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Technology Needs Assessment for Climate Change Mitigation

Barrier Analysis and Enabling Framework Report

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Barrier Analysis and Enabling Framework for Climate Change Mitigation

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Abbreviation and Acronyms

ADB	Asian Development Bank
AE	Alternate Energy
AIT	Asian Institute of Technology
ALGAS	Asian Least Cost GHG Abatement Strategy
CC	Climate Change
CDM	Clean Development Mechanism
CH4	Methane
CO2	Carbon dioxide
DG	Director General
DTU	Technical University of Denmark
E&CC	Environment and Climate Change
EE	Energy Efficiency
EGTT	Expert Group on Technology Transfer
NEPA	National Environmental Protection Agency
ESTs	Environmentally Sound Technologies
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHGR	Greenhouse Gas Reduction
GoA	Government of Afghanistan
IGCC	Integrated Gasification Combined Cycle
IBUR	Initial Biennial Update Report
LPA R&D	Logical Problem Analysis Research and Development
TNA	Technology Need Assessment
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Program

Glossary

Barrier: Obstruction or impediment that impedes technology transfer; a reason why a target is adversely affected, including any failed or missing countermeasures that could or should have prevented the undesired effect(s).

Biomass: The total mass of living organism in a given area or of a given species usually expressed as dry weight. Organic matter consisting of, or recently derived from, living organisms (especially regarded as fuel) excluding peat. Biomass includes products, by-products, and waste derived from such material. Cellulosic biomass is biomass from cellulose, primary structural component of plants and trees.

Capital goods: Machinery and equipment used in the production of other goods, e.g. consumer goods such as boilers, motors, steel, or pumps. May also mean 'producer goods'.

Caron dioxide (CO2): CO2 is a naturally occurring greenhouse gas, and a by-product of burning fossil fuels or biomass, of land-use changes and industrial processes. It is the principal anthropogenic greenhouse gas that affects Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured, and therefore it has a Global Warming Potential.

Climate Change: Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Consumer goods: Good and products specifically intended for the mass market and purchased by (private) consumers.

Diffusion: The process by which technology is spread or disseminated through various channels over time in a society, where the technology is gradually adopted by more and more members of the society (people, institutions, companies, etc.).

Enabling Environment/Framework: 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 efficiency of the transfer and diffusion of technologies.

Energy: The amount of work or heat delivered. Energy is classified in a variety of types and becomes useful to human ends when it flows from one place to another or is converted from one type to another.

Land-use: The total of arrangements, activities and inputs undertaken in a particular land-cover type (a set of human actions). The social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land-use change occurs when, e.g., the forest is converted to agricultural land or to urban areas.

Market/value chain: The chain of economic actors that own and transact a particular product as it moves from primary producer to final consumer.

Market mapping: An analytical framework for understanding market systems and an approach to market development that is both systematic and participatory.

Measures: Measures are technologies, processes, and practices that reduce GHG emissions or effects below anticipated future levels. Examples of measures are renewable energy technologies, waste minimization processes and public transport commuting practices etc. Measures can also be factors (financial or non-financial) that enable or motivate a particular course of action or behavioural change or is a reason for preferring one choice over the alternate. Often the word 'incentive' is used synonymously, sometimes with a slightly different interpretation.

Mitigation: 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.

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

Publicly provided goods: A category of technologies characterized by large investments, general public ownership, and production of good and services available for the public or a large group of persons.

Reforestation: Direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but converted to non-forested land.

Renewable Energy: Renewable energy is the energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, biomass, wind, rain, tides, waves and geothermal heat.

Stakeholder: A person, group, organization or system that affects or can be affected by an organization's actions.

Sustainability: The ability to meet the current needs while considering the carrying capacity of the Earth's supporting eco-systems without compromising the ability of future generations to meet their own needs.

Technology: Technology is 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 aspect such as equipment and products (hardware); the know-how, experience and practices (software) associated with the production and use of the hardware; and the institutional framework, or organization, involved in the transfer and diffusion of a new piece of equipment or product orgware technologies.

Technology transfer: Technology transfer involves vertical technology transfer, which is understood as the movement of technologies from the Research and Development "R&D" stage to the commercialization, and horizontal transfer, which involves the spatial relocation or diffusion.

Acknowledgement

The project on Technology Needs Assessment provides an excellent opportunity for Afghanistan to perform the country-driven technology assessment to identify environmentally sound technologies that might be implemented with a substantial contribution in addressing climate change mitigation needs of the country. The aim of the Technology Needs Assessment project is to support developing countries and the countries with economy in transition to meet their obligations under the United Nations Framework Convention on Climate Change "UNFCCC", bringing a contribution to the following: the priority of technology needs, which can be used in an environmentally safe technology package:

- To facilitate access to and transfer of environmentally sound technologies
- To facilitate the implementation of paragraph 4.5 of the United Nations Framework Convention on Climate Change "UNFCCC" on the know-how access;
- To define and prioritize the technologies, processes and techniques that are consistent with the mitigation of climate change and adaptation in the participating countries and aligned with the goals and priorities of the national development;
- To identify barriers that prevent primary/preferred acquisition, implementation and dissemination of technology; and
- To develop Technology Action Plans (TAPs) to overcome barriers, which will define the scope of activities and a favorable environment that facilitates the transfer, adoption and the dissemination of the selected technologies in the participating countries.

The technology's prioritization was the first step in the framework of technological transfer, which also included technical information, enabling environment, capacity building and understanding the mechanisms for technological transfer. The technology's prioritization is implemented by applying the methodology proposed by the United Nations Framework Convention on Climate Change and team for Technology Needs Assessment. The applied methodology has been adjusted to country-specific conditions. The technology's prioritization has been conducted through the following activities: the preliminary overview of options and resources; institutional arrangements and stakeholder's engagement; establishing decision's context; the assortment of priority sectors; establishing the criteria for selecting mitigation measures for prioritization; selecting priority measures; detailed analyses, assessment and stakeholder's consultation; and the selection of actions for high priority for further development and implementation. The current report provides information and data based on the existing national policies on climate change mitigation and development priorities of the country, the inventory of greenhouse gases emissions, stakeholder engagement and the institutional arrangements of Technology Needs Assessment, the process of sector prioritization, the identification of criteria, the assessment of technologies on the selected sectors by using the multi-criteria approach and technology's prioritization.

Afghanistan National Environmental Protection Agency (NEPA) hopes that the Technology Needs Assessment (TNA) project will serve as a key step towards addressing our climate change concerns by providing an assessment of the priority technology requirements. My special thanks are due to the members of the Technical Working Group on Mitigation and all other experts who contributed to the TNA process. I would also like to thank the numerous other ministries, divisions of the government, non-government and private sector experts who took time out of their busy schedule to meet with our consultants and provide data and information.

Lastly, I extend my gratitude to the Global Environmental Facility (GEF) for providing financial support. I also thank the UNEP Division of Technology, Industry and Economic for their technical support and guidance.

H.E. Shah Zaman Maiwandi
Director General, NEPA

Executive Summary

The main objective of barrier analysis after prioritization of technologies is to identify and analyze barriers and determine measures to overcome barriers aimed at facilitating technology transfer and diffusion. The approach used to set up the framework for the deployment of identified technologies involves; market analysis, barrier analysis, enabling environment, and cost-benefit analysis.

Barrier analysis for the deployment of identified technologies was set up through the use of logical framework analysis with the help of a logical tree. Barrier analysis comprises of the following steps; (i) identification of barriers from studies, experience and brainstorming and organization of the barrier into broad categories, namely: economic and financial, market failure, policy, legal and regulatory, information and awareness, etc (ii) screening of barriers to identify key barrier and known key barriers based on multi-criteria analysis approach, (iii) decomposition of barriers at four levels namely broad category, e.g. economic and financial, barriers within a category, e.g. high cost of capital, and elements of barriers, e.g. high interest rate.

Measures to overcome barriers involve the following steps; (i) process of identifying and describing measures, (ii) formulate problems to solution in logical problem analysis (through reformulating all the problems as positive statements about the future situation in which the problems are solved), (iii) assessment and categorization of the measures identified aimed at identifying measures with significant impacts, which then feed into a broader enabling framework for the transfer and diffusion of identified technologies.

The TNA process was aimed at evolving a set of activities that is closely linked to other relevant national development processes and to reflect the national response to climate change technology needs that is informed by the government & private sectors, the general public, and other stakeholders. Hence, the stakeholder involvement was considered very crucial to the success of the TNA process and the implementation of recommended activities.

The stakeholders were already identified from the relevant organizations and institutions in terms of stakeholder engagement and institutional arrangements stipulated by the UNDP/UNFCCC Handbook (2010). Accordingly, the members of the Working Groups included representatives of the Government institutions having the responsibility for policy formulation and regulation, potentially vulnerable sectors, private sector industries, organizations, manufacture, import & sale of technologies, technology users, financial institutions, relevant NGOs, institutions that provide technical support, donor organizations and other relevant institutions such as universities & research organizations. In order to get the stakeholder participation in the TNA process, two Technical Working Groups were established on a sectoral basis representing Energy and Waste sectors as prioritized under the prioritization process. The Technical Working Groups were mandated to decide on the

technologies appropriate for respective sectors, undertake market/barrier analysis and recommend an enabling framework for sectors.

The goals, objectives and the working arrangements of the participatory process was discussed and agreed with all sectoral stakeholder working groups via skype and zoom applications. The objectives of the project and the purpose of barries analysis was discussed and ratified at this meeting. The main purpose of the stakeholder engagement is to ensure their participation throughout the TNA process of selecting priority sectors, technology identification & prioritization, barrier analysis and development of enabling framework etc, as their participation in the process is crucial for successful implementation of the recommended technologies. Therefore, an ongoing arrangement has been established to ensure continuous and significant involvement of stakeholders at each stage of the TNA process. The roles and responsibilities of stakeholder groups have been defined during the initial meeting. Each stakeholder Sectoral Working Group included around eight persons representing related organizations in the respective sector. The compositions of the sectoral working groups were flexible with the provision of co-opting additional members depending on the requirement.

Afterwards, meetings and direct information exchange with stakeholders were organized to discuss and familiarize with the short-list of the barriers and measures to overcome barriers pre-selected and pre-analyzed by working groups, sector experts, expert team leaders and project coordinator.

This whole process of technology barrier identification was drawn from the literature review, meetings with stakeholders, Mitigation Expert Working Group and technology experts. It also included full use of TNA barrier analyses, information and templates provided by specialists of UNEP-DTU Partnership during and after regional capacity building workshops.

The technology barrier analysis process identified crucial economic and financial barriers and non-financial barriers. The latter was further broken down into many other sub-barrier categories including policy, legal and regulatory, institutional and organizational capacity, technical, information and awareness, social, cultural and behavioural and market imperfection.

Technology barriers and measures in the Energy sector:

Each of the two mitigation technologies in the energy sector, namely Small Hydro Power and Solar Energy, mainly for electricity, was categorized as a public good, which requires public sector support for its deployment and successful replication at different implementation scales. The review of barriers recognized that economic and financial barriers were associated with the high initial cost of development of the technologies which were due to the lack of incentives like subsidies or soft loans offered to individuals or communities, high cost of construction material and available technical expertise, and labor at the local levels. The non-financial barriers included lack of an approved energy sector policy to be further promoted. Moreover, absence or weak coordination between relevant line departments due to

weak integrated policies (draft renewable energy policy and waste management policy etc.) further aggravate the situation..

The barriers in the energy sector can be overcome by putting in place appropriate financial and technical resources for the development and diffusion of these technologies at the local level. The non-financial barriers can be tackled through formulating and approving renewable energy policies with consensus from all the important stakeholders, devising regulatory framework.

Technology barriers and measures in the Waste Sector:

Similarly, in the case of the waste sector, the primary focus in the face of climate change is the mitigation of technologies that help and increase the resilience of communities through mitigation efficient technologies. During the consultation processes with various stakeholder groups, high initial cost of installation and maintenance. The main element of this barrier identified was the lack of trained technical staff locally available for the design, installation and maintenance of the technologies, high rate of taxes and the customs duty imposed on import of technology parts, and a small, underdeveloped market for technology importers and suppliers in the country.

To help in achieving diffusion of these three technologies in the country, a number of enabling measures have been suggested-access to an appropriate subsidy, grants, or soft loans and training/capacity building of relevant staff.

CHAPTER 1: BACKGROUND & INTRODUCTION

1.1. Background

Technology Needs Assessment (TNA) is one of the foremost critical steps towards identifying and assessing climate change adaptation challenges within the United Nations Framework Convention on Climate Change's (UNFCCC) technology mechanism on technology development and transfer. For a climate-vulnerable country such as Afghanistan, TNA has an added significance for aligning its mitigation needs and opportunities with goals and objectives of its sustainable development programs.

In Afghanistan, the project on Technology Needs Assessment (TNA) was initiated in February 2019 in collaboration with UNEP-DTU Partnership, Asian Institute of Technology (AIT) and Climate Technology Centre & Network (CTCN) as a part of the Switch Asia regional program.

The purpose of the TNA project is to assist Afghanistan in the identification of its priority mitigation sectors, followed by prioritization of technologies in these sectors. This will form the basis for the development of environmentally sound technology projects and programs to facilitate transfer and diffusion of these priority technologies under Article 4.5 of UNFCCC. The main objectives of the project are to:

- Identify and prioritize, through country driven participatory processes, the technologies that can contribute to mitigation and adaptation goals of the participating countries while meeting their national sustainable development goals and priorities;
- Identify barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and
- Develop Technology Action Plans (TAP) specifying activities, and enabling framework to overcome the barriers and facilitate the transfer, mitigation and diffusion of selected technologies in the priority areas with national relevance.

The project also aims to build the capacity of Afghanistan to effectively meet the obligations under the UNFCCC for mitigating GHG emissions, to reduce the vulnerability of sectors and to protect livelihoods of the communities exposed to the adverse impacts of climate change.

For the implementation of TNA project in Afghanistan and accomplishment of the above stated objectives, the UNEP has engaged the services of a National Mitigation Consultant. The Director General National Environmental Agency designated as TNA Coordinator and his office as Secretariat for the project. The Consultant has completed and submitted the report on Technology Needs Assessment on Mitigation prioritizing technologies in energy & waste sectors. The second report on "Barrier Analysis and Enabling Framework" has now been completed and submitted for feedback from UNEP-DTU Partnership, AIT etc. After completion of these two reports, the work on the Technology Action Plan will be initiated in accordance with the UNEP guidelines for soliciting funding support from the international funding agencies and potential donors.

1.2. Introduction

The present TNA report II on "Barrier Analysis and Enabling Framework, further advances the work completed under TNA report I on prioritization of following technologies in energy and waste sectors. The technologies in the energy sector include:

1. Solar Energy
2. Small Hydropower Plants

The prioritized technologies in the waste sector are:

1. Biogas Technology
2. Reduce, Reuse, Recycle (3Rs)

Different stages of TNA project implementation followed in Afghanistan
STAGE (I)
TNA Report-I
Key elements:

- Identification and prioritization of the sector
- Identification and prioritization of the technology in each sector

STAGE (II)
Barrier Analysis and Enabling Framework
Report-II
Key elements:

- Barrier analysis for apiece technology and enablers of the barricades
- Enabling framework

STAGE (III)
Technology Action Plans & Project Ideas
Report-III
Key elements:

- Action Plan for apiece prioritized technology
- Crosscutting issues
- Specific project ideas in each prioritized sector

1.3. Methodology

The methodology adopted for "Barrier analysis" and "enabling framework" comprised of the following:

Barrier analysis

The work on barrier analysis has been carried out to identify economic and financial as well as non-financial barriers for each prioritized technologies in the energy and waste sectors. The process adopted for "Barrier analysis" included a literature review, to develop an understanding from the past interventions carried out in the area of the selected technologies in Afghanistan as well as in other developing countries.

Logical Problem Analysis involving preparation of Market map and Problem tree was used as a tool in the analysis of the starter barriers of different technologies. The primary reasons including (i) not widespread use, and (ii) lack of investment from private or public sectors of

a particular technology were identified through desk study research of literature as well as interviews from relevant experts. The residual barriers such as low maintenance of solar system were decomposed into other barriers such as availability of accredited technicians and limited public awareness of the technology. The working paper contained market maps, problem trees and solution trees, which contained a long list of actors involved in the market, starter problem, causes of problems, effects of problems, solutions, results and long term impacts.

This method `was applied with the consultation of the Expert Working Group on Mitigation constituted by Afghanistan National Environmental Protection Agency and other relevant stakeholders. The working document was discussed in detail in the meeting covering elements like the root cause of the barriers in the identified technologies in which case all problems/barriers were arranged around a starter problem. The work was further advanced by analyzing causal relation using root-cause analysis through deliberations on Problem Trees and Market Maps for the relevant technologies. The analysis of identified root-causes for the identified problems in the promotion of the technologies was discussed with the panel of experts represented in the Expert working group on climate change mitigation. The Problem Trees and Market Maps were finalized with the inputs of relevant stakeholders/ members of the Expert Working Group on Mitigation.

The document was discussed in detail in the meeting covering elements like the root cause of the barriers in the identified technologies in which case all problems/barriers were arranged around a starter problem. The work was further advanced by analysing causal relation using root-cause analysis through deliberations on Problem Trees and Market Maps for the relevant technologies. All identified problems were ordered in a hierarchy of cause-effect relations with starter problem in the centre and the direct causes below it and direct effects above. The problem tree was used to screen barriers, which were decomposed in consultation with the stakeholders.

