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Overcoming Barriers to the Transfer and Diffusion of Climate Technologies

UNEP RISØ CENTRE
ENERGY, CLIMATE AND SUSTAINABLE DEVELOPMENT

Overcoming Barriers to the Transfer and Diffusion of Climate Technologies

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Contents

Abbreviations

CEIT	Country with Economy in Transition
CHP	Combined Heat and Power Production Plant
CTI	Climate Technology Initiative
DCED	Donor Committee for Enterprise Development
EGTT	Expert Group on Techonology Transfer
EIT	Economies In Transition
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade, negotiated during the UN Conference on Trade and Employment
GEF	Global Environment Facility
GHG	Green House Gas
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IPCC	Intergovernmental Panel of Climate Change
IPP	Independent Power Producer
IPR	Intellectual Property Rights
LDC	Least Developed Country
MDG	Millenium Development Goals
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Action
NC	National Communication
O&M	Operation and Maintenance
PMCA	Participatory Market Chain Approach

PPA	Power Purchase Agreement
PV	Solar Photovoltaic System (Generating Electricity)
RE	Renewable Energy
R-PP	Readiness Preparation Proposal
SBSTA	Subsidiary Body for Scientific and Technological Advice
SME	Small Medium-sized Enterprises
TAP	Technology Action Plans
TNA	Technology Needs Assessment
TRIP	Trade-related Aspects of Intellectual Property (A WTO Agreement)
TTD	Technology Transfer and Diffusion
TT:CLEAR	UNFCCC Technology Information Clearing House
UNEP	United Nations Environment Programme
URC	UNEP Risø Centre
WTO	World Trade Organization

Preface

Technology Action Plans developed in the Technology Needs Assessment (TNA) project describe national policies and activities that would – if adopted – accelerate the transfer and diffusion of selected mitigation and adaptation technologies in a particular country. Good action plans must be based on a sound analysis of the barriers to technology transfer and examination of the measures that might help overcome these barriers. This publication provides guidance on how to conduct such analysis.

Although the main audience is national TNA teams and their consultants, the guidebook should be useful to anyone interested in seeing climate relevant technologies adopted more widely. Acknowledging that most technology transfer and diffusion processes take place without direct government intervention, the guidebook focuses on how governments can accelerate these processes through various policy measures. The guidebook thus aims to engage analysts and policymakers in the often messy process of technology transfer by suggesting a flexible and participatory approach, one that builds links between international experience and local stakeholder knowledge.

This guidebook is co-authored by Jørgen Boldt of Wazee Consulting, and three colleagues from the UNEP Risø Centre on Energy, Climate and Sustainable Development, Ivan Nygaard, Ulrich Elmer Hansen and Sara Trærup. Valuable comments and suggestions were provided by Catherine Smith and Mattia Vianello, both of Practical Action Consulting, and Professor B. Sudhakara Reddy of the Indira Gandhi Institute of Development Research.

This publication is part of a technical guidebook series produced by URC as part of the TNA project (http://tech-action.org). The project is funded by the Global Environment Facility (GEF) and is being implemented by UNEP and the UNEP Risø Centre in 36 developing countries.

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January 2012

Glossary

The explanations below are not necessarily universal, but are rather the connotations used for the purposes of this guidebook.

Adaptation. Short for 'climate change adaptation', meaning adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities. 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).

Capital goods. Machinery and equipment used in the production of goods, e.g., consumer goods or electricity.

Consumer goods. Goods specifically intended for the mass market.

Diffusion. The process by which a new technology is spread 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.

Goods. This word is used in a broad sense for anything which can be traded and is often referred to as goods and services.

Hardware. The tangible aspects of technology, such as equipment and products.

Incentive. Cf. 'Measure'.

Innovation. Involves both the processes of research and development and the commercialisation of the technology, including its social acceptance and adoption. However, this guidebook focuses on the later phases of innovation, not technical innovation in the sense of research and development.

Market chain. The chain of economic actors, who actually 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.

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. These guidelines do not distinguish between 'measure' and 'incentive'.[1]

Mitigation. In this publication 'mitigation' is short for 'climate change mitigation', meaning an action to decrease the concentration of greenhouse gasses, either by reducing their sources or by increasing their sinks.

Niche market. A focused, targetable portion of a market, where new technologies can benefit from learning opportunities.

Non-market goods. Goods not traded in a market.

Orgware. The institutional framework, or organisation, involved in the adoption process of a new technology.

Pathway. A channel or mechanism for the transfer and diffusion of technology.

Publicly provided good. A category of technologies, characterised by large investments, general public ownership, and production of goods and services available (free or paid) to the public or for a large group of persons. Examples are sea dikes, infrastructure such as roads and bridges, mass transport systems such as metros, and large scale hydropower.

Software. The processes associated with the production and use of the hardware, i.e., know-how (e.g., manuals and skills), experiences 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. A piece of equipment, technique, practical knowledge or skills for performing a particular activity. It is common to distinguish between three different elements of technology: the tangible aspects, such as equipment and products (hardware); the know-how, experiences and practices (software) associated with the production and use of the hardware; and the institutional framework, or organisation, involved in the transfer and diffusion of a new piece of equipment or product (orgware).

Technology transfer. Denotes the international or cross-border exchange of technological hardware artefacts, knowledge and organisational elements. Furthermore, technology transfer is understood as comprising the introduction of a new or relatively unfamiliar technological concept or practice in the recipient country.

Vulnerability. In this publication, 'vulnerability' is short for 'climate change vulnerability'. Vulnerability 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. Vulnerability is a function of the nature, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity.

Executive Summary

The target group of this guidebook is the TNA National Teams and their consultants. However, the guidebook may serve a wider audience who are engaged in addressing barriers to the transfer and diffusion of technologies. It complements the information provided in the TNA Handbook by focussing primarily on identifying barriers that hinder the transfer and diffusion of prioritised technologies and on developing measures to overcome these barriers.

The guidebook is structured in eight chapters. First, the guidebook introduces the main concepts to be used. Four generic categories are defined: consumer goods, capital goods, publicly provided goods and non-market goods. These categories are used throughout the book to ease the identification of generic barriers and measures. Thereafter, guidance is provided on how to identify and analyse barriers to the transfer and diffusion of climate technologies.

Subsequent chapters describe how to transform these barriers into measures that can be used to overcome them. The procedure builds on the assumption that an exact understanding of the rationale of the barriers, and the relations between them, can lead to a specification of the necessary measures. Following this, all four technology categories are analysed with a view to facilitating a proper understanding of the particular framework conditions for such technologies. Finally, recommendations are provided for governments to facilitate the actual diffusion of new technologies, in particular during the early and most difficult phases of diffusion when early adopters and possible niche markets play a significant role.

In addition to outlining the practical steps for undertaking barrier analysis and identifying measures to overcome the barriers, the guidebook illustrates the various approaches through case studies, covering both adaptation and mitigation examples. One such example shows how a set of complementary measures may be used to enhance impact, and how different sets of measures aimed at the same goal may have different economic and other impacts.

This guidebook has been developed as part of a large project on technology needs assessments and technology transfer. Other guidebooks for climate change mitigation and adaptation technologies have been developed in parallel. It is therefore important to stress that this guidebook is intended and applicable for concrete technologies, not for a whole sector (e.g., agriculture) or technology group (e.g., renewable energy). Given that there is no single solution to enhancing technology transfer and diffusion, policies need be tailored to country-specific context and interests. Therefore, the guidebook presents a flexible approach, identifying various assessment options and tools for analysts and decision-makers. The guidebook has been developed through an experience-based approach with feed back from national consultants and workshop participants alongside inputs from UNEP Risø Centre staff and external reviewers.

1. Introduction

1.1 Background and scope

Objectives and commitments regarding the transfer of technology exist under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The current Global Technology Needs Assessment (TNA) project (http://tech-action.org/) is designed to support 35 to 45 countries in carrying out improved TNAs within the framework of the UNFCCC. The project is being implemented in two rounds, with 15 countries engaged in the first round and another 21 to be included in the second round. In-country activities started in February 2010.

The purpose of the TNA project is to assist participant developing countries to identify and analyse priority technology needs, which can form the basis for a portfolio of projects and programmes to facilitate the transfer of, and access to, climate technologies and know-how through implementation of Article 4.5 of the UNFCCC Convention. Hence TNAs are central to the work of the Parties to the Convention on technology transfer and present an opportunity to track an evolving need for new equipment, techniques, practical knowledge and skills, which are necessary to mitigate GHG emissions and/or reduce the vulnerability of social, economic, and natural systems to the adverse impacts of climate change. The main components of the project are:

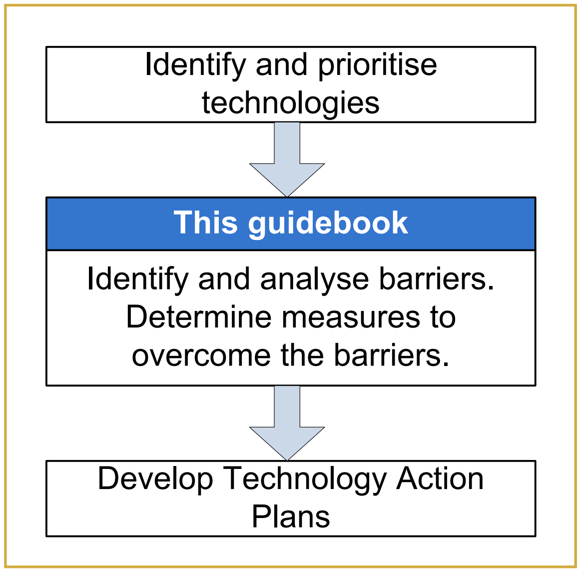
1. Through country-driven participatory processes, to identify and prioritise technologies that can contribute to the mitigation and adaptation goals of the participant countries, while meeting their national sustainable development goals and priorities.
2. To identify barriers hindering the acquisition and diffusion of prioritised technologies and to develop enabling frameworks to overcome the barriers and facilitate the transfer, adoption and diffusion of selected technologies in the participant countries.
3. To develop Technology Action Plans (TAPs) specifying a road map of activities (based on the enabling frameworks) at the sectoral and cross-cutting levels to facilitate the transfer, adoption and diffusion of selected technologies in the participant countries.

The TNA Handbook (Handbook for Conducting Technology Needs Assessment for Climate Change) was launched in 2010 by the UNDP with the aim of providing general guidelines for TNA activities.[2] The TNA Handbook provides detailed guidance on the first component, identifying and prioritising technologies, whereas the guidance on the barrier analysis and the technology action plan remains quite general.

The present guidebook is intended to enhance the level of guidance on the second component in the TNA project referred to above. The aim has been to provide practical and operational guidance on how to assess the barriers to identified technologies in the countries concerned, and on how to address and overcome these barriers. The guidebook does not provide detailed guidance on how to prepare a Technology Action Plan based on the identified and prioritised measures, which is the outcome of the current process. The TNA Handbook provides some general guidelines, and more specific guidance on

Technology Action Plans to be produced as part of the TNA project will be available on the TNA project website at www.tech-action.org

Figure 1.1: This guidebook enters the stage after the countries have selected the technologies to be transferred, and it leaves the stage again before the countries start to develop their TAPs.



While the authors hope the guidebook may serve a wider audience addressing barriers to the transfer and diffusion of technologies, the target audience is the TNA National Teams and their consultants. Therefore the guidebook adopts a pragmatic approach, taking into consideration the framework for the TNA project. It addresses the challenges in overcoming barriers to technology transfer and diffusion after a TNA Team has identified, assessed and prioritised technologies for climate change. It is important to stress that the guidebook is intended and applicable for concrete technologies, not for a whole sector (e.g., transport) or technology group (e.g., renewable energy).

As there is no pre-set answer to enhancing technology transfer and diffusion, policy actions need to be tailored to the specific context and interests. Therefore, the guidebook provides a flexible approach, identifying various options for analysts and decision-makers. The guidebook should therefore not be seen as a manual or blueprint for elaborating measures for the transfer and diffusion of technologies.

While acknowledging that most technology transfer and diffusion processes take place without government intervention, usually being driven by commercial incentives, this guidebook focuses on how governments can accelerate the transfer and diffusion of technologies by applying various policy measures. Successful government-facilitated technology transfer and diffusion may involve a combination of the processes enumerated below:

1. Identify, assess and prioritise technologies
2. Understand the economic and institutional framework
3. Identify and analyse barriers
4. Elaborate measures to overcome barriers
5. Facilitate technology transfer and diffusion

While the above list is to some extent a timeline, it should not be interpreted as such too rigidly. Some processes may be conducted in parallel, and the sequence may be altered. Also, although the overall process never stops, it needs to be repeated at regular intervals.

In spite of the programmes for the technology transfer and diffusion of mitigation technologies that governments and development organisations have drawn up during the last three decades, and despite the huge amounts of research on processes leading to the transfer and diffusion of technology, there are still essential deficiencies in the understanding of processes leading to the successful transfer and diffusion of technologies in general. While there are several examples of the transfer and diffusion of mitigation technologies, examples are relatively few for adaptation technologies. Guiding principles for the transfer and diffusion of adaptation technologies are therefore less empirically grounded than for mitigation technologies.

Against this background, it has not been possible to produce practical and operational guidance in all its aspects on how to assess the barriers to identified technologies in the countries concerned, or on how to address and overcome these barriers. So, even though the authors have attempted to synthesise pertinent information and present good learning cases, the guidebook should be considered a living document which should be amended and updated when justified by new insights.

The present guidebook should be seen as an integrated part of the TNA Guidebook Series, the Technology Transfer Perspective Series, and the Climate Techwiki (http://climatetechwiki.org/), which are products developed as supporting tools for the TNA project.

The TNA Guidebook Series
For more information on sector-specific issues, the following guidebooks are available at http://tech-action.org/

1. Technologies for Climate Change Adaptation – Coastal Erosion and Flooding
2. Technologies for Climate Change Adaptation – Water Sector
3. Technologies for Climate Change Adaptation – Agriculture Sector
4. Technologies for Climate Change Mitigation – Transport Sector
5. Technologies for Climate Change Mitigation – Crops and Livestock Management
6. Technologies for Climate Change Mitigation – Building Sector

The TNA financing guidebooks

1. Financing Options for Adaptation Project Profiles Identified in Technology Action Plans (Forthcoming)
2. Financing Mitigation Projects: Renewable Energy, Energy Efficiency, and Waste Management (Forthcoming)

Technology Transfer Perspective Series

1. Diffusion of Renewable Energy Technologies
    a. Case Studies of Enabling Frameworks in Developing Countries
2. Technologies for Adaptation
    a. Perspectives and Practical Experiences

Case studies of experiences on enabling frameworks for renewable energy technologies and practical experiences of working with technologies for adaptation are presented in the first two issues of the Technology Transfer Perspectives Series, available at http://tech-action.org/

1.2 Guidebook overview

This guidebook adds to the information provided in the TNA Handbook by focussing primarily on identifying barriers that hinder the transfer and diffusion of prioritised technologies and on developing measures to overcome these barriers. The guidebook is structured as follows.

Chapter 2 introduces the main concepts to be used in this guidebook. The central concept of technology is defined in the first section, and this is followed by a categorisation of technologies according to the goods and services they belong to or contribute to. The guidebook defines four generic categories: consumer goods, capital goods, publicly provided goods and non-market goods. These categories are used throughout the book in order to ease the identification of generic barriers and measures. The chapter continues by defining the concept of an enabling environment, and concludes by defining the concepts of technology transfer and technology diffusion.

Chapter 3 provides guiding principles for how barriers to the transfer and diffusion of climate technologies are identified and analysed. After a presentation of how the barrier analysis fits into the overall TNA process, the reader is taken through the following stepwise process: i) identify all possible barriers; ii) screen the gross list of barriers to disregard the less important ones; iii) classify the remaining key barriers into a hierarchy of categories; and iv) analyse the causal relations between barriers.

Chapter 4 continues Chapter 3 by translating the barriers into the measures to overcome the barriers. Exact understanding of the rationale of the barriers and their interrelations will indicate which measures may be necessary. The chapter is illustrated with examples of how a set of complementary measures may be used to enhance impact, and how different sets of measures achieving the same goal may have different economic and other impacts. It is therefore recommended to carry out an impact assessment of various sets of measures and to discuss the measures at the highest political level before selecting a set of measures to be included in the technology action plan.

Chapter 5 deals with technologies traded in a market place, essentially the technology categories of ‘consumer goods’ and ‘capital goods’, in order to understand properly the particular framework conditions of such technologies. This analysis may be conducted prior to or in parallel with the barrier analysis described in Chapters 3 and 4, both to support that analysis and to prepare the subsequent steps, described in Chapter 7. It is recommended to use the market mapping approach, in either a brief version or a lengthier version involving the key stakeholders.

Chapter 6 is similar to Chapter 5, but addresses the technology categories of ‘publicly provided goods’ and ‘other non-market goods’.

Chapter 7 makes recommendations for governments to facilitate the actual diffusion of new technologies, in particular during the early and most difficult phases of diffusion. It is recommended to focus on early adopters and possible niche markets as a means to kick-start the diffusion.

Chapter 8 summarises the general recommendations for the government-facilitated transfer and diffusion of climate technologies. Figure 1.2 illustrates the flow of the guidebook and the relations between the key topics. The arrows indicate the overall process from Chapter 3, through Chapter 4 to Chapter 7. Chapter 5 and Chapter 6 are side-tracks, going into more detail regarding particular technology categories. These two chapters are therefore illustrated by the long narrow boxes along the ‘main road’.

Please note that, although the process is presented as linear (from top to bottom in the diagram), it may be advisable to do some iterations (feedback loops) by returning to previous steps and possibly do amendments. As an example, while assessing and developing the measures to overcome barriers, it may be useful to have a second look at the screened list of barriers and reconsider whether some barriers that were removed from the gross list during the screening process should be included again, due to increased insight.

Figure 1.2: Structure of this guidebook and how it relates to previous and subsequent phases.

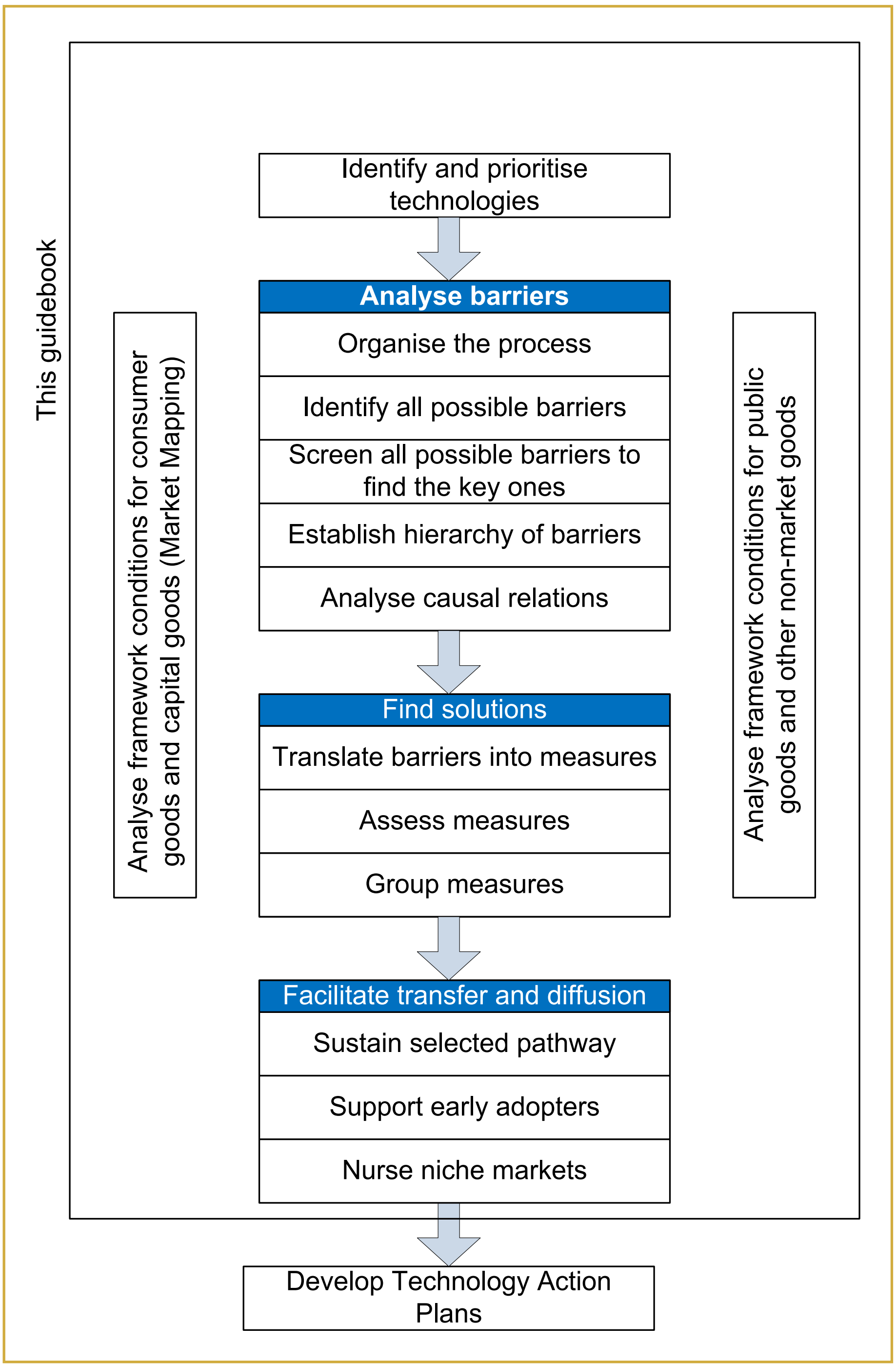


Photo: UNEP Risø Centre Photo Library

2. Understanding Technology

2.1 The technology concept

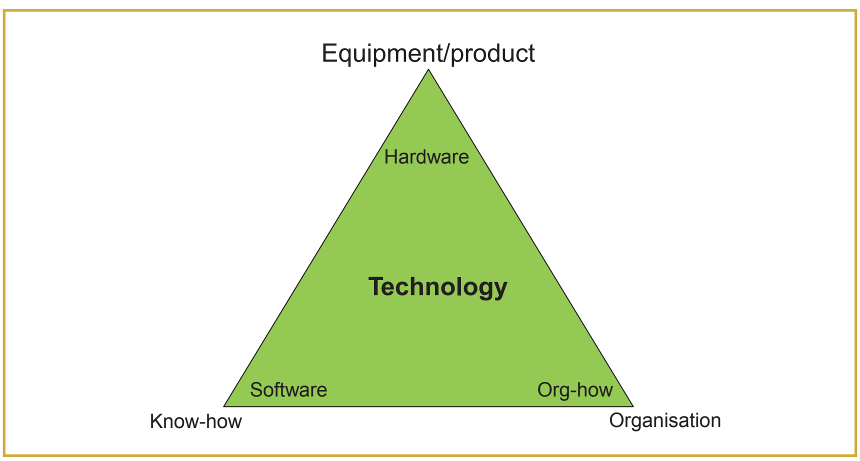
This guidebook makes use of the following definitions:

Technology is 'a piece of equipment, technique, practical knowledge or skills for performing a particular activity' (IPCC, 2000). It is common to distinguish between three different elements of technology:

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

Climate technologies are mitigation or adaptation technologies that contribute to reducing greenhouse gas emissions at the same time as they realise key development objectives, such as economic development, poverty alleviation, food and water provision, infrastructure, energy and health.

Figure 2.1: Elements of technology.



2.2 Technology categories and market characteristics

Technologies are transferred and used under different market conditions, and the barriers to their transfer and diffusion are intrinsically linked to market characteristics. To facilitate the barrier analysis, it is therefore useful to categorise technologies according to the types of goods and services they belong to or contribute to, as the different types of goods and services have distinct market characteristics. For the purposes of this guidebook, the following four generic categories will be used:[3]

Market goods:
1. consumer goods
2. capital goods

Non-market goods:
1. publicly provided goods
2. other non-market goods

In this way, technologies are not categorised according to their technical properties, but to the market characteristics under which they are transferred and diffused. As illustrated in the examples below, there will often be significant overlaps between the categories.

It is reasonable to expect that there are common features within each category as to which barriers predominate and how these particular barriers need to be addressed. It may, therefore, be instructive to distinguish the different types of goods when experience from barrier removal for one technology informs barrier removal for other technologies. Table 2.1 below provides details of the technologies that fall under each of the four categories:

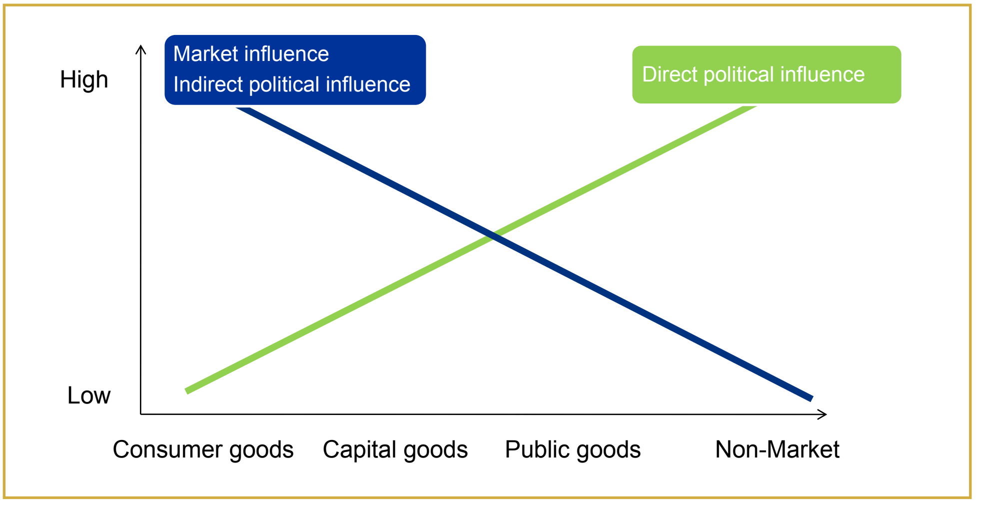
Table 2.1: Technology categories and their market characteristics.

Category	Description	Market characteristics	Technology examples
Consumer goods	Goods specifically intended for the mass market; households, businesses and institutions	– a high number of potential consumers – interaction with existing markets and requiring distribution, maintenance and installer networks in the supply chain – large and complicated supply chains with many actors, including producers, assemblers, importers, wholesalers, retailers and end consumers – barriers may exist in all steps in the supply chain – demand depends on consumer awareness and preferences and on commercial marketing and promotional efforts	Solar home systems, CFLs, energy-efficient air conditioners, drip irrigation tubes, seeds for drought-resistant crops
Capital goods	Machinery and equipment used in the production of goods, e.g., consumer goods or electricity	– a limited number of potential sites/ consumers – relatively large capital investment – simpler market chain, i.e., few or no existing technology providers – demand is profit-driven and depends on demand for the products the capital goods are used to make	Utility technologies, such as hydropower and increased water-reservoir technology, and technologies used in industrial processes, such as energy savings in agro-food industry

Category	Description	Market characteristics	Technology examples
Publicly provided goods	Technologies in this category are often (although not always) publicly owned and production of goods and services are available (free or paid) to the public or to a large group of persons	– very few sites – large investment, government/donor funding – public ownership or ownership by large companies – simple market chain; technology procured through national or international tenders – investments in large-scale technologies tend to be decided at the government level and depend heavily on existing infrastructure and policies	Sea dikes, infrastructure (roads and bridges, sewage systems), mass transport systems (metros)
Other non-market goods	Non-tradable technologies transferred and diffused under non-market conditions, whether by governments, public or non-profit institutions, international donors or NGOs	– technologies are not transferred as part of a market but within a public non-commercial domain – serves overall political objectives, such as energy saving and poverty alleviation – donor or government funding	Early warning systems for drought, seasonal forecast of rain for optimal planting, microfinance institutions, seed banks, energy saving by behavioural change

The transfer and diffusion of technologies within each of the four market categories are influenced differently by market decisions and political decisions. The diffusion of consumer goods is generally dominated by market decisions, whereas non-market goods are primarily diffused through political decisions. Government therefore has a direct influence on the diffusion of non-market goods, but only indirect influence on consumer goods. This relationship is illustrated in Figure 2.2 below.

Figure 2.2: Graphical illustration of political influence.



Schematic illustration of the level of direct and indirect political influence with respect to the four categories of technology. The categories are overlapping and should be seen as examples on a continuum from pure market to non-market.

The typology with four categories of goods is a further development of the categories suggested in the TNA Handbook (UNDP, 2010) and the ENTTRANS study.[4]

The TNA Handbook distinguishes between small-scale technologies (household and/or community level) and large-scale technologies (larger than household or community level), and again between short-term (proved to be a reliable, commercial technology in a similar market environment), medium-term (pre-commercial in that given market context; five years to full market availability) and long-term technologies (still in an R&D phase or a prototype).

ENTTRANS (2007) identified 'market forms' in its developing country case studies, one concerned with large-scale technologies, which tend to be at the national level and depend heavily on existing infrastructure and policies, and the other at the small-scale technology scale interacting with existing embedded markets and requiring distribution, maintenance and installer networks in the supply chain.

The cases studied were:

1. small-scale: biomass gasification cooking stoves, CFLs and solar thermal heating.
2. large-scale: concentrated solar power for grid or mini-grid electricity, wind turbines, energy efficiency in cement and steel industries, and large biomass- or biogas-based generation.

Chapters 5 and 6 discuss specific techniques and methods for barrier analysis related to technologies under the four types of goods. Chapter 5 focuses on commercial technologies that fall under the consumer goods and capital goods categories, while Chapter 6 looks at technologies associated with publicly provided goods and other non-market goods categories.

2.3 Enabling environment

A central concept in the present guidebook is the 'enabling environment', which is used interchangeably with the notion of an 'enabling framework' throughout the text. The enabling environment denotes the entire range of institutional, regulatory and political framework conditions that are conducive to promoting and facilitating the transfer and diffusion of technologies (IPCC, 2000). This includes the country-specific circumstances that encompass existing market and technological conditions, institutions, resources and practices, which can be subject to changes in response to government actions.

A number of elements or arenas of political influence in combination may be distinguished as comprising the notion of a larger enabling environment. These elements can be categorised as shown in Table 2.2 below, which depicts the main areas that governments can influence directly or indirectly in order to modify the framework conditions to promote technology transfer and diffusion. Although there are equally important circumstances pertaining to the enabling environment of the technology originator country, the main focus in the present guidebook is the enabling environment of the host (or technology recipient) country.

