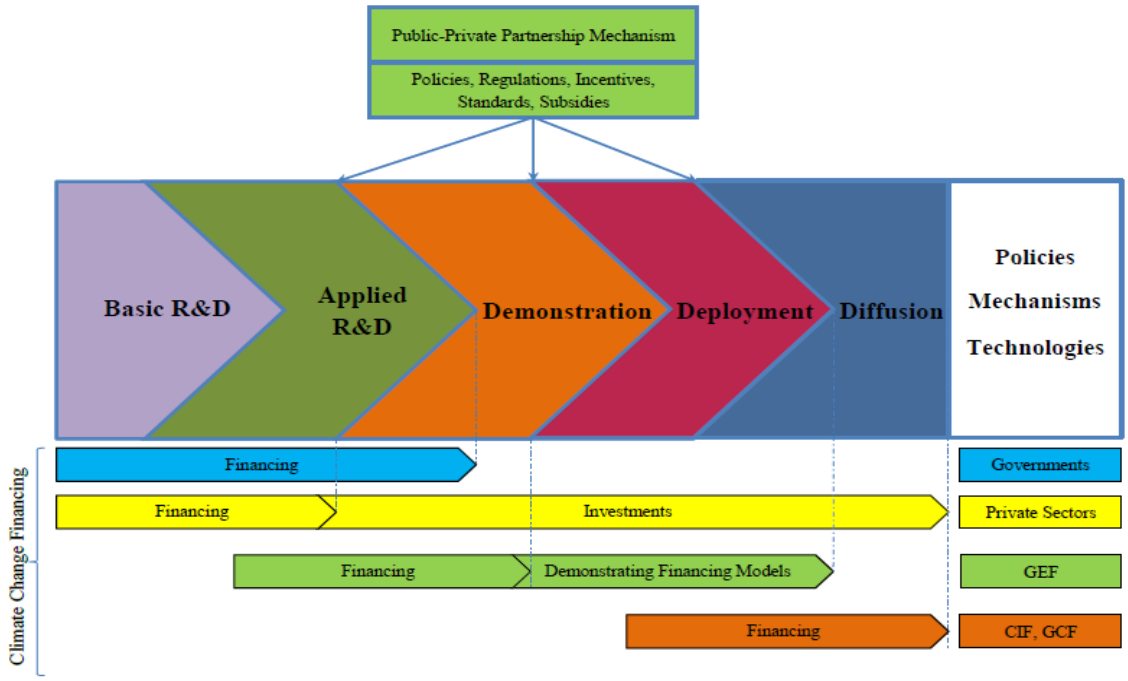
82. Next to identifying funding requirements for technology implementation, interviewees have pointed out that in TAPs and project ideas also more and **better information about potential funding sources should be included**.

83. It was considered good practice to acknowledge that **technologies in different stages of development** (*e.g*. R&D, demonstration, deployment in a market or diffusion to commercial application) **have different funding needs.** For example, while R&D and demonstration actions in a TAP may mainly rely on government funding, private sector capital (including venture capital, private equity, infrastructure fund investments[29] and debt finance through financial markets) could be appropriate for

[29] Venture capital is equity capital with a focus on relatively early stage technologies; investors are willing to accept higher risks for a relatively high internal rate of return (50 to 500%). Private equity has a stronger focus on more mature technologies with medium risk and internal rates of return of around 25%. Infrastructure funds focus mainly on infrastructural investments with long duration, steady, low risk and internal rates of return of around 15%.

technologies which are in a later stage of deployment and diffusion. Other potential sources of funding for deployment and diffusion of climate technologies are Climate Investment Funds (CIF) and the Green Climate Fund (GCF) (see Figure for an illustration).

Figure 4. Possible funding opportunities for different stages of technology development



84. With a view to supporting implementation of prioritised technologies, experts highlighted the **potential role of the GEF, MDBs and the CTCN**. For instance, TAPs and/or project ideas could possibly be submitted to the GEF as project identification forms (PIFs) which could subsequently be considered by the GEF for development of full investment proposals.

85. An important task of the CTCN is to **provide support to developing countries in conducting TNAs and enhancing the implementation of TNA outputs in the form of technology projects, programmes or strategies**. For instance, experts, in particular those with a MDB background, argued that the CTCN could help countries to find bilateral and multilateral funding sources, as well as tools and support for specific technology implementation aspects.

86. This implies that a TAP and project idea should be clear about actions needed for technology transfer within a country and characterise these in detail with identification of what kind of support is needed for TAP and project idea implementation, including 'how much?' and 'when?'. With this information, the **CTCN can select support tools and services from its portfolio**.

V. Key findings

A. Experiences, lessons and challenges related to conducting TNAs

87. TNAs conducted between 2009 and 2013 have generally followed a consistent step-wise methodological approach. Advantages of applying a consistent methodology across TNAs are that it supports countries in conducting all steps that are important for a TNA and facilitates analysis of TNA outcomes across countries.