The analysis of identified root-causes for the identified problems in the promotion of the technologies was discussed with the panel of experts represented in the Expert working group on climate change mitigation. The Problem Trees and Market Maps were finalized with the inputs of relevant stakeholders/ members of the Expert Working Group on Mitigation.

Enabling framework

After a thorough understanding of the barriers, the report proposes measures to overcome the barriers. The measures focus on creating an enabling environment for transfer and diffusion of prioritized technologies to lead Afghanistan on the path of the low carbon economy. The process followed in the development of “Enabling framework” involved literature review in learning from the success stories and best practices of the selected technologies within the country and abroad facing similar situations.

Logical Solution Analysis concerning the preparation of Market map and Solution tree was used as a tool in the analysis of the proposed solutions of different technologies. This method `was applied with the consultation of the Expert Working Group on Mitigation and other

relevant stakeholders and used to identify the solution to overcome the root cause of the barriers in the identified technologies.

The analysis of solutions proposed for the technologies was presented before the panel of experts represented in the Expert working group on climate change mitigation as well as other relevant experts and suppliers on the selected technologies The Solution Trees and Market Maps were finalized with the inputs of relevant stakeholders.

Prioritization of Barriers:
Brainstorm barriers: Mitigation consultant in coordination with the selected stakeholders reviewed and modified/added to the initial list of possible economic/financial and non-economic barriers. Each barrier was carefully analyzed and screened to retain only the essential ones based on stakeholders' knowledge in the area, experience acquired and lessons learned from the local implementation (where existing) of the technology.

Select and categories: Using a qualitative measure of relative importance, barriers were classified as high, medium or low. This was necessary since all barriers were not considered equally or highly important.

Rank barriers: A numerical hierarchy was applied to barriers considered 'high' importance, with one being the highest ranked. Based on the rationale to decompose only the 'killer/critical' barrier/s, it was decided that the two highest ranked barriers should be decomposed using the Log-frame Analysis. Table 1 below shows an example of the categorization and ranking applied.

No	Barrier	Criteria – Importance			
		High	Medium	Low	Rank
	Economic and financial				
1	Barrier A		x		
2	Barrier B	x			2
	Non-financial				
3	Barrier C	x			1
4	Barrier D			x	

Table 1: Categorization and Prioritization Process for Barriers

Each 'killer/critical' barrier was decomposed to find the causal relations and their resulting effects. The LPA was very useful in bringing together all the key elements of a problem and guide the systematic and logical analysis of inter-linked key elements. According to the TNA guidelines, barriers may be decomposed at three 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)

Following the decomposition of the barriers to identifying root causes, possible measures were identified to address those causes and overcome the barriers. Overlapping barriers for

each sector were identified to show the linkages among the barriers across the technologies. In this assessment barriers across all the technologies for each sector were considered, which will allow wider range of measures to be captured in the enabling framework for the technologies.

Sensitization of policymakers

In order to ensure political ownership of TNA process in the country it's important to ascertain serious follow up for the implementation of TNA prioritized technologies. Special one on one detailed meetings and briefing sessions were arranged with relevant central and provincial policy makers in order to discuss ownership of the process and to maintain the these efforts in a more sustainable manner. (List of policy makers involved and sensitized in this process is given in the annexes at the end of this report).

The goals, objectives and the working arrangements of the participatory process was discussed via Skype and zoom applications. The main purpose of Sensitization of policy maker's exercise was to ensure their participation throughout the TNA process of selecting priority sectors, technology identification & prioritization, barrier analysis and development of enabling framework as their participation in the process is crucial for successful implementation of the recommended technologies. Therefore, an ongoing arrangement has been established to ensure continuous and effective involvement of stakeholders at each stage of the TNA process. The roles and responsibilities of stakeholder groups have been defined during the initial meeting. Each stakeholder Sectoral Working Group included around 8 persons representing related organizations in the respective sector. The compositions of the sectoral working groups were flexible with the provision of co-opting additional members depending on the requirement. Following is the list of all the potential barriers shared with the participants for discussion.

Identified barriers' categories related to technologies implementation		
Barriers	**Energy Sector**	**Waste Sector**
Economic	Yes	Yes
Financial	Yes	Yes
Legal and regulatory	Yes	Yes
Institutional and organizational capacity	Yes	Yes
Human resources	Yes	Yes
Social, cultural and behavioural	Yes	Yes
Information and awareness	Yes	Yes
Technical	Yes	Yes

Table1 2: Identified barriers' categories related to technologies implementation

The third phase of TAP and project ideas

After the completion of above two TNA phases, the work on the final Phase-III Technology Action Plan (TAP) and Project Ideas' will be initiated in accordance with the UNEP DTU guidelines. On September 3 and 8, 2020, Afghanistan TNA team participated in 2 days of virtual training about the structure and preparation of TAP.

CHAPTER 2: ENERGY SECTOR

Meeting the energy deficit is of fundamental importance to Afghanistan's economic growth and its efforts to raise levels of human development. This pressing issue needs to be addressed through an integrated energy plan comprising short-term, medium-term and long-term actions. The broad vision behind the integrated energy plan should meet the demand for energy needs of all sectors in a sustainable manner at competitive prices with a greater reliance on indigenous resources. The sustainable development and growth in the energy sector can be ensured by developing technological base of optimal energy options. Under the energy sector, the Technology Needs Assessment report identified nine technologies. Out of these two top ranking technologies, namely Solar Energy (PV) and Small hydropower plants were prioritized for barrier analysis and preparation of Technology Action plan.

2.1. Preliminary Targets for Technology Transfer and Diffusion in Energy Sector

Despite the fact of Afghanistan being rich in energy resources, more than three decades of continuous conflict has destroyed or severely degraded much of its infrastructure base, including that of the energy. As a result, currently, Afghanistan relies heavily on electricity imports from neighbouring countries, which account for more than three quarters of Afghanistan's total electricity usage. In order to reduce reliance on imported electricity, Afghanistan has made it a national priority to promote the generation of domestic electricity. Over the last decade, Afghanistan has made significant reconstruction efforts at all levels of the energy supply chain in particular, the electricity sector.

Years of war and neglect have left Afghanistan's energy sector in poor condition. Electrification ratios and energy consumption rates are among the world's lowest. By some estimates, less than 10% of the population have intermittent access to publicly provided power, and per capita, electricity consumption is as low as 21 kilowatt-hours a year. Many load centres around the country get electricity only 2–3 hours a day. Such electricity shortage affects people in urban and most rural areas alike and constrains economic growth. The government has been developing the Afghanistan National Development Strategy (ANDS) since 2004, with the support of the international community. The energy sector has top priority in the ANDS, which calls for investments in infrastructure in general, but particularly for energy security. Achieving energy security will require expanding and improving transmission and distribution networks, and increasing domestic generation capacity by using a mix of hydro and thermal resources (Afghanistan Renewable Energy Policy 2015).

The need for a master in the energy sector was identified at the time the ANDS was first developed. The master plan was prepared in 2004 with the support of the World Bank. However, the master plan quickly became outdated, as MEW lacked the capacity to update it. MEW's power sector strategy, for instance, was based on the requirement assumed in the 2004 master plan. This requirement did not take into account the population increase between 2004 and 2007 and, therefore, significantly underestimated Kabul's needs in 2007. Although power projects are an ANDS priority, the ANDS power sector investment program has not been appropriately implemented. Without an updated master plan, many activities under the ANDS have become ad hoc and lacking in strategic management. Many aid agencies have

supported investment in the electricity sector without coordinating and consulting with one another. The North East Power System, a successful initiative of the ANDS, brought immediate power to major load centres in the northeast, but there were incompatibility issues because seven different aid agencies were involved,4 In many instances, the same type of equipment had different specifications, complicating future maintenance. Coordination would have brought some sort of standardization within the system.

To develop an enabling framework for the energy sector to require capacity within the Ministry to administer and update plans for the energy sector. This has to be thoroughly discussed with the other development partners during both the bilateral meetings as well as in the Inter Ministerial Commission for Energy, a forum of Afghan energy stakeholders comprising the government and key development partners in the sector. Other partners in the energy sector would include United States Agency for International Development, the Asian Development Bank, and the World Bank. Strategic prioritization of energy projects is needed, as priorities are difficult to determine and often vary among different officials. The government needs to prepare an updated master plan to prioritize power sector projects and set reasonable goals and periods.

2.2. Micro hydropower plants

2.2.1. General description

In small hydropower plant technology, moving water turns a turbine, the turbine spins a generator, and thus electricity is produced without using fossil fuel. The amount of power that can be produced by a micro hydropower plant is determined by the head (the height of power drop); the flow rate; and efficiency factor of the system. The higher the head, the smaller the flow rate needed to produce the same amount of electricity. Micro hydropower plants are best suited for isolated locations where there is no grid electricity. Off-grid power plants need local load controlling device to stabilize frequency and voltage supply. Micro hydropower plants can serve a small community and as well as cottage industrial units.

In Afghanistan, small and mini HP are the most effective water pressure mini hydroelectric diversion type HPP. Development of such HPP can reduce the cost of HPP: from USD 350 - 700 per kW to USD 100 - 250 per kW, at the cost of USD 0.05 - 0.4 cents per 1kWh of electricity and organize mass production of hydroelectric power station with pipelines in some foothill regions of Afghanistan with the realization of products to customers, installation and service work.

In Afghanistan, rural areas are virtually unserved. Supply in rural areas, unless attached to the MEW network, comprises mainly micro hydropower plants (having capacities below 500 kW) that might be privately owned, community-owned or belong to Government offices for self- consumption. A significant amount of small hydropower potential exists throughout Afghanistan, some of which may be grid connected while other sites may be relatively far removed from any of the existing major grids. Based on the findings of the Power Sector Master Plan, it will be years before any national grid serving the whole country can deliver power to remote areas. Therefore, a goal of studying isolated sites is to investigate possibilities for supplying relatively low cost electricity to locales that would otherwise benefit from grid power only in the longer-term.

71. In the case of grid-connected sites, smaller hydro plants act to enhance the reliability of local supply in the more remote areas of the power grid. By providing input to the system locally, they may also act to reduce the costs of transmission and distribution (ADB, 2017).

Fig1: Small Hydropower in rural Afghanistan

2.2.2. Identification of barriers of Small Hydropower (SHP) plants

The key barriers for SHP plants have been identified through literature review and bilateral meetings with the experts by the consultant, and stakeholder consultations during the meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-) and Market Map (Annex-) for the technologies. The barriers were grouped under ten different categories (Economic and financial; Market failure/imperfection; Policy, legal and regulatory; Network failures; Institutional and organizational capacity; Human skills; Social, cultural and behavioural; Information and awareness; Technical and Other Barriers). Barriers, proposed by participants during the discussion, supplemented the initial list of barriers and the summarized list was screened. The decomposition of barriers within the category, with elements of barriers and dimension of barrier elements was applied. While screening the stakeholders gave scores according to criteria (1-5) based on their own experience, using the score 5 as the most significant to effect on small hydropower technology diffusion. In order to enable stakeholders to approach and delimit a problem area, the Logical Problem Analysis (LPA) tool was applied as an analysis technique. LPA tools helped to create systematic and logical analysis of problems and to bring together all elements of the problem.

The major barriers hindering the diffusion of SHP technology were identified through literature review, stakeholders and expert group consultations, as problem trees (Annex-IX). The analysis of market map (Annex-X) reveals that certain capacity of the SHP plants and associated equipment are manufactured locally. The construction and assembling of SHP is done by technicians and the quality of locally manufactured turbines and equipment and construction and installation of SHP is a real concern. Other important market actors are retailer, intermediary and the consumer.

Table 3: Identified barriers for small hydropower plants

Category	Barrier dimension	Main Barrier
Economic and Financial Barriers	Cost	• High upfront cots and interest rate in Afghanistan • Insufficient subsidy or support especially on local & district level mainly
Non- Financial Barriers	Policy, legal and regulatory	• No clear policy on subsidy and concession • Inadequate renewable energy policy, strategy and action plan
	Technical	• Limited capacity and technology of productive use of energy especially in local areas • Lack of proper maintenances system
	Institutional and organizational capacity	• Insufficient capacity of and resources availability mainly in some of insecure areas.
	Information and awareness	• Inadequate public knowledge on SHPs capabilities

2.2.2.1. Economic & Financial

A. Initial High Capital cost:

High capital cost is one of the main barriers of technology diffusion. The small hydropower technology is mostly imported into the country. There is a need for studying best international practices and applying technologies that are more modern. The cost of equipment for hydropower plants can reach even half or more than half the total cost of

construction. The investments required for construction of 1KW HPP is estimated US dollar 5 to 6 thousand in rural Afghanistan (IRC, 2015).

Small hydropower technology is mostly imported to Afghanistan as the local production is very small, which lead to high investment capital costs. There are very few local manufacturers for small HPPs; the equipment is mostly imported from China, Pakistan and India. The scale and pace of development of small hydropower depend on the presence and degree of elaboration of appropriate technologies and ultimately of the cost of generated energy.

Investment costs of small HPP (1-10 MW) and very small hydropower plants (≤1 MW) can vary from $2000 to $7500 per 1kW and from $2500 to $10000 per 1kW, respectively, and for the named types of HPPs in an average of $4500-5000 per 1kW (Micro Hydro Power and Productive Use Promotion (GIZ Afghanistan, 2015).
The potential areas of SHP plants are remote. These areas are generally inaccessible due to poor infrastructure network. The operation and maintenance of the system, is often affected due to non- availability of spare parts in the local towns.

B. Difficulty to Access Finance:
The banks and other small-credit institution do not provide loan facility to construct SHP plants. Due to this reason, the potential SHP sites remain unharnessed.

C. Lesser Consumer Affordability:
The local communities living in potential areas for construction of SHP plant sites are pastoral and poor. Their paying capacity is limited and they are unable to bear the high initial capital cost of the SHP plants.

2.2.2.2. Non-financial barriers

A. No integrated policy and programs:
Current Afghanistan Energy Strategy does not adequately address the economic, financial and social barriers hindering the diffusion of SHP plants. It is because the production of electricity from the SHP plants is in kilowatts, which are mostly produced in remote areas not connected to the grid. As the focus of the government is to increase electricity amount in the grid through the exploitation of sources which produce energy in Megawatts to address the national energy crisis. The local level concerned government institutions do not have the capacity as well as regulatory mechanisms to establish efficient implementation and diffusion of the technology. Further, there is poor coordination among line agencies, which create hurdles in upscaling of the SHP plants. Absence of strategies and programs for the promotion of the technology and the specific localized guidelines for planning, designing, construction, operation and maintenance of SHP plants are hindering the diffusion of the technology despite having a huge potential.

B. Poor quality of SHP plants due to absence of Quality Standards and labelling:
Due to poor quality of standards and labelling the SHP machinery and equipment are not of high quality and the SHP plants machinery is generally unbranded and has no warranty.

C. Remoteness of the area resulting into lesser information & awareness:
There is no effective mechanism for dissemination of information and raising awareness among the masses regarding SHP plants. Generally, people are ignorant about the basic technical information of how energy can be harnessed from flowing water of nearby streams. There is no knowledge about machinery, equipment and accessories required for SHP plant, their costs, and relevant agencies from where necessary technical and financial information and support can be obtained.

About the basic requirements of the SHP, there is also lesser awareness among the Community Development Councils (CDSs), buyers, and sellers, of SHP plants. Further, the local technicians and mid-level professionals do not have adequate knowledge and experience of installation of SHP plants as well as providing back up support at the community level.

Due to lesser information, the responsible institutions and NGOs, face problems in proper designing of the SHP plants and sometimes the SHP plants are not capable of sustaining the impacts of disasters. Further, the curricula of education institutions also do not include information for skill enhancement on the subject.

D. Scarce Market Development Services:
The market for SHP plants business is very limited despite vast untapped potential due to absence of local industrial capacity to produce quality SHP plants machinery at mass scale. Another factor limiting market is non-availability of locally trained SHP plants technicians and experts, especially certified from accredited institutions. Non-availability of certified technicians and trainer's results in high risk factor, hence the banks are hesitant to extend loans for SHP plants.

E. Risk of disasters or reduced water flow:
Most of the potential sites for SHP plants are in ecologically fragile areas that are prone to disasters like floods; landslides; glacier hazards including glacier lake outburst floods, avalanches, mudflows etc. Another contributing factor is the increasing population pressure and global warming, which are triggering glacial melt, avalanches and other glacial hazards leading to increased risks for SHP plants.

2.2.3. Enabling framework for Small-hydropower plants

The enabling framework for overcoming the barriers in small hydropower plant described in the form of Solution tree (Annex-X) were identified and qualified by the following process:

The measures for overcoming the barriers were initially identified by TNA Consultant's own experience, his interviews with experts in the field, supplemented by experiences documented in the literature in Afghanistan and other countries. The Logical problem analysis helped in shifting from problems to solutions. The measures were grouped, prioritized and evaluated during the meeting of Expert Working Group on Mitigation.

2.2.3.1. Economic & Financial measures a. Initial capital cost reduced

To reduce the initial capital cost and increase the diffusion of SHP plants, taxes and duties on different parts of the technology manufactured locally may be reduced or eliminated by the Government. Another cause of high initial capital cost is also poor infrastructure as such; the infrastructure network of potential sites may be improved to assure easy accessibility of transportation of equipment and spare parts.

A. Establishment of the soft-term Credit line:

Establish windows for grant of soft loans through banks or small-finance institutions to the local communities to facilitate adoption and diffusion of the technology. The technicians for SHP plants need to be certified from some accredited institute, which will help in building the confidence of the banks and other lending institutions to give credit for SHP plants. Programs of awareness and income generation for the local communities of the area should be launched to increase the affordability of local communities to facilitate construction of SHP plants. So far, the credit line is not available, almost all the SHP plants have been constructed through local and international donors funding with local community participation.