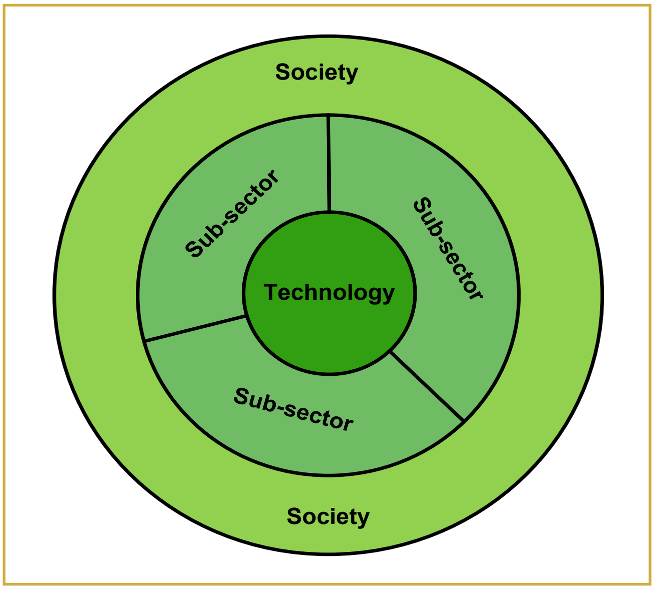
Table 2.2: Elements of enabling environments for transfer and diffusion of technologies.

Enabling environment elements	Relevant government policies (examples of areas of influence)	Barriers addressed (examples)
National macroeconomic conditions	– Trade policies and laws – Tax, subsidies, and tariff regime policies – Regulation of financial sector institutions – Public investment policies – Commercial law and practices	– Lack of adequate financing options e.g., 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	– Capability building programmes of governmental agencies and institutions – Initiatives to efficiency in government procedures and processes – Promotion of industry associations, networks, organisations and alliances	– Lack of functioning legal institutions – Lack of coordination between governmental agencies – Lack of stakeholder/community participation in technology choices – Lack of 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 programs) – Monitoring capacity enhancement programmes – Property rights regimes policies	– Lack of technology nurturing sites – Limited capacity to install, implement, operate and maintain technology – Insufficient specialised expertise in technology, practice, or organisational system – Lack of institutions or initiatives to set standards
Social and cultural	– Information dissemination, outreach and awareness-raising campaigns – Targeted assistance to promote early adopters and technology front runners – Promotion of public–private partnerships – Education policies	– Limited awareness, trust, or acceptance in the suitability/reliability of the technology – Aesthetic considerations of users to technology (e.g., products lack appeal) – Community resistance to technology or practice – Tradition, social esteem, pride, laziness and religious belief discouraging technology adoption

Sources: Painuly (2001), Painuly and Fenhann (2002), Beck and Martinot (2004) and Philibert (2006).

It follows from the table above that some areas of an enabling environment are more relevant or influential in promoting the transfer and diffusion of particular technologies. The issues of direct and indirect political influence are addressed more specifically in sections 5.8 and 6.4 regarding enabling environments for market goods and non-market goods. The concept of an enabling environment is illustrated graphically in Figure 2.3. below. The figure illustrates that an enabling framework can target the different levels: the society level, the sector level and the technology level. If, for example, the balance between imported and domestic technologies is in focus, pertinent policies may be implemented through general duties and taxes at the society level. If, on the other hand, the focus is the promotion of a particular technology, such as wind turbines, a policy instrument could be a feed-in tariff for electricity produced by wind turbines.

Figure 2.3: Various target levels of an enabling environment.



2.4 Technology transfer and diffusion

This guidebook uses the concept of technology transfer as 'the international or cross-border exchange of one or more of the technological hardware artefacts, knowledge, and organisational elements'. Furthermore, technology transfer is understood as comprising the introduction of a new or relatively unfamiliar technological concept or practice in the recipient country. Although such technological flows have conventionally been conceptualised as mainly North-South, the importance of South-South technology transfers has become increasingly apparent under the continuing processes of globalisation.

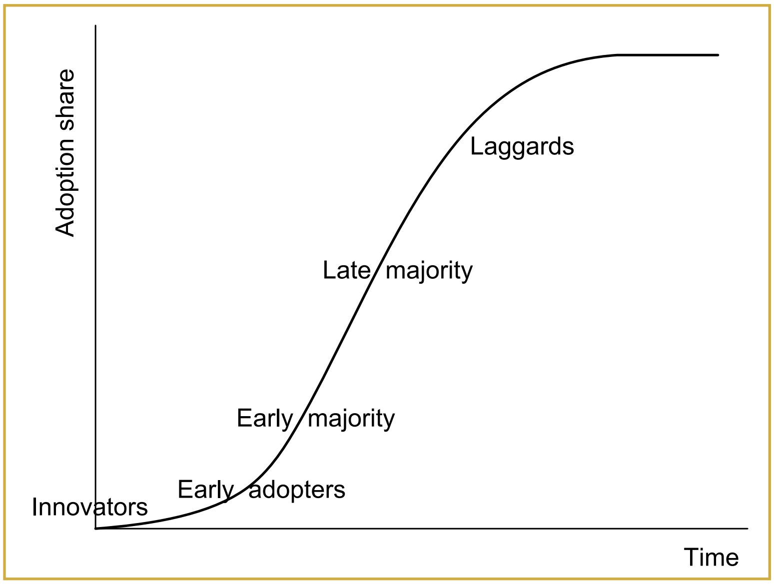
In contrast to that, 'technology diffusion' denotes the dissemination or uptake of specific technologies, e.g., wind turbines, hydropower plants, monitoring systems, or agricultural practices in a national context. Thus, technology diffusion comprises the process by which a new technology is spread through 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.).[5] Like technology transfer, the diffusion concept also applies to technological 'hardware', 'software' and 'orgware' elements.

However, it is clear that such conceptual categorisations may be problematic, for example, regarding large countries such as China or India, where the flow of technology and knowledge between sub-national states may be categorised more appropriately as technology transfer.[6] It may also be difficult in some cases to distinguish technology transfer from diffusion in cases where a new technology is gradually introduced and thus becomes increasingly familiar, characterised by a gradual uptake in a given country. Still, it may be useful to separate the two concepts to provide clarity and simplicity in addressing the complex issues at hand.

Moreover, technologies may be at different stages in the technology innovation cycle, i.e., the basic research and R&D, demonstration, deployment and replication, and diffusion stages (see e.g., the TNA Handbook for more details). Here, it should be mentioned that technologies at the later stage of the innovation cycle, i.e., commercially mature technologies or well-proven practices, are the main focus of the present guidebook.

Diffusion processes generally follow an S-shaped curve, as in Figure 2.4. Diffusion is seen as different stages of consumers' adoption classified as innovators (first to adopt), early adopters, early majority, late majority and laggards (last to adopt) according to the time of adoption since the technology is first introduced.[7]

Figure 2.4: The S curve of technology diffusion.



Rogers, 1962

For government-facilitated diffusion, there may be a political desire to obtain diffusion within a very short time, e.g., 60% adoption in five years. However, rapid diffusion may not be feasible from an economic point of view. If, for example, the aim is to replace existing long-life goods like refrigerators or power plants, it may involve extra costs to install a new technology, before the old ones have worn out.

It is during the initial phase of diffusion, sometimes referred to as 'take-off' (the main actors are innovators and early adopters), that the reliability, practicality and financial feasibility of the technology is demonstrated. This is a very difficult and critical phase. Despite being demonstrated and used abroad, local customers may not trust the solution, as it has not been demonstrated locally under the specific local conditions. How to start diffusion therefore needs special attention.

Photo: UNEP Risø Centre Photo Library

3. Identifying and Analysing Barriers

This chapter provides guiding principles for the identification and analysis of barriers to the transfer and diffusion of climate technologies (both market goods and non-market goods) in order to establish a sufficient basis for developing measures to overcome them.

Identifying barriers can be understood as tracing the reasons that hinder the transfer and diffusion of technologies. This includes the identification of any failed or missing measures that could have sustained the diffusion. The primary task is to understand the nature of the individual barriers, relationships between barriers, determine which barriers are important, and identify barriers that are easiest to remove. Barriers that are beyond the control of a country (e.g., rivers running dry for eight months in the year, global oil prices, EU trade barriers) will be acknowledged and taken into account, but should not be subject to further analysis, as they are not amenable to any policy action by the country concerned.

Just as a correct medical diagnosis is the key to determining the right cure, a thorough understanding of the barriers to the transfer and diffusion of climate technologies is the key to designing the appropriate portfolio of measures to overcome them. Barrier analysis is not an exact science, and a thorough understanding of the barriers may often be achieved by applying different approaches, or by combining the most appropriate elements of various approaches, as described in this chapter. This can help in focussing on the root causes of the barriers rather than just the symptoms.

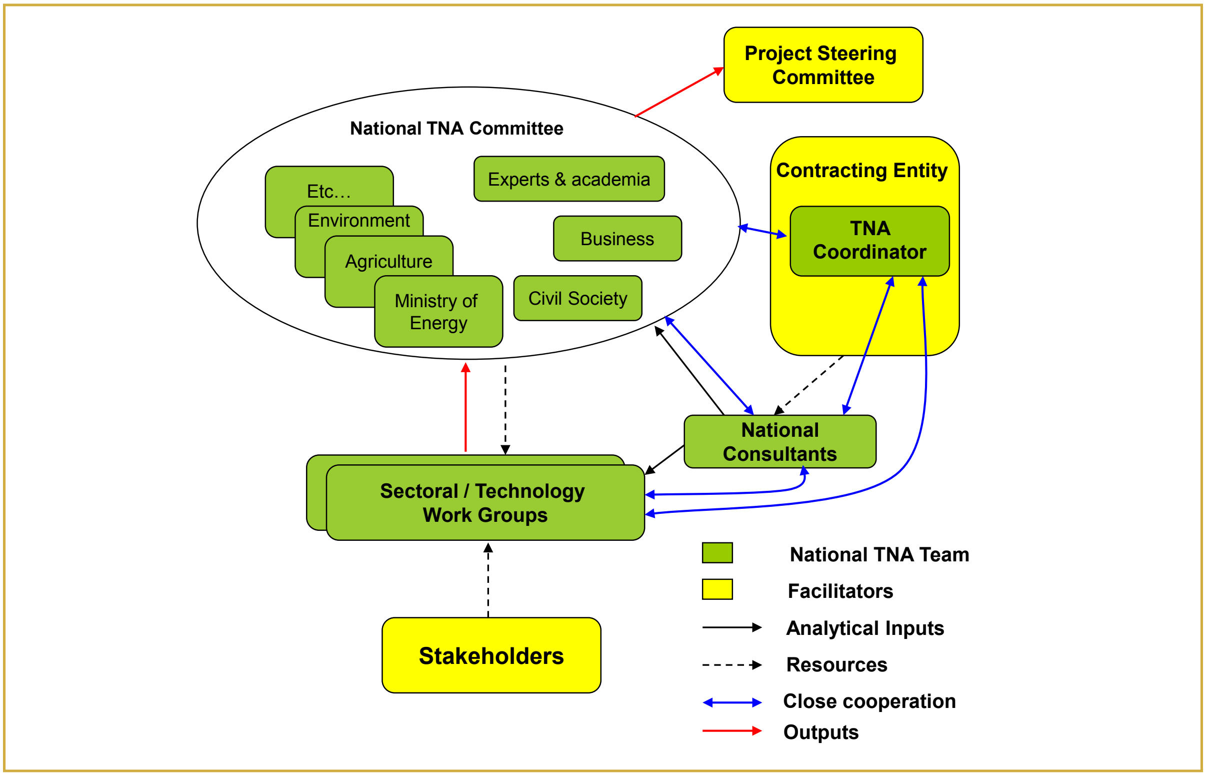
Main steps in identifying and analysing barriers and in developing measures to overcome them:

1. Organise the process; Section 3.1
2. Identify all possible barriers through literature survey, interviews and/or workshop brainstorms; Section 3.2
3. Screen the gross list of barriers to select the most essential ones; Section 3.3
4. Classify the selected essential barriers into a hierarchy of categories; Section 3.4
5. Analyse the causal relations between barriers; Section 3.5
6. Develop measures to overcome barriers by translating barriers into solutions; Section 4.2
7. Assess the costs and benefits of measures to determine whether they comply with policy objectives; Section 4.3
8. Select sets of complementary measures to include in programmes Section 4.4

3.1 Organising the process

A common institutional arrangement for a TNA project is described in 'Organising the National TNA Process: An Explanatory Note'.[8] The proposed institutional arrangement is illustrated in Figure 3.1.

Figure 3.1: TNA project: institutional arrangements.



In the TNA project, barrier identification and analysis should be conducted for a few selected technologies for each sector (approximately 4–8 mitigation technologies and 4–8 adaptation technologies). In most cases, these technologies have been selected by the sectoral working group through a multi-criteria analysis facilitated by the national consultant. The sectoral working group constituted by the TNA committee may include representatives from government departments with responsibility for policy formulation and regulation, private- and public-sector industries, electric utilities and regulators, technology suppliers, finance, technology end-users (e.g., households, small business, farmers, technology experts from universities and consultants) and others (international organisations, donors).

Identifying barriers and the measures to overcome them constitutes a new phase of the project, in which the consultant may again work in close cooperation with the sectoral working groups. In some cases, the consultant and the TNA team may decide to form specific technology groups, consisting of representatives from the sectoral working groups with specific knowledge of the technologies in question. In order to build up trust and continuity, it is important that the groups remain the same throughout the process, from barrier analysis to identification and proposing measures for the action plan. For some elements of the barrier analysis, e.g., the ‘market mapping’ technique, it may be necessary to include stakeholders that are direct actors in the market chain.

3.2 Identification of barriers

An initial step in the process is to conduct a desk study of policy papers and other pertinent documents to identify the primary reasons why the technology is not currently in widespread use, and why neither the private nor public sectors have invested significantly in it. Especially proper economic assessments of the selected technologies should be included in the desk study, but possibly also other relevant assessments, e.g., environmental impact and institutional capacity. Most such information is likely to be available already, either from the technology selection process or from other studies, and the information may add essential value to understanding the significance of individual barriers. Relevant case studies are also important. The desk study is carried out by the TNA consultant. This should, preferably, be supplemented by site visits and interviews with experts and stakeholders. Another option for obtaining the latter's views is to use questionnaires (cf. Annex E).

Under ideal conditions, a solid participatory approach is recommended, including workshops with the technology working groups. However, this guidebook is primarily designed for the scope and the budget of the 'TNA project', and therefore some short-circuits may be necessary. Since proper stakeholder participation can be time-consuming and costly, this is where the TNA Committee may decide to opt for cheaper and quicker approaches.

Also, the TNA Committee needs to consider carefully the usefulness of workshops. The number of stakeholders may be too large, or several of the key stakeholders may be high-level people (like permanent secretaries), who cannot or will not take one or two days out of their busy schedules. Under such circumstances, the risk is that the workshop outcome may become biased, incomprehensive or inconclusive. To support the Committee in obtaining a balanced position on the issue of participation, Cooke (2001) may be consulted. Nevertheless, a TNA Committee may have access to additional funds and may wish to conduct a thorough participatory process. For more information on participatory processes, see Chambers (1997), Chambers (2005), Kothari (2001), Hildyard (2001) and Rocheleau (1995).

Facilitating a participatory process requires skilled facilitators. A facilitator network such as the SEEP (Small Enterprise Education and Promotion) Network may be contacted[9] or, alternatively, the useful hints on good facilitation produced by the Market Facilitation Initiative (MaFI),[10] a joint venture between the SEEP Network and the Livelihoods Network, may be consulted.

The workshop facilitator may choose to start the workshop by using brain-storming as a means of identifying barriers. Common practice in brain-storming is that every proposal or idea is recorded. Participants are not allowed to suggest that any proposal be removed from consideration or ignored at this stage.

However, based on the preparatory work, the Consultant may find it useful to organise the barrier identification in separate sessions (possibly dividing the participants into different work groups), each with a particular focus on certain types of barriers. For this purpose, barriers can be categorised in various ways. Typical categories are:

1. **Economic and financial:** lack of access to finance, high cost of capital, financially not viable, inappropriate incentives
2. **Market failures:** poor market infrastructure, uneven playing field, inadequate sources of increasing returns, market control by incumbents
3. **Policy, legal and regulatory:** insufficient legal framework, highly controlled sector, clash of interests, political instability, bureaucracy, rent-seeking behaviour
4. **Network failures:** weak connectivity between actors, incumbent networks being favoured
5. **Institutional and organisational capacity:** lack of professional institutions, limited institutional capacity
6. **Human skills:** inadequate training, lack of skilled personnel

7. **Social, cultural and behavioural:** consumer preferences and social biases, traditions, dispersed settlements
8. **Information and awareness:** inadequate information, missing feedback, lack of awareness
9. **Technical:** uneven technical competition, lack of standards and codes, lack of operation and maintenance (O&M), unreliable product
10. **Other:** environmental impacts, lack of physical infrastructure

For technologies which are expected to be diffused in large numbers under market conditions, the market mapping technique, described in Chapter 5, may be used to identify market barriers more systematically, while for technologies such as coastal protection and large-scale hydropower, which require political decisions at a high level, barriers should be identified mainly based on the insights provided by the technology working groups. The categorisation of technologies according to their market characteristics was further described in Section 2.2.

Valid ideas may be obtained from studying generic barriers (as in Annex A). The list of generic barriers may be useful in ensuring that important barriers are not missed during the identification. Furthermore, project reports from similar implementers may add value. However, in order not to shadow stakeholders' own thinking, such information should not be presented early in the process, but rather provide food for second thoughts.

How to identify barriers:

1. Study recent policy papers, feasibility analyses, case studies etc.
2. Expert and stakeholder interviews, direct or through questionnaires (optional)
3. Workshop brainstorming by technology working groups
4. Compare with check list

Some barriers are common to all countries, regardless of size or type of technology, but there are also differences regarding the occurrence and importance of barriers under different economies. Furthermore, barriers may differ according to 'who' is transferring and/or diffusing the technology. The interests and perspectives of small local diffusers are often quite different from those of a large foreign company that is looking to expand its market in a developing country. Therefore, the actual and conceived barriers can also be very different for the two types of stakeholder. Thus, depending on the resources available for the barrier analysis, a thorough stakeholder analysis can add much value to the exercise (cf. section 5.6 for more details on stakeholder analyses).

From case studies in Chile, China, Israel, Kenya and Thailand, the ENTTRANS project (2007) found generic variations between small-scale and large-scale CDM technologies.[11] For a large-scale electricity-producing technology, the market chain (cf. sections 5.2 and 5.7) ends with the utilities and distribution companies, which already have their distribution networks in place.

There is a greater range of stakeholders involved in the market chain for small-scale technologies, and though the enabling environment is important, there is also an emphasis on the support services. The main differences compared to large-scale technologies are in the need for retailers, sales agents, promoters, installers, service agents and wholesalers. This is the network needed to reach the much larger range of end-users or customers who have to be motivated to buy and use the new small-scale product. It therefore seems clear that the adoption of small-scale technology will need either an interface to an existing network in order to reach customers, or the creation of such a network and interface to it. Programmes involving small-scale projects intended for transfer must ensure that this aspect is built into the programme design.

3.3 Screening barriers

Barrier identification (Section 3.2) results in a long list of barriers gleaned from various documents, interviews and/or the open-minded and non-selective recording of all ideas suggested by workshop participants.

When all conceivable barriers have been identified, the barriers need to be screened according to their significance. Workshop participants may now argue for and against the listed barriers to reach agreement by consensus or majority. Most important is to identify the essential barriers, i.e., barriers which definitely need be addressed for technology transfer and diffusion to occur, and the non-essential barriers, which are to be discarded and subsequently ignored. A simple screening may sort the long list of barriers into key and non-key barriers, thus keeping the objective in focus, namely the transfer and diffusion of a given technology.

Alternatively, the barriers can be screened through voting. All barriers are entered in random order, and each workshop participant is asked to give each barrier a mark, e.g., from 1 to 5, according to how important the barrier is from the participant's own perspective. The barriers are then ranked after adding up all the marks. Prior to the voting, the workshop participants may decide to delete, for example, the bottom third of the ranked barrier list.

Later in the process, when a more comprehensive understanding has been obtained, it may be useful to check the list of non-key barriers and assess whether some of them should be re-classified as key barriers.

It may be useful to apply more screening categories such as: killer (non-starter), crucial, important, less important, insignificant (easy starter). Changing WTO regulations is an example of a non-starter, since it is an extremely cumbersome and long-term challenge, if not impossible from the perspective of a single government.

Barriers may also be sorted according to who has the power to do something about it and who is driving change: e.g., the national government, local authorities or power utilities. However, this can wait until the measures to overcome barriers have been developed (cf. Chapter 4).

3.4 Decomposition

An initial analysis of the barriers that remain after screening can be conducted by discussing whether some barriers are actually composed of some of the other barriers, or whether one barrier is just a more concrete formulation of an overall barrier category.

Painuly (2001) has suggested decomposing barriers at four levels:

1. broad categories of barriers (e.g., economic and financial)
2. barriers within a category (e.g., high cost of capital)
3. elements of barriers (e.g., high interest rate)
4. dimensions of barrier elements (e.g., an interest rate of 15% per annum for households)

Level 1 may have been done already by the TNA consultant, as part of the preparation for the barrier identification; cf. section 3.2.

To conclude whether a barrier or a barrier category is relevant or not, the presence of at least one of its components at a lower level is necessary. Otherwise, the barrier may be more imaginary than real. Thus, this exercise may lead to further removals of barriers from the list that remains from the screening process. Figure 3.2 illustrates decomposition of barriers for a technology.

Example: Mini-hydropower plants
A number of barriers to the further development of mini-hydropower have been identified, e.g., through workshop brainstorming. In random order, the barriers are (numbers are for reference only):

1. Inadequate access to financial resources
2. High cost of capital
3. No comprehensive and strategic energy policy
4. Insufficient institutional framework
5. Insufficient capacity in Ministry of Energy
6. Energy needs of rural population not addressed
7. Insufficient skilled manpower
8. Disincentives to foreign investment
9. Rivers running dry
10. Low electricity tariff
11. Theft of spare parts
12. Lack of rural development policy
13. Lack of forestry policy
14. Monopolistic utility
15. Discrimination against independent power producers
16. Conflicting legislation

Having completed the barrier identification, participants are now invited to argue the relevance of each proposed barrier. After some discussion, consensus is reached that barriers 11, 12, and 13 may be removed from the list (screened out). If consensus is not possible, secret voting may be used, cf. text above.

Furthermore, the workshop facilitator suggests that no. 9 be disregarded, since nobody can influence the weather. This is accepted by the participants.

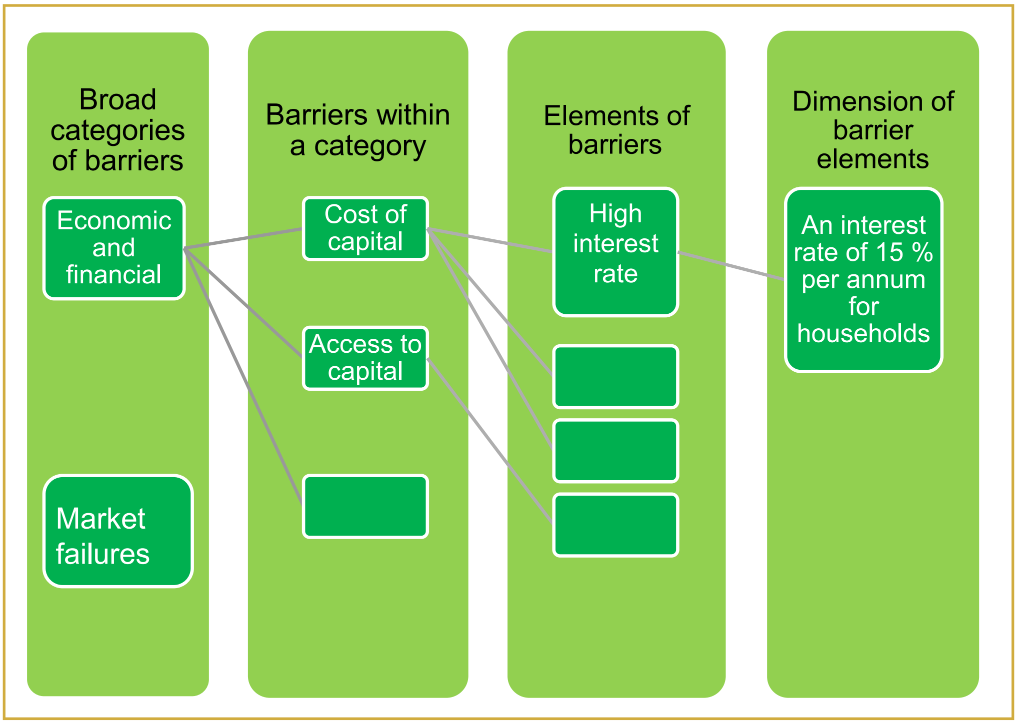
Thus the original list of 16 barriers has been reduced to 12 barriers.

Later in the process, when solutions to overcome the barriers have been addressed, the workshop realises that some mini-hydropower plants may be established by stakeholders operating in rural areas (e.g., local companies and foreign investors). Barrier no. 12 is therefore reinserted in the list.

The workshop may decide to rank the barriers, e.g., through voting. The result is that barriers 3 and 5 are found most important. A further discussion of these two barriers reveals new barriers, essentially causes of the two barriers, e.g., 'Insufficient budget' and 'Limited experience in Ministry of Energy with mini-hydro and rural electrification'. This, in turn, brings a new stakeholder into the picture, the Ministry of Finance.

One advantage of decomposing a barrier is that it clarifies the reasons why a barrier exists and makes it easier for stakeholders to comprehend its significance. Another advantage is that appropriate measures to overcome a barrier may be identified more easily, when there is a more exact and detailed description of the barrier.

Figure 3.2: Decomposition of barriers: an example.



The summaries of proper financial and other assessments of the selected technologies made available by the consultant before the barrier identification process (cf. section 3.2) are also of great value for the decomposition process. As an example, a feasibility analysis usually illustrates the cost of capital, and in particular why the cost may be considered too high for potential investors. Thus decomposing the barrier ‘Cost of capital’ into its barrier elements and further into their dimensions may be easily deduced from the feasibility report.

Annex A presents a detailed list of generic barriers for climate technologies.

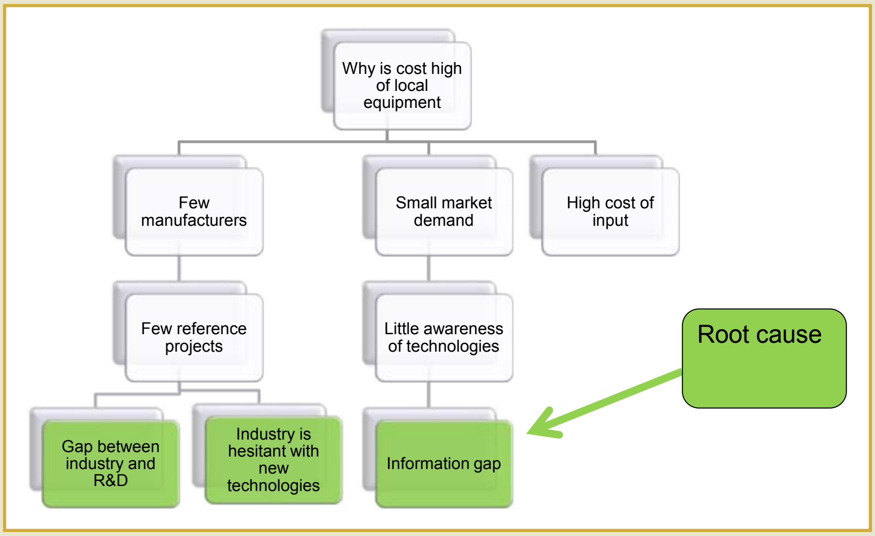
3.5 Causal relations

The decomposition of barriers gives some insight into how they are related. This can be taken one step further by analysing the causal relations between them. Problems are often masked for a variety of reasons. Instead of wasting time and resources alleviating the immediately obvious symptoms of problems, an understanding of the ‘true’ problems is needed before action can be taken.

Root cause analysis is a method of reaching a deeper understanding of a problem. By directing corrective measures at the root causes, it is commonly believed that the likelihood of problem recurrence will be minimised. However, it is recognised that the complete prevention of recurrence by a single intervention is not always possible. Basically, root cause analysis asks why a problem occurs, and then continues to ask why it does so until the fundamental problem is reached. Often the root problem is an opportunity, as it also contains information on how to eliminate or reduce it.

Example: Root cause analysis
Problem: 'high costs of local equipment'.

1. Why is the cost high? Because there are 'few local manufacturers'.
2. Why are there few local manufacturers? Because there are 'few good reference projects'.
3. Why are there few reference projects? Because there is 'a gap between industry and R&D' and because 'industry is hesitant with new technologies'.
4. If there is no immediate answer to why there is a gap between industry and R&D and why industry is hesitant, then these two problems are the root causes of the problem 'high costs of local equipment'.



There may be other answers to the first question, why is the cost high? For example 'low market demand' and 'high cost of inputs'. Each of these explanations is then questioned, e.g.:

1. Why is market demand low? Because there is 'little awareness of technologies'.
2. Why little awareness? Because of an 'information gap' (existing information on new technologies does not reach potential customers).
3. Then the 'information gap' is also a root cause of the problem of 'high costs of local equipment'.

Logical Problem Analysis (LPA) is another tool for analysing causal relations. It is a discussion and analysis technique, which enables a group of stakeholders to approach and delimit a problem area. LPA method is a standard systematic design approach used by a large number of donors. Since this method is also generally well known among key stakeholders in most developing countries, it facilitates critical assessment both within the stakeholder community and subsequently by potential donors. LPA is part of the Logical Framework Approach or LFA (Norad, 1999; AusAid, 2005). The main aim of the LPA is to arrange observed or alleged problems into a hierarchy of causes and effects as a basis for preparing a concrete and realistic action plan. Each problem is linked to causes and effects, with direct causes below and direct effects above, so that multi-level cause-and-effect paths are created to form a 'tree' known as the problem tree or the causal factor tree.