88. Among the first tasks in a TNA is to determine its '**ownership**'. Experience has shown that most TNAs have been co-ordinated by a ministry responsible for climate change issues. A lesson from this experience is that for high-level political recognition of a TNA and relevance of its results for national

strategic planning processes, it is good practice to also involve key planning ministries, via an inter-ministerial committee with experts from these ministries.

89. For the **institutional and organisational structure** of the TNA process, experience shows that the national TNA teams usually consist of a TNA coordinator, a National TNA Committee, a National Steering Committee, sectoral/technology working groups, relevant stakeholders and national consultants.

90. TNAs are **participatory processes** and it has been good practice to involve stakeholders from various groups during each TNA step. Experience has shown that successful engagement of stakeholders adds new knowledge to the process and can enhance their familiarity with technologies for mitigation and adaptation.

91. Good practice lessons from stakeholder engagement in TNAs include:

- **Engage stakeholders from a broad range** of public and private sector organisations;
- **Form a core team of stakeholders** who are active in most TNA steps and communicate regularly with their 'wider groups' (including outreach of TNA results);
- **Actively engage high-level decision makers** in TNAs by clearly communicating TNA goals and envisaged results and how these can support high-level policy planning;
- **Actively involve financial experts** in TNAs to provide criteria for successful technology implementation and perform financial reality checks for prioritised technologies;
- Involve 'change agents' or 'champions' who can **'sell' prioritised technologies to a wider audience** within a country.

92. In most of the TNAs between 2009 and 2013, **criteria for the prioritisation of sectors and technologies** have been derived from national development priorities or from existing national strategic development plans. Generally, criteria for sector prioritisation have been of a higher-level, national nature, such as energy security, employment and environmental protection, while criteria for technology prioritisation have been more technology-specific, such as technology costs. In most TNAs, criteria were identified in consultation with stakeholders.

93. It has been a good practice to **apply the criteria for sector and technology prioritisation** in an MCDA to assess potential benefits of mitigation and adaptation measures for sectors and benefits and costs of technology options within these sectors.

94. In order to support technology prioritisation, it has become good practice to increase stakeholders' **familiarity with potential technologies** that could be considered during the technology prioritisation.

95. An important good practice lesson has been to consider benefits and costs of larger scale introduction **of a technology within a sector**, instead of at the level of a project only. As a result, the outcome of a technology prioritisation is a set of portfolios with technologies which have been prioritised based on their combined development and climate mitigation or adaptation benefits and costs within the sector context.

96. Following technology prioritisation, **TAPs and project ideas** are formulated to prepare for the implementation of priority technologies within a country. It is good practice to start the work towards TAPs and project ideas with identification of barriers to technology implementation.

97. As a next step towards TAPs and project ideas **measures to address identified barriers** are identified. Good practice TNA examples have characterised these measures and prioritised them. Possibly, when measures are common across technologies within a sector, sector-level measures for addressing barriers can be formulated. Identified measures are then included in a TAP and can be considered when formulating a project idea.

98. In the recent TNAs, more than 260 **project ideas** have been formulated. These ideas generally include information about project objectives, outputs, relationship with sustainable development priorities, project actions, timelines, budget requirements and responsibilities. Based on this experience, good practice are:

- **To formulate goals and objectives clearly** and, to the extent possible, quantitatively;
- **To describe foreseen project actions in detail** with information about project timelines and responsible organisations per action;

- **To include detailed budget information**, specifying different cost items and how to finance these.

B. Possible options for further strengthening the TNA process

99. With respect to the organisation of a TNA, the following possible improvements can be suggested:

- **Ensure stronger engagement of high-level decision makers** from key planning ministries (e.g. Finance, Economic Affairs) and financial experts;
- **Ensure that the TNA is receptive to the inputs of these stakeholders**.

100. In TNAs conducted during 2009-2013, MCDA has been a widespread decision support tool. However, TNA practitioners have also indicated that the application of MCDA has not been uniform across countries (*e.g*., different scoring and weighting techniques) and that software for MCDA was not always available or difficult to obtain. Therefore, **a more uniform approach of the MCDA tool has been recommended.**

101. **The assessment of barriers** for prioritised technologies, for inclusion in a TAP, preferably **takes place with a larger sector system or market context**, rather than focussing on a technology investment project alone. Building further on good TNA practice, these barriers would need to be identified for different technology innovation stages.

102. Such a broader, more systematic, perspective also acknowledges **that technologies are not implemented in a vacuum, but in an existing system with an enabling environment** (*e.g.* legislation, culture, behaviour, *etc*.), market actors and available supporting services (*e.g*. finance, legal support, technical support, *etc*.). For successful technology innovation a clear understanding of the system into which the technology is implemented is required.