2.2.3.2. Non-financial measures

A. Policy and regulatory measures:

The current energy strategy may be revised to include necessary incentives for the promotion of small hydropower plants such as availability of soft term loans, creation of revolving fund, training of professionals and technicians and their accreditation from certified institutions. The policy may also include measures for strengthening the capacity of local level institutions dealing with the subject of small hydropower plant. Necessary regulatory measures and specific localized guidelines also need to be developed to establish efficient implementation and diffusion of the technology.

Keeping in view the scale of energy crisis, there is a need that the provincial governments should also develop their Renewable Energy Policies to effectively utilize available options for renewable energy production and assign mandates to concerned departments.

B. Development of Good Quality SHP plants:

There is a need to establish quality standards and to introduce energy rating labelling of SHP plant machineries and equipment to ensure supply of good quality SHP plants. This measure will increase the efficiency and reliability of SHP plants. The labelled products will be backed by warranty period and after-sale service guarantees.

B. Information and Awareness Creation:

It critical to increased coverage of weather and hydrological data monitoring stations and generate necessary data required for proper designing of SHP plants and forecasting for future flows including disasters during the lifecycle of SHP plants. There is a need to develop innovative strategies for awareness creation through print, electronic, and conventional methods to inform the stakeholders about the requirements, technical parameters, and benefits of the technology. The Professional and Vocational training centers should include

essential elementary training on SHP plants. In addition, the formal education system needs to include SHP plants technology in its curricula.

C. Market Development Services increased:
To develop new markets and expand existing markets for SHP plants, the vendor needs to streamline timely availability of SHP plants and its accessories at the demanded potential site. The product being introduced in the market should be of reliable quality manufactured as per international standards and backed up by after sale service and sufficient guarantee period. This would be achieved by increasing the capacity of local industry and technicians. Provision of tax rebates on local production will help in reducing the price and increasing the consumer market of the plants.

D. Risk of disasters reduced & improved water flow:
The Initial Environmental Examination (IEE) may be made mandatory prior to installation of SHP plants so that the adverse impacts are identified and appropriate measures taken in advance to mitigate the risks of potential disasters like land sliding, glacier hazards. The feasibility study prepared for SHP plants will help in installing SHP plants at the sites with sustained water flow. This would also ensure uninterrupted functioning and long life of the SHP plants. Under Environmental Management Plans (EMP), the SHP operators can be asked to undertake afforestation, compensatory forestation and Sustainable forest management to reduce deforestation. Promotion of renewable energy and energy conservation initiatives will result in reducing carbon footprint of Afghanistan and meeting livelihood needs of communities.

2.2.4. Cross-cutting barriers

The barriers identified in the energy sector, i.e. solar PV system, solar geyser and SHP plants have a number of common elements such as high capital cost, difficulty to access finance, absence of energy rating labeling and standards, the remoteness of area causing less information and awareness, government policy do not contain required incentives for the promotion of renewable energy, strategy and regulations. The following barriers have been found as root- causes hindering diffusion and creation of enabling environment for identified energy technologies. The details of such crosscutting barriers are as follows:

2.2.4.1. High capital cost and difficulty to access finance

High capital costs and difficulties in accessing adequate finance are common to the solar PV technologies in the country. The average cost per household for solar PV and SHP plants is around USD 5000 to 6000. This cost is high considering the income level of the target population. The main factors affecting initial capital cost include government taxes and duties on import of equipment and types of machinery for power generation.

The potential sites for SHP plants are in remote and backward rural areas and various solar PV applications are best suited for the remote areas of the country with large sunny hours. There is no credit facility available on concessional rates for solar energy and SHP plants. This is limiting the expansion and diffusion of the selected renewable technologies, due to low income of the consumer.

2.2.4.2. Absence of energy rating labeling and standards

Energy products such as Solar PV and Small Hydro motors and turbines are produced and sold in markets without standards and labeling. The local products are generally unbranded, having low efficiency with no warranty.

2.2.4.3. No proper budget for information and awareness raising

In Afghanistan, general public have low level of information and awareness about technical specifications of Solar PV and Small Hydro motors and turbines, product suitability and performance efficiency in the local climatic conditions. In the absence of such vital information, it is difficult for the consumers to assess suitability and selection of appropriate equipment, appropriate to their specific needs. Another important barrier is the availability of skilled and properly trained person to operate and maintain solar PV and Small Hydropower plants. Updated information about the technologies is not readily available in the country. Even when the equipment is procured, it is difficult to acquire the services of a locally trained and certified technician for installation and maintenance. One of the reasons of low awareness is also that it is inadequately addressed in the curricula and research and development efforts.

2.2.4.4. Government Policy, Strategy and Regulations do not contain required incentives for promotion of renewable energy

Afghanistan National Energy strategy does not adequately address innovative approaches that can boost diffusion and creation of enabling environment for solar PV and Small Hydropower plants technologies. Further, there is a need to develop strategies and regulations for ensuring coordination and cooperation among various concerned authorities and regulatory agencies, institutes and other stakeholders. The absence of such measures, result in delays and restrict the progress in renewable energy development and commercialization. Approval procedures for getting commensuration letter for tax, duties rebate in importing, and issuing permits is time consuming.

2.2.5. Enabling framework for overcoming the barriers

2.2.5.1. Access to soft term-loans

In energy sector, there is scope of establishing credit line for soft loans in the DFIs and Small-finance banks. The State Bank of Afghanistan has already created a special window for Financing Power Plants Using Renewable Energy up to 10 MW. For increasing the diffusion of identified technologies, the banks and DFIs need to expand their outreach up to the village level, simplify the procedure for grant of loan, establish special window to extend concessional loans for the purchase of Solar PV, Solar Geyser and Small Hydro power plants. This objective can also be achieved by establishing Revolving Funds at the central and provincial levels. Establishment of such facilities will increase coverage of recipients of soft-term loans at the grassroots level and will result in increasing income-generating opportunities.

2.2.5.2. Commencement of energy rating labeling and standards

The regulatory system for running solar PV and SHP plants should have clear and specific performance standards. Labels and minimum energy performance standards (MEPS) will help in diffusion of this technology and will gain confidence of buyers as well as of sellers.

2.2.5.3. Information & awareness rising

Dissemination of information and awareness through print, electronic and conventional methods should be beefed up. Launching of pilot demonstration projects and establishment of energy technology parks for renewable energy technologies will generate interest among the masses to adopt the technology. The subject of renewable energy technologies should be included in the curricula to impart adequate information about benefits of the technologies and their application to solve the energy crisis in the country. Emphasis should also be given on training of professionals of line agencies and civil society in renewable energy technology and dissemination of weather forecasting.

2.2.5.4. Government policy strategy and regulations

There is a need to revise the National Policy for the Promotion of Renewable Energy (2015) to create an enabling environment for the diffusion of renewable energy technologies particularly solar PV and SHP plants. There is also a need to develop a strategy for promotion of renewable energy at the national, provincial and local levels and develop legislative framework to ensure effective implementation of policy measures. To activate the market penetration further legislative and regulation base should be developed and improved in order to promote the diffusion of technology, including regulations on permits, preparation and approval of projects.

2.3. Solar technology

2.3.1. General description

Solar photovoltaic (PV) system, off-grid and on-grid at household or small institution level, is a consumer good. It consists of solar PV panels, charge controller, 12 or 24 volts battery and Direct Current (DC) powered lighting, fan and other appliances. If lighting and appliances are Alternate Current (AC) powered, a converter is required to convert solar DC to AC. Solar PV cells are of three types i.e. amorphous, mono-crystalline and poly crystalline. Life of amorphous cells is less (5-8 years) while for other types life is more than 25 years. It was reported that Afghanistan has the potential to produce over 222,000 MW of electricity by using solar panels. The use of solar power is steadily increasing throughout country. Annual average solar insolation varies from four to 6.5 kWh/m2/day, with over 300 days of sunshine per year Renewable and Sustainable Energy Reviews (Richard K. Burns, 2011).

Fig 2: Solar Panel in rural Afghanistan

Solar Systems provide household's lights, and electrical power for televisions, fans, mobile charging and small appliances. Following are some of the benefits of Solar PV system:

- Due to long hours electricity load shedding the solar system overcomes the discomfort, loss of production and business and improves the quality of life.
- The system facilitates and creates new employment opportunities as well as support in establishing cottage industries. It will also benefit in increasing the working hours.
- The solar PV provides clean energy, better health conditions and significantly reduces the risk of fire as opposed to use of candles and kerosene lamps. It also provides learning opportunities for students in the evenings.
- The system can also replace use of fossil fuel for energy generation. It helps in reducing national level GHG emissions by replacing fossil fuel to clean energy sources. Thus, it helps to fulfill international commitments of the country.
- The system can be a source to claim Certified Emission Reductions, which can be a source of additional income through Clean Development Mechanism projects.

After three decades of conflict, with huge social and environmental costs, and despite hundreds of billions of dollars of donor investments over the past decade, there are still over 25 million Afghan people who lack electricity to meet basic power needs and stimulate economic growth. Most of these people live in rural areas with limited access to health care, education, or a reliable income. These rural Afghan people typically live in small villages, often scattered over challenging mountainous or desert terrain. There is little likelihood for most of them to ever receive electricity from the conventional electric grid in the coming decades. Only through photovoltaic (PV) technologies can a majority of these rural Afghan villages hope to enjoy basic electrical service.

The Afghanistan Clean Energy Program (ACEP) was a US$22 million funded program from September 2009 to March 2012 primarily focused on solar energy and has been the single largest United States Agency for International Development (USAID) funded solar energy initiative to date. ACEP's main goals were to provide basic electrification services primarily

through PV technologies. Winrock International provided engineering technical support to USAID for ACEP. ACEP primary activities were the installation of PV power systems (PVPS) for villages not connected to the power grid. ACEP benefitted over one million Afghans and installed 500 kW of PV power systems for villages, clinics, schools, and farms in 21 Afghan provinces. Many systems were installed in difficult areas under trying circumstances. In a few instances work crews were kidnapped by the Taliban, or jailed by corrupt local authorities; all were fortunately released unharmed. A few systems in the south were stolen or sabotaged by Taliban elements. However, ACEP persevered and was able to complete all its PV projects, which contributed to local improvements in health, education, nutrition, and income. ACEP also distributed solar lanterns to 10,000 households in Badakshan, Bamiyan, Kandahar, and Wardak provinces.

2.3.2. Identification of barriers for Solar Technology

The key barriers for Solar Energy has been identified through literature review and bilateral meetings with the experts by the consultant and stakeholder consultations during meeting of Technical Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at annexes).

In Afghanistan, at present the production or manufacturing of solar panels is almost negligible. The solar panels are either imported or assembled locally from imported Solar Energy wafers. The off-grid and on-grid Solar Energy market is picking up fast in both in urban and rural areas. Being a primary player in the market for solar products, the importer has a crucial and faces many financial, institutional, policy barriers etc. The other important players are producer, assembler, retailer, whole-seller and the consumer at the receiving end.
Regarding the other parts of the Solar Energy system such as charge controller and converter to convert solar Direct Current (DC) to Alternate Current (AC) electricity are partly imported and still not produced in Afghanistan. For Solar Energy system deep discharge batteries are recommended which are not produced in Afghanistan and are imported. Similarly, DC powered lighting; fan and other appliances are also imported. Due to non-availability and high price of deep discharge batteries, mostly batteries used for vehicles, which are not very efficient, are being used in Solar Energy systems installed in residential and commercial buildings. The major barriers in the wide diffusion of Solar Energy are categorized under economic, financial, and non-financial barriers as below:

Table 4: Identified barriers for Solar PV in Afghanistan

Category	Barrier dimension	Main Barrier
Economic and Financial Barriers	Cost	• High cost of the solar panels both in cities and additional cost for the transportation to the local districts and remote villages. • Insufficient subsidy or support especially on

		local level
Non- Financial Barriers	Policy, legal and regulatory	• No specific policy provisions to provided subsidy and concession • Inadequate renewable energy policy, strategy and action plan
	Technical	• Limited capacity and technology of productive use of energy and demand • Lack of proper maintenances system
	Institutional and organizational capacity	• Insufficient capacity of provincial and district level staffs. Security and accessibility to some of the most remote areas.
	Information and awareness	• Inadequate public knowledge on Solar energy capabilities

2.3.2.1 Economic & Financial

A. High up-front cost:

One of the most important barriers for installation of Solar Energy in both large and small scale is the high upfront capital cost. The upfront cost of small Solar Energy is approximately Afs.100 thousand per kW (US$1500/kW). The initial capital cost of panels and batteries are hindering expansion of solar market due to lesser consumer affordability. There is no formal mechanism available for grant or loans at affordable rates of interest. Further, due to non-availability of certified trainers and technicians, the banks are hesitant to grant and loans because of high risk factor.

2.3.2.2 Non-financial barriers

A. Low awareness:

In general, public have low level of awareness and low priority about Solar Energy in Afghanistan. Due to low awareness, there is an absence of technical knowledge in buyers, sellers, and technicians. Further, lesser knowledge with regard to suitability and selection of appropriate equipment, suiting to the specific needs of the client is limiting the solar market. Skilled and properly trained work force to operate and maintain Solar Energy technology is not readily available in the country since there is no mechanism for skill enhancement

training and dissemination of the knowledge. One of the reasons of low awareness is that it is inadequately addressed in the curricula, limited research, and development efforts.

B. No Quality Standards and labeling:
In Afghanistan, solar products are sold in the market without standards and labeling. These are generally unbranded and have no warranty. In case of large Solar Energy, due to absence of testing laboratory facility hairline cracks in the solar panels cannot be tested before installation, which is a major risk.

C. Government Policy, strategies and legislation provide lesser incentives for promotion of solar technologies:
The Policy for the Development of Renewable Energy for Power Generation does not properly lays down the framework for large scale solar power projects and does not properly address innovative approaches e.g. exemption of taxes in case of local manufacturing that can boost diffusion of solar technologies at small scale / off-grid level. Silica is the main raw material for producing solar panels and it is in abundance in Afghanistan but due to absence of incentives and technology, the solar photovoltaic are not being produced from silica and these are only being assembled from imported PV wafers. Thus, the cost of Solar Energy is high. There is less coordination and cooperation within and among various ministries, agencies, institutes and other stakeholders delays and restrict the progress in renewable energy development and commercialization.

D. Less Technological Skills:
Lack of appropriate technological skills in respect of Solar Energy systems among the technicians because of the absence of any formal accredited training facilities hinders the dissemination of Solar Energy technology among the prospective consumers. Because of less scale of business and few distribution networks the interest of the technicians and private vocational training institutions are also limited in the area of Solar Energy technology skill enhancement and training.

E. Less Coordination between Government Departments & NGOs:
There exists no mechanism for coordination between government departments and the working of NGOs, particularly in respect of diffusion and dissemination of renewable energy technologies. Because of the lack of existence of this mechanism whatever work being done by NGOs and private sector agencies, the progress is not accounted for while compiling a national scenario. However, the role of NGOs and private sector organizations are significant and needs to be streamlined through any establishment of formal system of coordination and monitoring through some government institution.

2.3.3. Enabling framework for overcoming the barriers for solar technology

The measures for overcoming the barriers were initially identified by TNA Consultant's own experience, his interviews with experts, supplemented by experiences documented in the literature in Afghanistan and other countries. The Logical problem analysis helped in shifting from problems to solutions. The measures were grouped, prioritized and evaluated during the meeting of Expert Working Group on Mitigation (Annex-XX).

2.3.3.1. Economic & Financial measures

A. Establishment of soft-term credit line:

There is a need to establish a credit line for soft term loans in the Development Finance Institutions (DFIs) and Micro-finance banks/institutions for grant of loans on concessional rates for the purchase of solar systems. This objective can also be achieved by establishing revolving funds at the central and provincial levels as well as establishing certification system for Solar Energy trainers and technicians. The banks will need to identify their willingness to extend credit line for solar systems provided availability of certified trainers and technicians are ensured to reduce the risk factor. The government will need to grant partial waver of taxes and duties on import of solar system equipment and machinery. To capture the market some venders have introduced installment payment for the off-grid home based Solar Energy system. Establishment of such facilities will increase income-generating opportunities.

B. Business model:
Keeping in view the rapidly increasing demand for Solar Energy in Afghanistan, the business model needs to be designed to encourage domestic manufacturing by giving incentives, such as tax rebate, tax credits for new investments and improving procedures for registration, to make it competitive with the imported Solar Energy system. A successful business model, therefore, needs to establish a diffusion and monitoring plan for continuous improvement of product as well as service delivery system. For off-grid users, availability of DC equipment, accessories and supplies will help in reducing the overall cost of the system. Domestic manufacturing would result in price reduction and timely availability. This approach would foster more responsibility in the management and maintenance of the system and would help to build a sustained local market.

2.3.3.2. Non-financial measures

A. Establishment of Quality Standards & Labeling:
The solar energy quality standards, once established will guarantee availability of reliable product quality in the market. The labeled products will be backed by warranty period and after-sale service arrangements. Establishment of Testing laboratories will help in detecting hairline cracks in the solar panels, which will increase the efficiency of the panels.

B. Awareness:
Awareness of public can be improved through print, electronic and conventional methods. The results can be better achieved through development and implementation of behavior change strategy. Experts at village level can help in further awareness creation. There is a need to increase solar related information in the curricula. The professional and vocational training centers may include basic trainings on solar system, its installation, operation and maintenance. Demonstrations of the technology at grassroots level will increase the awareness of the public regarding different components of the solar system and appropriate solar system required for their houses.