Figures 3.3 and 3.4 show a simple problem tree. All problems are arranged around a starter problem. A starter problem is a problem considered by the group of stakeholders to be at the heart of the problem area. The starter problem is often a very generic or overriding problem. It is usually the first problem that comes to mind when asking the fundamental question, as in Figure 3.3: Why do we have so few solar photovoltaic (PV) systems in our country?

Figure 3.3: Simplified example of a problem tree: solar photovoltaic (PV) systems.

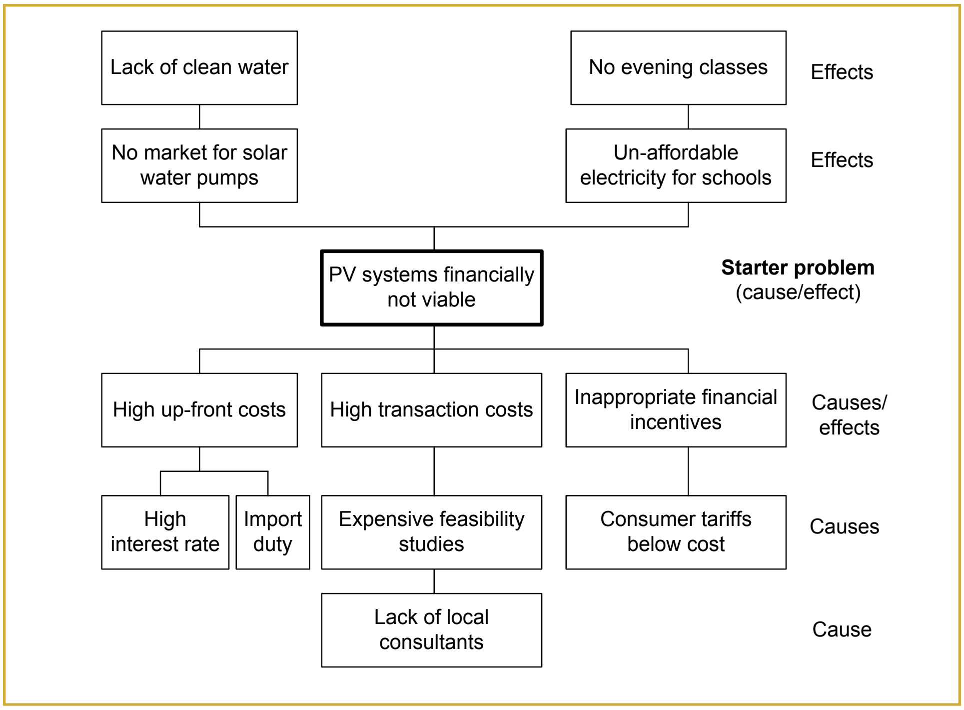
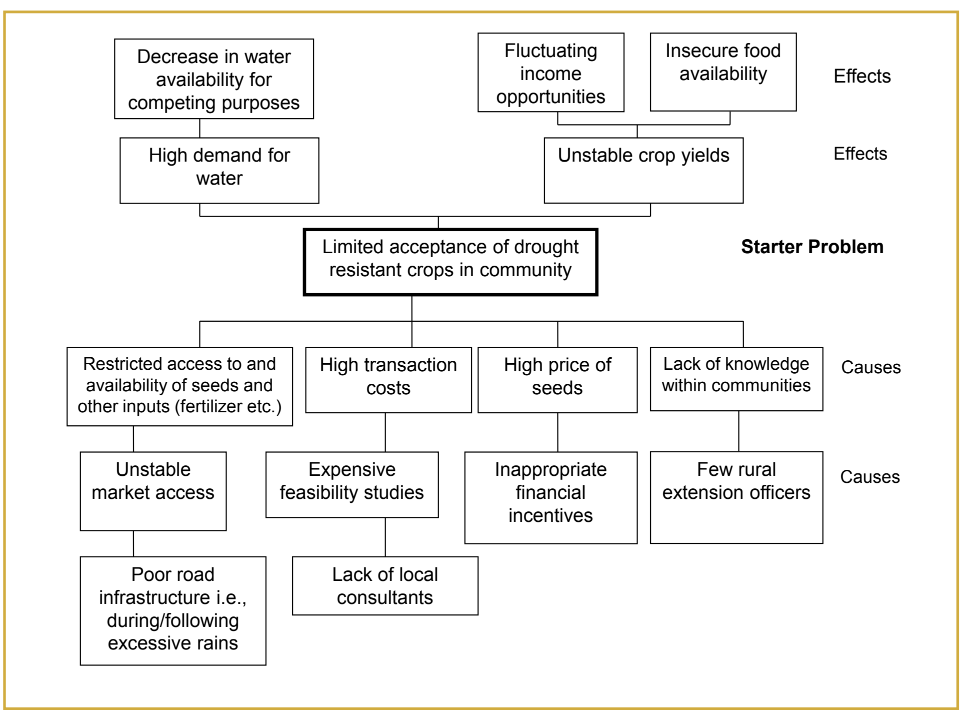


Figure 3.4: Simplified example of a problem tree: drought resistant crops



The problem tree should include all barriers selected by the screening process. In the simplified example shown above, a high import duty is a barrier to imported products and a means to protect local products. The example hence illustrates that a problem for some stakeholders may be a solution for others. Therefore, it is often useful to attach notes to the problem tree to clarify such ambiguities. Also, this problem tree may be expanded to include separate causal streams for imported and local products.

All identified problems are ordered in a hierarchy of cause-effect relations (strings), with the starter problem in the centre, the direct causes below it and the direct effects above. Each new problem will be linked to causes and effects respectively, so that multi-level cause-effect paths are created to form the problem tree.

The problems situated at the bottom of the tree are called root problems or root barriers. Removal of a root barrier may delete or reduce effect barriers, although not necessarily automatically. For example, removal of the import duty will reduce the barrier of 'high up-front costs', which may or may not be sufficient to make PV systems financially viable in some market segments.

Removal of the 'import duty' plus an essentially lower interest rate should lower the up-front costs, which would make PV systems financially viable in at least one of the two market segments included in the tree (water pumps and schools). If this is not the case, the tree needs be re-designed, since it should only include barriers which can be overcome.

The major advantages of the LPA are that it:

1. ensures that fundamental questions are asked and weaknesses analysed
2. brings together in one place all the key elements of a problem
3. guides systematic and logical analysis of the inter-related key elements
4. highlights linkages between problem elements and external factors

Bearing these advantages in mind as key objectives of the exercise, one should not exaggerate the fine-tuning of details in the problem tree.

The LPA should be carried out as a participatory process involving representatives of all key stakeholders. For practical and economic reasons, the identification of barriers (cf. Chapter 4) and the analysis should therefore be conducted as a single coherent process, i.e., by convening only one workshop, which may last more than one day. However, if the barrier identification has been thorough and all essential stakeholders have been successfully involved, and if resources and time are short, the TNA team or a consultant may conduct the barrier analysis. In this case the team may wish to circulate the results to the stakeholders for comments, both to ensure quality and to safe-guard the spirit of cooperation among the latter.

3.6 Summary

This chapter has provided guiding principles on how barriers to the transfer and diffusion of climate technologies can be identified and analysed using a stepwise process. The description comprises how to organise the process, how to identify all possible barriers, how to screen and select the most important barriers and how to decompose the barriers and make them more specific. The description further includes guidance on how to establish a hierarchy of barriers and finally how to use LFA more systematically to analyse causal relations. The next chapter takes over from here by translating the barriers into the measures to overcome the barriers. This is based on the concept that an exact understanding of the logic of the barriers and their relationships will lead to conclusions about which measures are required. The contents of this and the next chapter are indicated by the red ellipse in the figure below.

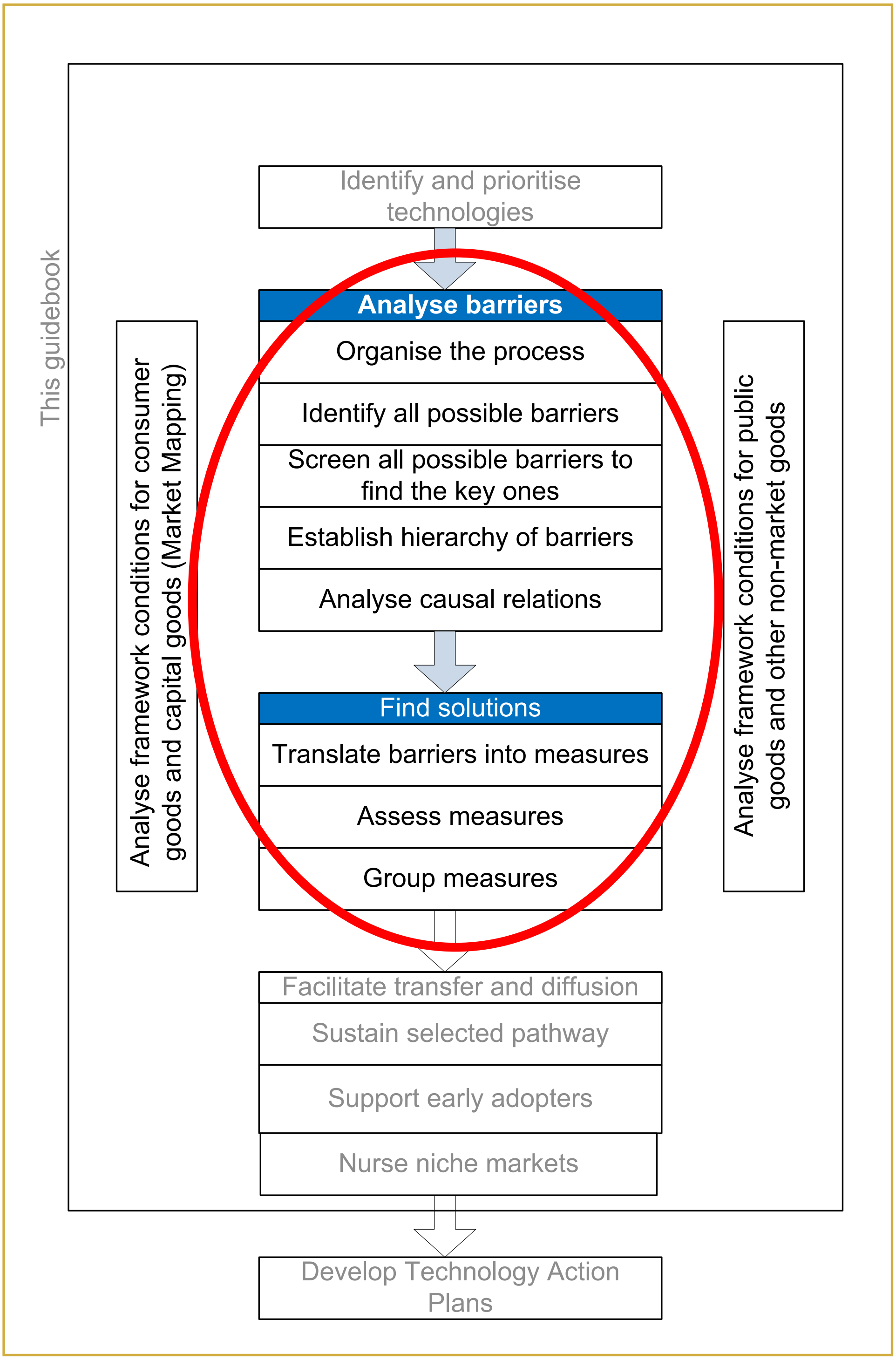


Photo: UNEP Risø Centre Photo Library

4. Measures to Overcome Barriers

Having established a thorough understanding of the barriers (the diagnosis), the next step is for the TNA Committee to analyse how the barriers can be removed or overcome (the cure). The guiding principles presented here are valid for both market goods and non-market goods.

In this guidebook, 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. In the literature, the word 'incentive' is often used synonymously, or sometimes with a slightly different interpretation. However, these guidelines do not distinguish between 'measure' and 'incentive'.

It can be quite useful to distinguish between policy goals and measures. As an example, policy statements or goals like 'the Government will increase rural people's access to electricity' are frequently found in national action plans and programmes, while a proposed measure to fulfil this objective is inter alia '10,000 new solar home systems to remote villages before 2015'. On the face of it, this appears to be a very concrete goal, but it remains an 'empty' goal until concrete measures are proposed on how to reach it, for example, subsidies to ensure or facilitate implementation.

The analyst may also wish to consider existing disincentives. A disincentive is often an incentive for a competing action, e.g., a fossil fuel subsidy, usually introduced to increase the affordability of fossil fuels, is a typical disincentive for renewable energy.

4.1 The process of identifying measures

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

1. The TNA Consultant's own experience, supplemented by documented experience on policy measures from other countries, would in general be a very important input into this process. The consultant should therefore be well prepared for the workshop. There is considerable sector-specific information available on the web, published by various development institutions, including the World Bank. To provide examples for the present guidebook, UNEP Risø Centre has dedicated an issue of the Technology Transfer Perspectives Series (Haselip et al, 2011) to providing case studies of enabling frameworks for renewable energy technologies in various developing countries.[12]
2. Measures already touched on during the barrier analysis may be another important input. Although barrier analysis and the identification of measures are in theory distinct processes, practice shows that it is difficult for participants to think of barriers without at the same time thinking of measures or solutions. Although measures are not part of the barrier analysis, it may be practical to take notes, which can be used as input to the identification of measures. The H diagram, further described in

the TNA Handbook, may be used to identify what is good or bad about the existing system. This can lead to a discussion among stakeholders of what can be done about barriers.

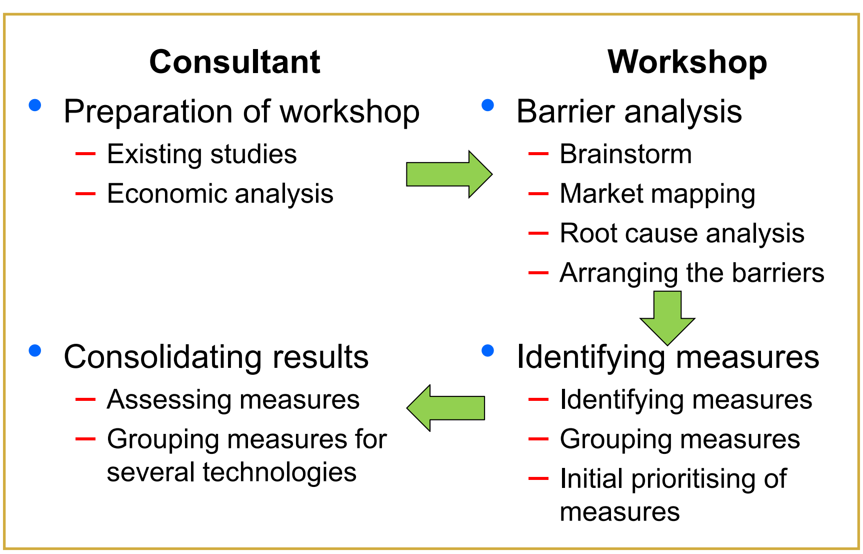
3. In the case of technologies for consumer goods and capital goods, the market mapping tool may have been used for identifying barriers. In this case the market mapping tool will also be used for the identification of barriers (see chapter 5).
4. In cases where the logical problem analysis has been used to identify barriers, the same tool should be used to move from problems to solutions. This will be described further in section 4.2.

It may be convenient to address the barriers category by category, using the same categories as used when identifying the barriers in section 3.2. These could include:

1. Economic and financial measures
2. Measures to address market failures
3. Policy, legal and regulatory measures
4. Measures to prevent network failures
5. Measures to increase institutional and organisational capacity
6. Measures to improve human skills
7. Social, cultural and behavioural measures
8. Measures to increase information and awareness
9. Measures to address technical barriers
10. Other measures

When the measures have been identified and evaluated by the facilitated workshop, the consultant needs to go back to the office to assess, prioritise and group the measures and to present them in a report. The consultant will then present the report for discussion and approval by the sectoral workgroup or the TNA committee. The different steps in barrier analysis and the identification of measures are illustrated in Figure 4.1 below.

Figure 4.1: Who is doing what in the process of identifying barriers and measures.

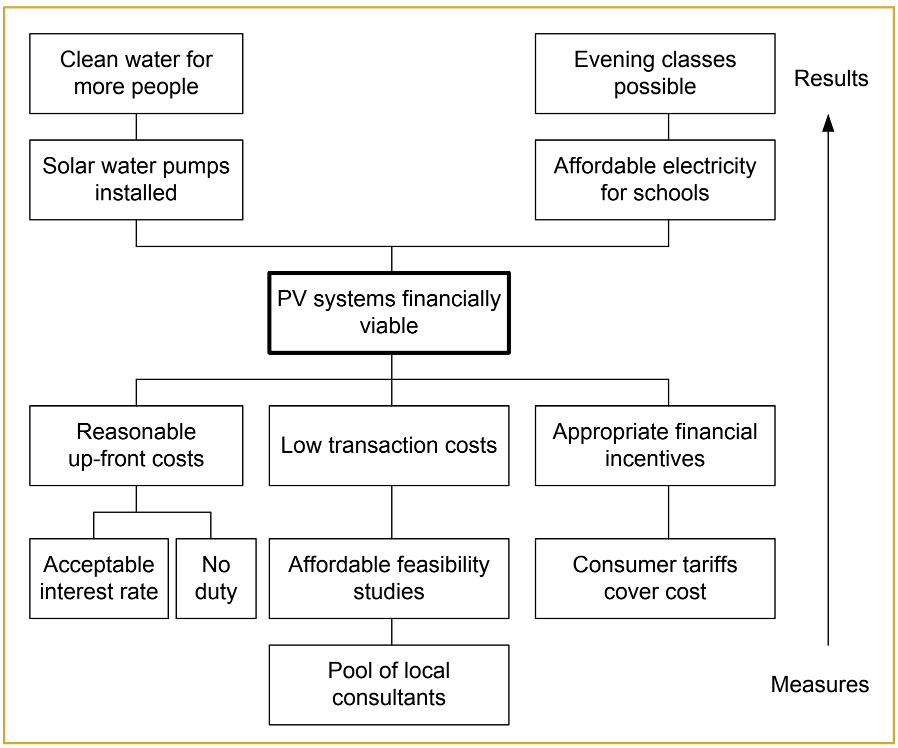


4.2 From problems to solutions in Logical Problem Analysis

In cases where Logical Problem Analysis has been used as a tool in the barrier analysis, this tool is also essential in the identification of measures. In practice this is done by reformulating all the problems as positive statements about a future situation in which the problems are solved, e.g., the 'pollution of X water source' becomes 'clean X water source', thus becoming an objective. At the same time, the cause-effect relations of the problem tree are converted into measure-result relations.

Figures 4.2 and 4.3 show a reformulation of the case problem tree into an objective tree. The objective tree is a logically organised presentation of objectives. In principle, by implementing measures to achieve the objectives at the root of the tree, all the objectives above in the tree should automatically be achieved. However, reality is often more complex than that.

Figure 4.2: Example of an objective tree, mitigation.



A reformulation of the problem tree in section 3.5. Alternative to acceptable interest rate: a grace period of e.g., five years (no instalment is due during the grace period; only interest payments due). Alternative to increasing consumer tariffs: find some consumer segments with a higher than average willingness to pay.

The objective tree is not a reflection of the 'real world', as is the problem tree, but rather an outline of what may be done to solve the problems. Once the objective tree has been established, the measures-result strings of the tree can be seen as different approaches or strategies. One such string is (see Figure 3.3):

Acceptable interest rate → Reasonable up-front costs → PV systems financially viable → Affordable electricity for schools → Evening classes possible.

Another one is:

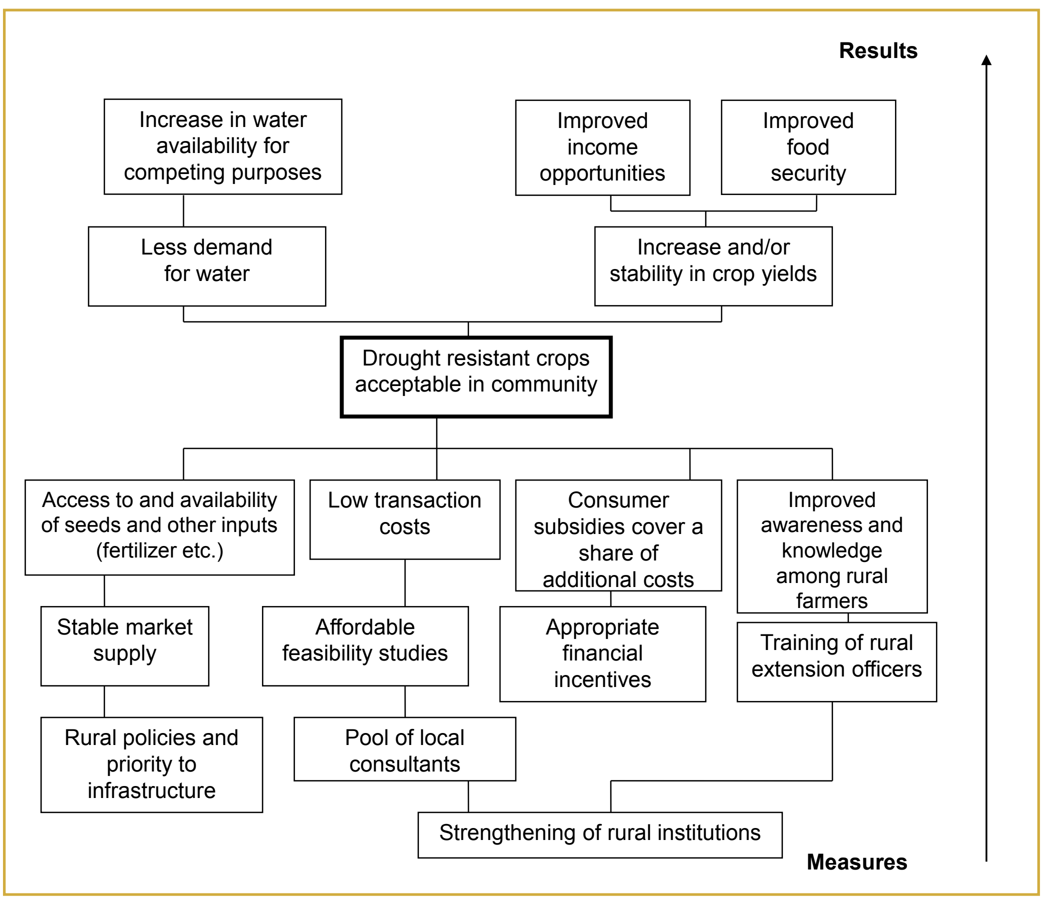
Pool of local consultants → Affordable feasibility studies → Low transaction costs → PV systems financially viable → Solar water pumps installed → Clean water for more people

By overlaying (blacking-out) the strings to reveal one string at a time, each potential strategy can be reviewed, and its operational potentials can be discussed in relation to the interests and ambitions of the stakeholders and the available resources. Against this background, the most feasible strategy or strategies can be selected. This implies that it is not necessary to remove or reduce all the essential barriers. In the example, PV systems may become feasible for water pumping by lowering the transaction costs, although the market for PV water pumping will be further increased by also adding appropriate financial incentives.

It is important to include all objectives (i.e., address all the equivalent barriers) in a given measures-result string, and if it turns out that just one essential barrier in a string cannot be overcome, then that string is not feasible. However, this does not mean that all activities to remove barriers are needed for successful transfer and diffusion to occur, as there may be other feasible strings.

To ensure a transparent selection of strategies, relevant selection criteria must be established. The criteria will vary between different situations, but may be grouped around economic, social and environmental impacts. The selection may also be conducted by inviting stakeholders to indicate their preferred strategies.

Figure 4.3: Example of an objective tree, adaptation.



A reformulation of the problem tree in section 3.5.

4.3 Assessing measures to overcome barriers

In order to prepare an optimum selection of measures for policy-makers, they should be assessed according to a number of aspects. Most important is to assess the consequences for society (a socio-economic assessment) and for the future owners and users of the technology (a financial assessment). This is often done by means of a Cost-Benefit Analysis and/or a Cost-Effectiveness Analysis.[13] Since policy-makers are usually focussed on obtaining the best value for money, such assessments are necessary for the policy process.

Other consequences may also be included in the assessment, e.g., impacts on resource use, the environment, fiscal balances, trade balances and employment. An indication of which consequences will be relevant to include may be obtained from the national development objectives, but it would be wise to consult policy-makers in this regard.

Example: What is the outcome of an assessment?
The measure is establishing on-grid wind turbines, and the incentive is a feed-in tariff.

The effects of establishing wind turbines are many: the combination of high initial investment and no fuel costs will have a high influence on the trade balance initially, with the influence dying down gradually.

Effects of the feed-in tariff: if the premium is paid by the government, it will impact on the fiscal budget. If the premium is paid by the utilities (in reality a cross-subsidy), the general tariffs will increase, in principle affecting economic growth, trade balance, employment etc., but in practice insignificantly.

Such impacts can be presented to the policy-makers in exact terms, with some uncertainties, possibly illustrated by sensitivity analysis.

If the result of an assessment shows that it is not feasible or otherwise acceptable to transfer and diffuse a particular technology, it may be necessary to review the identification and prioritisation of technologies and go through the subsequent steps once again.

4.4 Grouping measures and design of programme

Experience shows that to achieve a significant impact on the diffusion of a specific technology it is necessary to apply a relatively broad set of complementary measures addressing barriers at various levels. This means that measures should be considered from all the categories used under identification in section 4.2. Often measures are classified into two main groups: financial and non-financial measures, as it is of importance to policy-makers which measures can be implemented by legal or other interventions, and which measures need to be financed (nationally or externally). An overview of financial and non-financial measures commonly used for the diffusion of renewable energy is shown in the textbox below. A full description of the measures is provided in Annex C.

Example: Policy measures most commonly used to promote the diffusion of renewable energy (details in Annex C):

Financial measures

1. Production incentives (e.g., subsidy per produced kWh electricity)
2. Standard power purchase agreements
3. Investment subsidies
4. Loan guarantees
5. Set-asides
6. Green marketing (e.g., a premium tariff on ‘green’ electricity)

Non-financial measures

1. Market liberalisation (e.g., by allowing competitors to the incumbent fossil-based monopoly)
2. Improved infrastructure
3. Improved access to the grid
4. Obligations to generate or purchase ‘green’ electricity
5. Voluntary agreements
6. Competitive concessions (companies are competing for a time-limited monopoly to supply a technology in a specific region)
7. Government-assisted business development (e.g., by public-private partnership)
8. Involving local communities and civil society
9. Discouraging alternatives (e.g., environmental taxation of fossil fuels)
10. Research, development and demonstration
11. Testing and certification
12. Information and education

Relevant case studies of enabling frameworks for the diffusion of renewable energy technologies in developing countries, such as those illustrated in Haselip et al. (2011), can provide useful input as to how such measures can be combined to enhance the effect. The textbox below provides a brief description of one of the examples describing measures for enhancing the diffusion of solar water heaters in Tunisia.

Example: A portfolio of complementary measures: solar water heater programme in Tunisia

The solar water heater (SWH) programme in Tunisia has combined financial and non-financial measures. Financial incentives comprise:

1. A 20% capital cost subsidy, up to TND 100 (USD 72) per square metre (M^2), for all new SWH installations.
2. The interest rate for bank loans for residential was set as ‘Tunisian money market monthly average rate (TMM) + 1.5%’. Thus, in July 2011, for example, the interest rate charged would have been 4.25% (TMM) + 1.5% = 5.75%.
3. The financial support for SWH systems stems from a newly implemented energy efficiency fund or FNME. These incentives are funded by tax revenues from motor vehicle registrations and VAT and custom duties on air-conditioning systems.
4. Indirect tax benefits: exemption of SWH systems from VAT and customs duties reduced by 10%.
5. Regulatory policy mandating the use of SWHs in new public buildings.

Besides this a series of supportive accompanying measures were introduced, consisting of quality standards, certification and supplier accreditation schemes, extensive public awareness-raising campaigns, capacity-building for government officials and financiers and installation training.

The programme has achieved impressive results. By the end of 2008, 80,000 M^2 of collector surface had been installed, and a network of 30 suppliers and 733 installation and service professionals established. For more info consult (Ölz, 2011) in Technology Transfer Perspective Series (www.tech-action.org).

Similar examples may be found for other mitigation technologies. Combining measures is also good practice for programmes for the diffusion of adaptation technologies. An example of a combination of measures in a programme for a seasonal weather-forecasting technology is shown in the box below.

Example: A portfolio of complementary measures: seasonal weather-forecasting programme in Lesotho (based on Clements et al., 2011)

Access to seasonal weather forecasting and climate information is common across most adaptation contexts. Based on her experience in Lesotho, Ziervogel (2009) has pointed out that, although seasonal climate forecast information is useful to some farmers, disseminating the information is a challenge. This is because it is often disseminated in English rather than Sesotho and via a press release that does not have the follow-up support that farmers would like. As a result, they are unable to examine the information in greater depth. This hampers discussion between farmers and experts as to what the information needs are and how it might be used.

Ziervogel (2009) suggested the following complementary measures to overcome the barriers to a seasonal forecasting programme in Lesotho:

1. Information should be disseminated in the local language.
2. Timely dissemination of forecasts enabling farmers time to make decisions.
3. Personnel within the meteorological service, with adequate time dedicated to developing appropriate dissemination strategies, such as radio and print materials. Forecasts are issued at national level via a press release and expected to ‘filter down’ through the district level to the end-users. This is seldom carried out effectively due to weak coordination between state institutions, such as the Ministry of Agriculture and the District Agricultural Offices.
4. Extension agents should be trained to communicate information effectively to farmers. Also, farmers have indicated a preference for receiving the information from village chiefs at community meetings.
5. Follow-up support should be provided to farmers (from agents, input suppliers or other organisations) such as reducing the number of livestock, reducing the density of field crops, or planting more drought-resistant crops.

Besides the importance of using complementary measures, the literature suggests that financial measures should be simple, transparent and predictable in order to attract investors. The measures in the Tunisian water heater programme are examples of this. Feed-in tariffs for electricity from renewable energy is another example of simple and transparent financial measures. For feed-in tariffs it is important that there be a predictable decline in tariffs over time, so investors can predict their future incomes.

The transfer and diffusion of technologies is normally a long-term process and thus needs a long-term commitment. The box below describes the EC-ASEAN Cogen Programme, carried out in three phases from 1991–2004.