C. Ways for enhancing the implementation of prioritised technologies

103. Most TAPs and project ideas in TNA reports between 2009 and 2013 contain insufficient information to be considered for finance and investment. For a government or investor to decide on allocation of resources for technology implementation, it needs to know clearly what **the ratio of technology benefits to costs looks like.**

104. In a TNA, this information can be derived from the technology prioritisation stage when technology benefits are assessed against environmental, social and economic criteria, while cost estimates have in several TNAs also been assessed during this stage. In a TAP, these benefits for a country can be presented to governments/investors in combination with costs of larger-scale technology implementation, including costs of measures to address barriers. Such a benefit-to-cost ratio provides an **estimate of the economic rate of return of technology implementation within a country.**

105. Linking TNAs to national development plans can be important for attracting funding for implementation of prioritised technologies. When governments announce their willingness to allocate, as part of development plans, funding for implementation of prioritised TNA technologies in combination with supporting policy instruments (*e.g*. feed-in tariffs), this could **trigger potential investors' interest in the TNA and its results.**

106. Therefore, as explained above**, early involvement of key planning ministries in TNAs can be important for implementation of TNA results**. The latter could also facilitate support from MDBs or other donors and funding sources whose counterparts in developing countries are often key planning ministries (such as Finance, Economic Affairs, Industry, Agriculture and Transport).

107. Technology implementation could also benefit from **inter-country cooperation,** beyond the current regional training support, as this could lead to better co-ordination of TNAs and requests for international support. **The CTCN could play a major advisory role in this co-ordination**, thereby supported by NDEs and MDBs.

108. **MDBs can also support technology implementation** in a number of ways, such as supporting technology demonstration projects and providing expertise for technology deployment and diffusion. In

particular, MDBs could support implementation of TNA priority technologies by offering finance provisions, expertise and knowledge for technology investments.

109. Finally, for successful implementation it is important that TNA teams, when preparing TAPs, develop a clear view on **what could be suitable funding sources for a technology,** including public and private sector funding sources, including whether funding can support technologies in an R&D, demonstration, deployment or diffusion stage.

110. Possible sources of funding to be considered are: multilateral funding (GEF, MDB, CIF, CTF, etc.), bilateral financing sources (e.g. JICA, KfW and AfD) and private funding sources (e.g. commercial banks, venture capital, private equity funds).

VI. Some issues for further consideration

A. Supporting the TNA process

111. In general, TNA practitioners interviewed for this report have been satisfied with the guidance provided by URC on organising the process, familiarising with technologies, identifying barriers, preparing reports, and identifying funding sources. At the same time, it could be considered:

- **To communicate and present good practice TNA examples** on a platform which other countries can consult when conducting a TNA themselves;
- **To provide a guidance on how a TAP and/or project idea can lead to a technology implementation**, possibly including generation of benefit-to-cost ratios which would help potential investors and governments to assess a technology's internal rate of return (as a project) or economic rate of return (as a technology innovation programme).

B. How TNAs could be supported by the Technology Mechanism and the Financial Mechanism , and possible role of TNAs for these Mechanisms

112. As indicated in this report, **implementation of TNA results can be technically supported by the CTCN, in conjunction with the role of NDEs**. For future TNAs, NDEs could potentially become important sources of information for the CTCN with respect to a country's support needs when implementing results of a TNA. An issue for further consideration, as highlighted by some interviewees, is that these **NDEs will need to have sufficient human capacity and expertize** for performing this task.

113. On the other side **TNAs and TAPs represent high quality informative tools for NDEs to fulfil their role and mandate** to act as the focal points for the CTCN in their countries, identify and promote local organizations/experts, liaise with other stakeholders to mainstream the issue of climate technologies, facilitate and monitor the implementation of CTCN assistance, (on the international level) share good practices of climate technology activities with other countries' NDEs and governments, and cooperate with regional and global stakeholders through the CTCN.

114. This report has highlighted the role of the Financial Mechanism under the Convention in supporting TNAs and implementation of their results. Especially regarding implementation of prioritised technologies, it has been suggested that **TAPs and project ideas could possibly be formulated as PIFs** for consideration by the GEF. Similarly, TNA results could be prepared as project proposals for mitigation and adaptation actions which, for example the GCF could consider for financial support.

115. Another issue for further consideration is **how TNAs can better serve as bottom-up sources of information** for the work of, among others, the GEF, and GCF. For instance, as TNAs follow a similar methodology across a wide range of developing countries, 'larger pictures' can be obtained of, *e.g*., regional technology, capacity building, and funding needs. Based on that, *e.g*., regional capacity building and funding support programmes can be formulated, which could, for instance, support the GCF and the GEF in allocating their funding resources.

C. Implementation of TNA results with the financial resources from outside the Convention

116. For future TNAs, the main challenge will be to progress towards enhanced implementation of prioritised technologies via, for example, projects and polices with short term impacts and programmes and strategies with supporting polices focusing on long term impacts. It has been suggested in this report that **TAPs and project ideas should enable potential investors and funders to screen the financial and/or economic feasibility of a technology implementation actions,** with short term, and also long term, impact.

117. For that, it can be considered that National TNA teams:

- **Receive guidance on how to present a sound proposal for a technology investment**, either at the project/programme, or at a strategy/policy level, so that governments and other potential funders can assess the benefits against the costs;
- **Involve financial experts actively throughout a TNA**, so that they can communicate criteria for financial feasibility and perform financial reality checks for prioritised technologies.