C. Strategy & Regulatory measures:
Introduction of payment of solar system in installments by the retailers can reduce the burden of high initial cost and can result in increase of clientele.

D. Regulatory mechanisms for increasing coordination between Government & NGOs:
Considering the overall potential and to avoid duplication of efforts, there is a need to establish a regulatory mechanism for coordination between NGOs and Government

departments in promotion of renewable energy technologies, particularly Solar Energy systems. The advantage of establishment of this mechanism will result in avoidance of duplication of efforts in site identification, surveying and preparation of feasibility studies of both by private sectors, NGOs and the government agencies. However, there exists an opportunity of establishing a system of developing a roster of Solar Energy importers and capacity of systems imported by NGOs and private sector organizations who come to a government institution for seeking approval of subsidy in duty or tax during imports of Solar Energy equipment and systems. This arrangement will facilitate the government to take a stock of unrecorded initiatives of Solar Energy installed in Afghanistan through NGOs and private sector.

2.3.4. Effects and impacts of enabling framework of solar technologies

Effects and impacts of enabling framework of solar technologies initially identified by the consultant on the basis of literature review and interviews with the experts were presented in the Expert Working group meeting for their prioritization and evaluation. The prioritized measures were as follows:

2.3.4.1. More access to electricity

The wide diffusion of solar PV will lead to more access to electricity.

2.3.4.2. Reduced GHG emission & indoor pollution

The production of electricity from solar PV instead of conventional source of fuels, which are dominated by furnace oil for grid and biomass for off-grid, will reduce usage of fossil fuel and deforestation; as a result, it will lead to reduction in GHG emission and indoor pollution for off-grid situation.

2.3.4.3. Better education

More and regular supply of electricity will result in less disruption in education system and more availability of time for spreading education.

2.3.4.4. Better health coverage

Modern health facilities and equipment’s require electricity and hence more and regular availability of electricity will lead to better health coverage.

2.3.4.5. More job opportunities

As energy is considered the engine of growth and development, more and regular supply of electricity will result into better performance of different sectors of economy and more job opportunities, which will result in reduction of poverty and increase in standard of living.

CHAPTER 3: WASTE SECTOR

The effects from decades of war in Afghanistan have left the country facing severe environmental challenges, from deforestation to water management. Among these issues is the inability of the country to treat and dispose of municipal solid waste and sewage. Across the country, the poor handling of waste and chemicals is made all the more problematic by a lack of information about the generation, processes and composition of waste and its management. This information void is represented in the only piece of legislation related to waste management in Afghanistan, the Waste Management Policy, which addresses all the chemical management needs.

3.1. Preliminary targets for technology transfer & diffusion

The Waste Management Policy was endorsed by the National Environmental Protection Agency, the overarching government authority for the protection of the environment, in 2010. The Waste Management Policy is now being revised by the National Environmental Protection Agency. The provision of a clean and healthy living environment through the improved management and control of waste to support a "healthy life for all Afghans" is the vision for the Waste Management Policy. The National Environmental Protection Agency seeks to increase the capacity of government institutions, which relate to biodiversity, agriculture, forestry, land, climate change, and so on. Because there is no strong legislation, except for the Environment Law, it is difficult to grasp the development of the chemicals and waste agenda, particularly when it relates to the production, management and imports of chemicals.

Estimates by the National Implementation Plan of Afghanistan on Persistent Organic Pollutants show a very low amount of hazardous waste generation in the country, but the emission of toxin from unregulated dumpsites is unknown. In the meantime, economic development is leading to growing industries, construction and imports of chemicals from neighboring countries, and so Afghanistan's story can be perceived from another angle. The infant legislative system for the sound management of chemicals and waste in Afghanistan might not be ready for the pressure spurring from blooming industries. To minimize the growing emissions of harmful pollutants, the country will need access to green and clean technologies.

In the capital city of Kabul, increasing generation of solid waste and its improper management has imposed daunting impacts. The city of 5 million people generated 3050 tons of solid waste every day in 2018. Data analysis shows that if an estimated 25% waste reduction is achieved gradually by 2023, then the total cost of the system will be reduced to 1505.9 million Afs/year, much lesser than the estimated cost at 2210 million Afs/year. Developing an integrated solid-waste management (ISWM) plan for Kabul city based on an

overview of the existing system and practices, including the gaps in the entire value chain. A paradigm shift from business-as-usual scenario to an ISWM approach is recommended. The proposed strategies, when implemented effectively, will increase the recycling rate and reduce the requirement for landfilling in Kabul city. Policy reforms to encourage waste reduction and segregation, and the establishment of facilities for recycling, treatment, and landfilling are proposed. Moreover, the willingness to pay of citizens indicates the total cost of waste management system, estimated at 111.53 million Afs/month, can be recovered effectively.

3.2. Reduce, Reuse and Recycle (3Rs)

3.2.1. General description

The 3Rs Concept of technologies to be implemented can substantially contribute to the reduction of the amount of waste disposed on land. To carry out the implementation of the 3Rs concept of technologies requires a high degree of coordination and organization of the waste management chain. For the purpose of reduction of the waste problems in future, reduction in waste generation and reuse of old, products such as electronics can be one of the most important factors. The reduction, for example, possible at consumption level includes better buying habits and cutting down on the use and purchase of disposable products and packaging. In addition, recycling is viable and the best option for a range of waste products. In some economies, there are already well-organized recycling businesses processes in place for a range of products (e.g. furniture, clothing textile etc.) and materials (e.g. paper, iron, glass and steel).

With ultimate goal of reducing the disposal of wastes at uncontrolled sites and hence, to reduce GHG emissions, the 3Rs' technology is aimed at achieving the followings:

- Reduce pollution problems and improve the livelihood across the country
- Create job opportunities and improve the socio-economic status of the urban population
- Reduce GHG emissions across the country especially in the urban settlement.

3.2.2. Identification of barrier Analysis for 3Rs technology

A well-functioning waste management system allows residents to dispose of their waste in an appropriate manner. Components of a waste management system include the facilities and equipment used to temporarily store waste (collection bins) or transfer collected waste to its final disposal site. The majority of Technical Working Group observations point to problems with the waste management system. The major barriers in the wide diffusion of 3Rs technology are categorized under economic, financial, and non-financial barriers as below:

Table 5: Identified barriers for 3Rs technology in Afghanistan

Category	Barrier dimension	Main Barrier
Economic and Financial Barriers	Cost	• High cost of landfill sites maintenance and insufficient municipal budgeting • Insufficient subsidy & concession
Non- Financial Barriers	Policy, legal and regulatory	• No specific policy provisions to provided subsidy and concession • Inadequate renewable energy policy, strategy and action plan
	Technical	• Limited capacity and technology for proper waste management i.e. lack of sanitary landfill sites, proper incineration equipment, etc. • Lack of proper maintenances system
	Institutional and organizational capacity	• Insufficient capacity of provincial and district level staffs • Lack of public and private partnership (PPP) mechanism
	Information and awareness	• Inadequate public knowledge about the

		health impacts of uncontrolled solid waste.

3.2.2.1. Economic & Financial

A. High up-front cost:

The central and provincial municipalities usually pay the cost for waste collection and landfill sites in Afghanistan, however in most cases due to insufficient funding for the maintenance and operation of these facilities makes it challenging & difficult. High cost for the establishment of composting plant is another key dilemma for the central and provincial governments.

3.2.2.2. Non- Financial barriers

A. Lack of Waste Collecting Points:

The most frequently cited barrier to effective waste management identified was a problem with non-fixed waste collection points. People can find an appropriate location to put their solid waste that there were an insufficient number of collection points, or, points are not sited appropriately, or, that collection points are not fixed. Also in Afghanistan, many residents refuse to have a bin in front of their home because they fear others will bring their garbage there too, thereby establishing a neighborhood waste collection point, rather than a household one.

B. Irregularity of Waste Collection:

Waste collection routes in major cities of Afghanistan including Kabul are not divided into proper zones, there is no system of collection routes for each truck; they struggle to complete their set tasks each day. The waste collectors are unable to adhere to their collection schedule. Waste collection services were a common issue of concern for most technical working group members. During working group discussions, the representative of Kabul municipality also recognized this problem. The second most commonly cited issue was the frequency of waste collection. Nearly all municipalities in capital and provinces lack basic resources to sustain the services on regular basis.

C. Inadequate Waste Collection Vehicles:

In Kabul and other major cities, no waste transfer station to take waste for sorting. This travelling distance in conjunction with the volume of waste generated each day means that waste collection trucks make a few trips per day to the landfill site. Most of the TWG members stated that deficiencies in waste collection trucks (too few or poorly maintained) were barriers to effective waste management.

D. Inadequate Access to Waste Bins:

In Afghanistan, waste bins are placed at the kerb-side ready for collection by the waste trucks. Inadequate access to these waste bins as one of the main barriers to effective waste management. Waste bins pose a problem for both public and private use. The municipality in the past provided kerb-side waste bins for public use in Kabul city mainly (for example, some people took the bins away because they were unsightly and smelled bad) and so the municipality ceased to provide bins. In the absence of a municipality, waste bin service most waste bins are now provided by private business or by households. These private bins are

simple receptacles, such as plastic baskets or bins made from old tires. Many people simply use plastic bags. Many respondents mentioned the inadequacy of the capacity of the bins placed in dormitories.

E. Alternatives to Final Waste Disposal (Burning and Illegal Dumping):
Minimizing waste at the source was the only solution. Residents will require managing their waste reducing and reusing, as well as disposing of their own waste by burning or burying rubbish on their own land.

F. Improper Waste Separation Facilities:
Waste separation is an important strategy to reduce the amount of solid waste going to landfill. It is a goal of the management to reduce the amount of waste going to the municipality landfill site because dumping is costly. In addition, the operators of the landfill are limiting the amount of waste they will accept from central and provincial municipalities. This means waste separation is an important element of waste management for this provincial government. However, there is no formal waste separation process in place. Rather, informal systems have emerged.

G. Organizational & policy barriers:
Many members of the technical working group indicated that organizational barriers stand in the way of effective waste management. Five key organizational barriers to effective municipal waste management include problems for the local authority such as lack of planning, strategic direction, and management (including lack of training) and poor communication between municipalities' staff and the community. Poor communication was the most commonly cited problem raised by the members of the TWG. There were two major issues within poor communication. Most of the technical working group participants mentioned that "lack of information" is an issue for effective waste management especially in Kabul city. Community participation and awareness are linked directly to waste management problems. The literature suggests that encouraging people to participate will increase awareness, input and reception. Here, socio-cultural barriers—those social and cultural factors that determine people's activities—refer to lack of participation, poor co-operation and negative attitudes of residents.

3.2.3. Enabling framework for overcoming the barriers in 3Rs Technology

3.2.3.1. Economic and financial measures

In order to overcome high financial costs associated with setting up composting plants, it is recommended to establishing clear procedures for providing incentives or subsidies for encouraging private participation in composting ventures to facilitate the availability of necessary finance. This could potentially be done by using domestic and international funding sources to provide incentives for promoting public-private partnerships in setting up composting plants. These funding sources could be used to provide incentives such as tax rebates; custom duty exemptions on import of related equipment. Ensuring appropriate financial mechanism to support development waste management prioritized technologies to offset the high capital and operation and maintenance cost. Ensuring that sufficient financial resources are available to R&D institutions for strengthening and undertaking research, training and technology awareness raising activities among stakeholders. Strengthening operation and maintenance institutional capacities at national and sub- national

levels. Special training to train local technicians in operation and maintenance of the prioritized technology.

3.2.3.2. Non-financial measures

It is crucial to have a formal system of waste management in the country with specific institutions looking into waste management aspects with clearly defined responsibilities. Key components of constructing such a structure would be:
To identify specific organizations looking into following specific aspects:

- □□□ proper□□□□□□□□□□□□□□□□□□□□□
- Characterization and segregation.□
- □□□

In addition, it is important to build capacity of line institutions to carry out effective waste management and facilitate implementation of composting plants in the country. Currently, government capacity is limited in terms of technical human resources, it requires experts in technology evaluation, and it's monitoring. The understanding and management potential of the municipalities is very limited for managing. In order to ensure these following steps could be undertaken:

In order to build awareness regarding composting, it is important to disseminate information and awareness through campaigns on the technology and its benefits at both municipal and household level. In order to do this, following steps could be undertaken:

- Develop content of such campaigns
- Develop campaign material, in form of brochures, pamphlets etc.
- Door-step communication on segregation and storage
- Occasional clean-up campaigns on littering and indiscriminate disposal
- Use of print and electronic media, flyers, movies, etc.

Policy and regulatory frameworks are important which act as a guide to avoid technology externalities faced by its users. A key component of the enabling framework for overcoming the barriers to the diffusion of prioritized technologies in the waste sector should be the earliest adoption of draft national waste management policy and the enhanced operationalization of the existing national climate change policy and its implementation framework's related recommendations. An increased budgetary allocation must support this policy measure for the above-mentioned prioritized technology through the facilitation and mobilization of national budgetary resources including external donor agencies. Likewise, strong regulatory environment is crucial in handling municipalities' imperfection and failure specifically in case of technology innovation benefits from patents and intellectual property rights.

Participation of private entities in development and diffusion 3Rs environmentally sensitive technology is highly acknowledged. Capacity of local private sector is a defining element in delivery of successful technology to end-user both for private and public agricultural

technology. This includes private manufacturing firms for various efficient recycling and resuming systems.

Ensuring the required investment is the fundamental enabling factor across all municipal sector technologies implementation. All the enabling measures can benefit from fundamental measures such as training, human and institutional capacities enhancement, strengthening laws and regulations, setting of appropriate policies (incentives or disincentives), ensuring climate informed-decision making and planning, promoting research and technology awareness, and implementing pilot demonstration projects.

3.3. Biogas Technology

3.3.1. General Description

In Afghanistan biogas capture from landfills have a greater potential contribution to socio-economic development of the regions across the country by the expansion of employment opportunities. Moreover, it improves the security of energy supply. Biogas capture from landfills improves the livelihood of people in the rural settlement of the country and as well as it provides the sustainable supply of energy and enhances population health by removing the hazards they face from the landfills both in the short and long runs. Biogas capture technology involves excavating the ground and constructing bio- digestion tank using the usual construction materials such as stones and cement. The tank is sealed to ensure anaerobic decomposition of biodegradable materials.

Domestic biogas plants vary in size, depending on the household's needs and quantity of feedstock – mainly animal manure; however, other organic material such as kitchen waste, crop residues, and night soil (human excreta) could supplement it. Water availability is also important because the collected manure must be mixed with water in the bio digester (typically at a ratio of 1:1). In general, the smallest size biogas plant (1 m3 capacity) requires about 25 kg of manure per day (supplied by about two-three cows) and 25 liters of water respectively, which can meet the cooking and lighting needs of a three- to four-member family (Table 3). The largest family-size plant (6m3 capacity) can cover the needs of a relatively large joint family of 18-24 members. There are many designs of biogas digesters for household use, including the floating drum and the heat-sealed plastic or rubber bag (balloon) type. However, the fixed-dome design is perhaps the most applied given its relatively low construction and maintenance cost, reliability, simplicity, durability, and long lifetime. In addition, the plant is constructed underground, protecting it from physical damage and saving space.

At a household level, the use of solid biogas resources - firewood, charcoal, animal dung, and crop residues is very high, about 90% of total firewood provides 65% of the domestic fuel. Anecdotal evidence and historical sources show that rural population is almost totally dependent on biomass fuels for cooking and heating, while lighting is provided by kerosene. In urban areas, there is a push to use liquefied petroleum gas (LPG) to offset fuel wood consumption and its resulting air pollution.

Household fuels	Ktonne/yr	Overall share of household use (%)

Fuel wood	6,145	65
Charcoal/other	1,013	25
Coal	122	3
Kerosene	55	2
LPG	135	3

Table 5: Household biogas resources

Two types of technology have been suggested in Afghanistan for household biodigesters namely: Rotating drum: the metal lid, which encloses the gas chamber, is made such that it is manoeuvrable so that the gas contained therein is redistributed and the fixed dome where the chamber container lid is fixed. The digesters can be constructed in different sizes depending on the requirements of the household and its capacity to supply raw waste materials. Currently the bio-digesters are being constructed in sizes of 6m3, 8m3, 10m3, and 12m3. The bio-digesters generate different amounts of biogas according to sizes. The main aim of biogas capture technology is to prevent methane gas from escaping to the atmosphere where as a greenhouse gas its global warming potential is 21 times more powerful than Carbon Dioxide.

Biogas technology was introduced in Afghanistan about 20 years ago, on a very small scale, and through NGOs mostly in rural parts and mainly in central highlands of Afghanistan. However, financial and technical barriers such as high cost of construction, inadequate financial support, low design, construction and management skills, social and cultural beliefs and inadequate information have hampered diffusion in the country. The German GTZ in collaboration with the Ministry of Energy has been promoting the technology in the country for some time now. The waste residues are comparable to mineral fertilizers in plant nutrients and can therefore be used in farms for crop growth resulting in great savings for the farmers who use them instead of expensive commercial fertilizers. Bio-digesters are constructed at the households or institutions where the gas is used for cooking and lighting. The market demand is mostly from farmers in rural areas and is driven by factors such as availability of farm wastes and the need for affordable clean energy. Some NGOs within the country are conducting training of households on the operation of bio-digesters through demonstrations among other methods.