At the end of the assessment and grouping process, several competing sets of measures may have been identified, each of them leading to the same outcome, but with different costs and impacts. The final choice of one set of measures over another is a political question, which needs to be discussed at the highest level in the ministries involved before selecting the final set of measures to be presented in the Technology Action Plan.

Case study: the EC-ASEAN Cogen Programme

A long-term agreement between the European Union (EU) and the Association of Southeast Asian Nations (ASEAN) dating back to 1980 was established with the aim of increasing economic cooperation between these regions. Within this overall framework, the EU–ASEAN Cogen Programme was conducted from 1991 to 2004, with the purpose of enhancing the adoption and diffusion of proven biomass cogeneration technologies from Europe into ASEAN countries. As such, the programme provides an appropriate and successful example of an international cooperative initiative with the objective of continuing to increase the adoption of low-carbon technologies in the energy sectors of certain developing countries.

The objective of the EU–ASEAN Cogen Programme was to develop national planning capacities to adopt similar initiatives through the provision of technical assistance to relevant institutions in the process of implementing the programme. It also aimed at facilitating and providing business opportunities for private companies in both regions to engage in technology transfer activities. The programme focused particularly on the implementation of cogeneration technologies in the ASEAN wood and agro-industries, utilising biomass residues from these industries in order to replace fossil fuels in their energy-consuming processes.

The first phase of the programme (1991–1994) was an identification phase for what was to become Cogen II. It aimed at increasing awareness of EU technologies in the ASEAN market and providing information to EU suppliers of the opportunities in ASEAN. The first phase, however, also succeeded in implementing seven demonstration projects.

The second phase (1995–1998) focused on the completion of 16 full-scale demonstration projects promoting further reference projects. The Cogen coordinating team worked as a business facilitator and thereby laid the basis for an accelerated dissemination of biomass cogeneration technologies in Cogen III through already established company relations.

The purpose of Cogen III (2002–2004) was to secure further deployment and demonstrate the ability to replicate such initiatives in ASEAN. Eight additional projects were implemented, most with a higher capacity than the earlier projects. The training and capacity-building of representatives from private companies and government agencies was a central aspect. To this end, a number of seminars, conferences, matchmaking events, site visits and individual consultations were provided by the Cogen team. Strategic management tools and models for the purpose of coordinating the efficient implementation of future projects were also introduced.

A Technology Action Plan can take many forms, but this goes beyond the scope of this guidebook. The reader will find more information on the Technology Action Plan at the TNA project website: www.tech-action.org

4.5 Summary

Chapter 3 provided guiding principles on how barriers to the transfer and diffusion of climate technologies are identified and analysed. The present chapter has described how measures to overcome the barriers are identified, assessed and categorised and how they form part of a wider enabling framework for the transfer and diffusion of technologies. The next chapter provides a supplementary approach, addressing specifically the technologies under the category of ‘market goods’, those which are transferred and diffused entirely through market mechanisms. The place of the next chapter in the overall structure of the guidebook is indicated by a red ellipse in the figure below.

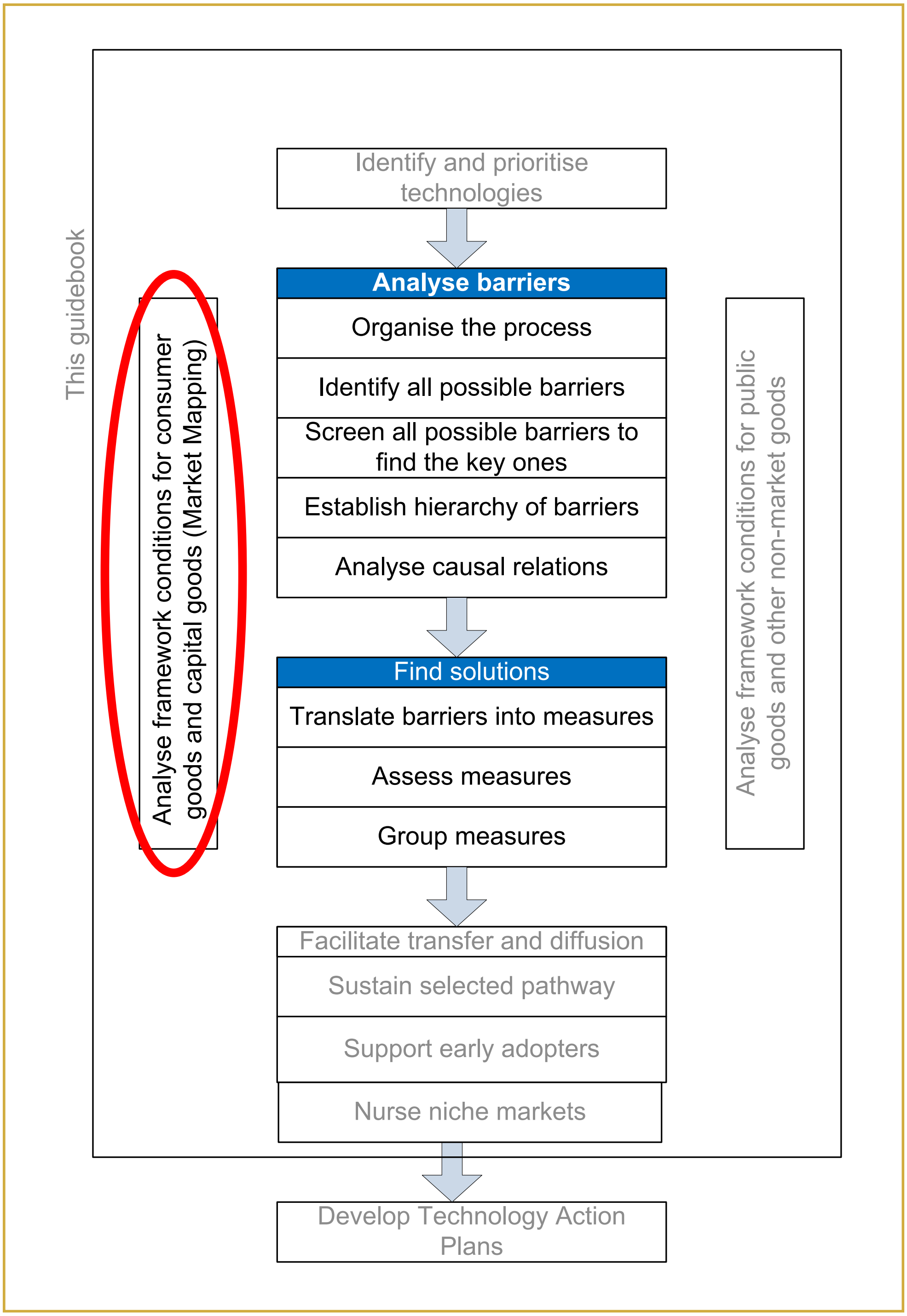

This guidebook
Identify and prioritise technologies
Analyse barriers
Organise the process
Identify all possible barriers
Screen all possible barriers to find the key ones
Establish hierarchy of barriers
Analyse causal relations
Find solutions
Translate barriers into measures
Assess measures
Group measures
Facilitate transfer and diffusion
Sustain selected pathway
Support early adopters
Nurse niche markets
Develop Technology Action Plans
Analyse framework conditions for consumer goods and capital goods (Market Mapping)
Analyse framework conditions for public goods and other non-market goods

Photo: UNEP Risø Centre Photo Library

5. Market Goods

This chapter deals with technologies traded in a market place, essentially the technology categories of 'consumer goods' and 'capital goods', in order to understand properly the particular framework conditions of such technologies. Consumer goods are small-scale goods specifically intended for the mass market, while capital goods are machinery and equipment used in the production of other goods, e.g., consumer goods or electricity. The analysis may be conducted prior to or in parallel with the barrier analysis described in Chapters 3 and 4, both to support that analysis and to prepare the subsequent steps described in Chapter 7.

Assessing the market potential for new technologies and the means for market penetration is a well-established discipline, which is seen in numerous variations. Most market assessments focus on the heart of the market – demand, supply and transactions – pinpointing demand-side weaknesses, supply-side weaknesses and market opportunities, and often leading to the formulation of a marketing plan. Numerous experienced consultants with expertise in market analysis are available, and such consultants could be asked to assist the TNA Team in assessing the potential for the diffusion of priority technologies.

This guidebook focuses on a relatively new approach, the Market Mapping Approach, which offers features of particular relevance for technology diffusion in developing countries.

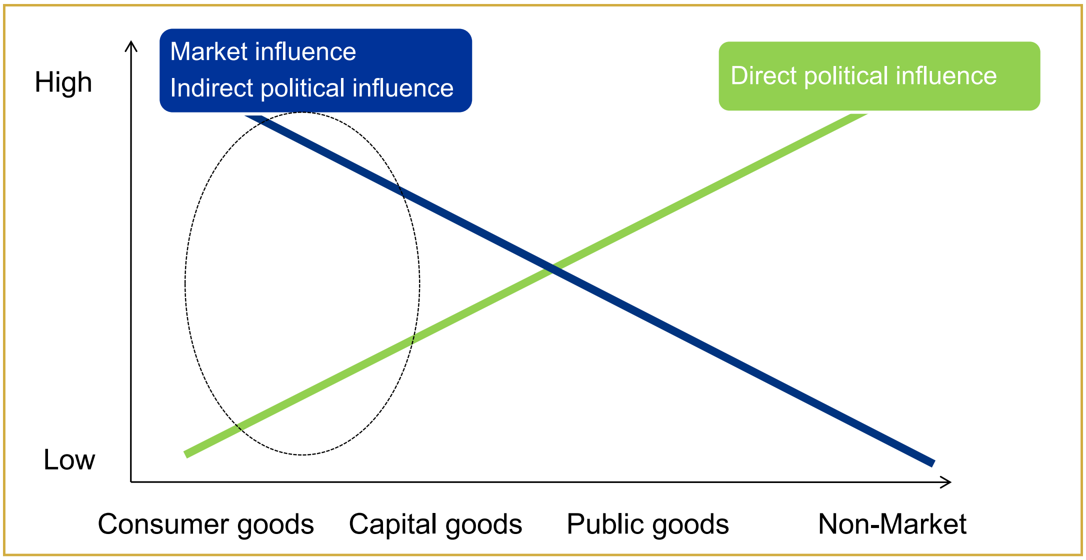
5.1 Market mapping

Market mapping is an analytical framework for understanding market systems and an approach to market development that is both systemic and participatory. The market map is a very useful way to conceptualise, visually represent and communicate knowledge about the entire commercial and institutional environment in which specific market chains operate. The tool helps to explore who the market actors for a technology are, what support services are available to them and the nature of the enabling business environment.

Market mapping (or the Participatory Market Chain Approach, PMCA) has been developed by Albu and Griffith (2005, 2006) for application in the agricultural and energy sectors of developing countries and for agricultural commodities.

The approach can be very useful for the technology categories of 'consumer goods' and 'capital goods' (cf. Section 2.2), as demonstrated by several projects conducted by Practical Action (Albu and Griffith, 2006; PISCES and FAO, 2009; PISCES, 2010). Experience has been gained with agricultural consumer goods, such as milk, cheese, hibiscus, charcoal-dust briquettes, vegetable oil, spice dryers and ethanol stoves, and with bioenergy technologies (capital goods), such as jatropha electrification, biodiesel-based water-pumping, farm biogas, and charcoal and biomass supply to households and industries.

Figure 5.1: Graphical illustration of political influence and Market Mapping.

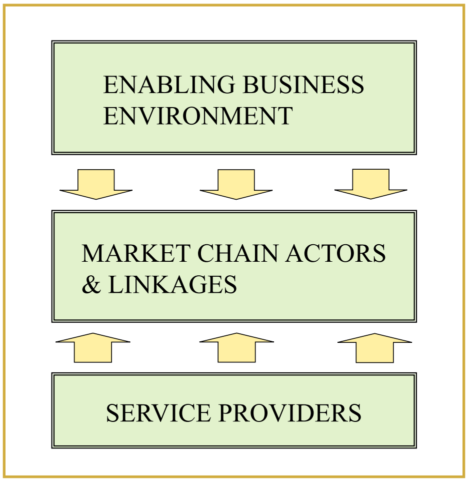


The Market Mapping is primarily relevant for consumer goods and capital goods, where technology diffusion is contingent on a well-functioning market.

ENTTRANS (2009) have also applied the approach successfully to consumer goods and capital goods. However, there is still much learning to do in sectors other than agriculture, so extreme caution is required if one wishes to employ the approach in a sector with substantially different features.

The analytical part of market mapping is similar to the frequently used value-chain analysis.[14] A particular virtue of market mapping is that it combines the analytical approach with a participatory approach, possibly leading to actual improvements in the market chain in its own right (cf. section 5.5).

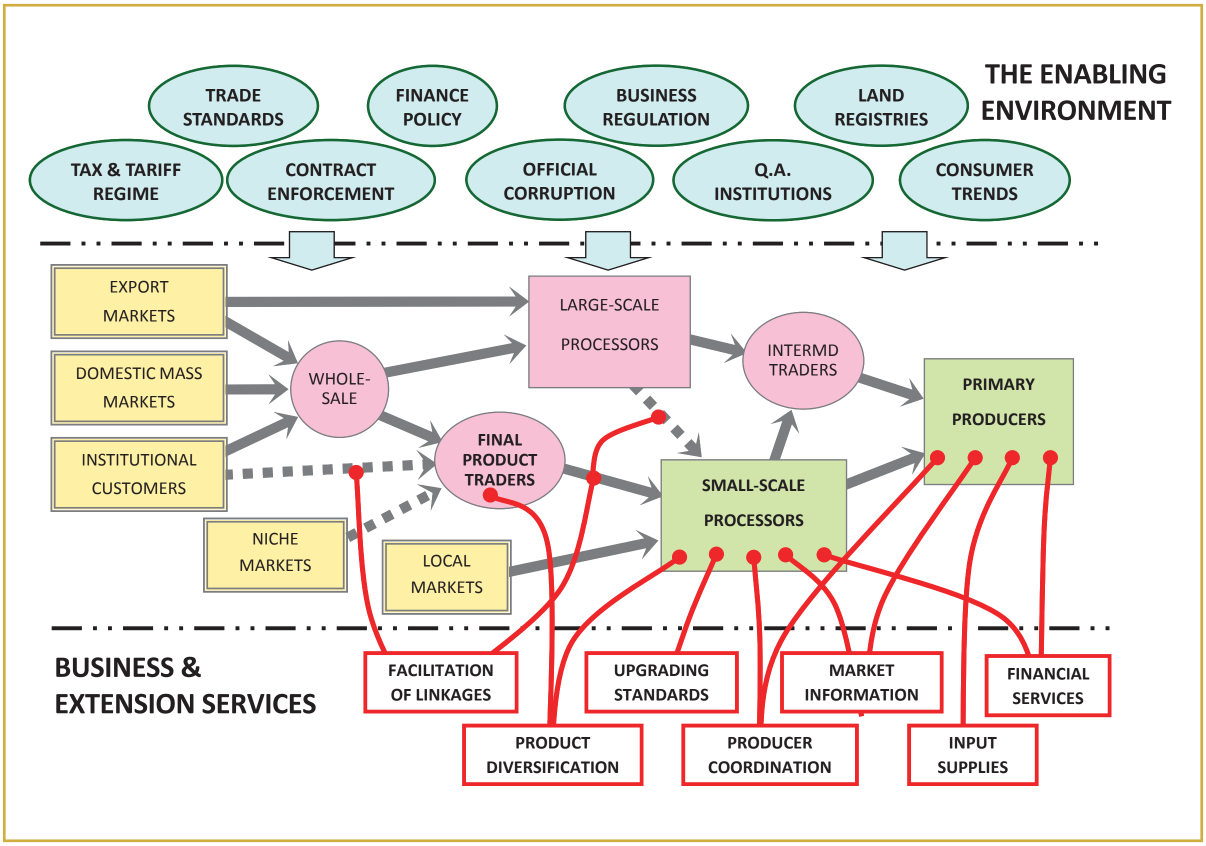
Figure 5.2: The essence of the market map.



Source: Albu and Griffith (2005).

A generic example is shown in Figure 5.3. Contrary to convention, the schematic figure shows the flow of income from left to right, with the flow of goods going in the opposite direction.

Figure 5.3: The Market Map complete, a generic schematic.



Source: Albu and Griffith (2005).

The map has three components, separated by the horizontal dot-and-dash lines:

1. The central component is the market chain (the yellow, pink and green boxes in the middle of the map), which comprises the economic actors who produce and transact a particular product as it moves from primary producer to final consumer.
2. The second component, the enabling business environment (the upper blue ovals in the map), is a charting of the critical factors and trends that shape the market-chain environment and operating conditions.
3. The third component, the input and service providers (the lower white squares in the map), is concerned with mapping the services that support, or could potentially support, the market chain's overall efficiency.

5.2 The market mapping process

Overall, the market mapping exercise can take place in a three-stage process, including:

1. the creation of a preliminary market map
2. a participatory process involving the market players
3. an action phase resulting from the formation of a functioning network of market actors based on the relationships formed and the trust engendered.

Experience of using the market mapping approach is still limited. However, the recommended reference documents (cf. the text box) give examples, based on actual experiences, of the operational challenges and solutions. A major challenge is bringing together disparate, competing, mutually suspicious and demanding business people, and motivating them to work for a common goal. Consultants with limited facilitation experience could therefore benefit from teaming up with a skilled facilitator in this part of the process (cf. section 5.5).

Sources of inspiration

It is recommended to consult the following documents for further details and guidance:

1. Albu, M. and A. Griffith: 'Mapping the market: a framework for rural enterprise development policy and practice', Practical Action, 2005.
2. Albu, M. and A. Griffith: 'Mapping the market: participatory market-chain development in practice', Small Enterprise Development, vol. 17, no. 2, 2006.
3. DFID (UK Department for International Development) and SDC (Swiss Agency for Development and Cooperation): 'The operational guide for making markets work for the poor (M4P) approach', October 2008.
4. PISCES and FAO: 'Small-scale bioenergy initiatives', 2009.
5. ENTTRANS: 'Promoting sustainable technology transfers through the CDM: converting from a theoretical concept to practical action', 2007.

PISCES and FAO (2009) present fifteen market maps from concrete case studies dealing with small-scale bioenergy initiatives. The focus is on agricultural produce rather than technology. However, there are some elements pertaining to technology transfer:

1. Case 7: Ethanol stoves in Ethiopia. One of the core technologies, the stove, has been developed and patented by a Swedish company, but is manufactured in Ethiopia. The manufacturer receives technology support from the Swedish company. The ethanol is produced by a local sugar company; no mention of distiller technology.
2. Case 11: Ethanol stoves and micro-distilleries of ethanol in Brazil. Same stove technology as in case 7. The origin of the micro-distiller technology is not mentioned, therefore nor is technology transfer and diffusion.
3. Case 9: Biodiesel in India. An interesting combination of South-South (oil press from Kenya) and North-South (biodiesel process from Canada) technology transfer and diffusion. Also, a local laboratory is engaged in technology innovation.
4. Case 12: Biodiesel in Guatemala. See text box in section 5.5.

Similarly, PISCES and FAO has reported (PISCES, 2010) three cases of participatory market mapping to promote the sustainable use of bioenergy for improving energy access in Kenya and Sri Lanka.

ENTTRANS (2007) reported market maps for a number of low-carbon energy technologies in five case-study countries:

1. concentrated solar power for grid or mini-grid electricity; Kenya.
2. a biomass gasification stove for cooking in households or institutions; Kenya.
3. large-scale imported electricity supply technologies (wind turbines); China.
4. large-scale imported energy efficiency technologies (in cement industry); China.
5. small-scale solar heating and cooling; China and Thailand.
6. large-scale technologies such as biomass- and biogas-based generation; Thailand.
7. small-scale compact fluorescent lamps; Thailand.

5.3 Preliminary market map

A preliminary market map can be helpful as the basis for further discussions, in particular to identify key stakeholders and their interrelations. It may be produced by a facilitating agency such as the TNA consultant, using existing literature and information gathered from key informants. If there is a shortage of resources or time, the preliminary market map may be used as a final map, that is, as an alternative to the map produced by the participatory process described below. However, this will, of course, imply a significant loss of the important benefits (see below) that come from using the participatory approach.

When a preliminary map is produced as a preparatory step to the participatory approach, it is recommended that the map is not shown to the stakeholders, as it may act to trap the participants in a particular model that differs from their own perceptions of the system.

5.4 Participatory market mapping

The participatory market chain approach (PMCA) can facilitate the collaboration that is necessary for improving linkages and efficiencies within the market chain, for effective lobbying on business environment issues and for coordinating activities where producers are numerous but small-scale.

The participatory process requires the market players to:

1. identify tangible incentives to engage busy and sceptical actors in the exercise;
2. form market opportunity groups of representatives through whom a large number of market actors can be represented; and
3. conduct a PMCA to create a market map, while also facilitating efficiency, improving coordination, stimulating innovation and bolstering trust within the market chain.

Participatory market mapping is one of the elements of the participatory approach which is generally being recommended in this guidebook. The advantages and the limitations of the participatory approach have already been discussed in section 3.2. Specifically for participatory market mapping, Albu and Griffith (2006) have presented some lessons learned and some rules of thumb, which include the following:

1. Few entrepreneurs, least of all buyers, are attracted by the idea of attending a 'development project' meeting. They may suspect the facilitator's motives, e.g., fearing pressure to give their suppliers a better price. Tangible issues or intervention proposals (so-called hooks) that might attract the initial interest of wary actors are therefore absolutely necessary. The preliminary market map can help facilitators identify very specific issues of mutual interest and turn them into proposals that will draw diverse actors into the process.
2. Market opportunity groups offer a way to inform and build the confidence of producers, so empowering them to participate on a more equitable basis in both the PMCA workshops and any subsequent negotiated agreements.
3. The convening of 'interest forums' has been an important tactic for engaging stakeholders and institutions, which, although outside the market chain, still have an important stake or influence, e.g., service-providers, policy-makers and other moulders of the business environment.
4. PMCA workshops are the key events in operationalising the market map, bringing together diverse market-chain actors to stimulate interest, bolster trust and facilitate collaboration in relation to linkages, services or the business environment. Typically the workshop involves participants in

reflecting and building on the preliminary mapping in a joint effort to establish a common framework of understanding for action.

5. Moving from analysis to action: the relationships, knowledge and trust generated are used to effect changes in the business environment and access to services.

Participatory market mapping involves:

1. the identification of market stakeholders;
2. the identification of incentives for engagement by these stakeholders in the technology diffusion process; and
3. meetings with stakeholders to generate a detailed map of the system in which they operate in order to identify opportunities to increase the efficiency of the operation of the market and opportunities for development and co-operation.

An essential outcome of the overall process is the possible creation of a network among the market actors themselves, improving the ground for introducing or generating innovation in products, processes and market access. Thus, market mapping can be an end in itself: bringing market actors together to build trust and lead to further collaborations outside the purpose of the exercise.

Case study: biodiesel in Guatemala
Participatory market mapping was used in introducing a cash crop, jatropha oil seeds, for poor farmers (PISCES, 2009). The collaboration helped establish mutual understanding, trust and networking among participants. Farmers were grouped into co-operatives and similar organisations, a local industry purchased and operated the biodiesel production equipment, and large-scale investors bought the oil directly from the co-operatives or the industries.

Furthermore, some universities and private research companies involved themselves in R&D. This kind of follow-on innovation often happens automatically, shortly after a new technology has entered a society.

5.5 Identifying and analysing stakeholders

Stakeholders are individuals, groups, institutions and companies that have something at stake. Stakeholders have an interest in a particular decision, either as individuals or as representatives of a group. This includes those who influence a decision, or can influence it, as well as those affected by it. Stakeholders may thus work for or against the planned changes in a system during all its main phases. It is therefore suggested that a stakeholder analysis is elaborated during the initial phase of the technology transfer process, and that the analysis is reviewed and amended if necessary during consecutive phases.

It is recommended that the stakeholder analysis be conducted by the consultant contracted by the TNA Committee and presented to the Committee for comments before starting the market mapping process. This is to ensure that an optimum composition of stakeholders is invited to participate in the market mapping exercise. A basic stakeholder analysis includes four main elements:

1. Identify and list all persons, groups, institutions and companies affected by the problem area or environment. The 4R's approach (Relationships, Rights, Responsibilities and Revenues) is valuable in

helping identify and categorise stakeholders.[15] It may be supplemented with yet another R for risks, including voluntary and involuntary 'risk-takers' and 'risk-bearers', as suggested by the World Bank.[16]

IPCC (2000) and ENTTRANS (2007) recognise a diversity of stakeholders in the process and identify the following key actors:

a. technology developers, including research organisations
b. technology owners and suppliers
c. product buyers and users
d. financiers and donors
e. market intermediaries, including consultants, NGOs, community groups, trade organisations
f. information providers
g. government agencies
h. educational institutions
i. international organisations

Many stakeholders have probably been identified during the preceding technology prioritisation process. However, in dealing with specific market chains for particular technologies, there will be a need to replace some stakeholder representatives with stakeholders operating directly in the market chain. For example, a representative from a manufacturers' association should be replaced by representatives from actual traders and manufacturers of solar water heaters if the market chain concerned revolves around solar water heaters. Also, some stakeholders may disturb an actual market mapping process and should therefore not be invited.

2. Identify the main interest of each stakeholder in relation to the problem area. The interest can be economically, politically, personally or geographically delimited. The stakeholder analysis will need to clarify the different interest groups that actively support, oppose or would be affected by the new technology, including: (i) ministries, departments and agencies; (ii) enterprises; (iii) interest groups, such as trade unions; (iv) civil society organisations and consumer groups; (v) other sub-groups within the general population. It should show the different perspectives of each group, as well as where different perceptions may lead to failures in the required reforms. It should also cover an assessment of how key groups within institutions may affect the policy options being considered for technology diffusion.

3. Categorise the stakeholders in clusters of related interest and name the clusters. The linkages in the market map may be useful for this purpose. An important feature of the market map is that it maps the linkages between the stakeholders within the market chain, as well as between market chain participants and service providers. It may thus serve as an important tool to illustrate which types of stakeholder need to be engaged in technology diffusion.

4. Analyse the significance of stakeholders. Within each cluster, analyse the significance of stakeholders for the problem area, e.g., interests, fears, strengths, weaknesses and their influence on the problem area and/or how they may be affected by an intended intervention.

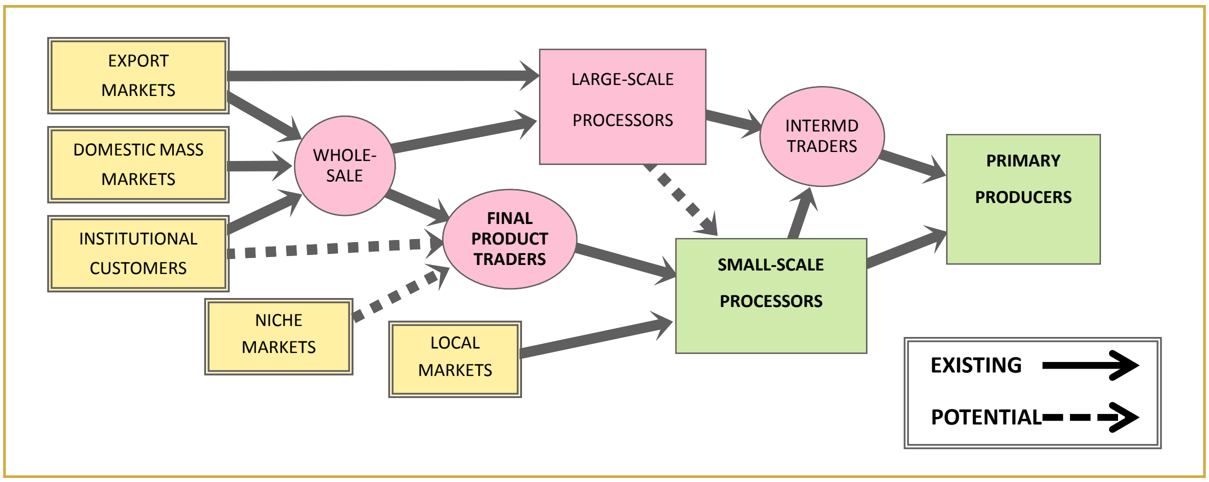
Actual and perceived imbalances of power within the market chain can impede the participatory process. Building up trust is therefore important to facilitate the open sharing of information and to reduce transaction costs. Albu and Griffith (2005) gives valid advice on how to build such trust.

5.6 The market chain

The market chain is a central component of the market map. It maps the economic actors who actually own and transact a particular product as it moves through the market chain from primary producer to final consumer. By better understanding the contribution that each actor in the chain brings to the product, the aim is to identify inefficiencies, inequities and losses that can be remedied, or added-value that can be captured. Actors taking legal possession of (parts of) the product should be mapped as part of the market chain, whereas other actors belong to the enabling business environment (section 5.8) or the business service providers (section 5.9).

A clear objective of the market map approach is to help stakeholders realise mutual benefits by improving the 'systemic efficiency' of the chain. Key to this is helping stakeholders become more aware of functions and processes along the chain that are needed to satisfy more lucrative or reliable markets. Thus, an important aspect of the market mapping technique is the emphasis on the participation of stakeholders in the process of elaborating the market map.

Figure 5.4: Market chain actors and links (a generic schematic).



Source: Albu and Griffith (2005).