3.3.2. Identification of barriers for biogas technology

Table 6: Identified barriers for Biogas technology in Afghanistan

Category	Barrier dimension	Main Barrier
Economic and Financial Barriers	Cost	• High cost, epically to hire experts and skilled labor • Insufficient subsidy or support especially in some of the most remote areas of

		Afghanistan
Non- Financial Barriers	Policy, legal and regulatory	• No specific policy provisions to provided subsidy and concession • Inadequate renewable energy policy, strategy and action plan
	Technical	• Limited capacity and technology of productive use of energy and demand • Lack of proper maintenances system
	Institutional and organizational capacity	• Insufficient capacity of provincial and district level staffs
	Information and awareness	• Inadequate public knowledge about proper use and advantages of biogas technology

3.3.2.1. Economic and financial barriers

A. High cost of construction of bio-digesters:

Although most of the construction materials are, local and they are not expensive. The construction technicians also demand high labor costs because they are few. Imported components are charged high import duty.

B. High transaction costs:

Feasibility studies are expensive because there are only a few experts in this area.

C. Lack of financial incentives:

The Government does not have in place financial incentives that could encourage small-scale farmers to acquire bio-digesters at affordable costs.

D. High maintenance costs:

Replacement parts of bio-digesters are expensive. The technical personnel charge high fees because they are few.

3.3.2.2. Non-financial barriers

A. Low awareness:

Low awareness of the benefits of bio-digesters as sources of reliable and clean energy

Most people on local level are not informed of the benefits of bio-digesters in terms of health, farm inputs and clean energy.

Lack of training of potential bio-digester users

Most of the potential users do not know how to operate bio-digesters for proper generation of methane gas energy.

Lack of adequate space for construction of large bio-digesters

Many of the small-scale farmers have small areas of land, which they utilize for mixed farming. The space may not be able to accommodate large bio-digesters.

B. Lack of market links:

Market links among the farmers, construction companies are low, and therefore the market is low.

C. Policy, Legal and Regulatory:

Insufficient legal and regulatory framework followed by complex procedures and inadequate regulations for climate change technologies. In Afghanistan, the other major policy barrier is the lack of efficient enforcement and inability to enforce laws and regulations.

D. Institutional and Organizational Capacity:

In Afghanistan lack of professional institutions to properly promote and disseminate the technology. There are some institutions but with limited capacity. There is also limited capacity for research and development in this sector.

E. Human Skills Barrier category:

Inadequate training facilities, consultant's and lack of expenses to train stakeholders. Lack of skilled personnel for the installation and operation of the technology and lack of service and maintenance specialist. Limited dissemination of information to technology users, lack of market information & lack of access to technology resource assessment data.

3.3.3. Enabling Framework for biogas technology

3.3.3.1. Economic and Financial

The government will need to give waiver on import duty and other taxes on all the components that will be imported for the purpose of construction and operation and maintenance of methane bio-digesters. The justification will be based on environmental and health benefits and poverty reduction among the small-scale users, mainly on the local level.

A. Reduce interest rates:

The financial institutions will form partnership with the government to provide low interest loans for development of bio-digesters in order to promote clean energy in rural households towards environmental conservation.

B. Reduce maintenance costs:

The government will give tax waiver to components that will be manufactured locally or imported for the purpose of maintenance of bio-digesters and reduce the cost of cooking

stoves and gas lamps. The government should give tax waiver on the cooking stoves and gas lamps that use methane gas specifically.

3.3.3.2. Non-financial measures

A. Make available skilled technical personnel:

Technical training institutions in the country will need to develop customized training courses for technicians who will undertake construction and maintenance of the bio-digesters.

B. Bio-digesters are modified and improved to meet the emerging needs:

Research and development institutions will be given funds to conduct research and development of appropriate methane capture bio-digesters that will respond to consumer demands such as those that are portable. The funding will come from a special climate fund, which will be created by the government.

C. Implement training and public awareness campaign for users:

The responsible institutions within the government in collaboration with research centers and construction companies will conduct training and public awareness campaigns for households on the operation and maintenance of the bio-digesters. The public awareness campaign will include explaining the benefits of methane energy production on the environment and health and benefits to the farmers in terms of availability of organic fertilizers, which are rich in plant nutrients.

D. Establish market links for biogas

Market links will be developed within the households and between the households and the technology suppliers towards increasing the demand for the bio-digesters.

CONCLUSION

Some of the identified barriers are similar throughout all the technologies. For instance, weak capacity and lack of information on use and advantages of the technology are some of the main barriers to deployment of all prioritized technologies under the energy sector. Unfamiliarity with new technology could also be mentioned as a social barrier to application of prioritized technologies.
With regard to waste management, regulatory actions from the government are needed in order to increase efficiency of irrigation water use. High cost of investment and infrastructure is another barrier to the wide application of the technology. Not having access to low-interest and long-term financial means, private farmers are unable to provide sufficient investment for the development of the technology.

Social barriers are also important for all the technologies selected for both sectors, as local users are mostly unaware of economic and environmental advantages of the selected technologies. Besides, to the resistance to change and cultural biases, in rural Afghanistan introduction and implementation of any new technology can be challenging to adopt for some time.

Capacity building activities are critical for more sustainable use of the selected technologies. It includes activities related to awareness raising and increase of knowledge of all related stakeholders such as decision-makers, technology users, and service providers of applied technology. These include organization of round-table discussions, training sessions, workshops, seminars and study tours for relevant technologies.

Information campaign on the advantages of applied technology is the measure used to address the barrier of “Low level of awareness of economic and ecological advantages”. It is considered an effective tool to raise awareness level of the advantages of the technology. This includes dissemination of information on technology advantages, as well as current opportunities for national and local decision makers and local communities (technology users), through mass media, publications, organization of workshops and seminars.

Subsidy mechanisms are effective tools to promote and stimulate application of the technologies. At present, most of the farmers cannot afford to buy and apply relevant technology. This is a financial barrier and could be eliminated by improving access to reasonable financial resources, such as credits.

It is important to support private initiatives through different subsidy (loan guarantee) using funding from international donors, and governmental institutions and private banks. Strengthening capacity building of R&D institutions, stakeholder consultations and access to information at different levels. Improved capacity of R&D institutions with targeted programs and effective coordination with ongoing programs is significant for the successful deployment and dissemination of high priority technologies. Different groups of stakeholders should be involved, such as relevant R&D institutions, Energy Efficient Centers, associations and NGOs, business, local authorities and experts. Adequate dissemination of information could be organized through the dedicated internet platform on Energy Efficient technologies and websites, as well as experts that are more knowledgeable. International cooperation should be strengthened for obtaining adequate information and learning material and implementation pilot projects.

Better coordination between the donor agencies, private sector initiatives, local administrations and NGOs is needed for application of technologies. This is an opportunity for improving the quality of the projects and achieving better joint results. It will also help to avoid replicated activities and measures in technology deployment. The quality of pilot projects can be significantly improved with stronger coordination and emphasizing of information and outreach components. This will help to collect, analyze and disseminate the practical information, thereby increasing general awareness of the population and the decision makers who would be willing to take the necessary policy decisions.

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ANNEX I: problem tree for small Hydro-power technology

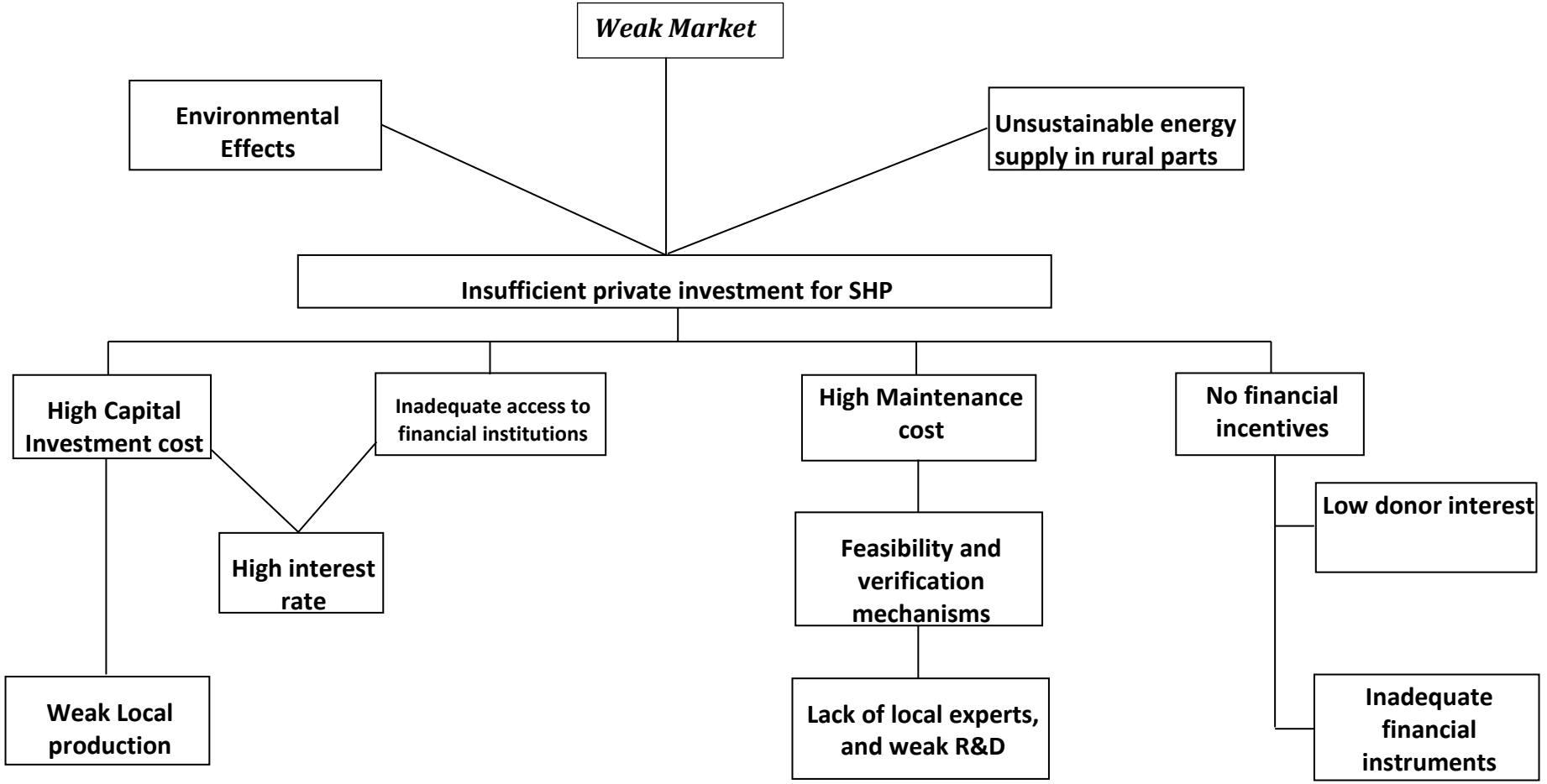


Figure 1: Problem tree for economic/financial barriers for small Hydropower technology

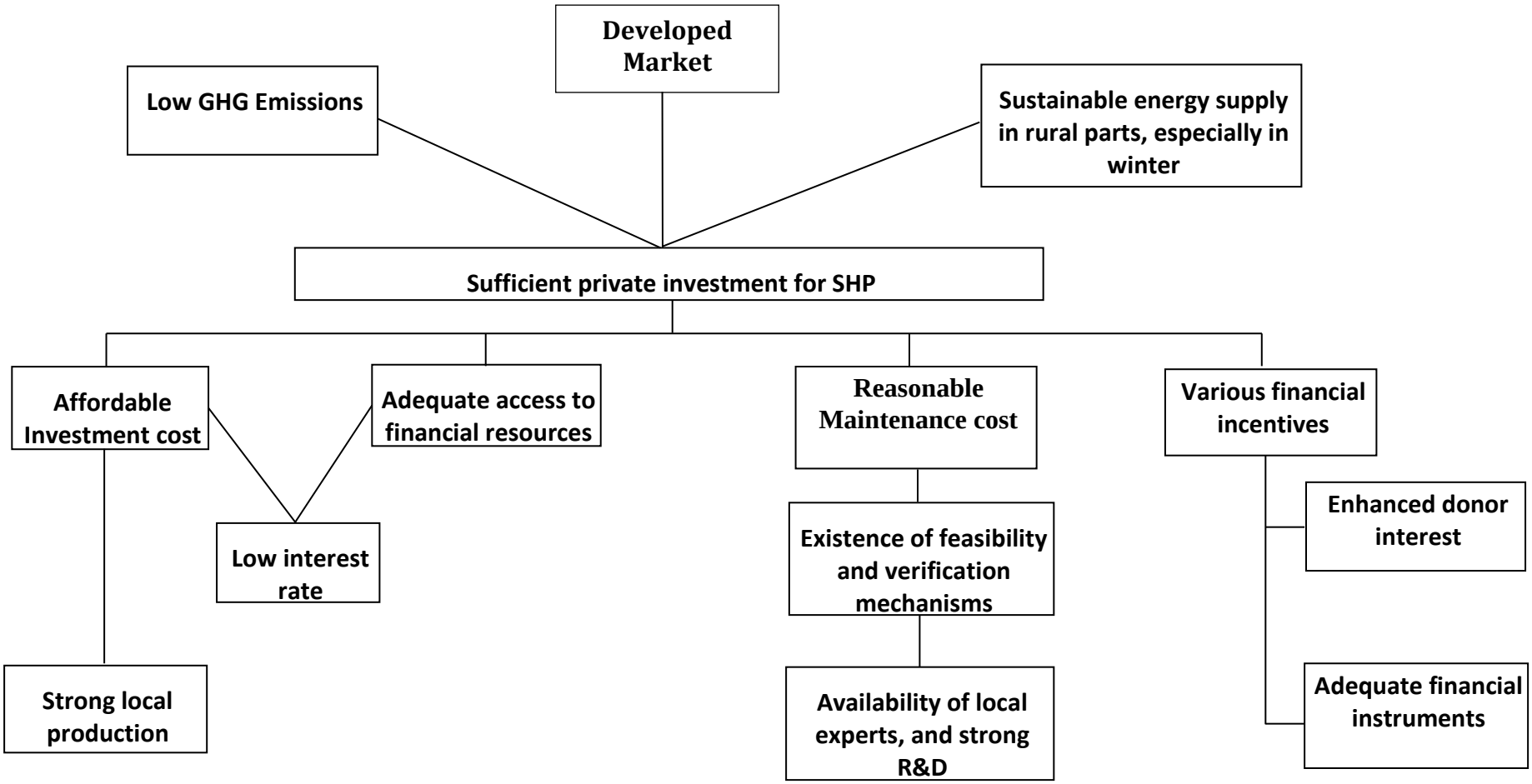


Figure 2: Solution tree for economic/financial measures for small Hydropower technology

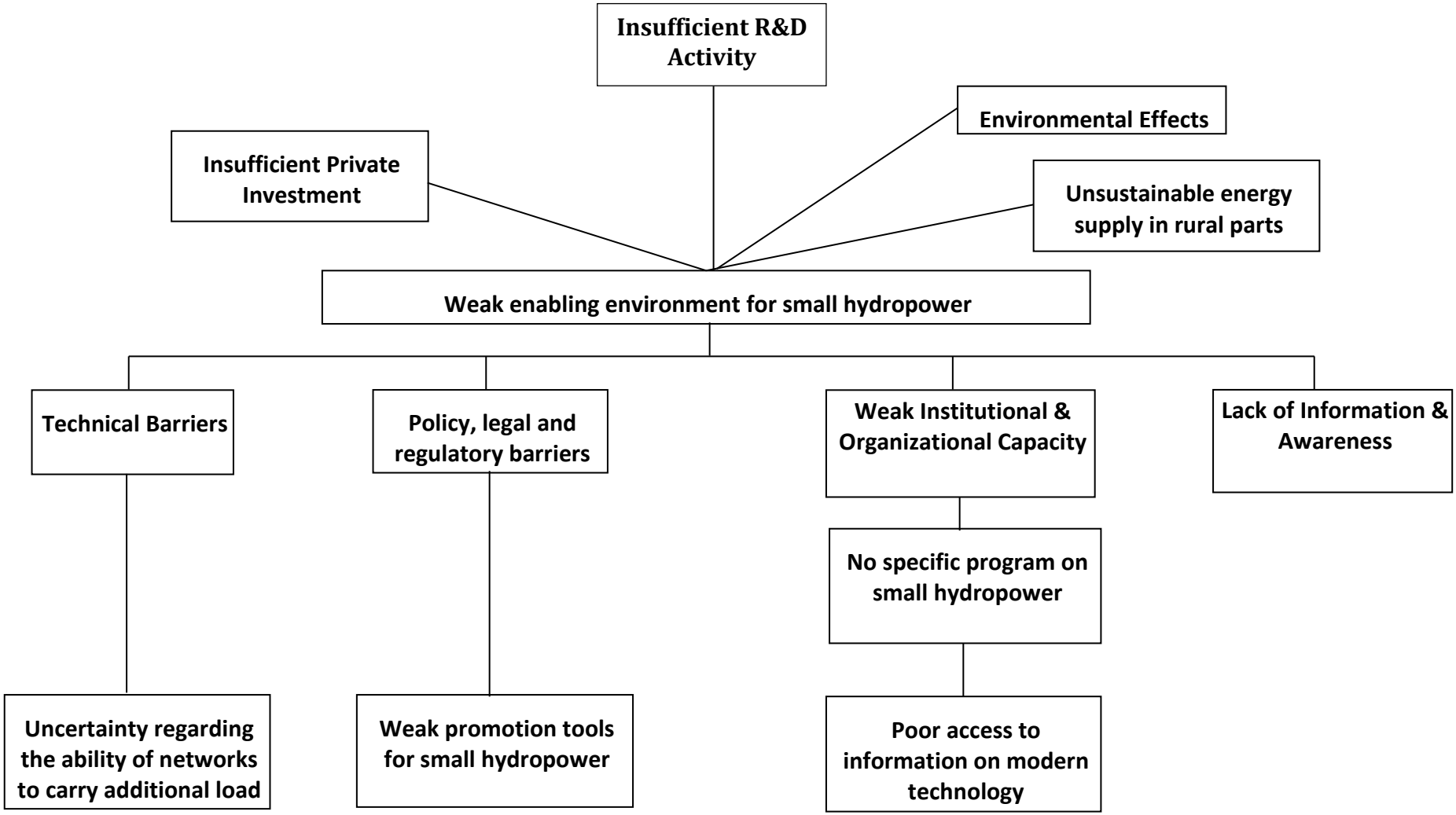


Figure 3: Problem tree for non-financial barriers of small hydropower technology

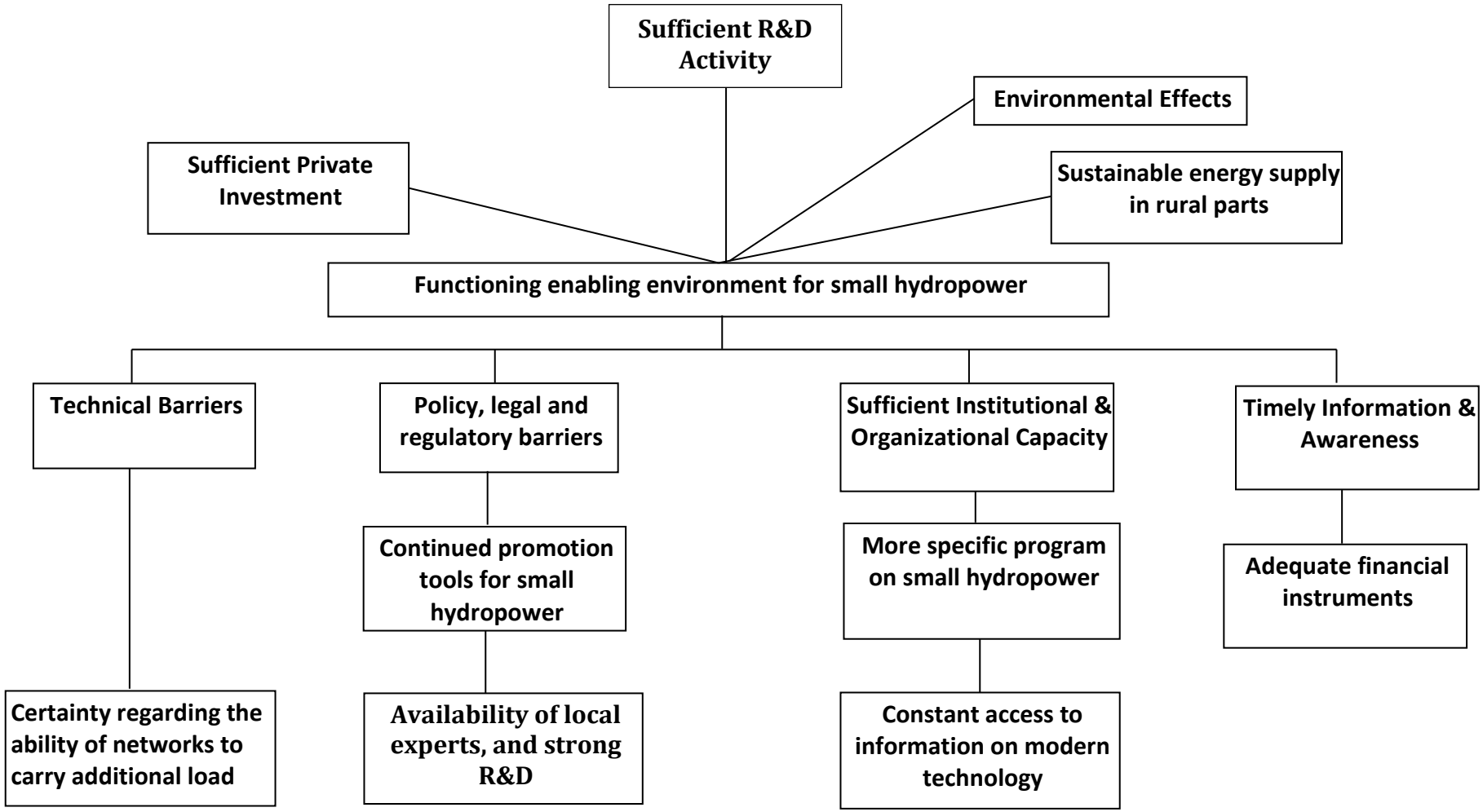


Figure 4: Solution tree for non-financial measures of small hydropower technology

ANNEX II: Problem Tree Solar Energy Technology

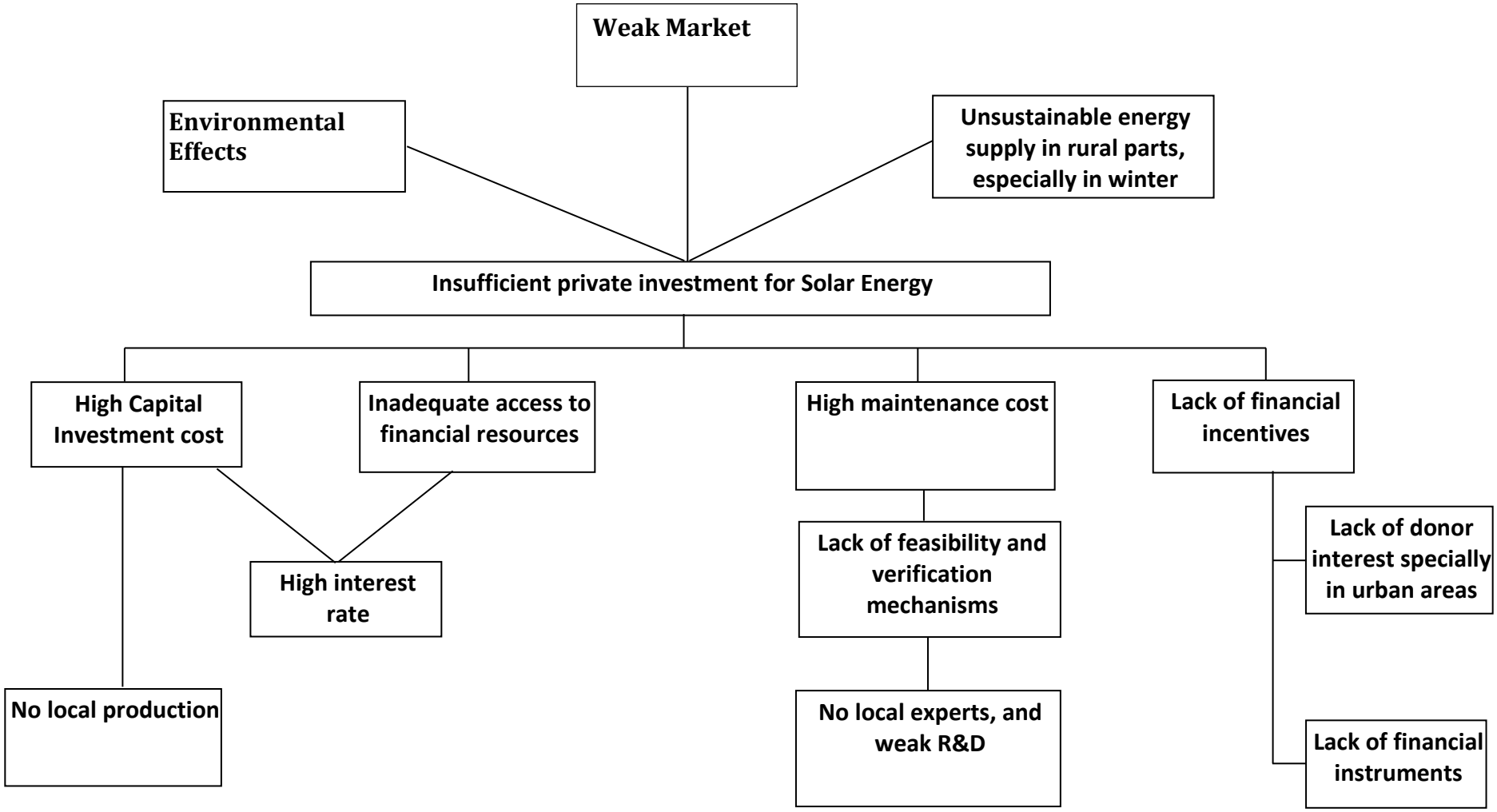


Figure 5: Problem tree for economic/financial barriers for Solar Energy

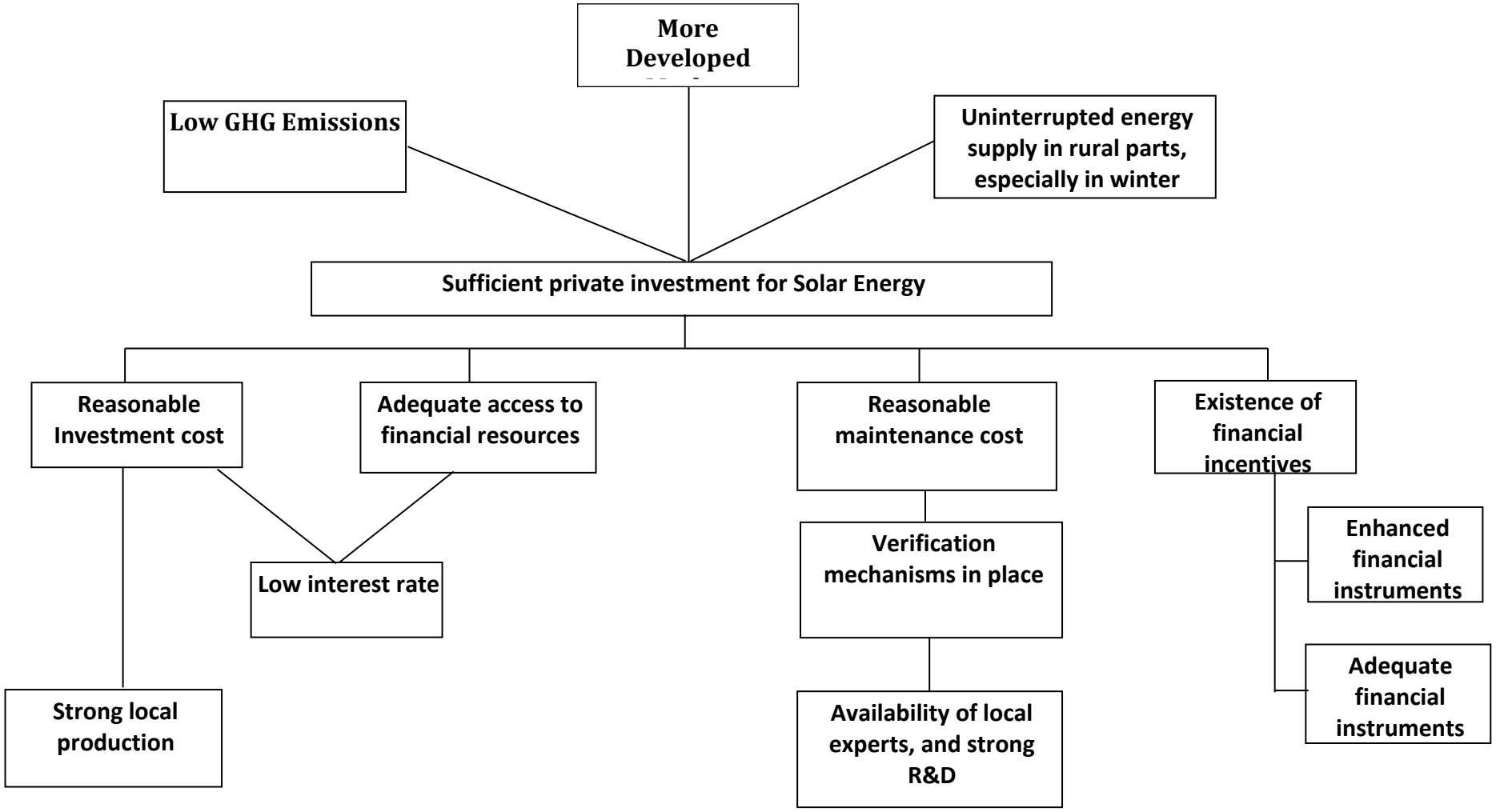


Figure 6: Solution tree for economic/financial barriers for Solar Energy

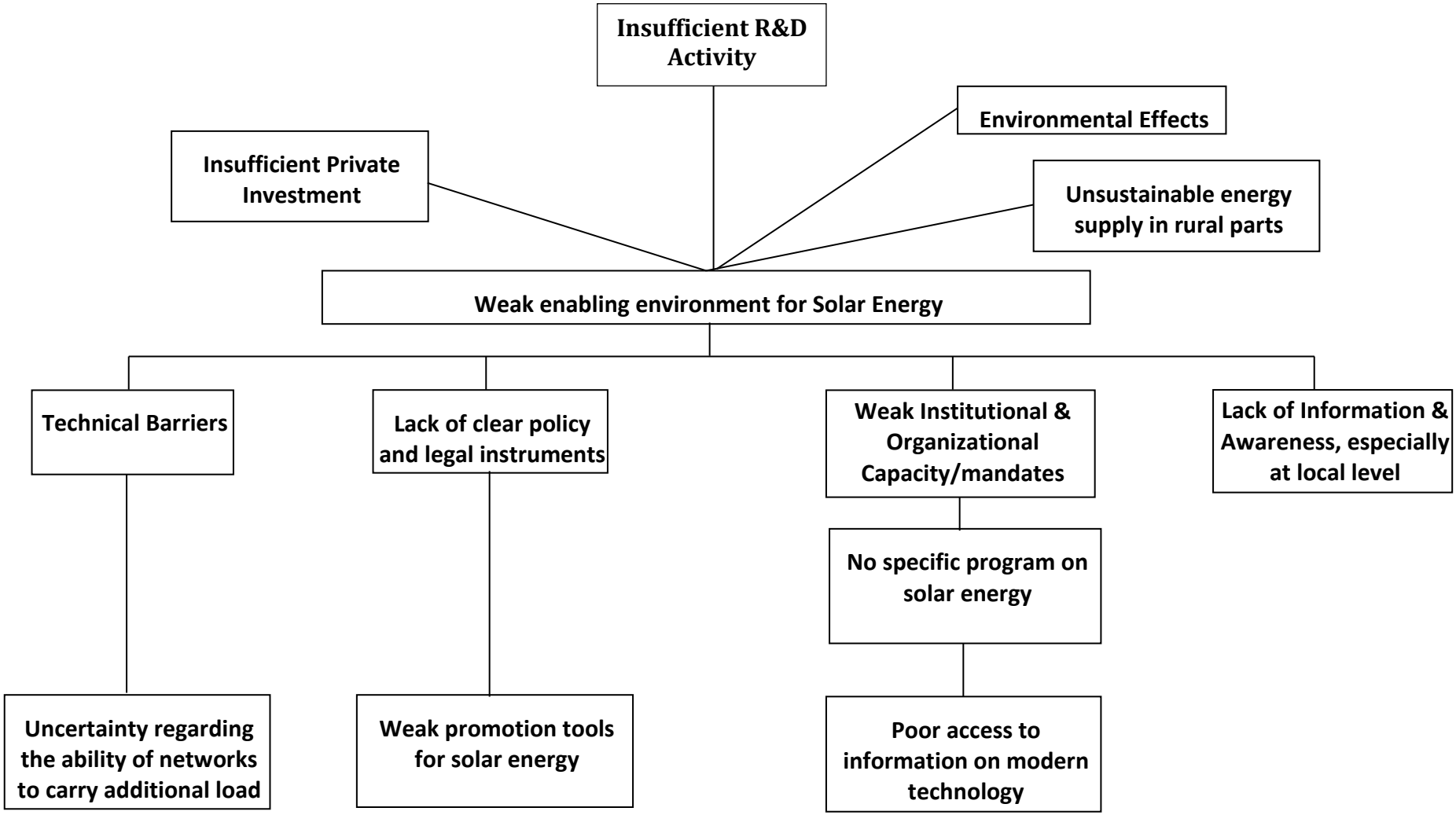

Insufficient R&D Activity
Environmental Effects
Insufficient Private Investment
Unsustainable energy supply in rural parts
Weak enabling environment for Solar Energy
Technical Barriers
Lack of clear policy and legal instruments
Weak Institutional & Organizational Capacity/mandates
Lack of Information & Awareness, especially at local level
No specific program on solar energy
Uncertainty regarding the ability of networks to carry additional load
Weak promotion tools for solar energy
Poor access to information on modern technology