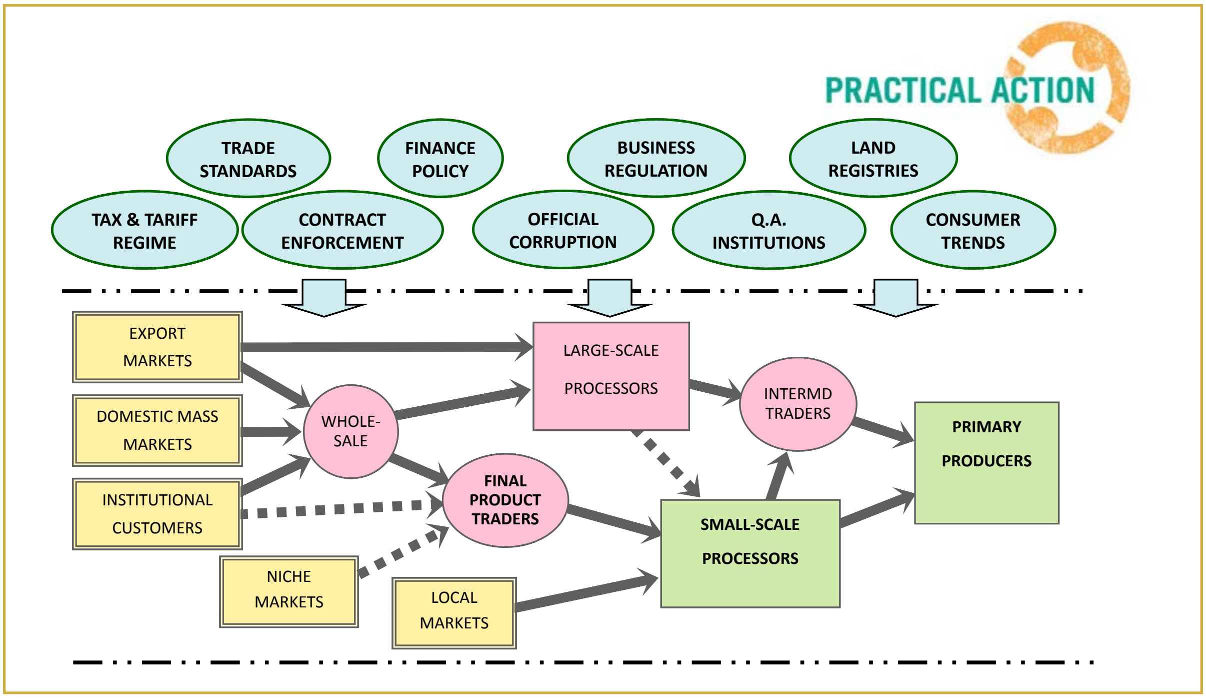
5.7 Enabling environments for market technologies

The second component of the market map is a charting of the critical factors that shape the market-chain environment and operating conditions, but that may be amenable to change. These 'enabling business environment' factors are generated by structures and institutions that are beyond the immediate control of economic actors in the market chain.

The purpose of charting the business environment is to understand the elements that affect the entire market chain and to examine the powers and interests that are driving change. This knowledge can help determine avenues and opportunities for realistic action to improve the enabling environment via concerted lobbying, coordinated campaigns and advocacy.

The enabling business environment can be seen as a subset of the enabling environment described in section 2.3. According to Albu and Griffith (2005), the enabling business environment encompasses the following elements, which are illustrated graphically in Figure 5.5.

Figure 5.5: Enabling business environment related to the market chain (a generic schematic).



Source: Albu and Griffith (2005).

Relating to market demand:

1. consumption trends (prices, volumes and quality expectations)
2. taxes, subsidies and tariff regimes

Relating to transformation activities, i.e., the costs of doing business:

1. infrastructure constraints and investment policies
2. transport policies and licensing
3. technological development
4. trade regime (import/export)

Relating to transaction activities:

1. systems of finance
2. gender roles in business and finance
3. registration of land and property
4. legal requirements for contracts
5. commercial law and practices
6. business licences and regulation
7. standards quality control and enforcement

For new entrepreneurs wishing to enter the market with a new technology, major barriers are often the transaction costs and the amount of time needed to obtain approvals from numerous authorities. To reduce this barrier, government may establish a 'one-stop shop', i.e., a single office where the entrepreneur can receive all necessary information and applications, as well as submit applications to the various authorities. Another, not necessarily alternative measure to reduce this barrier is to elaborate an investor/project-developer handbook or website, including information on all pertinent requirements and procedures. Valid information on business environments is available at www.businessenvironment.org/dyn/be/besearch.home, operated by the Donor Committee for Enterprise Development (DCED).

5.8 Identifying support services

In most effective market chains, the economic actors who form the chain are supported by inputs from other enterprises and support organisations. The third component of the market map is concerned with mapping those services that support, or could potentially support, the market chain's overall efficiency. This includes identifying particular service needs and their locations within the market chain in order to understand the opportunities for using and further developing services to improve market-chain efficiency or equity.

The range of services that can potentially add value is huge and includes:

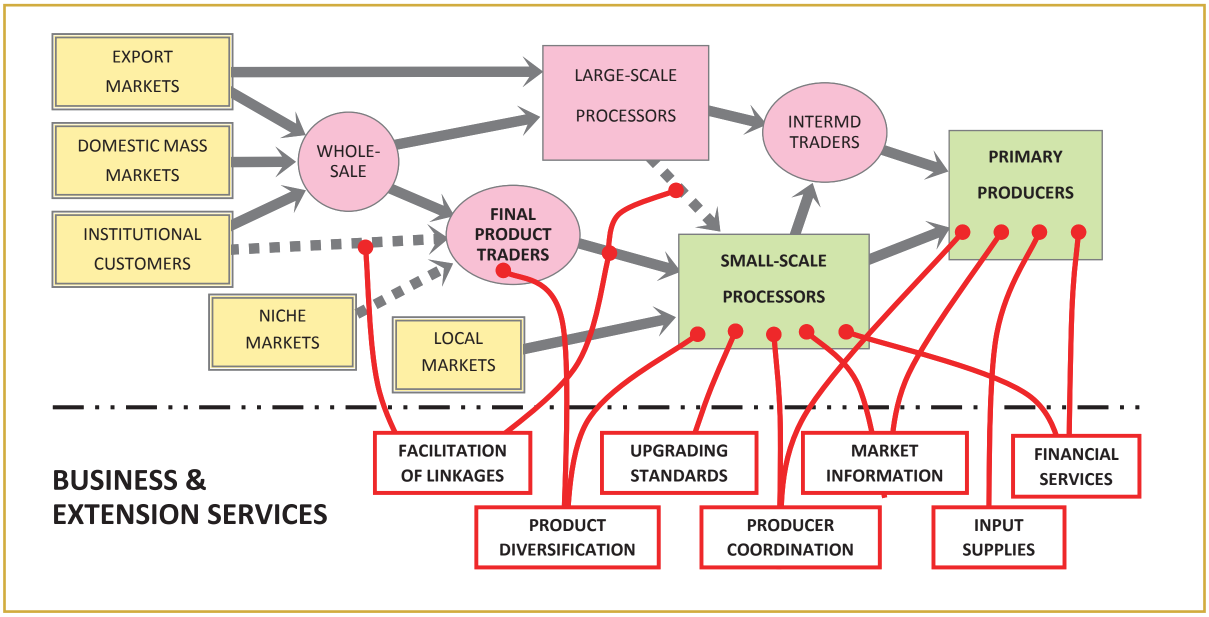
1. input supplies
2. market information
3. marketing support
4. financial services
5. legal services (contracting)
6. transport services
7. engineering (support for product development and diversification)
8. human skills development
9. quality assurance (monitoring and accreditation)
10. business advice (business-plan and bargaining support)

It is important to recognise that service options are not confined to conventional government extension services and private fee-based services. There are also embedded services, where services are incorporated within a commercial transaction for another product, e.g., pest control advice offered to a contract farmer by a trader.

In practice, differentiating between the enabling business environment and the support services is not always clear cut, and different countries or groups may view them differently, so that there may be an overlap between them (cf. ENTTRANS (2007), para. 6.1.2). The most obvious overlapping topics are:

1. financial services
2. legal services
3. professional engineering services; and
4. government planning and support, including R&D, codes and standards

Figure 5.6: Extension/business services related to the market chain (a generic schematic).



Source: Albu and Griffith (2005).

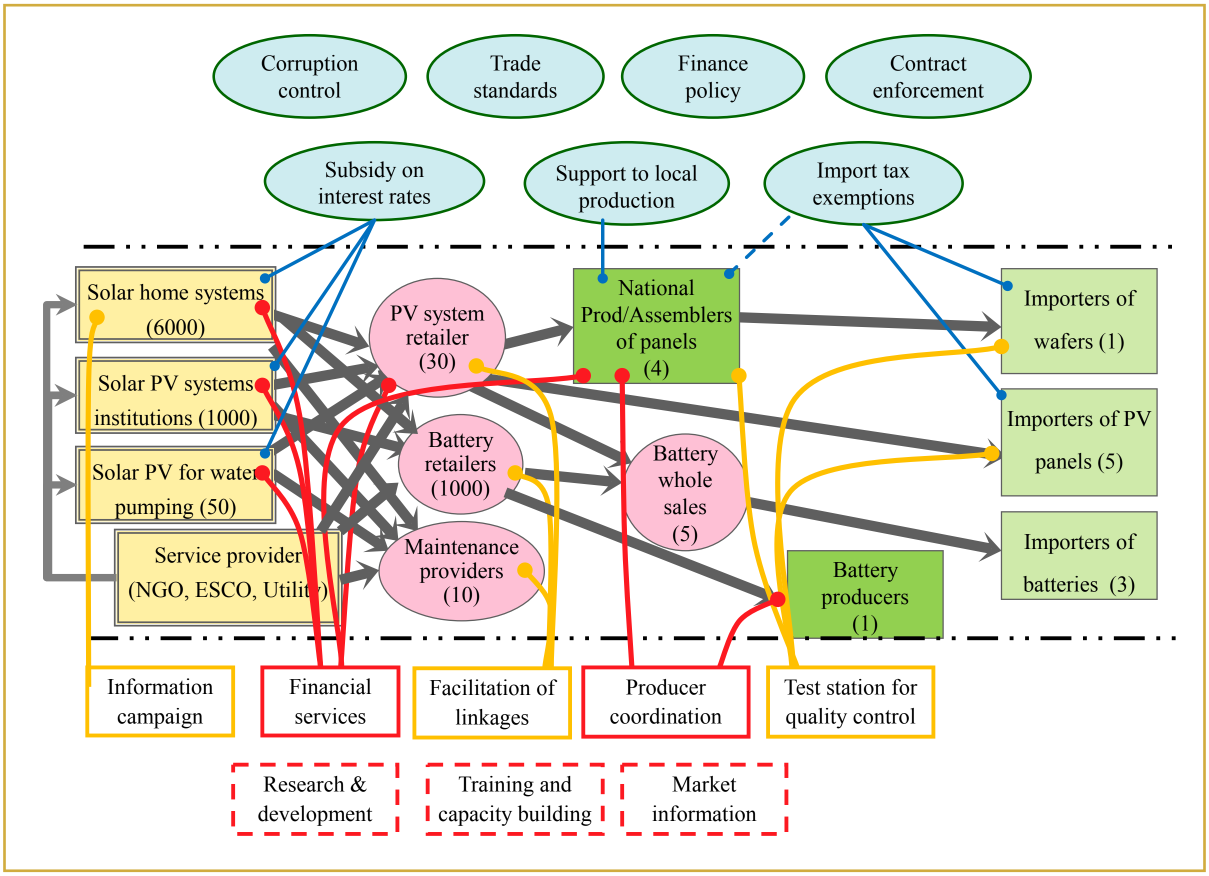
For the outcome of the participatory process, it is not overly important whether one function is mapped as part of the enabling business environment or the support services, so there is no need to go through lengthy discussions. It is more important that all essential stakeholders, functions and relations are mapped, and that the map does not become too complex in attempting to achieve scientific correctness. Valid information on business development services (BDS) is available at www.bdsknowledge.org/, operated by the Donor Committee for Enterprise Development (DCED).

Country teams can determine how current and planned government initiatives and donor programmes address barriers (cf. Chapter 3), and then identify possible refinements to these programmes and new initiatives that would help to address these barriers (cf. Chapter 4).

5.9 Example of market mapping for solar PV

In this section an example of the market mapping of solar PV technology is provided to give the reader a more practical understanding of the process of market mapping. The measures suggested in this example are by no means exhaustive and should be used as inspiration rather than as a blueprint for how to design an enabling framework for the diffusion of solar PV. A full explanation of the process and the result of developing this market map are to be found in Annex D.

Figure 5.7: Constructed example of a market map for solar PV



5.10 Summary

Chapters 3 and 4 provided general guiding principles on how barriers to the transfer and diffusion of climate technologies are identified and analysed, and how measures to overcome the barriers are identified. In the present chapter this general approach has been supplemented by a thorough description of the market mapping approach, which it is recommended be used as a supplementary tool for two market categories, consumer goods and capital goods.

Chapter 6 will similarly investigate the characteristics of barriers and measures for non-market goods, which are diffused by more direct government involvement. The place of the following chapter in the overall structure of the handbook is indicated by the red ellipse in the figure below.

Chapter 5 and Chapter 6 together form the basis for the recommendations in Chapter 7 for governments to facilitate the actual diffusion of new technologies.

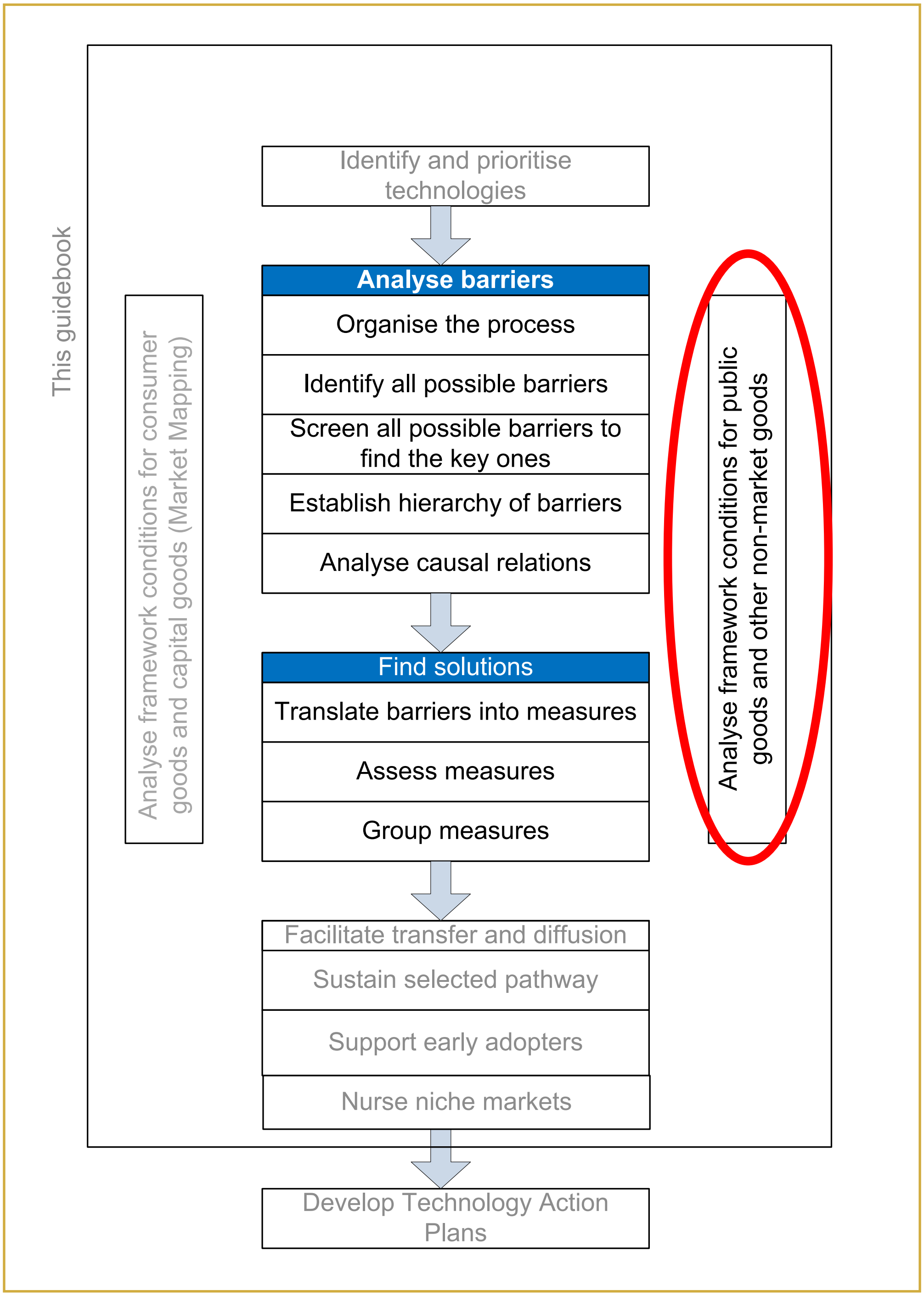

This guidebook
Analyse framework conditions for consumer goods and capital goods (Market Mapping)
Identify and prioritise technologies
Analyse barriers
Organise the process
Identify all possible barriers
Screen all possible barriers to find the key ones
Establish hierarchy of barriers
Analyse causal relations
Find solutions
Translate barriers into measures
Assess measures
Group measures
Facilitate transfer and diffusion
Sustain selected pathway
Support early adopters
Nurse niche markets
Develop Technology Action Plans
Analyse framework conditions for public goods and other non-market goods

Photo: UNEP Risø Centre Photo Library

6. Non-market Goods

This chapter deals with the technology categories of 'publicly provided goods' and 'other non-market goods' (cf. definitions in section 2.2) in order to understand the particular framework conditions for such technologies. The chapter builds upon the descriptions of how to identify and analyse barriers in Chapter 3 and how to formulate measures to overcome barriers in Chapter 4. For publicly provided goods and other non-market goods, the stakeholder identification and analysis can be conducted in a manner equivalent to the description for market goods in section 5.6.

6.1 Publicly provided goods

Publicly provided goods in this context comprise mitigation and adaptation technologies such as large-scale hydropower schemes, sea dikes, flood defence, infrastructure such as roads, bridges, freshwater and sewage systems, and mass transport systems such as metros.

Technologies in this category may be traded in a market place like consumer goods and capital goods, as they are purchased by public entities from private constructors and manufacturers. However, the market is often not as liquid, as the public entities purchase their goods through a tendering process, which may be restricted to a limited number of invited national and international construction companies. Large-scale publicly provided goods projects will generally be preceded by thorough analyses such as cost benefit analyses, feasibility studies and environmental impact assessments, which are all outside the scope of the present guidebook. The selection of technologies to be included in the TNA project will most often be based on input from such studies in a national context.

Governments can play a role in supporting people and businesses to overcome barriers to these technologies, create an environment conducive to the appropriate technology decisions and increase the opportunities for technology diffusion. While a public entity, such as a ministry or a government agency, has the power to take decisions on such projects, a main barrier will often be finance. One way of overcoming this barrier will often be loans from international finance institutions. As procurement is normally based on government decisions, there are in general no market barriers, as for consumer goods and capital goods, and therefore most barrier categories (cf. Annex A) may be irrelevant in this case.

However, besides the financial barrier, there might be negative effects for some groups in society. A mass transport system, although generally being a least cost option per person km, may cause traffic congestion during the construction phase and it may even in some cases entail the resettlement of both rich and poor people. These negative effects are 'cost elements' in the cost benefit analysis, and should of course be minimised. Some of these negative effects may also turn out to be real barriers, as political pressure by local people and international NGOs may influence government and international financial institutions. On the other hand, such barriers cannot be dealt with by improving the enabling environment, as discussed for consumer goods and capital goods.

Most important for large-scale projects is to conduct thorough impact assessments on the environment and social and security issues.

Mass transport system: a simple example of publicly provided goods

Stakeholders

- Government, city council, bus and rail operators, transport associations
- National NGOs, tourist organisations, environmental organisations

Benefits

- Increased mobility, transport time savings, social equity benefits, fewer people killed, reduction of noise, air pollution and CO_2

Costs

- Traffic congestions during construction
- Cost per person km generally lower than other alternatives

Barriers

- Lack of proper studies of feasibility, costs and benefits
- Lack of finance

Who take decisions?

- Government, city council and external finance institutions

6.2 Other non-market goods

With regard to identifying barriers to transferring and diffusing these technologies, this category is similar to publicly provided goods, but while the hardware element is high in the publicly provided goods category, non-market goods are dominated by the software and orgware elements of technology (cf. the broad technology definition in section 2.1). Non-market goods can be divided into three main groups within which technologies share some characteristics in terms of barriers and how to overcome them.

The first group comprises technologies provided by institutions. Examples are early warning systems for drought, seasonal forecasts of rain for optimal planting, new vaccination systems and the introduction of genetic screening for water-borne pathogens. Before deciding on implementation, a cost-benefit analysis will be needed to address the relevance (this may have been done as part of the TNA selection process), but if the intervention is considered beneficial, implementing the service is mainly dependent on access to finance and a government decision to implement it. It is also highly dependent upon technical capacity and access to required skills and equipment at the institutional level in the countries concerned.

Technologies provided by institutions: a simple example of non-market technologies

- Early warning systems for drought
- Seasonal forecast of rain for optimal planting
- New vaccination systems due to climate change
- Introduction of genetic screening for water-borne pathogens

Who takes decision on implementation?

- Public entities (ministries, government agencies)
- Donors, development banks (in terms of finance)

What are the barriers to implementation?
- Lack of proper studies of feasibility, costs and benefits
- Lack of finance

What are the barriers to functioning?
- Lack of resources for running the service
- Lack of qualified personnel

What are the measures?
- Government and donor decisions

The second group comprises institutional change with the objective of reducing vulnerability and improving rural livelihoods. Examples are microfinance institutions, seed banks, forest management groups and village development groups.

While new institutions evolve in competition with existing institutions, they are not diffused under market conditions, but initiated and supported by development actors, such as government agencies, donor agencies and NGOs. Barriers to such institutions becoming sustainable and actually playing the roles that donors and governments have attributed to them are many. Examples of barriers are capture by local elites, disputes over external resources, misappropriation of funds and strategies of dependence on continued donor finance.

Institutional change to reduce vulnerability and improve rural livelihoods
- microfinance institutions, seed banks
- forest management groups, and village development groups

Who takes decision on implementation?
- development actors such as government agencies, donor agencies and NGOs.

What are the barriers to implementation?
- Funding, decisions by development actors

What are the barriers to functioning?
- Capture by local elites, disputes over external resources, misappropriation of funds, strategies of dependence

What are the measures for improved functionality?
- better project preparation, support to local initiatives
- Improved information, better training, better understanding of local needs

Such barriers can be reduced, for example by improved information, better training, economic support and governance. Better project preparation through rural appraisal techniques may improve the understanding of the complex relationship between donor projects and recipients at the local level, enable the achievement of ownership of technologies by the community, and ensure that lessons learned from past community-based projects are considered, synthesised, assimilated and disseminated.[17]

The third group comprises behavioural change at the individual level. Examples are energy-saving measures, such as turning off lights or air conditioning when they are not needed, changing from individual cars to public transport and bicycles, improved hygiene made necessary due to climate change, use of mosquito nets and changing farm practices. The barriers to behavioural changes are both complex, multiple and difficult to overcome. Examples are socially and culturally embedded practices, tradition, social esteem, pride, laziness and religious beliefs.

There are some general measures for this category, such as information and training, in order to encourage behavioural change. Jones (2010) has provided valid recommendations for adaptation policy to overcome social barriers to adaptation. In some cases a measure may consist of distributing heavily subsidised goods. The goods need to be subsidised heavily enough that they can compete with conventional goods, for instance, selling a CFL bulb at the price of an incandescent bulb. A heavy subsidy may also be used to promote the purchase of goods that would otherwise not be bought, such as mosquito nets.

Example: local farmer associations involved in adaptation and local development.

- Practices of adaptation to drought and heavy rainfall in four villages in South Africa and Mozambique have been analysed by Thomas et al. (2005), who shows that, by working together in voluntary associations, villagers have been able to spread the risks of adopting new technologies and to experiment with new crop varieties on their own terms.

  Agricultural projects which utilised local knowledge and had a market base were the most successful. Knowledge transfer from other regions was facilitated through government training.
- McGray et al. (2007) has reported a number of cases of adaptation from around the world.
- There is a body of research revealing the difficulties involved in creating local institutions by donor intervention. Examples in the literature are Nygaard (2008), Engberg-Petersen (2002) and Crewe and Harrison (2002).

Measures in terms of information, training and the distribution of free goods need to be prioritised by the TNA Consultant and the technology group (cf. section 3.1) based on existing evidence of the impact of such incentives in other countries. Some guidance on this may be found in the relevant technology guidebooks (cf. section 1.2).

Behavioural change at the individual level

- Energy saving measures, such as turning off the light or the air conditioning, when you are not present
- Changing from individual cars to public transport and bicycles
- Improved hygiene made necessary due to climate change
- Use of mosquito nets, and changing farm practice

Who takes decision on implementation?

- Development actors such as government agencies, donor agencies and NGOs.

What are the barriers to implementation?

- Complex, multiple and difficult to overcome
- Culturally embedded practices, tradition, social esteem, pride, laziness, religious beliefs

What are the measures for improved functionality?

- information and training
- free goods: energy-efficient light bulbs and mosquito nets

6.3 Enabling environments for non-market goods

The context for improving the quality and efficacy of the transfer and diffusion of climate technologies implies multi-facetted enabling environments. The elements of an enabling environment for publicly provided goods and other non-market goods are of a different nature than the enabling business environment for marketed goods (Section 5.8). This is even more the case for adaptation technologies.

As described in Section 2.3, an enabling environment should be understood as the set of resources and conditions within which the technology and the target beneficiaries operate. For non-market goods, like many adaption technologies, such conditions (or enabling environment elements) include relevant policies, human and organisational capacity-building and appropriate infrastructures.

To give an example, in a situation where an adaptation technology seeks to accommodate storm risks in a coastal area by building storm shelters, the storm shelters are of little use if the early warning system and communication infrastructures do not exist. In such a case, the technology (storm shelters) is contingent on a communication infrastructure such as an early warning system.[18]

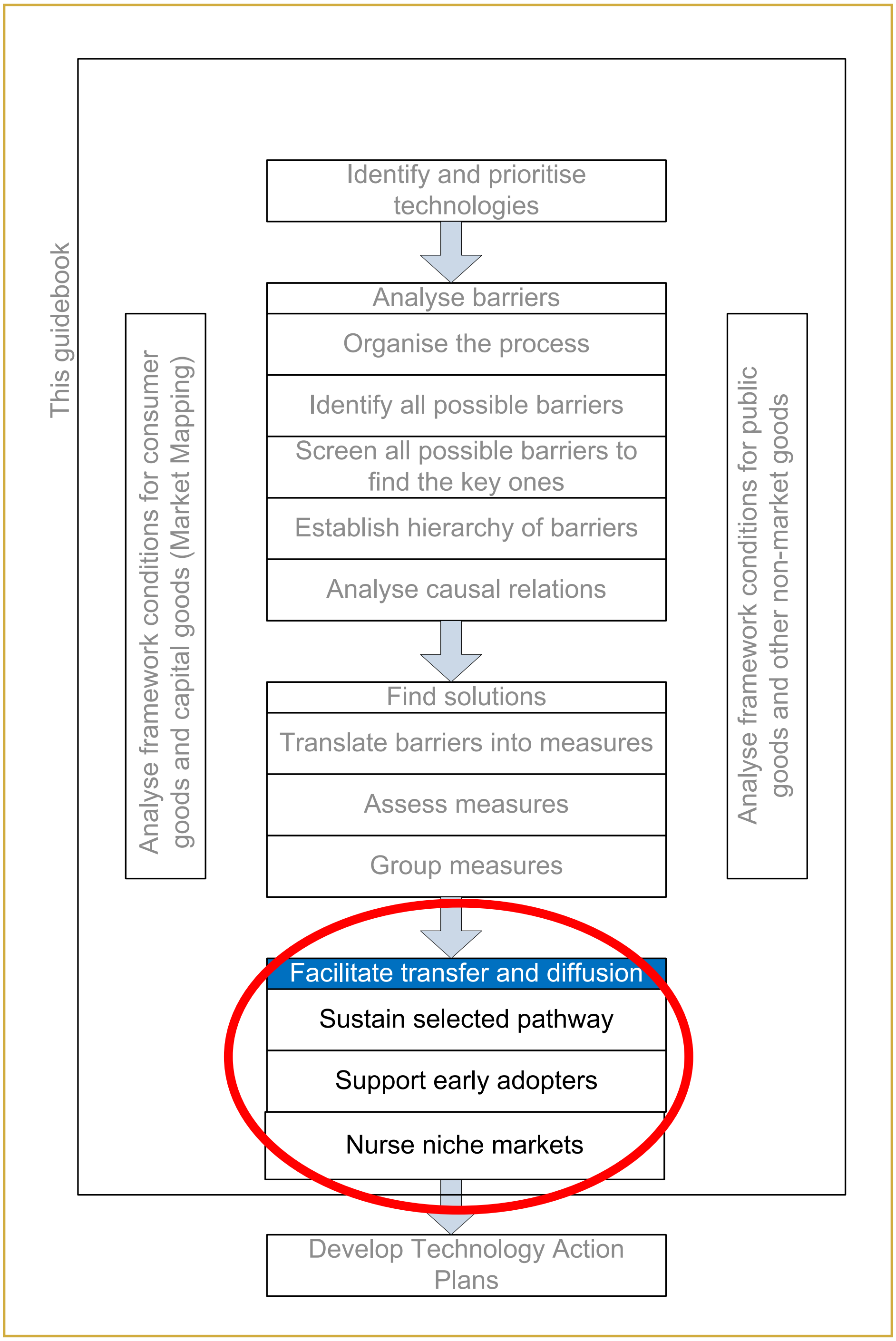
Strengthening this enabling environment element (the communications infrastructure) would therefore contribute significantly to diffusing storm shelters.

Another example might involve a situation where a local farming community opposes the introduction of a new technology, such as an unfamiliar cropping technique, because of the (mis)perception that the technology is useless or ineffective in catering for local farming needs. The elements of the enabling environment relating to information and education should thus be strengthened to overcome the community resistance barrier. This may be in the form of awareness raising campaigns, information dissemination (including site visits, presentations, and more) and promotional activities.

6.4 Summary

Chapters 3 and 4 provided general guiding principles on how to analyse barriers to the transfer and diffusion of climate technologies and how to identify measures to overcome them. Chapter 5 supplemented this general approach by introducing market mapping as a tool to explore barriers and propose measures for market-based technologies. The present chapter has focussed on the specific challenges to the diffusion of non-market technologies. It has been shown that the general enabling framework for these technologies can be strengthened by specific means. However, compared to the technologies in the market goods category, government and government institutions have much higher direct influence on the diffusion of technologies which fall into the 'non-market goods' category. For some of these technologies, such as early warning systems, which mainly involve the creation of new institutions, the boundary between technology and measure becomes blurred, as governments can create new institutions as a measure.

Chapters 3, 4, 5 and 6 form the basis for recommendations on how governments can facilitate the actual diffusion of new technologies. This is the theme of the next chapter, whose place in the overall structure of the guidebook is indicated by the red ellipse in the figure below.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Develop Technology Action Plans
Analyse framework conditions for consumer goods and capital goods (Market Mapping)
Analyse framework conditions for public goods and other non-market goods

Photo: Andreas Flensborg

7. Kick-starting Actual Technology Transfer and Diffusion

Having identified and analysed the barriers to technology transfer and diffusion (Chapter 3) and understood the specific framework conditions (Chapters 5 and 6), a solid foundation has been laid for determining how actual technology transfer and diffusion can best be facilitated. As explained in section 2.4, it is the initial phase of diffusion, when the reliability, practicality and financial feasibility of the technology are to be demonstrated, that is the most critical phase. The present chapter therefore highlights how to overcome general barriers to the initial transfer and diffusion. Some of the suggestions and recommendations may be included in the Technology Action Plans.

7.1 Pathways for technology transfer and diffusion

This section addresses the policy options available to encourage the transfer and diffusion of technologies. The pathways, also called channels or mechanisms, for transfer and diffusion will depend on the country context and type of technology. Also, it is essential to be observant as to who is transferring or diffusing the technology by elaborating on the interests and perspectives of different actors in their attempts to do so. For instance, in the case of an improved stoves programme, the drivers and interests of the diffusers will be different from those of a large private-sector company that is looking to broaden its market in a developing country (cf. section 5.6 on stakeholder analyses).

There are several pathways through which the various stakeholders can interact in order to transfer and diffuse technologies. The most common include:

1. Trade in goods and services.
2. Direct trade in knowledge via licensing.
3. Foreign direct investment (FDI). Money invested in production by a foreigner rewarded with part-ownership (stocks) of production. For example, a foreign corporation may finance a factory in return for stock certificates, giving a share of the profits from production and some voting rights in the enterprise management.
4. Joint venture. A contractual agreement joining together two or more parties for the purpose of executing a particular business undertaking. All parties agree to share in the profits and losses of the enterprise.
5. Sub-contracting. E.g., an international company sub-contracts a local company to employ its technology.
6. Equity investment. Money that is invested in a firm by its owner(s) or holder(s) of common stock (ordinary shares), but which is not returned in the normal course of the business. Investors recover it only when they sell their shareholdings to other investors, or when the assets of the firm are liquidated and the proceeds distributed among them after satisfying the firm's obligations.
7. Fee-for-service. The service provider owns the installation, and the consumer pays a regular fee.

8. Franchising. An agreement whereby one party (the franchisor) provides another (the franchisee) with the right to carry on a business under a system or marketing plan and using a trade mark or symbol owned by the franchisor in return for a fee paid by the franchisee.
9. Concession. A business operated under a contract or license associated with a degree of exclusivity in business within a certain geographical area, granted by the government or a public entity. An example is a contract between the authority owning public service infrastructure (e.g., roads, power, water, telecommunications) and a private party, allowing the latter to operate the public assets and retain the revenues for a specified period (usually 20–30 years).
10. Donation. Official development assistance (ODA) and government assistance programmes.
11. Cooperative research arrangements and co-production agreements.
12. Deployment of staff, including exchange of scientific and technical personnel.
13. Promotional activities, such as marketing.
14. Science and technology conferences, trade shows and exhibits.
15. Education and training (of nationals and foreigners).
16. Open literature (journals, magazines, books and articles).

Each pathway represents different types of flows of knowledge, money, goods and services among different sets of stakeholders. Each pathway has very different implications for the learning that occurs and ultimately the degree of knowledge transfer that takes place beyond simple hardware transfers.

IPCC has classified pathways into three primary types (IPCC, 2000; Section 1.6, page 57):

1. government-driven pathways are technology transfers initiated by government to fulfil specific policy objectives;
2. private sector-driven pathways primarily involve transfers between commercially oriented private-sector entities and have become the dominant mode of technology transfer;
3. community-driven pathways are those technology transfers that involve community organisations with a high degree of collective decision-making.

For a government, the key issue is whether the pathway is driven by the government or not. Governments are in direct control of some important technologies (e.g., power transmission lines, water supply systems, city mass-transport systems), and these will require government-driven pathways. In such cases governments can use direct interventions.

For private-sector and community-driven pathways, the government's role is more a matter of setting frameworks for and facilitating smooth passage through pathways. If, for example, the pathway of 'direct sales' needs to be pursued as a primary measure for technology transfer and diffusion, then government has certain rules to facilitate technology transfer and diffusion. That would essentially be to reduce import duties and improve the system for standards and certification. The other issues mentioned (advertising, product compatibility) leave little room for government action.

At a general level, experience and theory provide ambiguous guidance regarding the benefits of alternative pathways. Much depends on the capacities to absorb and adapt technologies, and other factors. However, Hoekman et al. (2004) offer extensive discussion and some 'rules of thumb' about the predominant pathways, i.e., trade in goods and services, foreign direct investment, direct trade in knowledge via technology licensing and movements of people. The analysis argues that:

1. International technology transfer is predominately mediated by national policies rather than by international policies.
2. The relationships between the various pathways of technology transfer are complex. Trade and FDI are often complementary, whereas FDI and licensing may be either complementary or substitutes. International movements of staff are often needed to allow trade, licensing or FDI to occur or to increase the efficiency of such transactions.
3. Open trade policies are critical for developing countries in attracting technology. But openness is not sufficient: there also needs to be an absorptive capacity and the ability to adapt foreign technology, both of which are related to human capital endowments. The implication is that the liberalisation of trade and open FDI policies need to be complemented by policies to strengthen domestic R&D programmes and private and public research laboratories and universities, as well as provide a sound basis of technical skills and human capital accumulation for countries to take full advantage of technology transfer.
4. The nature of international technology transfer and appropriate policies follow a technology ladder. Many middle-income developing countries are at the duplicative imitation stage, hoping to absorb free or cheap foreign technologies into labour-intensive export production and evolve higher value-added strategies over time. Licensing is a key source of technology transfer for these countries.
5. The poorest countries have barely stepped on to this rung of the ladder. Given weak business environments and weak absorptive capacity, licensing is not a realistic option for LDCs. Instead, the emphasis should be on using trade to benefit from foreign knowledge and acquiring technology through FDI. With this pathway, foreign enterprises generally transfer technological information to their subsidiaries or local joint-venture companies, some of which may 'leak' into the host economy. Government's role is then to optimise this spill-over effect.
6. Given the limited guidance offered by theory, it is helpful to revisit briefly the history of successful efforts to move up the technology ladder. Japan is a pre-eminent example of a country that developed technological capacity rapidly. Korea is another technology follower that encouraged learning via duplicative imitation of mature technologies that foreign firms had permitted to enter the public domain or were willing to provide cheaply. Brazil, Mexico, Malaysia and the export-intensive regions of China and India are other examples of movement from 'pure' to 'creative' imitation.

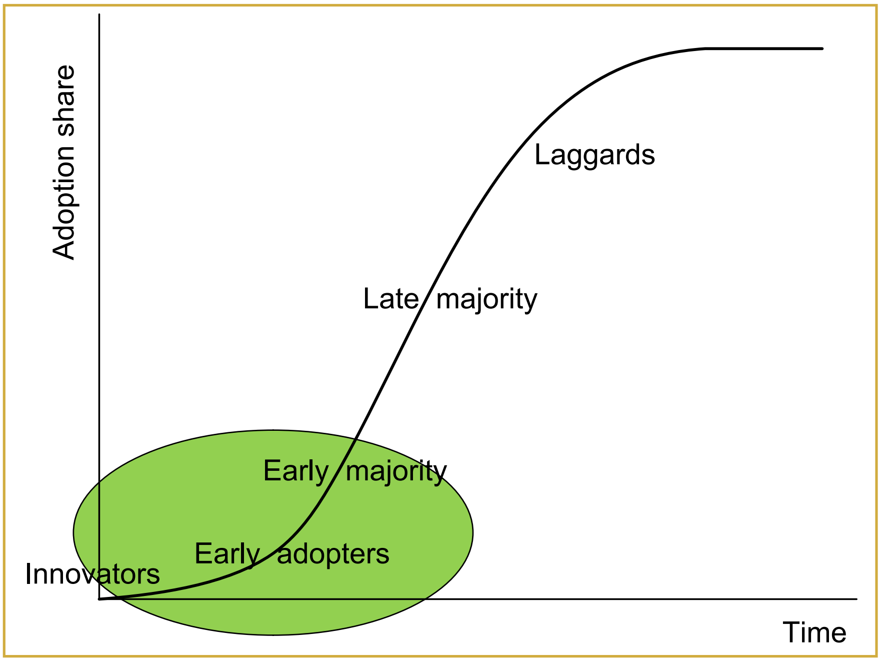
7.2 The essential role of early adopters

A key challenge in facilitating the initial diffusion is to identify candidate innovators and early adopters (cf. section 2.3). Most technology transfer and diffusion happen within the private sector, but governments may play a crucial role through direct support to innovators and early adopters or through duty exemptions, tax holidays or support to manufacturing facilities. Governments or local authorities may also stimulate the interest of potential early adopters, e.g., by 'green procurement'.

For the purposes of this guidebook, 'early adopters' and 'prime movers' are used almost synonymously, although a distinction can be made. An early adopter adopts the new technology entirely for his or her own sake (unwittingly motivating others to follow the good example), while a prime mover actively persuades others to adopt the technology for commercial or other reasons.

Early adopters thus pave the way for the early majority, often by providing a good example to their neighbours or people in equivalent positions (e.g., shopkeepers and hotel managers). Therefore, a high concentration of the early majority is often seen in geographical proximity to the early adopters, and from there further adoption spreads geographically. To facilitate such a development, it can thus be instrumental to motivate and support early adopters in a concentrated geographical area, in order to enhance the mouth-to-ear effect among neighbours.

Figure 7.1: The S curve of technology diffusion.



The S curve (cf. Figure 2.1 in Section 2.3) highlighting the early stages, where the market may need some support from the government.

In general, the transfer and diffusion of a new technology is a long, uncertain and complicated process. Since the introduction of a new technology often involves the decline of an incumbent one, actors can be expected to try to obstruct the development of the new one, for example, in the political arena. Hence, strong actors, or groups of actors, who can promote the new technology need to emerge. In other words, 'prime movers' are key actors in the introduction of new technologies. They perform four important tasks in promoting the new technology: raise awareness, undertake investments, provide legitimacy and diffuse the new technology. The key issue is to understand why and how such actors emerge and in particular how their emergence and sustained existence can be supported (Jacobsson and Johnson, 2000).

Often, prime movers are located within the capital goods industry. A strong local capital goods industry can have additional beneficial effects on the local rate of diffusion in at least three ways. First, the capital goods industry often acts as an educator of users. Secondly, a strong local supplier industry is in a favourable position to satisfy the sometimes specific demands of the local market. Thirdly, a developed supplier industry can more easily influence the institutional set-up through the sheer force of its economic importance (Jacobsson and Johnson, 2000).

The role of a prime mover may be played not only by individual actors; a constellation of actors is another possibility if a number of actors share an interest in promoting a new technology. The prime movers of renewable technologies, which are often small-scale and decentralised, might be clusters of smaller firms organised in new networks, which perhaps are specific to each renewable energy technology. For instance, one could well imagine that suppliers of solar collectors form networks with construction firms, as well as with housing co-operatives.

For consumer goods and other non-market goods, the innovators and early adopters are often among the young and highly educated within the targeted group.

7.3 Niche markets and application areas

A niche market is a focused, targetable portion of a market, where new technologies can benefit from learning opportunities. A business that focuses on a niche market is addresses a need for a product or service that is not being addressed by mainstream providers or is not attractive to mainstream consumers.

In the context of technology transfer and diffusion, a niche market is a segment in which a technology that may generally be considered too costly or too risky may be the first choice for several customers. By focussing on such market segments, the technology infrastructure may be developed, so that a broader marketing strategy can become feasible afterwards. Theories of niche markets and cases of best practice can be found in the strategic niche management literature.[19]

A well-known example is the installation of solar PV systems in remote rural settings and on islands, where other energy supply options are extraordinarily expensive, or where there are customers with a high willingness to pay, e.g., rural dispensaries (for vaccine cooling) and telecommunications. A focussed initial introduction of PV systems in such niche markets will demonstrate the technology, activate local entrepreneurs and increase learning in government agencies, institutions and NGOs, thereby paving the way for the development of measures that can ease the introduction of the technology into other market segments.

Ghosh et al. (2006) suggest a possible approach which involves a focus on specific 'application areas' that satisfy a set of criteria that are critical to large-scale diffusion, and then tailoring the scaling up strategy to the characteristics of the user groups for each application. Exemplified by biomass gasifiers in India, four broad application categories are suggested:

1. enhancing process-heat delivery efficiencies in small and medium-sized enterprises (SMEs)
2. substitution of traditional and inefficient biomass burning in informal enterprises
3. captive power supply in enterprises where there is an availability of excess and waste biomass, which in some cases may be cheaper than grid power and offer higher reliability
4. electric power supply in rural areas

Moving from categories 1 to 4, the technology becomes increasingly advanced, i.e., more complex, more expensive and with more market barriers.

The term 'application area' is used above as an equivalent to niche market, except that it is used for technologies being transferred and/or diffused outside market conditions. It can be a good idea to try out particular innovations on a small scale, e.g., a bus rapid transit route, a pedestrianised street, a form of traffic calming, or a policy of keeping freight trucks out of congested areas that are important for pedestrian interactions. Trialling the innovation in a small area and carefully studying the results is a way of ensuring that policy implemented on a larger scale is well-considered and well-tested, based on lessons learnt from one or more trial applications. Also, external funding may be easier to obtain if the innovation is undertaken in this staged way, with a small amount of funding for the trial, and full funding once the viability and details of the innovation have been established.

Although, the concept of the ‘niche market’ has been developed for a market context, it may also be applied for other non-market goods, i.e., new technologies that are initially introduced in segments of society where the chances of success are greater than in other segments, in order to achieve a learning effect and enhance the growth of expectations. Increases in expectations arise as growing uptake reduces uncertainty and both users and suppliers gradually become more confident about the quality, performance and longevity of the technology. For example, technology target communities in each country have a unique set of characteristics in terms of livelihood strategies, access to resources and services, opportunities for diversification of livelihoods and local governance processes and structures. One aim in enhancing technology transfer and diffusion is to demonstrate models of best practice for selected technologies in areas where there is good experience from previous development interventions that can be scaled up and replicated across a range of climate and socio-economic contexts.

7.4 Summary

While Chapters 3, 4, 5 and 6 addressed barriers and measures at the technology level, the present chapter has addressed barriers and measures at a more general level. The chapter starts out by providing an overview of the various business models or pathways which may be used in the transfer and diffusion of technologies. This opens a discussion of choices between direct sales, turnkey contracts, joint ventures, licensing agreements or other pathways to knowledge transfer in the design of programmes for technology transfer. The next chapter goes on to discuss the essential role of early adopters and how they can be identified and supported. This leads to a more detailed description of the important role of niche markets in the early stages of diffusion of technologies, and how niche markets can be created. The background information on technology transfer and diffusion provided may be useful when identifying elements of an enabling framework, to be included in the final product, the Technology Action Plan. The next chapter will provide a brief summary of all the steps from the stage where technologies have been selected up to elaboration of the Technology Action Plan. Elaboration of the action plan is outside the scope of this project, but more information can, as mentioned previously, be found on the TNA project website: www.tech-action.org

Photo: Andreas Flensborg

8. Overcoming Barriers: A Brief Summary

This guidebook has addressed the process of overcoming barriers to the transfer and diffusion of technologies. Although there is no pre-set answer to enhancing technology transfer and diffusion, the present chapter summarises some general recommendations on how the opportunities for successful technology transfer and diffusion may be enhanced by a systematic and informed approach to overcoming the barriers.

1. For some technologies the challenges may be immense, conceived as next to impossible to overcome. Thus for the purpose of gradually increasing the learning of how to facilitate the actual transfer and diffusion of technologies, it is recommended that the TNA Team begins applying the processes described in this guidebook by focussing on those high-priority technologies that only need modest government intervention to become successfully transferred and diffused, in order to achieve positive experience with the entire process and to avoid frustration from aborted attempts.[20]
2. Barriers can be identified quickly by taking inspiration from a gross list, as in Annex A. However, it is advised to: 1) conducting a desk study of policy papers and other pertinent documents to identify the primary reasons why the technology is not currently in widespread use; 2) supplementing this with expert and stakeholder interviews (either directly or by using questionnaires); and 3) conducting a workshop with key stakeholders (Chapter 3). Then Annex A can used to check whether any essential barriers have been forgotten or ignored.
3. The next step is to analyse the identified barriers. This can begin by ranking the barriers according to significance (section 3.3) and/or classifying them into a hierarchy of categories (section 3.4).
4. More important is to understand the linkages between barriers, including which barriers are only symptoms of problems and which are real problems. For this purpose, root cause analysis (section 3.5) may be applied. A short-cut is to let the TNA Consultant do the analysis, but a better result can be achieved by involving stakeholders in a workshop. A more thorough approach is to do a Logical Problem Analysis (sections 3.5 to 4.1). This will need a longer workshop, but an added benefit is that this method can also be used to translate the problems into solutions. In doing so, by the end of the day stakeholders' views will have been collected on which measures are needed to overcome the barriers.
5. In order to prepare an optimum selection of measures by policy-makers, they should be assessed, i.e., their potential benefits should be compared with their potential costs (section 4.2). For policy-makers it is often most important to have a socio-economic assessment, while for the owners and users of the technology a financial assessment will be more relevant. If the result of an assessment shows that it is not feasible or otherwise acceptable to transfer and diffuse a particular technology, it may be necessary to review the identification and prioritisation of technologies and go through the subsequent steps again.
6. In order to achieve a significant impact on the transfer and diffusion of a specific technology, it is necessary to apply a relatively broad set of complementary measures addressing barriers at various

levels. This means that measures should be considered from most of the categories used under identification and grouped into sets of complementary measures.

7. Steps 1–7 are general steps that may be followed for every technology, but technologies are different, and steps 8–10 may be conducted prior to or in parallel with the barrier analysis described in Chapters 3 and 4, both to strengthen that analysis and to prepare the subsequent steps 11–13.
8. For a technology that is transferred through a market chain, it is suggested that an analytical tool be used to understand properly the market system prior to the analysis of the barriers that are hindering the introduction of the technology into the local market. It is recommended to use market mapping (Chapter 5) for consumer goods and capital goods. The need for a thorough market assessment is not equally important for publicly provided goods.
9. A quick solution is to produce a preliminary market map (section 5.4). This can be produced by the TNA consultant using existing literature and information gathered from key informants. But if considered expedient, and within the given time and resource constraints, it is suggested that the participatory market approach be applied (section 5.5), involving the market players. In this way, the market map will be of better quality. But more importantly, the participatory market chain approach can facilitate the collaboration that is necessary for bolstering trust and improving linkages and efficiencies within the market chain, as well as for effective lobbying on business environment issues and in coordinating activities. An essential outcome of the overall process is the possible creation of a network among the market actors themselves, thus improving the ground for introducing or generating innovation in products, processes and market access. Thus, this approach will be part of the solution, not only an analytical tool.
10. A different approach is needed for non-market goods. The transfer of technologies in the 'publicly provided goods' category may seem simpler than for 'consumer goods' and 'capital goods', mainly because government has a direct influence over the transfer and diffusion of most publicly provided goods, but only indirect influence over the transfer and diffusion of consumer goods and capital goods, which are market-based (section 6.1). For other non-market goods, it is of particular importance to take adequate account of the technology recipients (section 6.2).
11. When international transfer of a technology is needed, a proper pathway for the transfer should be selected, e.g., foreign direct investment or trade in goods or knowledge (section 7.1). Experience does not provide unambiguous guidance, but there are some 'rules of thumb', in particular regarding what appears to be most appropriate for middle-income developing countries and the poorest countries respectively. The role of government on the supply side is to ensure the enabling policy framework.
12. In preparing the diffusion of the selected technology, it is often essential that both the demand for and the supply of the technology is nourished. To support the demand side, it is recommended to focus substantial attention on the most critical phase of diffusion, the so-called 'take-off' (cf. section 2.4), in particular by identifying early adopters (section 7.2). These are either found in particular niche markets (section 7.3) or may be more dispersed.
13. At the end of the assessment and grouping process (step 6, with inputs from steps 8-12), several competing sets of measures may have been identified, each of them leading to the same outcome, but with different costs and impacts. The final choice of one set of measures in favour of another is a political question which needs to be discussed at the highest level in the ministries and governmental agencies involved before selecting the final set of measures to be presented in the Technology Action Plan.

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ANNEXES

Annex A.
Generic Barriers to the Transfer and Diffusion of Climate Technologies

This annex presents a gross, but not exhaustive list of generic barriers, based on a range of sources.

Barriers can be explored and analysed at four levels (Painuly, 2001):

1. broad categories of barriers (e.g., economic and financial)
2. barriers within a category (e.g., high cost of capital)
3. elements of barriers (e.g., high interest rate)
4. dimensions of barrier elements (e.g., 15 % per annum for households)

For some categories it may be useful to insert a fifth level between levels 1 (category) and 2 (barrier), clustering barriers with common features.

The definition of categories is very much a matter of taste and can therefore be done in numerous ways. ENTTRANS (2007) categorised all barriers according to the different aspects of the market map: market chain aspects, enabling environment aspects and support services aspects. The categories used in this annex are more in line with traditional thinking. A central consideration has been to formulate a system that is practical in bringing the technology transfer process forward.

The distinctions between the categories are not clear cut and cannot be, simply because there are essential overlaps and linkages. For example, institutional and technical barriers will sooner or later appear as economic and financial barriers. Describing such complexity is difficult, and the system of categories has primarily been defined for ease of presentation – and hopefully for ease of understanding.

A way to use the barrier list is first to do your own barrier identification, and afterwards to use the list for checking whether any essential barriers have been forgotten or ignored.

The following format is used:

Barrier category

Barrier

- Barrier element

  with explanations in parenthesis (…).

The fourth level, dimensions of barrier elements, has been ignored in this presentation.

1. **Economic and financial**
   a. Lack or inadequate access to financial resources
      i. Lack of financing instruments and institutions
      ii. Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations)
      iii. Lack of venture capital
      iv. Lack of access to credit for certain consumers
   b. High cost of capital
      i. Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)
      ii. Government policies on cost of capital (e.g., high tax on profits)
   c. Financially not viable
      i. High up-front costs
      ii. High resource costs (material, labour, capital)
      iii. High modification and implementation costs
      iv. High discount rates (customers have a strong preference for the money they have today over the same amount of money tomorrow; in particular, private manufacturers and very poor people have a short economic horizon, while utilities have a longer horizon; discount rates for climate technologies may be higher than usual due to risk or uncertainty being perceived as high)
      v. Use of payback time criterion limits consideration of overall economic lifetime benefits
      vi. Low affordability amongst rural and peri-urban dwellers
      vii. Inadequate resource base (due to actual lack of or fierce competition for resources)
   d. High transaction costs
      i. Gathering and processing information (feasibility studies; due diligence)
      ii. Technology acquisition, implementation etc.
      iii. Bureaucracy, procedures and delays
      iv. Costs underestimated in economic analysis
   e. Inappropriate financial incentives and disincentives
      i. Favourable treatment for conventional energy and large-scale projects (subsidies, low taxes)
      ii. Insufficient incentives to develop climate technologies
      iii. Split incentives (the decision-maker, e.g., a property developer of collective dwellings, receives little or no incentive, whereas the users, e.g., the tenants, receive the benefits of energy savings)
      iv. Non-consideration of externalities (negative externalities (pollution, damage from this) from conventional energy not considered in pricing, positive impacts of climate technologies not valued)
      v. Taxes on climate technologies (high import duties on equipment, duty exemption limited to small products, other direct or indirect taxes on climate technologies)
      vi. Difficult or expensive to export profits
      vii. Non-tariff barriers on import/export of climate technologies
      viii. Consumers pay below marginal cost
      ix. Average cost pricing is done

f. Uncertain financial environment
   i. Uncertain electricity tariffs (e.g., non-transparent tariff adjustment procedure)
g. Uncertain macro-economic environment
   i. Volatile inflation rate and high price fluctuations
   ii. Unstable currency and exchange rates
   iii. Balance of payment problems and uncertain economic growth

2. Market failure/imperfection

a. Poor market infrastructure
   i. Poorly articulated demand
   ii. Difficult procurement (by consumers; e.g., inconvenient product location)
   iii. Missing or under-developed supply channels (e.g., logistic problems)
   iv. Disturbed or non-transparent markets
   v. Lack of liberalisation in energy sector
   vi. Mismanaged energy sector
b. Underdeveloped competition
   i. Insufficient number of competitors (property developers and rental market have no incentive to invest)
   ii. Regulations prohibiting entry into the energy sector
   iii. Unwieldy requirements for entry
   iv. Lack of level playing field (fair competition)
   v. Market control by dominant incumbents implies that the selection process may not involve a free choice by customers
c. Restricted access to technology
   i. Technology not freely available in the market
   ii. Lack of product visibility
   iii. Technology developer not willing to transfer technology
   iv. Problems in import of technology or equipment due to restrictive policies, taxes etc.
d. Inadequate sources of increasing returns
   i. Economies of scale and experience of new technologies cannot be achieved
   ii. Economies of scale only at high investment level
   iii. Market size small (small market potential, low density of consumer demand, limited or difficult access to international market)
   iv. Low ability or willingness to pay among consumers
e. Market control by incumbents
   i. Well-established and more competitive or cheaper alternatives
   ii. Barriers created by existing suppliers

        iii. Monopolistic or quasi-monopolistic utility model (prevents new market entrants)
    f. Lack of reference projects in country
    g. Unstable market situation, which hinders the procurement of international technological investment from donors
    h. Fair trade policies

3. Policy, legal and regulatory

a. Insufficient legal and regulatory framework
    i. Absence of laws and bylaws on climate technologies (contract law, IPR protection)
    ii. Complex procedures, e.g., power generation permits, customs formalities
    iii. Legislation may favour incumbent technology
    iv. Lack of government faith in climate technologies, unsupportive policies
    v. Inadequate or unwieldy regulations for climate technologies
    vi. Lack of coherent economic policies (e.g., alignment of fiscal policy with tax regimes)
    vii. Absence of plans and programmes (e.g., rural electrification plan or programme)
    viii. Inappropriate balance between the protection of IPR and the promotion of technology transfer
    ix. Unclear arbitration procedures
b. Inefficient enforcement
    i. Missing or ineffective executive and regulatory bodies
    ii. Insufficient willingness or ability to enforce laws and regulations
    iii. Lax attitude
c. Policy intermittency and uncertainty
    i. Uncertain government policies (= political risks for investors)
    ii. Lack of long-term political commitment
    iii. Stability of laws (frequent amendments)
d. Clash of interests (struggle in the political arena between proponents of new and incumbent technologies)
    i. ESTs go against the perceived interest of the dominant actors in the sector
    ii. ESTs perceived as a threat to utility monopoly and to utility profit
e. Highly controlled energy sector (may lead to lack of competition and inefficiency)
    i. Government or utility monopoly of energy sector
    ii. Private sector entry restricted (e.g., independent power producers)
f. Red tape (bureaucracy)
g. Rent-seeking behaviour and fraud

4. Network failures

a. Weak connectivity between actors favouring the new technology

    i. Stakeholders dispersed and poorly organised
    ii. Multiple stakeholder collaborative learning and knowledge transfer activities absent or weak
    iii. Insufficient coordination between relevant ministries and other stakeholders
    iv. Insufficient cooperation between industries and R&D institutions
    v. Absence of trade associations and effective consumer bodies (problems and views on barriers cannot reach the policy-makers effectively; no or weak lobbying to facilitate technology transfer)
  b. Incumbent networks are favoured by legislation etc.
  c. Difficult access to external manufacturers
  d. Lack of involvement of stakeholders in decision-making
    i. Stakeholders' consultation culture missing
    ii. Difficult communication
    iii. Fear of opposition

5. Institutional and organisational capacity

  a. Lack of professional institutions
    i. Lack of institutions or mechanisms to generate and disseminate information
    ii. Lack of institutions to promote and enhance market
    iii. Need for specialised agencies at planning level and operational level (ESCOs)
    iv. Lack of a regulatory body in the energy sector
    v. Lack of institutions to support technical standards
  b. Limited institutional capacity
    i. Lack of interest or capacity in existing institutions
    ii. Limited institutional capacity to solicit ideas and encourage potential entrepreneurs
    iii. Limited R&D culture (R&D facilities missing, lack of capacity for R&D, lack of appreciation of R&D role in technology adaptation)
  c. Small size of local companies (limited ability to absorb new techniques and information)

6. Human skills

  a. Inadequate training facilities
    i. Lack of experts to train
    ii. The educational system may fail to react quickly enough to the emergence of new generic technologies
  b. Inadequate personnel for preparing projects
    i. Lack of domestic consultants (to reduce transaction costs)
    ii. Lack of experts in negotiating IPR contracts
  c. Lack of skilled personnel for the installation and operation of climate technologies
    i. Lack of entrepreneurs (relatively low profitability, unwieldy or restrictive regulations; may lead to lack of competition and supply constraints)

d. Lack of service and maintenance specialists

7. Social, cultural and behavioural

a. Consumer preferences and social biases
    i. Aesthetic considerations, product lacks appeal
    ii. High discount rates of consumers (mentioned under 'Economic and financial')
    iii. Lack of social acceptance for some climate technologies (e.g., landfill or manure gas for cooking may not be acceptable)
    iv. Technology stigmatisation (a technology is perceived as 'for the poor', e.g., mud-stoves)
b. Traditions and habits
    i. Resistance to change, due to cultural reasons
    ii. Need for users to modify behaviour (e.g., solar cookers certainly require people to modify their cooking habits)
c. Lack of confidence in new climate technologies
    i. Unknown product, due to inadequate information, lack of local participation
    ii. Technology seen as alien and of no use
d. Dispersed or widely distributed settlements
e. Inadequate understanding of local needs
    i. Lack of stakeholder involvement
f. Gender participation

8. Information and awareness

a. Inadequate information
    i. Poor dissemination of information to technology users (on product, benefits, costs, financing sources, potential project developers etc.)
    ii. Poor infrastructure for communication of small-scale project support
    iii. Lack of market information
    iv. Lack of knowledge or access to climate technologies resource assessment data, implementation requirements
    v. Lack of agencies or agencies ill-equipped to provide information
b. High risk perception of climate technologies
    i. Uncertain new technology
    ii. Uncertain benefits
    iii. High investment risks
    iv. Irreversibility of investment and a lack of flexibility of plant and machinery for other uses
    v. Perception of complexity
c. Lack of media interest in promoting technologies

d. Language
e. Feedback mechanism lacking or inadequate
f. Lack of awareness about issues related to climate change and technological solutions

9. Technical

a. Product not reliable
    i. Lax quality control
    ii. Poor documentation of reliability
    iii. Need to modify and demonstrate unfamiliar products to local conditions
b. Poor O&M facilities
    i. Lack of skilled personnel
    ii. Slow after-sales service
    iii. Limited availability of spare parts (few suppliers, long supply routes)
    iv. Need to import spare parts
c. Inadequate standards, codes and certification
    i. Lack of institutions or initiatives to set standards
    ii. Lack of facilities for testing and certification
    iii. Insufficient quantity and quality of controlling and measuring equipment
    iv. Standards not obligatory
d. Technical risks
e. Uneven technical competition
    i. Lack of scale and experience
    ii. Poor performance in relative terms
    iii. Weak infrastructure (ESTs may need strong physical infrastructure such as roads and electric grid)
f. System constraints
    i. Capacity limitation with grid system (e.g., intermittent RET electricity)
g. Complexity of new technology, insufficient expertise

10. Other Barriers

a. Environmental impacts
    i. Local pollution
    ii. Ecological aspects
    iii. Competition for resources
    iv. Divergent plans, incentive structures and administrative requirements from different donors, finance institutions and government branches

Annex B.
Technologies for Climate Adaptation

Until now most interventions and discussions regarding the transfer of climate technologies have focussed on mitigation technologies, one reason being that many professionals have only a vague idea of what adaptation technologies actually are. In the context of this guidebook, it therefore appears relevant to facilitate a clearer and more concrete understanding of adaptation technologies: what are they, and which particular features necessitate diverging approaches?