Figure 7: Problem tree for non-financial barriers for Solar Energy

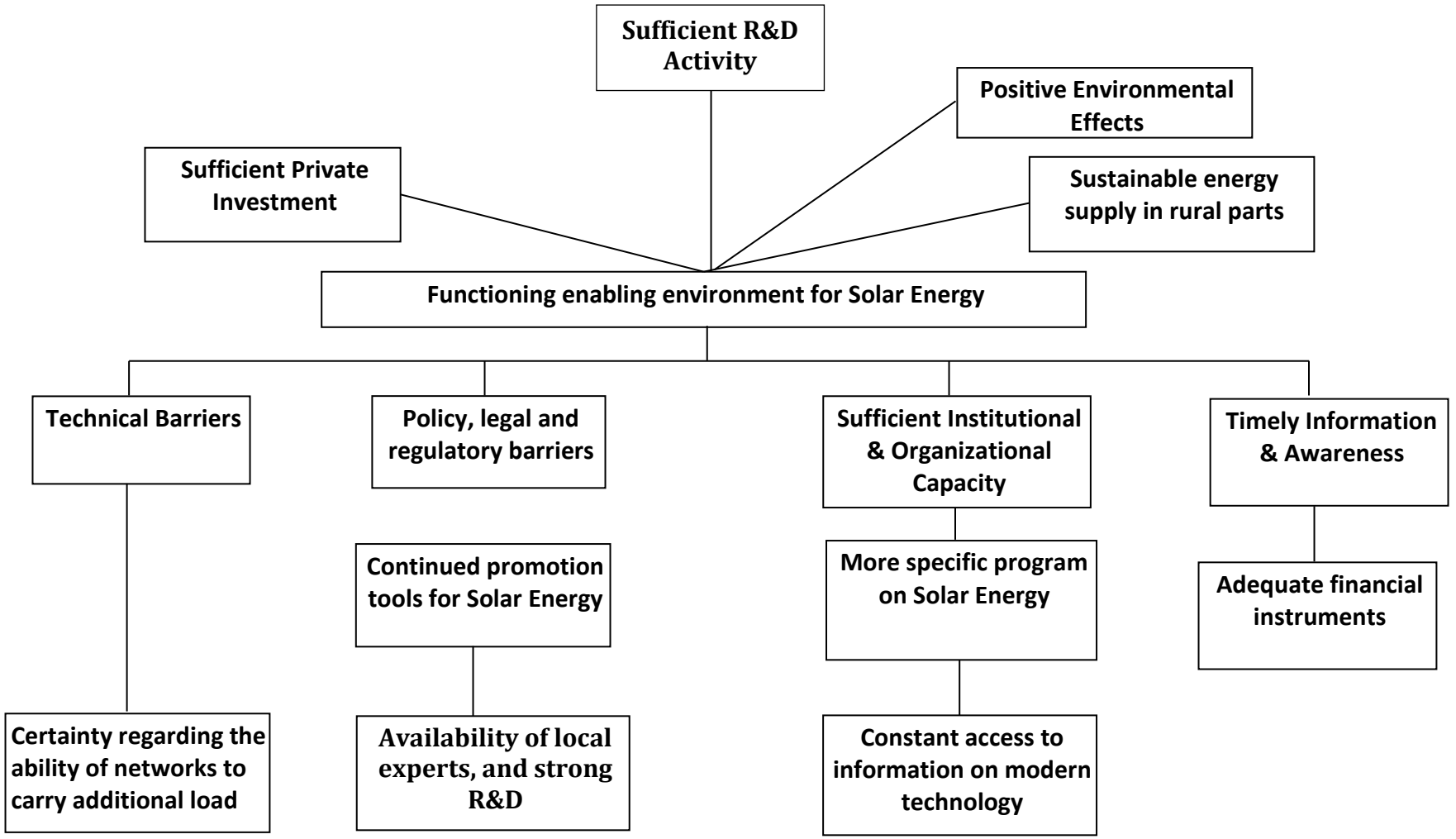


Figure 8: Solution tree for non-financial barriers for Solar Energy Technology

ANNEX III: problem tree for 3Rs technology

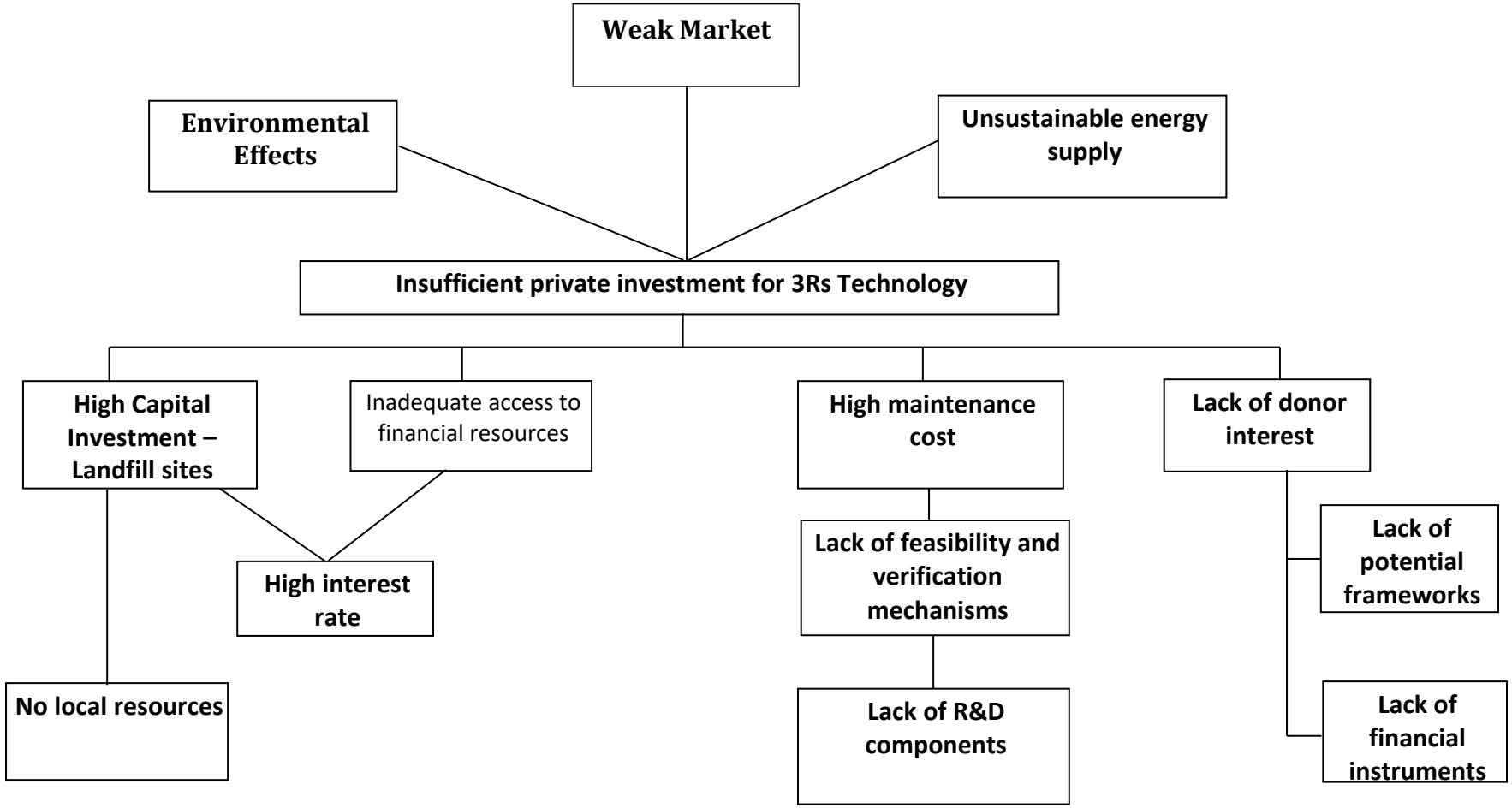


Figure 9: Problem tree for economic/financial barriers for 3Rs Technology

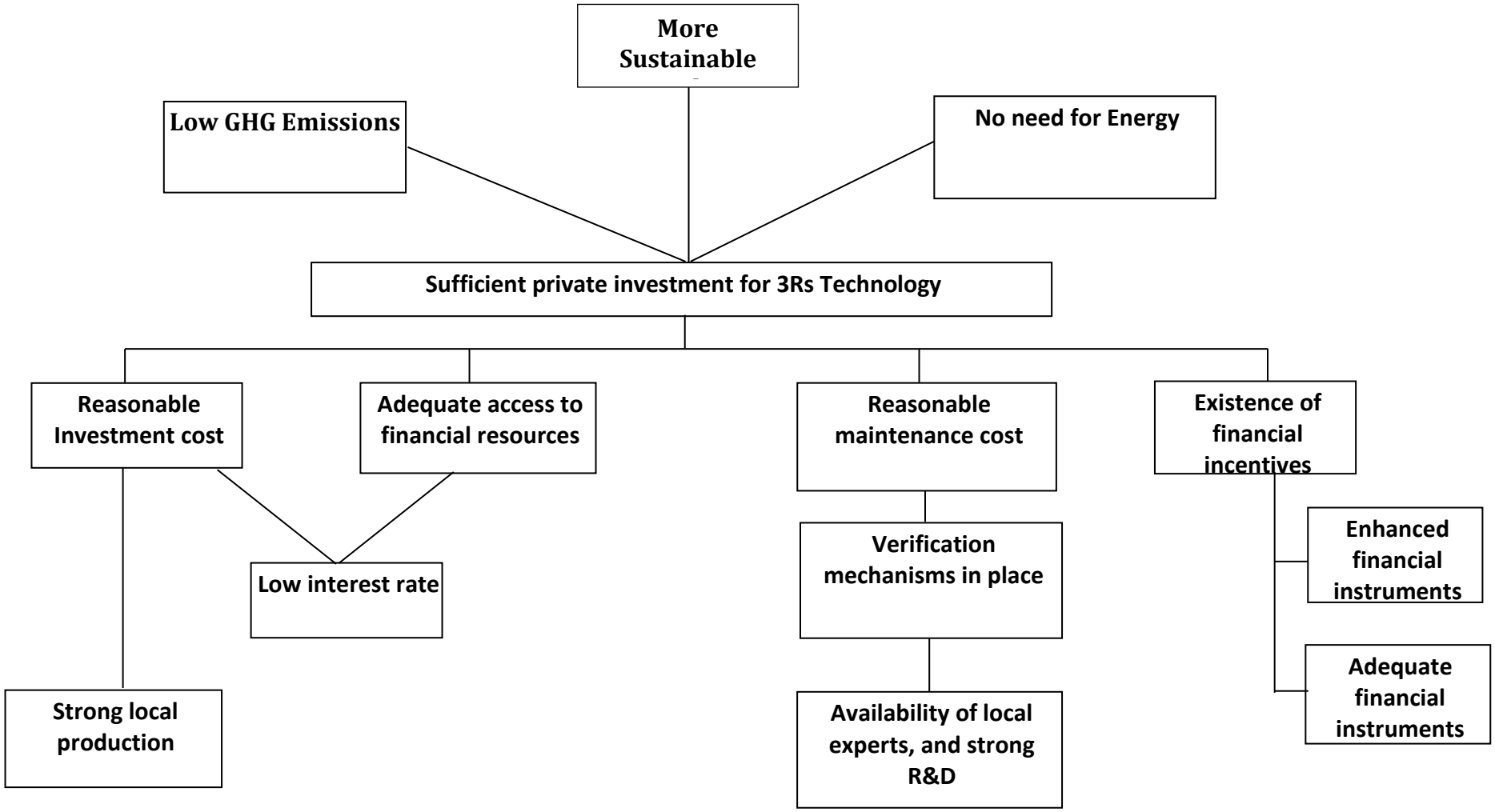


Figure 10: Solution tree for economic/financial measures for 3Rs Technology

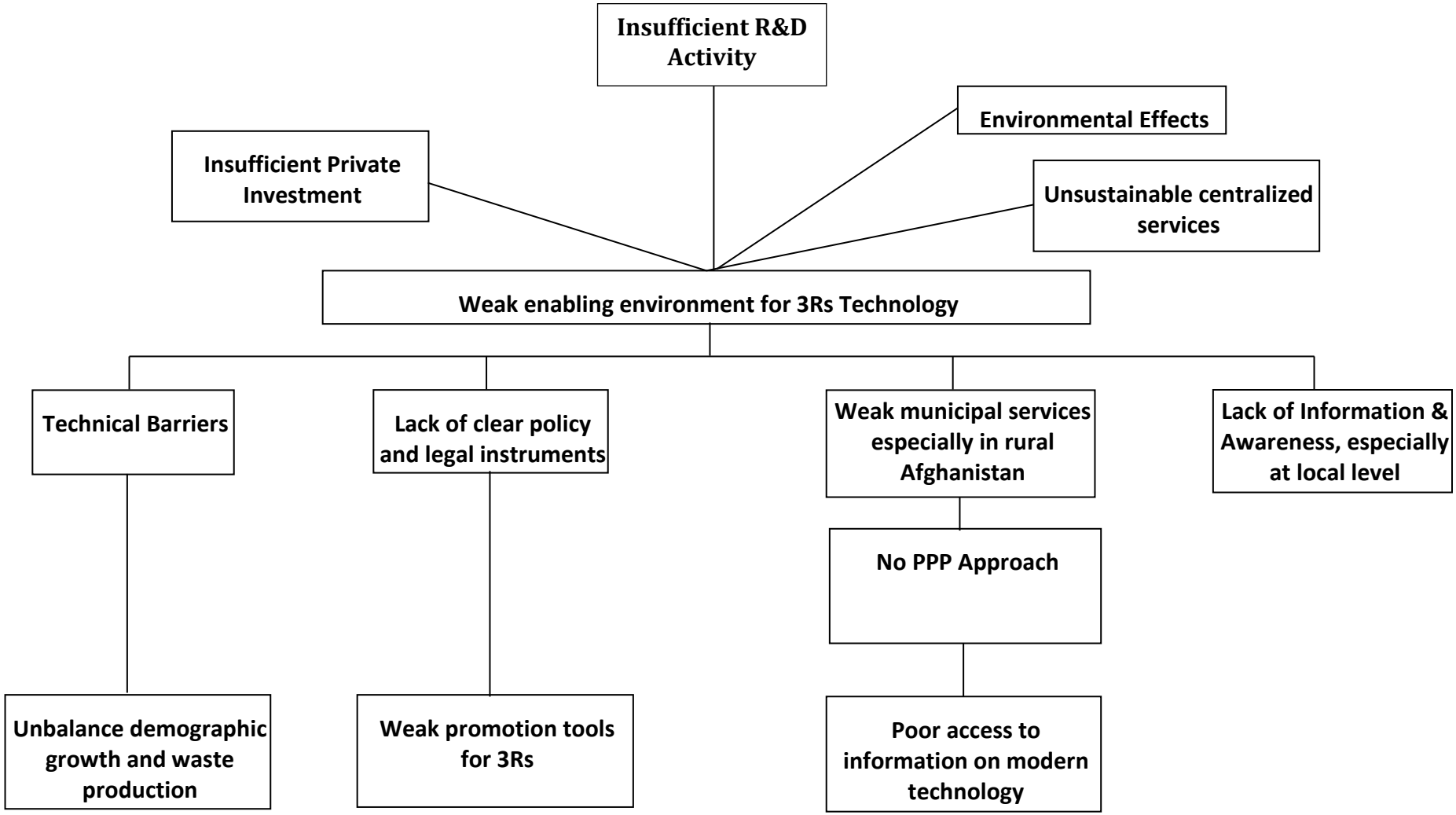


Figure 11: Problem tree for non-financial barriers for 3Rs Technology

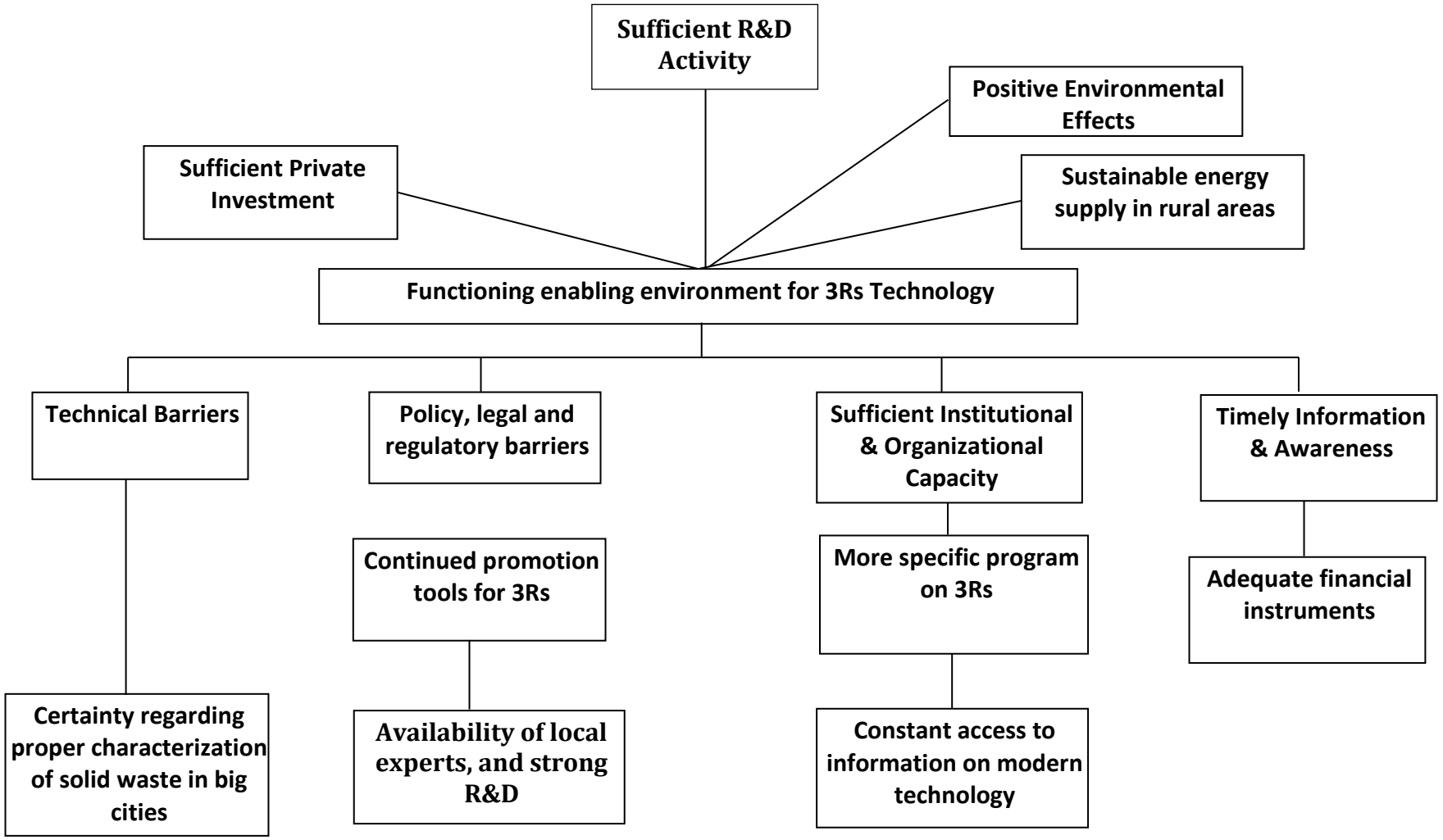


Figure 12: Solution tree for non-financial measures for 3Rs Technology

ANNEX IV: Problem/Solution trees for biogas Technology

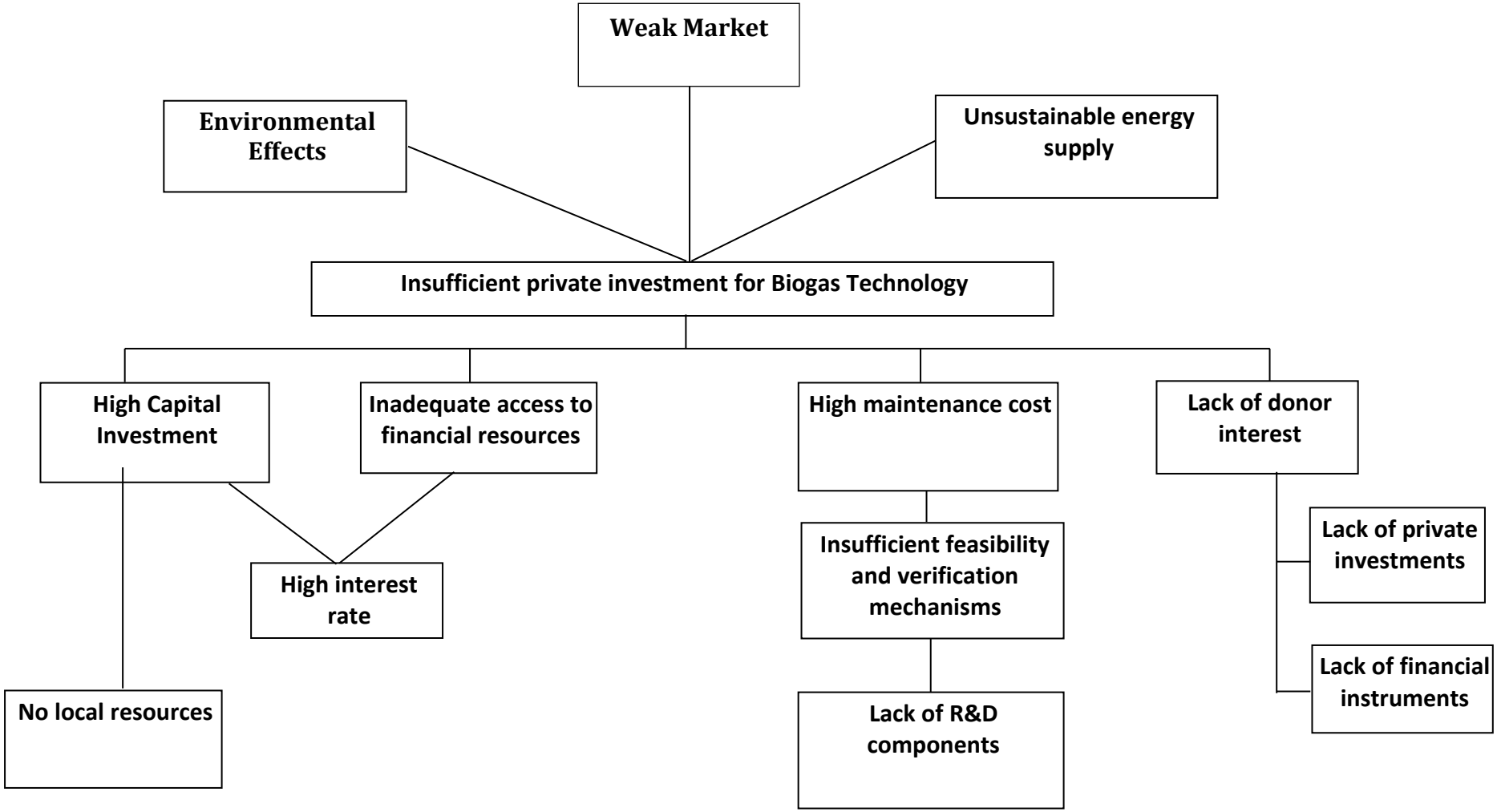