Adaptation is defined as adjustments to natural and human systems to reduce their vulnerability to actual or expected climate change effects. Various types of adaptation exist, e.g., anticipatory and reactive, private and public, and autonomous and planned. Vulnerability 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. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity.

The vulnerability and capacity of societies to adapt to climate variability and change is determined by a number of different factors, such as income levels, education, institutions, health status, knowledge, and skills and technology, to mention just a few. Consequently, most adaptation measures are carried out as part of larger sectoral or national initiatives involving, for example, planning and policy development, integrated coastal zone management, water resource management, health programmes etc. On the other hand, actions which contribute to adaptive capacity may also be unrelated to climate change concerns, for example, education and poverty reduction. Consequently, the strengthening of adaptive capacity is a precondition for the design and implementation of adaptation strategies, and technology is one among many elements that are commonly scarce in a developing country setting.

Nationally, many countries have conducted vulnerability and adaptation needs assessments as part of their National Communications, proposed adaptation projects for funding in National Adaptation Programmes of Actions (NAPAs), and made submissions on approaches and strategies for adaptation under the Nairobi Work Programme. Furthermore, some TNAs have been conducted that include climate change adaptation. These activities, conducted at the national level, provide essential background materials and a starting point for more specific and improved TNAs for climate change adaptation. However, it is a new area of effort to study aspects of technology needs assessments in the area of adaptation to climate change, and there are a number of prevailing challenges.

Although most initiatives and measures for adaptation to climate change involve some form of technology, adaptation issues are rarely characterised along technology lines. Also, given the blurred boundaries between adaptation and sustainable development, few technologies can be defined as technologies for adaptation per se, with the exception of genetically designed seed varieties and coastal engineering technologies.

A common practice of mitigation has been the transfer of technologies from developed to developing countries. Transfers for adaptation may not follow the same patterns. Climate adaptation is often the continuation of an ongoing process, in which the same techniques for adaptation have been used for generations (for example, building houses on stilts to cope with floods), but face barriers to their further implementation and use. Recognising that adaptive capacity is highly heterogeneous within a society or locality, much of the current understanding of human adaptation to climate change comes from local-level studies. Such studies can establish broad lessons on the adaptive capacity of individuals and communities, lessons that feed into adaptation planning. In many cases, adaptation technologies already exist to some extent. Examples include addressing the changing climate by storing water in dams so that it can be available during drought periods, or improving seed varieties with traits to improve their tolerance to stress, salinity, drought and extremes of temperature.

The entry point for identifying, prioritising and implementing adaptation technologies is primarily impact assessments and their inter-linkages with development priorities, where the most vulnerable sectors and regions or communities constitute the basis for adaptation technology assessments. A number of climate-risk screening tools, approaches and exercises have been developed to support efforts in mainstreaming climate change into development planning, including guidance on the identification, prioritisation and implementation of adaptation options. A good overview of existing tools and their applications is provided in Olhoff and Schaer (2010).

A sector categorisation is most commonly used when addressing technologies for adaptation, which is why it is the one chosen for the TNA guidance for adaptation. Table B.1 below provides a comprehensive list of adaptation technologies for different sectors.

Table B.1. Examples of adaptation technologies for different sectors (source: WTO-UNEP Climate change and trade, 2009)

Sector	Adaptation technologies
Agriculture	Systematic observation and seasonal forecasting, introduction of drought-resistant crops, crop management, land management, improved water use and availability, including rainwater harvesting, leakage reduction, hydroponic farming, building shelter-belts and wind-breaks to improve the resilience of rangelands, capacity-building of local authorities, adjustments to planting dates and crop varieties, spatially separated plots for cropping and grazing to diversify exposures, early warning systems.
Water resources and hydrology	Water transfer, water recycling and conservation (soft technologies to support the preparation of on-line, searchable flood-risk maps), water harvesting, increase reservoir capacity, desalination, erection of protection dams against avalanches and increased magnitude of potential debris flows stemming from permafrost thawing, changes in livelihood practices (e.g., by the Inuit), including changing hunt locations, diversification of hunted species, use of Global Positioning Systems (GPS) technology, encouragement of food sharing.
Coastal zones	Dykes, sea-walls, tidal barriers, detached breakwaters, dune or wetland restoration or creation, beach nourishment, indigenous options such as walls of wood, stone or coconut leaf, mangrove afforestation, early warning and evacuation systems, hazard insurance, practices such as using salt-resistant crops, building codes, improved drainage, desalination systems.

Health	Vector control, vaccination, impregnated bed nets, health education, greater care with water storage, using appropriate clothing, taking siestas in warm climates, using storm shelters, air conditioning, health education, early warning systems, implementation of heat health alert plans, including measures such as: opening of designated cooling centres at public locations; information to the public through local media; distribution of bottled water to vulnerable people; operation of a heat information line to answer heat-related questions; availability of emergency medical service vehicles with specially trained staff and medical equipment; disease monitoring and prevention and treatment, access to health services and health alert information.
Infrastructure	Urban planning to improve the efficiency of combined heat and power systems and to optimise the use of solar energy, minimise paved surfaces and plant trees to moderate urban heat island effects and reduce the energy required for air conditioning, limit developments on flood plains or potential mud-slide zones, establish appropriate building codes and standards, provide low-income groups with access to property, use physical barriers to protect industrial installations from flooding, climate proofing of investments.
Forest and ecosystems	Supporting implementation of adaptation technologies, modelling movements of species due to climate change and the vulnerability of habitat to rises in sea level.
Finance	Internalise information on climate risks and help transfer adaptation and risk-reduction incentives to communities and individuals: capital markets and transfer mechanisms alleviating financial constraints to the implementation of adaptation measures, including bank loans, e.g., for purchase of rainwater storage tanks, setting up crop insurance; creation of local financial pools (as alternative to commercial crop insurance), setting up revolving credit funds, fostering risk prevention through implementing and strengthening building standards, planning risk-prevention measures, developing best practices, and raising awareness of policyholders and public authorities. Adopting forward-looking pricing methods in order to maintain insurability (not yet implemented).

Table B.1 illustrates the wide range and multifaceted nature of available options for adaptation in different sectors. It is also clear from the above that many adaptation technologies are not new and that many have been utilised for generations to cope with climate variability and improve livelihood resilience to socio-economic stresses.

Other categorisations of technologies for adaptation may, however, be more appropriate in different contexts, e.g., according to:

1. When in the adaptation process they are implemented; technology needs for anticipatory adaptation may be different from those suitable for reactive adaptation.[22]
2. The innovation level of the technology, including: (i) traditional technologies which by definition relate to familiar methods and techniques to cope with climate variability at the community level that have been tested for generations; given their local and historical roots, it is recommended that these be taken into account as much as possible; (ii) modern technologies, for example, new crop hybrids and systems of drip irrigation making better use of limited water; and (iii) future technologies, for example, malaria vaccine.
3. The climatic zone in question: tropical, arctic, floodplain, mountains etc.
4. The actors involved: individuals, community organisations, private sector, local government, international donors etc.

Annex C.
Incentives to Diffuse Renewable Energy Technologies

Incentives to promote the diffusion of technologies are often sector-specific, and it therefore makes little sense to describe incentives in generic terms. Nevertheless, many incentives can be used in several sectors. As one example of a taxonomy of incentives, this annex focuses on renewable energy technologies.

There are several types of incentive, e.g., financial and non-financial, and incentives are targeted at different sections of the energy sector, e.g., the supply side and the demand side.

In practice several incentives are often introduced simultaneously so that they supplement one another. For instance, the effect of a new tax on electric water-heaters can be increased by simultaneously offering consumers information on solar water-heaters.

All relevant parties in the different areas of supply and demand must be actively involved when incentives are being formulated and combined. Otherwise, important opportunities could remain untapped.

The following main points should be taken into consideration when selecting incentives:

1. The incentives should be as cost-effective as possible, both for the energy sector and for society as a whole.
2. As far as possible the incentives should be self-regulating and independent of bureaucratic involvement. New initiatives should preferably be based on and interact with the interests and the technical, economic and organisational resources of the different parties themselves.
3. The incentives should aim at ensuring a gradual shift in the existing energy system, so that no sudden or significant difficulties appear in any of its sectors.

These main considerations are not always compatible. For this reason, selecting the incentives, their formulation and administration requires careful balancing of the various considerations.

Financial incentives

It is not only important that renewable energy use be increased, but also that this growth be sustainable. Large subsidies can foster a tremendous use of renewable energy, but since most subsidies are not sustainable, it is important for the technologies to become cost-competitive for sustainable and commercial markets to be developed.

If the goal is to maximise renewable energy generation, then a fixed incentive or set-aside should apply to all technologies. This minimises the incentive payments for the maximum use of renewable energy and allows future cost reductions of technologies which are currently too expensive to be deployed. This would encourage biomass power, but solar PV, solar thermal electric or wind would not be deployed until cost-competitiveness was reached through decreasing technology costs or the discovery of excellent resources. Because this goal is not technology-specific, it allows a new renewable energy technology to come on board and does not compel the use of expensive technologies or inadequate resources.

If the goal instead is to deploy and begin the commercialisation of certain technologies, then individual incentives or set-asides can be set for each technology. As an example, small incentives could be used to promote biomass power, with much larger incentives for more costly yet still promising technologies such as PV. This is a more costly and comprehensive programme that should be carefully assessed because the amount of funding needed to make PV cost-effective for utilities is quite high on a per MW basis in comparison to biomass.

In some cases one can come a long way just by removing existing distortionary subsidies for fossil fuels, thereby coming closer to a level playing field.

One incentive (probably a financial incentive) is likely to be the primary driver for renewable energy development. Supporting incentives will be needed to fill the remaining gaps in overcoming barriers to the development of renewable energy. For instance, a primary incentive which focuses on overcoming the cost-effectiveness barrier may still need financing mechanisms to overcome the high capital investment barrier.

There are many methods for governments to promote renewable energy. A summary is presented in the table below.

Incentives	Advantages	Disadvantages
Production incentives	Easy to implement. Easy for developers. Encourages renewable energy production.	Does not directly address high first-cost barrier. Can be abused if incentive too high.
Investment incentives	Overcomes high first cost barrier.	Encourages investment, not production.
Renewable set-asides	Allows control over amount of renewable capacity added. Competitive bidding encourages cost reductions.	Can be very bureaucratic. Bids may be controlled by one entity. May lead to lumpiness in installations.
Power-purchasing agreements	Long-term, standard agreements help developers and facilitate investment.	Difficult to achieve when the electricity supply industry is in the process of restructuring.
Environmental taxation	Correct energy prices, including costs of environmental impacts, provide a more level playing field for renewables.	Taxes are often politically unfavourable.
Externality adders	Allows for full-cost accounting in power planning.	Implementation does not always follow planning.
Research, development and demonstration	Builds long-term foundation for technological and industrial development.	Difficult to pick a technological winner to invest RD&D in.
Government-assisted business development	Builds market infrastructure.	
Green marketing	Allows choice in power purchases.	May be under-subscribed.

Of these, the methods that have been most successful in promoting renewable energy development are investment incentives, production incentives and set-asides. Some options, such as environmental taxation, RD&D and green marketing, have been helpful, but have not had the same impact. Other options, such as the establishment of standard power-purchasing agreements, may be a necessary condition for renewable energy promotion, but they may not be sufficient.

Production incentives

A production incentive provides a financial incentive for the generation of electricity from renewable energy. Some of the problems with this approach include the disincentive for cost-competitiveness. One way to finesse this is to design a diminishing incentive over time. Another way to limit excessive profits is to pay an incremental subsidy above conventional energy costs.

If a production incentive is used, it is recommended that:

1. The level of a production incentive should be carefully designed to encourage cost-competitiveness and efficiency in power production. This could be a function of the technology, location and time of generation. The electricity regulator would have to set this in a way that encourages least economic cost electricity generation. The full avoided economic cost of generation would be the ideal level for this production incentive. As a starting point or in the absence of quantified external costs, purchase by the generator of negative units at the wholesale electricity price could be considered. The purchase of negative units at the applicable wholesale tariff would effectively mean sale by the generator of the units at the same price as the wholesale tariff (including whatever time of use or other structure the tariff might have). There would be no premium on the renewable energy (RE) generator per unit, nor any profit to the distributor for reselling the units. In this way, there is no difference between the price paid to the generator and the price at which the distributor sells the electricity. The distributor would have to be obliged or given some other incentive (like green pricing) to buy this energy.
2. The programme should be periodically monitored and evaluated to readjust the incentive level in order to encourage renewable energy generation and discourage abuse of the incentive.
3. The incentive rules and regulations should be clearly stated so that developers and investors can easily develop projects and acquire financing.

The production incentive also does not necessarily offset the large capital investments and correspondingly high initial risks of renewable energy development. In order to deal with these problems, supporting measures, such as long-term, standard power-purchasing agreements and special financing mechanisms may be necessary. These are discussed in the next section.

Power-purchasing agreements

Clearly, one of the most important mechanisms for grid-connected renewables is the establishment of standard, reliable, long-term power-purchasing agreements. This is a key component for the success of renewable energy on the grid. It must be clear to the private sector and their financiers that they can hook up their power plant to the grid and receive a certain payment for energy over a set period of time.

In a period in which the electricity supply industry and/or the electricity distribution industry is being restructured, it may be very difficult, if not impossible, to obtain long-term contracts.

Investment subsidies

Investment subsidies and tax credits have proved easy to abuse and have been replaced with other types of incentive in some countries. Therefore investment subsidies should generally not be used as a primary driver for renewable energy development. Investment subsidies are notable for overcoming one of the main barriers to renewable energy: high capital investment costs. However, financing mechanisms (access to credit, revolving credit funds, soft loans, etc.) can also overcome this barrier and are less prone to abuse. Investment subsidies may still be very useful in promoting small-scale technologies for residential and small commercial or industrial enterprises, which have little access to good financing. If they are to be used, very careful oversight is necessary to guard against abuse.

Investment subsidies encourage the installation of renewable energy capacity. But if the power plants are sited in areas where resources are not good, if proper O&M is not carried out, or if bad designs are installed, then the result could be a large amount of installed capacity but little electricity generated.

Loan guarantees

The high investment costs of renewable energy are a significant barrier, and the finance aspects need to be examined to determine whether special finance mechanisms are needed. This will be especially necessary if investment subsidies are not used. With the recent economic crisis, preferential finance for power plants and preferential loans or tax breaks for renewable energy businesses may be necessary to encourage the private sector. Along these same lines, loan guarantees can help reduce the financing risks and thus lower costs.

Set-asides

A set-aside is a block of energy supply, e.g., 50 or 200 MW, that is earmarked for renewable energy capacity. A transparent solicitation procedure can be used to select the most competitive projects, or standard offers can be set, with energy suppliers meeting capacity on a first-come, first-served basis.

Such a demonstration programme on a limited scale can be done without either setting unwarranted precedents or changing the current cost of electricity.

The establishment of full-scale demonstration projects will fulfil several objectives:

1. significantly help resolve the concerns of energy-sector stakeholders
2. support the practical learning processes
3. bring international technology and experience to the country
4. create show-cases for the country's citizens for how clean air, clean water and sustainable energy systems can be obtained

The winning projects will receive financial support, e.g., a subsidy per kWh or a guaranteed fixed electricity tariff, to ensure attractive paybacks.

To prepare a bid for power capacity requires that the project be fully developed to the stage of banking and contracting with potential electricity buyers. This preparation can be very costly. Therefore it is very important that the bidding conditions are clear and reliable, so that the bidders can trust that their bids will be treated fairly and that the conditions offered are stable and viable. The bidding process should therefore go through a pre-qualification stage before real bids are invited. During the pre-qualification process, the bidders will outline their project, justify the fuel resources available and prove the investor's financial viability.

Many project developers can be predicted to face a lack of available expertise for solving the unfamiliar technical problems related to the project preparation phase. It is therefore recommended to establish a team of experts to assist the bidders with information and counsel to help increase the quality of the tenders. The team should be established as a special unit within the responsible ministry.

The services offered to project developers may take the form of either direct technical assistance or financial assistance to employ a consultant to carry out a pre-feasibility study.

The technical assistance should comprise:

1. resource availability analysis, e.g., availability of bagasse as a reliable fuel
2. legal and regulatory issues
3. commercial issues (power purchase agreements, fuel contracts)
4. financial issues; as some developers (power companies, multinationals) have ready access to cheap finance, whereas typical RE owners (e.g., a sugar factory or a wood industry) can only obtain much more expensive finance, the special unit could provide guidelines for project financing, including financial risk assessment
5. sector experience
6. technical issues (e.g., available co-generation technologies, contacts with equipment suppliers, complementary fuels)

To ensure sufficient diversity of the programme, the projects may be grouped into separate categories so that no one technology will eclipse the others. The programme may, for example, distinguish between the following technologies:

1. bagasse-fired combined heat and power production (CHP) plants
2. CHP in the wood and pulp industry
3. wind farms
4. mini-hydro
5. micro-hydro
6. solar thermal power generation

Among the problems identified with current set-asides include bureaucratic and expensive bidding processes, with a 'lumpiness' in installations, discouraging development of the less mature technologies.

However, the benefits of this mechanism may be worth the trouble to implement them. The key advantage of using a competitive set-aside is that it encourages cost-competitiveness with regard to renewable energy technologies. This is important because, in addition to reducing the cost to the utility and end-user, it also demonstrates to government policy-makers and the public that renewable energy technologies can be cost-effective. Another important advantage is that the government can easily determine and control the installed capacity of renewable energy generation.

Green marketing

Green pricing programs allow specified types of generator, determined by size and type of energy used, to obtain a higher payment than is generally the case. The extra costs to the utility are recovered through a special sales tariff for green electricity, which is offered to customers wanting to support renewable energy through their energy bill.

Green marketing appears to be effective in some countries and is becoming increasingly popular. However, it perpetuates the idea that renewable energy is expensive and needs support. It does not aim to decrease the cost of renewable energy, but may coincidentally have this effect in real terms in the long run.

The motivation for setting 'green tariffs' is based on the assumption that there are certain electricity customers who would be willing to pay a premium for electricity produced in a way which is deemed environmentally sustainable. This financial incentive should be provided for the generation of green energy. An alternative to a green tariff is to increase the taxed component of non-sustainable energy, thus raising electricity tariffs to the point where green-generated energy becomes cost-effective.

This offers a unique opportunity to developers of independent power producers (IPP) in that, by virtue of the higher tariffs, the income stream from a sustainable energy plant can exceed that of other generation options and offers the potential to increase the profitability of the project. If the capital and operating costs of two different IPP plants are equal, but one can sell its electricity at a higher tariff by generating it in a sustainable manner, the green option will be the preferred one. It was indeed this mechanism which was used as an incentive for the development of much of Europe's renewable energy IPPs.

In order to market green energy, a number of criteria must first be satisfied:

1. the electricity generation sector must be open to competition
2. the transmission system must be accessible to all suppliers
3. electricity distributors must not be locked into a supply contract with a single generator
4. customers must have a choice of suppliers
5. a certification system for electricity must be in place to ensure that electricity sold as green has indeed been generated in a sustainable manner

The last point is very important in terms of the structure of the electricity market. The actual mechanism used to promote green energy will have a deep impact on the market's structure and development. The different options followed in Europe and the different effects that result have shown that there is currently no ideal model that will lead to an increased uptake of sustainable energy without skewing the market in an inefficient manner. The conditions described above are those that would be found in a liberalised electricity market with competition at least in generation and distribution.

Non-financial incentives

Liberalisation of the energy market

The single most important facet of a country's regulatory approach is its attitude to liberalisation, that is, the opening up of its energy market to private and international finance, expertise, ownership and control. On the face of it, any measures that relax government control over the power industry and encourage private investment and reform would seem to be positive for sustainable energy investment, since reform attracts international investment and expertise, encourages competition and efficiencies, and provides governments with capital to reinvest in renewable energy sources (amongst other things). However, in some countries concerns have been raised about the adverse impacts that increased competition has had on equity and environmental goals, as well as the ability of a competitive market to ensure sustained investment and security of supply at low prices in the long term. Different advantages and problems for sustainable energy development may be experienced at each stage of liberalisation.

Aside from the obvious environmental effects, renewable power production has three main differences from non-renewable power production that must be considered in the context of any process of liberalisation:

1. first, there is a relative lack of expertise and experience in designing, building and maintaining renewable technology
2. secondly, whether it be a large hydro-power plant or a small photo-voltaic cell, renewable power production requires a higher initial investment and does not produce as quick a return on investment as non-renewable plant
3. thirdly, the power produced is, by its nature, not as reliable and steady as that produced by a traditional power plant, since it relies on intermittent inputs such as sunlight

These three factors give renewable power sources a natural, initial disadvantage in the types of regulatory structure that are seen in liberalised markets.

Generally, there are four distinct stages to liberalisation: commercialisation, unbundling, privatisation and competition (both wholesale and retail), although in practice two or more of these stages may be combined in one piece of legislation, and one need not necessarily follow the other.

Commercialisation and corporatisation

When a government decides to commercialise a state-owned enterprise, it essentially relinquishes detailed control in favour of autonomy for the enterprise and a focus on efficiency and cost-cutting. Under commercialisation, the government maintains ownership but removes subsidies and preferential fiscal policies and requires full recovery of capital, operations and maintenance costs. Corporatisation entails the formal and legal move from direct government control to a legal corporation with separate management.

A commercialised body that is focused on costs will need to find the least expensive route to supplying rural areas, since generally they are the areas least well supplied at present and are thus in need of investment. This could have a positive impact on investment in distributed renewable generation, since in general it will cost less to install sustainable power sources such as photovoltaics or wind turbines than it will to connect remote areas to a central grid supplying conventionally produced electricity. In addition, a non-privatised body will still retain its social obligations, and this may cause it to favour renewable energy sources over conventional ones.

Therefore liberalisation to this stage could have a positive effect on renewable usage in distributed developments for scattered or rural populations. There may not, however, be any significant effect on the level of investment of bulk reticulated renewable generation investment, other than a possible improvement in the ability to adopt new technologies due to the improved commercial focus.

Unbundling

In a pure sense, unbundling (or restructuring) energy services is accomplished by breaking up the components of traditional bundled services, assigning existing costs to the various service components and developing prices based on these costs. Unbundling the electricity sector brings about the separation of the industry into generation, transmission, distribution and supply.

International experience indicates that the conditions and tariffs whereby independent power producers can gain access to the transmission system and use to ‘wheel’ power for sale directly to electricity users fundamentally affects such producers’ choice of technologies in grid-connected applications. Transmission access (including fair-cost structures enabling access) has the potential to stimulate the development of new renewable power generation. Because renewable resources are location-specific, developers of renewable power generation depend on access to transmission lines to sell power to the grid. Moreover, transmission access gives renewable power producers the ability to sell power to locations where, and at times when, it is more highly valued than by the local utility.

Despite legal and physical access to transmission lines, renewable power producers may not have equal access to transmission capacity because of unfavourable contract terms. Producers of intermittent generation may be charged more per kilowatt-hour to transmit power than their dispatchable competitors. Transmission access charges may be based on a generator’s maximum rated capacity or what it actually generates during peak periods. Moreover, the site-specific nature of renewable energy may be a drawback under some transmission pricing schemes. Tariffs may be based on distance or contract paths, regardless of actual transmission costs.

Privatisation

Privatisation is the sale of public bodies to the private sector, leading to an emphasis on both cost reduction and revenue maximisation, as profitability becomes the key performance measure.

It is sometimes argued that privatisation without first creating a competitive market will be detrimental to end-use customers since it is likely to mean a guaranteed private monopoly income for the new owners of the previous state monopoly.

Technology preferences for investments in new generation result partly from the differences in financing available to public utilities, private utilities and independent power developers. Finance for investments is given in the forms of ‘balance sheet financing’ and ‘project financing’. Both forms require that the project proposed for financing is profitable. The difference is the security that is offered to the lender. In balance sheet financing, the lender (e.g., a national or regional power company) relies on its overall financial position to repay the loan. In project financing, the loan is given to the particular project company that has been set up, and the lender relies on the cash flow of the project for repayment of the loan.

For various reasons, IPPs (independent power producers) have a dominant position when it comes to using renewable energy. Their projects depend on project financing. Independent power developers therefore face a higher cost of capital and a shorter repayment period than the vertically integrated utilities.

Other things being equal, the cost of energy from a capital-intensive renewable project to either a private utility or an independent power producer is generally higher than to a public utility.

Because of these financial considerations, independent power producers prefer generation options that have relatively low capital costs per megawatt, a short construction time in order to yield revenue quickly, high efficiency and the ability to operate most of the time.

Power-purchasing agreements (PPAs) can also affect the financing for renewables, depending on the extent to which provisions in these agreements are geared to the characteristics of renewable generation options. Since most independent power projects have been thermal to date, the terms of standard PPAs are often geared to such projects. Payment schedules and other terms in PPAs may create incentives for independent power producers to choose technologies with a relatively low capital cost per megawatt over options with comparable life-cycle costs but higher capital costs. PPAs often generate fixed price payments to developers over a limited period of time. Adequate payment schedules are particularly critical for capital-intensive power generation options. Independent power producers must attract private debt financing on the strength of the PPAs. They must often recover their capital investments over the fixed-price contract period, which is generally less than the facility's life span. This is harder to do for IPPs of capital-intensive generation options, putting them at a disadvantage relative to developers of fuel cost-intensive options.

Renewable energy faces other barriers in obtaining long-term power contracts. The transaction costs incurred in participating in the bidding process may favour certain technologies. Per megawatt, the costs of preparing a bid for a thermal project are less than for a renewable project. Thermal projects can be readily determined and are not particularly site-specific, allowing bids to be prepared more quickly and cheaply. Producers of power from renewable energy resources may find the transaction costs of negotiating PPAs prohibitive.

There is likely to be a general reluctance to invest in less profitable areas, such as rural areas, where distributed generation investment is most common, whatever the type of power source to be used. Traditional power-purchasing structures that might be implemented on privatisation also cause a problem for renewable sources since they favour non-renewable power sources producing a predictable, steady flow of energy. Thus privatisation could have a negative impact on renewable investments.

Competition

Once unbundling has taken place, competition can be introduced into one or more of the sectors.

International experience indicates that wholesale competition is not likely to favour renewables in bulk power markets. Compared with long-term bilateral PPAs, short-term or spot markets make it more difficult to finance and develop renewable generation options. For one thing, renewable projects bidding into spot markets are harder to finance than generation projects with low capital costs. Lenders are reluctant to provide debt capital for renewable energy projects, especially in countries where spot markets have yet to establish a track record. Since lenders require power projects to demonstrate steady, predictable cash flows to meet debt-servicing requirements over several years, the revenue risk created by unpredictable spot markets effectively precludes financing.

Retail competition is also likely to affect the ability of renewables to compete in bulk power markets. The incentive to retain and attract customers that is created by retail competition makes electricity suppliers seek opportunities to minimise rates and to differentiate themselves from competitors. Some retail suppliers are trying to differentiate themselves by marketing 'green' (environmentally friendly) electricity generation.

This market niche is smaller in developing countries because environmental consciousness is generally lower, as are income levels, so generally the willingness to pay ‘extra’ for the environment is also lower.

Improved infrastructure

A basic pre-condition for developing a free market is that the required physical infrastructure is in place. If, for example, palm-oil derivatives were to compete with diesel as a fuel for vehicles, there needs to be a substantial infrastructure supporting this market.

Currently, diesel has a virtual monopoly in both transport infrastructure and outlets. The monopoly can be broken by financial instruments (subsidising the new entrant to the market) or by legal instruments that oblige the owners of the existing infrastructure to create a fair market place.

Access to the electric grid

National energy laws must allow IPPs to set up renewable energy systems and sell their generated power to the grid operators. The key question for grid access is whether IPPs should have unlimited access to sell their output to the grid operator, or whether limits to either annual capacity additions or total installed capacity should be imposed. The answer depends on the balance between on the one hand the government’s wish to promote renewable energy, and on the other hand its wish to keep down the cost of subsidies.

An IPP license may be obtained from the national electricity regulator.

Competitive concessions

A competitive concession is granted to a private company in a province through a tendering process, with priority given to building and operating solar photovoltaics, wind, hydro-powered micro-turbines and diesel generators for a limited number of years.

Obligations to generate or purchase green electricity

In some countries, the government has obliged the power utilities to generate electricity based on renewable energy sources, thus kick-starting a significant technological development.

Where suppliers are unable to meet this obligation, they may be allowed to purchase green certificates from another supplier to show that that supplier has made up the shortfall. Otherwise, the suppliers may buy themselves out of the obligatory green quota by paying a penalty. In other words, companies that have excess renewable capacity will be able to ‘sell’ it to other providers, thus giving them a financial incentive to increase their renewable sources, whilst also providing a ‘stick’ to ensure that companies do not rely too much on others, since these green certificates are likely to attract a high premium.

An essential part of the green certificate system, which is promoted by some countries, is to oblige utilities to fulfil given quotas for renewable energy. Utilities can fulfil such commitments in several ways: by developing their own renewable power plants, by negotiating bilateral agreements with independent producers, or by purchasing green labels on the open market.

Voluntary agreements

In 1998, the Federation of Energy Companies in the Netherlands (EnergieNed) created a Green Label System for electricity generated by renewable energy. The green labels are purchased by members of EnergieNed. There is no legal footing, the system is based on a voluntary agreement, and there is no ecotax exemption for green labels. If the industry does not meet a certain target, agreed with the government, an optional measure in the Dutch electricity act will be implemented that requires final users to consume a certain amount of green electricity.

Public-private partnerships

Some individual countries have built up an impressive level of global knowledge and understanding about renewable sources. One of the ways in which this has been made possible is through the development of innovative alliances to help their expertise be shared between public and private bodies.

By establishing national knowledge centres, experience will be obtained by the sector itself sharing knowledge of successes and failures regarding full-scale projects in commercial operation.

Involving local communities and civil society

Mexico has a rural electrification programme, whereby the government charges the national power utility with responsibility for rural electrification, using photovoltaics where possible. Only local authorities participate in the scheme, avoiding any intervention by foreign institutions. The various governments – federal, state and municipal – made funds available and planned the overall strategy, while the public utility concessionaire handled standardisation and monitored the technical characteristics of the equipment. Government agencies did the project planning, development and management, and, following a competitive tender, private industries supplied, installed, maintained and trained the users of the system, i.e., the local community. The community provided technical support, agreed to use the system properly and underwrote maintenance costs etc.

Overall such schemes are deemed successful, but there were a few problems. First, the system quality was exaggerated prior to installation, which led to an expectation–reality gap. Secondly, there were problems with the installation standards. Thirdly, consumers were unused to the technologies and damaged the systems by using them wrongly.

Some countries, however, have developed measures which should mitigate such problems by providing technical back-up and education bodies. For example, in India, the Ministry of Non-Conventional Energy Sources developed a network of nodal agencies at the state level, complemented by measures to involve local agencies and the private sector – all overseen by the National Planning Commission.

A highly successful scheme in Denmark – the wind guilds – is credited with being of major assistance in the successful development of Denmark's wind turbine generation. As part of the Danish wind power initiatives started in the 1970s, wind guilds were set up to own and operate turbines. Members of the guild originally had to live within 3 km of the site in order to help mitigate concerns about noise, environmental effects etc.

Discouraging alternatives

Often, the coupling of renewable 'encouraging' regulation with non-renewable 'discouraging' regulation is the key to the success of the former. This is usually done through financial disincentives, e.g., eco-taxing, but there are also other means.

A very stringent means to discourage technologies or fuels is actually to ban them or to introduce a temporary moratorium on their production and use.

Testing and certification

Barriers to the development of renewable production include the practical implications of building and testing prototypes, coupled with the perception that the new technologies may not be reliable in the absence of industry standards. Governments can help to overcome this by providing facilities and funding for the testing and certification of new technologies and thus developing a reliable standard.

Information

In most countries there is a strong need to increase awareness among the public, the private sector and government officials regarding the applications and benefits of renewable energy.

Education

Primary education, higher learning and vocational training all need new curricula that match the changing technological and economic environments.

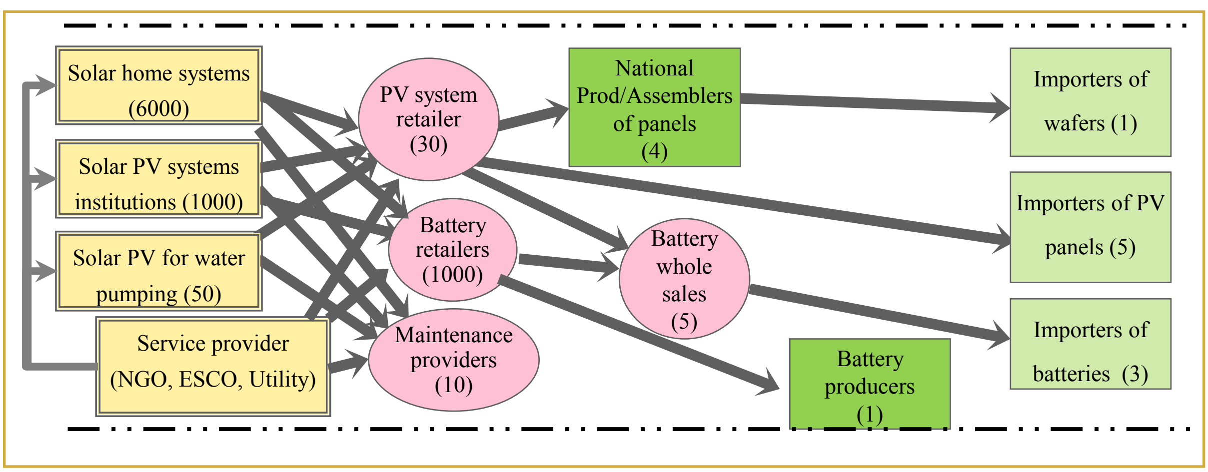
Annex D.
An Example of Market Mapping

This example of the market mapping of solar PV technology has been drawn up to provide the reader with a more practical understanding of the process of market mapping. The example describes both the result and the group process in which it has been developed. It should be stressed that market mapping can be done in a number of ways, contingent on how the group and the facilitator find it most practical. The following therefore rather serves as an example than as a step by step cook-book. Likewise, the measures suggested in this example are by no means exhaustive and should be used as an inspiration rather than a blueprint for how to design an enabling framework for the diffusion of solar PV.

Market chain actors and links

The first step is to map the actors who directly take part in the market chain from consumer to importation or production of the product and to establish the flow of money between them. The market for small-scale PV systems is divided into three different segments: i) solar home systems for individual consumers; ii) solar PV systems for institutions such as schools, health centres and administrative building; and iii) solar PV systems for water pumping. Although the products are similar from a technical point of view, each market segment faces different market barriers. Further, in the case of solar PV, a substantial part of the equipment used in the three markets is currently procured by service providers such as utilities, NGOs, or energy service companies (ESCOs). These companies constitute a special market segment with a special access to funding, although the users may be the same as those described above. Over time it is expected that a larger share of PV systems will be sold directly to consumers, and the four market segments are therefore described separately.

Figure D.1: Example of identified market chain actors for solar PV



The next level in the market chain comprises the retailers and wholesalers of panels, batteries and whole systems. As these intermediaries are essential in making the market function, there may be important constraints at this level, which can be addressed. There may for example be only one or two actors controlling the market, or there may be a need for a nationwide retailer system. Local production or assembling of batteries and solar panels may in some cases ensure local employment and products at lower costs. In this example there are four such producers. As the production of solar cells (wafers) will normally be produced in large quantities in highly specialised factories, these will in most cases be imported and become parts of the assembled panels. Importers of wafers are shown in the box at the right, along with importers of solar PV panels and importers of batteries.

In order to understand the market structure and the level of competition in the market, it is already important at this stage to collect information on the numbers of consumers within each market segment, the number of retailers, the number of producers and the number of importers. It is possible to make part of the market actor chain more detailed. In the figure above, only imports of wafers are seen as an input to the local production or assembly of panels. In reality there is a need for import of a number of other parts to be assembled, such as aluminium for frames, wires, glass, controllers, etc. The level of market constraints for such items may also be considered by elaborating this chain in the analysis.

Remember, developing the map of market chain actors is useful in a group discussion because it leads the group through a common understanding of the market and its possible constraints. It is also useful at a later stage in visualising these constraints.

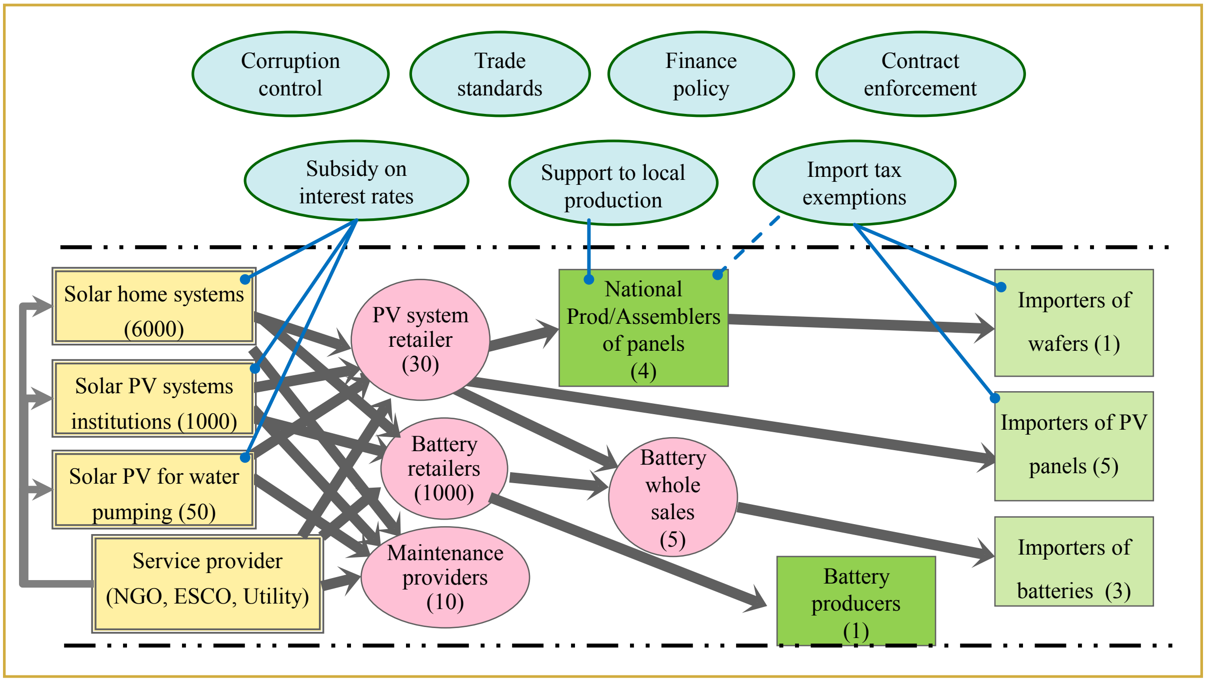
Enabling environment

The purpose of charting the enabling environment is to understand the elements that affect the market chain for solar PV and thus make it possible to examine the powers and interests that drive change. The first step is to map the existing elements of the enabling framework, and the next step is to analyse whether new elements should be added and to what extent existing elements should be improved.

The enabling environment comprises elements of general importance for the market chain, such as the level of corruption control, the certainty of contract enforcement, the stability of finance policy, and the enforcement of trading standards. Such general elements, though important, are often difficult to change. Therefore, for the present exercise, the most important elements are identifying the existing and potential measures to improve the functionality of the market chain.

In this case, high interest rates on loans are considered to be a main barrier against selling SHS and PV systems to consumers. Programmes for reducing interest rates on loans for solar PV systems have been successful in a number of other countries, so a group member proposes to consider this here. The specific level of subsidy and the modalities need more scrutiny and depend on the structure of the financial sector, including mini- and microfinance institutions, which will be looked at when mapping financial institutions below. For now this option is indicated in the diagram by blue arrows in the market map.

Figure D.2: Example of identified enabling environment of importance for the PV market chain



On the other hand, there is already an exemption from import taxes on solar panels and wafers. One problem, however, is that the national assemblers of panels import a number of other parts for the final product, such as aluminium frames, controllers etc., which are not exempt from the 25% import tax. The assemblers therefore face an 'unjust' competition from the imported panels, which are fully exempted from tax, and they ask for a tax exemption also for the other imported and taxed parts they are using in the production. Would this be a good solution, or would it for example be possible for the government to identify other measures to support local producers? This is indicated by the blue arrows in the figure.

Note that the mapping process should serve as a tool for brainstorming, and at this stage it is important to identify options, but not necessarily to reach to an unanimous agreed conclusion.

Identifying support services

The next step is to identify 'support services', which can facilitate the market chain. These initiatives can be supported by governments and by donor programs. At this stage financing sources are not considered. Linkages between support services and market actors are illustrated by arrows in red and yellow.

Financial services

For the time being it is difficult for private consumers and government institutions to finance the high up-front costs for SHS (Solar Home Systems) and for PV systems for institutions. In some countries, there are good examples of establishing a loan facility for solar PV installations, where local banks, in cooperation with the retailers and a donor-backed security fund, provide cheap loans to PV systems. This finance facility may also provide preferential loans for investment in local production facilities.

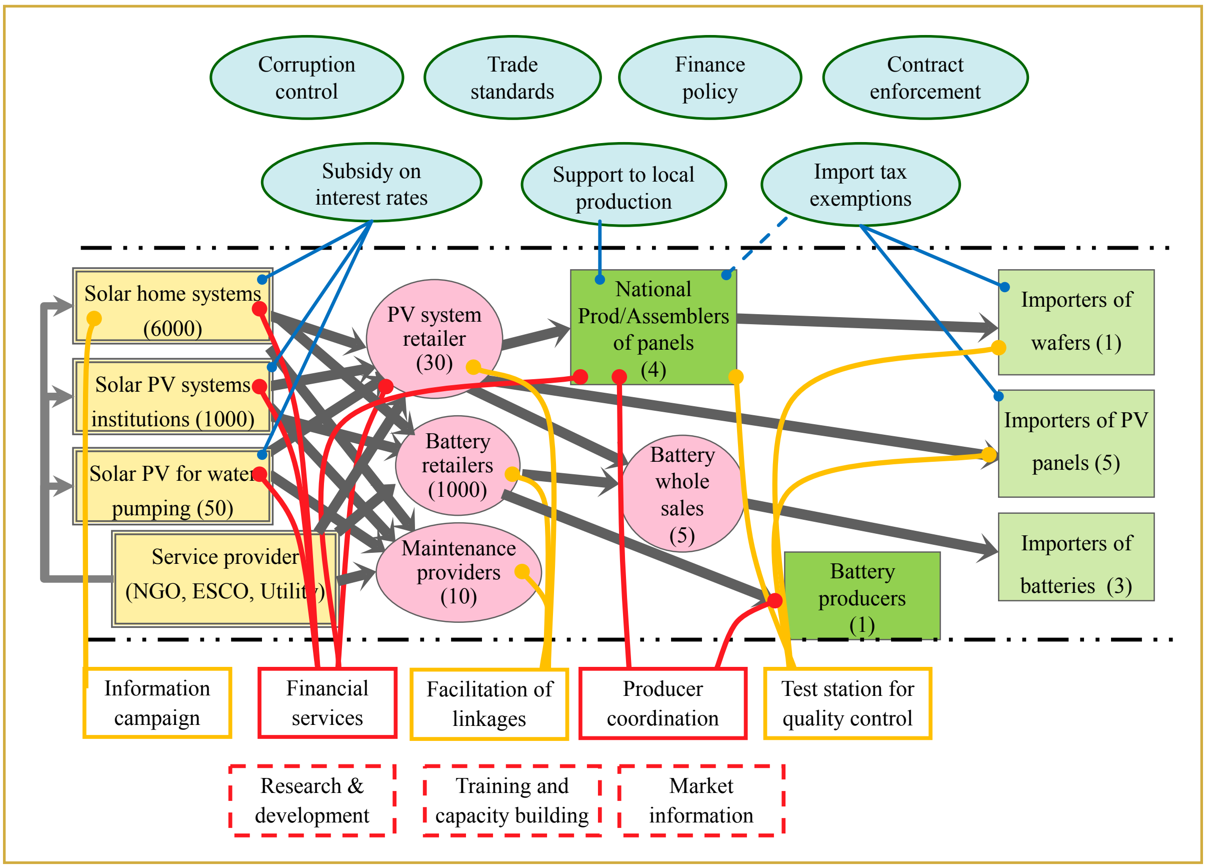
Information campaign

Lack of information for potential customers in rural areas is seen as a major barrier for current sales. It is therefore advisable to establish a general information campaign, which will inform rural customers about prices, services and the credit facility mentioned above.

Facilitation of linkages

A problem may arise that the retailer system for PV systems and batteries and the maintenance companies do not communicate with each other. As an example, batteries preferred for solar PV systems are not sold through the standard wholesale and retail systems for car batteries, but are imported at a much higher cost by the PV systems retailers. One measure to reduce costs may thus be to encourage or facilitate the three groups to coordinate their products and services in order to reduce costs and thus increase the market to the benefit of all.

Figure D.3: Example of full market map for the solar PV market chain



Producer coordination

Exchanges of information and learning among businesses within the same niche market have proved to be essential for the development of competitive industries. It is noticed that existing companies in the countries are working very much in isolation, and a producer representative has therefore proposed obtaining assistance to establish a producer association, with the objective of addressing the common needs faced by the producers, such as better training of engineers and skilled workers, easier import restrictions, customs facilities etc., and to establish cooperation between producers, for example in negotiating contracts with suppliers of wafers or other items.

Test station for solar panels

Solar panels of poor quality are increasingly imported into the country, and there is growing concern among all the market chain actors present that poor quality panels may undermine the reputation of solar panels among consumers. To avoid this, a majority of actors proposes to establish a test station for solar panels, which could be responsible for a labelling system for solar panels based on a number of parameters, such as efficiency, durability, etc. It could also set some minimum quality standards for the panels to receive a label. At the same time, the test station could serve as a training facility for technicians and technical specialists needed throughout the PV market chain.

Research and development and capacity building

It was also pointed out that there is a need for support to research and development at the national level to ensure that national expertise is available to solve specific problems in the industry, as well as to ensure that engineers and technicians are trained by professionals with up-to-date knowledge on solar PV technology. If the test-station mentioned above is linked to the technical university, synergies may result between the test station, research and development and capacity-building.

Market information

It was also recognised that a general lack of knowledge existed about consumer preferences and the price elasticity of the market, e.g., the size of the market contingent on the sales prices of systems. It was therefore suggested that such a study should be supported for the benefit of the whole market chain, as well as a further input to describe the need to reduce further the sales prices on PV systems by other means, such as a targeted investment subsidy for a shorter period of time, in order to push the market to a level where economies of scale over time will reduce costs.

Annex E.
Questionnaire on Barriers to the Diffusion of a Climate Technology

A template

A questionnaire is not a key route to identifying barriers, but it can be useful in collecting some people's inputs, e.g., people who are unable to attend workshops.

Specific questionnaires need to be tailored with regard to two aspects: technology and stakeholders. E.g., one questionnaire might be devised for policy-makers and NGOs on wind energy, another for manufacturers and traders on solar water heaters.

Replace the abbreviation CT (climate technology) with the name of the technology in question.

Not every stakeholder needs to respond to questions in all categories.

Questions should be tailored according to the interests of the stakeholders, and non-pertinent questions should be avoided.

All example questions in this template should be regarded as sources of inspiration. They are only illustrative and should not be understood as rigid suggestions.

Also, respondents should be invited to add other barriers than those already listed.

1. Information on the technology

Technology:

Sector:

Priority:

Service provided:

Size:

Availability:

2. Information on the respondent

Name:

Organisation / Department:

Designation:

Particular interest in the technology: E.g., manufacturer, trader, user, legislator.

3. Economic and financial issues

Some problems are listed below. Please rank them in order of importance.
No. 1 is most important, 2 second most important etc. Cross if not applicable.
Please feel free to add more items to the list and add detailed descriptions to the items.

Barrier	Rank
Difficult to obtain loans	
High cost of loans (high interest rate, short maturity)	
The CT is too costly	
High cost of preparing the investment (transaction costs)	
Insufficient/inappropriate incentives	
Favourable treatment of alternative technologies	
Uncertain financial environment (e.g., electricity tariffs)	
Uncertain macro-economic environment (e.g., inflation rate, currency exchange rate)	

When do you typically want your investment in CT to be paid back? ……… years.

Did you ever try to obtain a loan to purchase CTs? ☐ Yes ☐ No

If yes, were you able to get it? ☐ Yes ☐ No

If no, what do you think were the reasons?

4. Market failure/imperfection issues

Some problems are listed below. Please rank them in order of importance.

Barrier	Rank
Under-developed supply channels	
Non-transparent market	
Small market size	
Unstable market situation	
Underdeveloped competition	
Economy of scale difficult/impossible to be achieved	
Mismanaged sector	
Technology not freely available in the market	
Lack of reference projects in the country	

5. Policy, legal and regulatory issues

Explanatory note on existing policies and key organisations.

Do you think organisations such as AAA, BBB, and CCC are working satisfactorily in line with the policy intentions of the government?

☐ Yes ☐ No

Does the approach of these agencies need to be modified to accelerate the programme?

☐ Yes ☐ No

Are the existing regulations adequate for promoting the CT programme?

☐ Yes ☐ No

Are there some regulations that are obsolete and create problems in projects operating smoothly?

☐ Yes ☐ No

If yes, please specify.

In the light of experiences so far, do you think the CT policy needs to be updated?

☐ Yes ☐ No

If yes, broadly what are the areas that may need a re-examination.

What do you think are the barriers that need to be looked into, e.g., by enacting new legislation? Please rank the barriers in the list below in order of importance.

Barrier	Rank
Insufficient legal and regulatory framework	
Insufficient enforcement	
Unstable and uncertain policies	
Struggle in the political arena	
Highly controlled sector	
Problems in land acquisition	
Problems in getting clearances	
Bureaucracy	
Corruption	

6. Network failures

Some problems are listed below. Please rank them in order of importance.

Barrier	Rank
Weak connections between stakeholders promoting the new technology	
Strong networks of existing technologies favoured by legislation	
Difficult access to external manufacturers	
Lack of involvement of stakeholders in decision-making	

7. Institutional and organisational capacity

Are there sufficient professional institutions? ☐ Yes ☐ No

If no, which type of institutions do you miss?

Do the existing institutions have sufficient capacity for your purpose?
Tick if the approach needs to be upgraded for the CT programme:

	Agency AAA	Agency BBB	Agency CCC	Others (specify)
Professional approach				
Technical expertise				
Accessibility				
Sensitive to programme needs				
Others (if any)				

Do you have any specific recommendations for any of the following agencies?

AAA

BBB

CCC

Others

Do you think some other organisations should be involved in the programme?

☐ Yes ☐ No

If yes, what are the organisations and what are your suggestions about the roles they could play?

Did the AAA (name of organisation/agency) help you in the project?

☐ Yes ☐ No

If yes, are you happy with the AAA's role?

☐ Yes ☐ No

Reasons for your satisfaction/dissatisfaction.

	No	Yes
Professional approach	( )	( )
Technical expertise	( )	( )
Easy access	( )	( )
Others, if any		

Do have any specific recommendations to AAA to improve the overall programme?

Do you think some other organisations should be involved in the in the programme?

☐ Yes ☐ No

If yes, what are your suggestions and what role they could play?

Are the existing regulations adequate for promoting the programme?

☐ Yes ☐ No

If no, are there hurdles that need to be addressed by enacting some legislation? Please specify.

Are there some regulations that are obsolete and create problems in the project operating smoothly?

☐ Yes ☐ No

If yes, please specify.

Are the various organisations involved in the programme sensitive to your needs and concerns?

☐ Yes ☐ No

If no, please specify the expectations from the other organisations.

8. Human skills

Some problems are listed below. Please rank them in order of importance.

Barrier	Rank
Lack of skilled personnel for manufacturing and installation	
Lack of skilled personnel for preparing projects	
Lack of service and maintenance specialists	
Uneven technical competition (more experienced competitors)	
Inadequate training facilities	

9. Social, cultural and behavioural issues

Some problems are listed below. Please rank them in order of importance.

Barrier	Rank
Traditions and habits	
Consumer preferences and social biases	
Lack of confidence in new ESTs	
Dispersed/widely distributed settlements	
Lack of understanding of local needs	

10. Information/awareness issues

Do you have sufficient information on climate technologies?

☐ Yes ☐ No

If yes, have you installed them in your industry/institution/home?

☐ Yes ☐ No

If no, what are the reasons for not installing? Please mark 3 for very important, 1 for not important, 2 for in between:

Problem	Mark
Poor or lack of information about its costs and benefits	
Media not interested in the technology	
EST not easily available in the market	
High initial cost	
High operation and maintenance cost	
Waiting to know more about its performance and durability	
Lack of credit facilities	
Inadequate subsidy	
The CT is not important for our needs	
Non-availability to required specifications	
Lack of technical expertise for maintenance	
Not interested	
Others, if any	

Do you think there is insufficient awareness about climate technologies among other stakeholders (consumers, entrepreneurs, NGOs etc.)?

Do you think that conservative attitudes by stakeholders are hampering the introduction of climate technologies?

Do you think there is lack of commitment among stakeholders for a successful climate technology programme?

Do you think more demonstration projects need to be designed?

11. Technical issues

Some problems that are encountered in the climate technology programme are listed here. Please rank them in order of importance.
No. 1 is most important, 2 second most important etc.
If required, feel free to add more items to the list.

Problems	Rank
Difficulty in getting equipment and spare parts	
Available technology / equipment quality is not good	
Problems in getting clearances	
Poor operation and maintenance facilities	
Inadequate standards, codes and certification	
New technology is too complicated	
Lack of infrastructure facilities (please specify)	
Others (please specify)	

12. Overall assessment

Do you think there is enough interest and involvement by entrepreneurs in climate technologies?

Are you satisfied with the progress of the climate technologies so far?

If no, what are the main barriers in your opinion (rank them):

Technical

Information and awareness

Economic and financial

Institutional

Regulatory

Market

Social

13. Other issues

Please feel free to comment on any relevant issue which you think is missing above.
E.g., environmental impacts.

Endnotes

1. Other frequent and very similar phrases are ‘policy tools’ and ‘policy instruments’.
2. The ‘Handbook for Conducting Technology Needs Assessment for Climate Change’ (UNDP 2010) is referred as the TNA Handbook in this guidebook.
3. In order to keep the names of the categories short, the term ‘goods’ embraces what are usually referred to as goods and services.
4. ENTTRANS: ‘Promoting Sustainable ENergy Technology TRANSfers through the CDM: Converting from a Theoretical Concept to Practical Action’, 2007. This is one of the very few extensive studies using the market mapping approach (as described in Chapter 5 of this guidebook) on climate technologies. The project was implemented (2006–2007) by a large consortium of institutions from the EU and developing countries.
5. This definition agrees with the classical and broader definition originally suggested by Rogers (1962): ‘Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding.’
6. The distinction between ‘technology transfer’ and ‘diffusion’ used here is different from other interpretations of technology transfer by the IPCC and UNFCCC (including the EGTT), where this distinction often does not occur (see e.g., IPCC, 2007).
7. A distinction is sometimes made between adoption and absorption, where adoption involves the mere usage of the technology, while absorption reflects the sustainability and efficacy of usage. In this guidebook the term ‘adoption’ covers both meanings.
8. http://www.tech-action.org/Guidebooks/OrganizingNationalTNAprocess.pdf
9. www.seepnetwork.org
10. www.slideshare.net/marketfacil/state-of-the-practice-in-market-facilitation-2008
11. According to the Marrakech Accords (UNFCCC, 2002; Decision 17/CP.7, para. 6), projects can be considered small-scale CDM projects if they are either renewable energy projects with a maximum capacity of up to 15 MW, energy efficiency improvement projects reducing energy consumption by up to 60 GWh per year, or other projects reducing annual CO_2-eq. emissions by a maximum of 60,000 tonnes.
12. Available at www.tech-action.org
13. For methodologies, see the financing guidebook (UNFCCC, 2006) and the Handbook for Conducting Technology Needs Assessment (TNA) for Climate Change (UNDP, 2010; Annex 10).
14. A thorough manual is available at www.value-links.de/manual.html

15. The 4 R's approach developed by IIED (International Institute for Environment and Development). http://www.policy-powertools.org/Tools/Understanding/docs/four_Rs_tool_english.pdf

16. 'Options Assessment Sourcebook', World Bank Report 264/03, July 2003.

17. For this purpose, it may be useful to apply the approach called Participatory Rural Appraisal or the Framework Tool for Technology Receptivity, developed by SouthSouthNorth (2007).

18. In this example, the early warning system is hence both an element of the enabling framework and an adaptation technology

19. See, for example, http://alexandria.tue.nl/extra2/200511821.pdf and http://www.ou.nl/Docs/Faculteiten/MW/MW%20Working%20Papers/GR%2006-03%20Caniels%20en%20Romijn%20maart%202006.pdf

20. If, for example, a government wishes to promote the diffusion of solar photovoltaic technologies for electricity generation, this will be easier for off-grid solar home systems than grid-connected systems, since the latter may be less feasible economically and also involves extra challenges in elaborating grid-connection rules and a tariff system.

21. PRA: Participatory Rural Appraisal. PLA: Participatory Learning and Action.

22. Anticipatory adaptation includes measures such as crop and livelihood diversification, seasonal climate forecasting, community-based disaster risk reduction, famine early-warning systems, insurance, water storage and supplementary irrigation. Reactive or ex-post adaptation measures include emergency response, disaster recovery and migration-reactive or ex-post adaptations, for example.

This guidebook provides practical and operational guidance on how to assess and overcome barriers facing the transfer and diffusion of technologies for climate change mitigation and adaptation. The guidebook is designed to support the analysis of specific technologies, instead of pursuing a sectoral (e.g. transport) or technology group (e.g. renewable energy) approach. Given that there is no single solution to enhancing technology transfer and diffusion, policies need be tailored to country-specific context and interests. Therefore, the guidebook presents a flexible approach, identifying various assessment options and tools for analysts and decision-makers. The guidebook has been developed through an experience-based approach with feedback from national consultants and workshop participants alongside inputs from URC staff and external reviewers.

The guidebook is a supplement to the Technology Needs Assessment (TNA) Handbook developed by the UNDP in 2010, which has a stronger focus on the identification and selection of sectors and technologies.

This publication is one of several guidebooks produced as part of the GEF-funded Technology Needs Assessment (TNA) project, currently being implemented by UNEP and UNEP Risø Centre in 36 developing countries across Africa, Asia and Latin America.

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http://www.uneprisoe.org/

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