Figure 13: Problem tree for economic/financial barriers for Biogas Technology

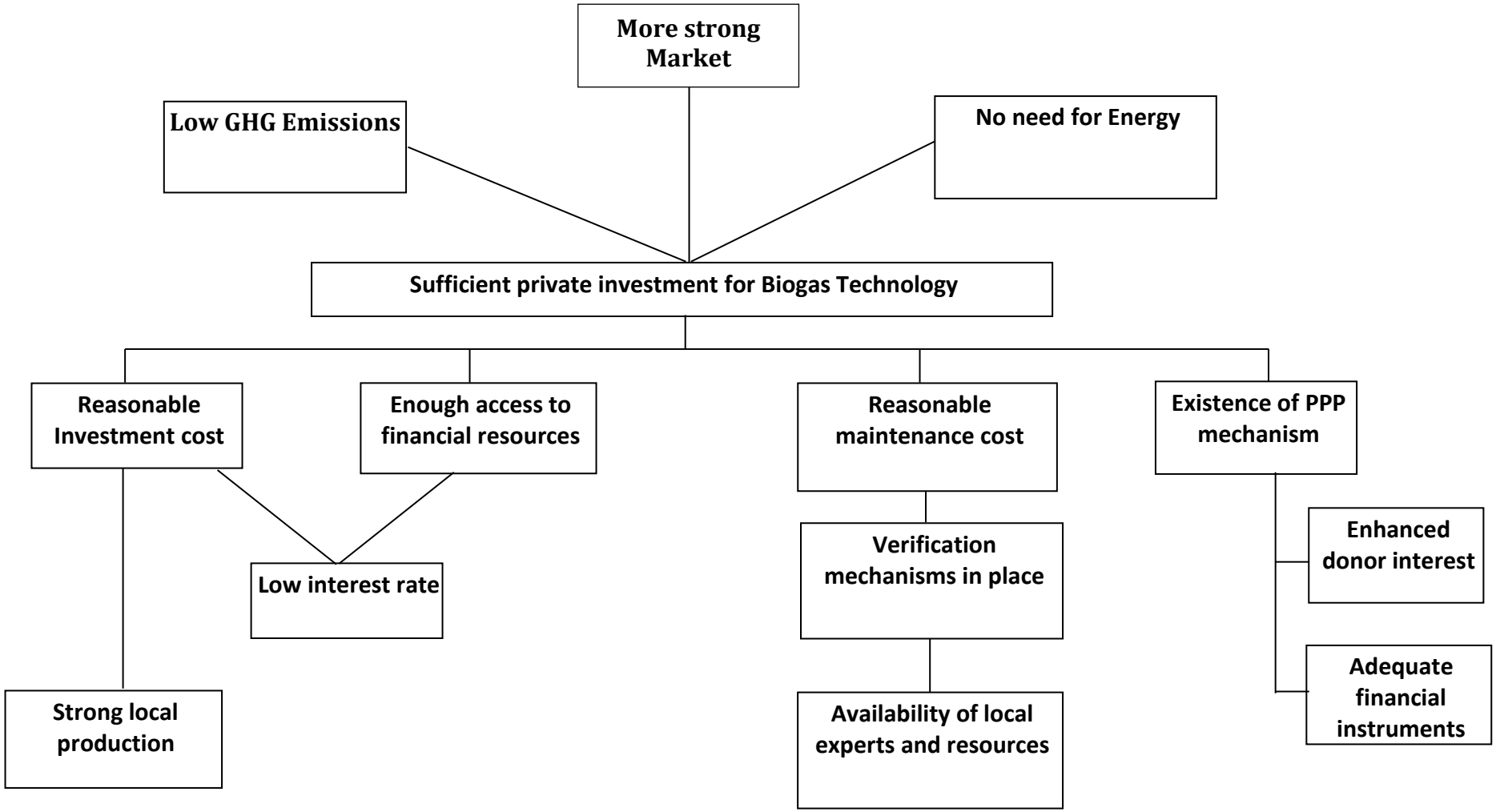


Figure 14: Solution tree for economic/financial measures for Biogas Technology

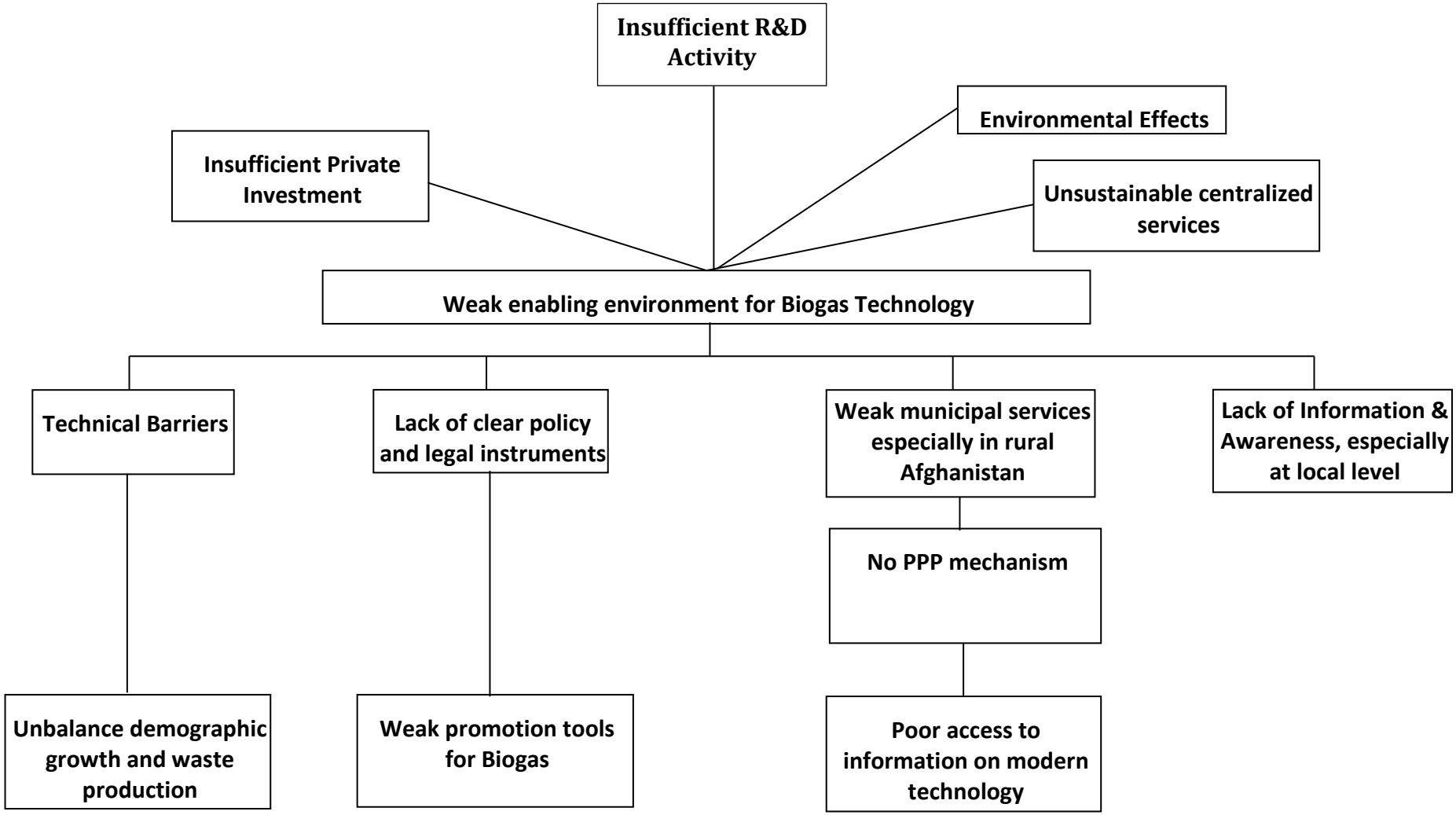

Insufficient R&D Activity
Environmental Effects
Insufficient Private Investment
Unsustainable centralized services
Weak enabling environment for Biogas Technology
Technical Barriers
Lack of clear policy and legal instruments
Weak municipal services especially in rural Afghanistan
Lack of Information & Awareness, especially at local level
No PPP mechanism
Unbalance demographic growth and waste production
Weak promotion tools for Biogas
Poor access to information on modern technology

Figure 15: Problem tree for non-financial measures for Biogas Technology

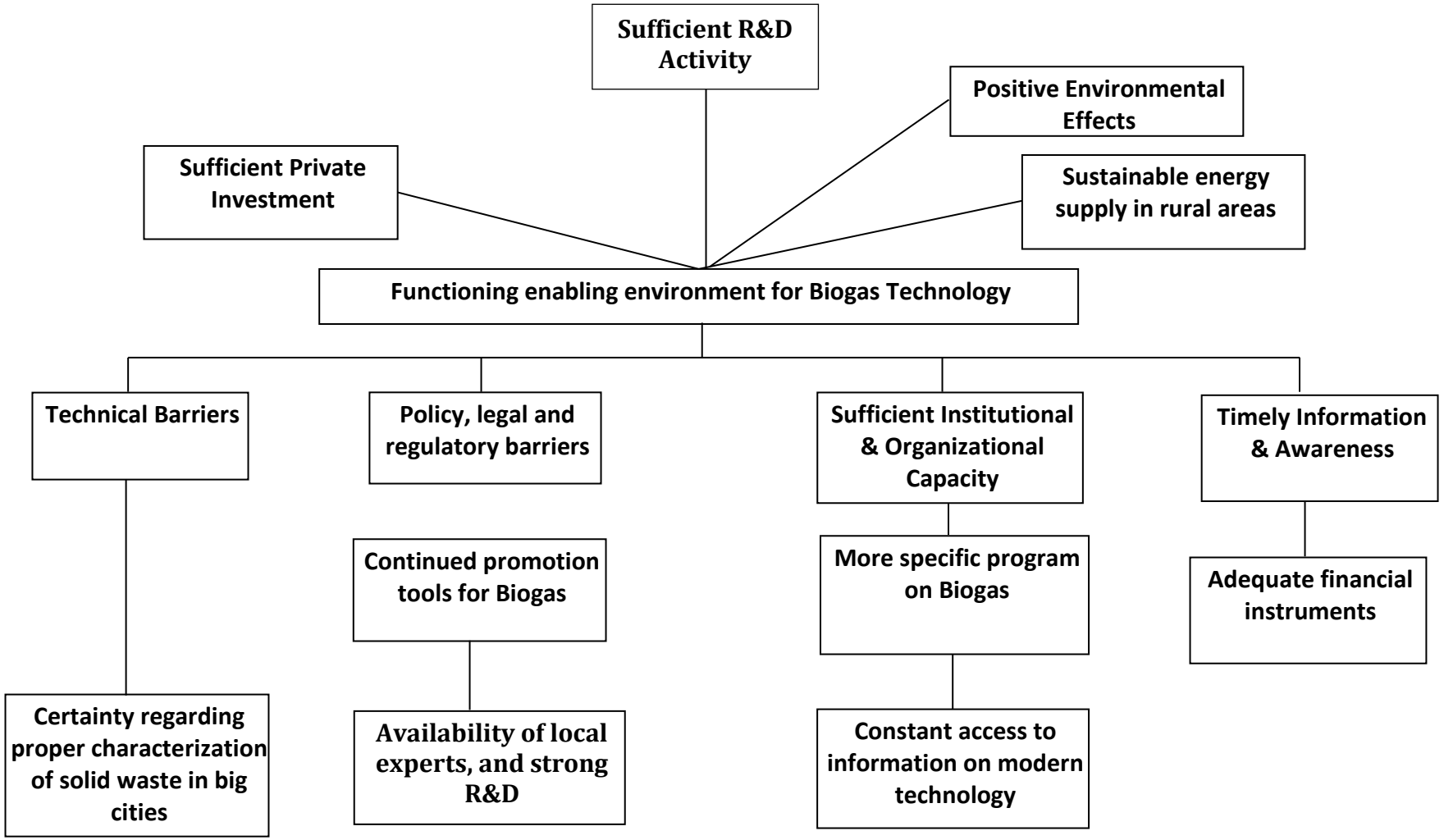
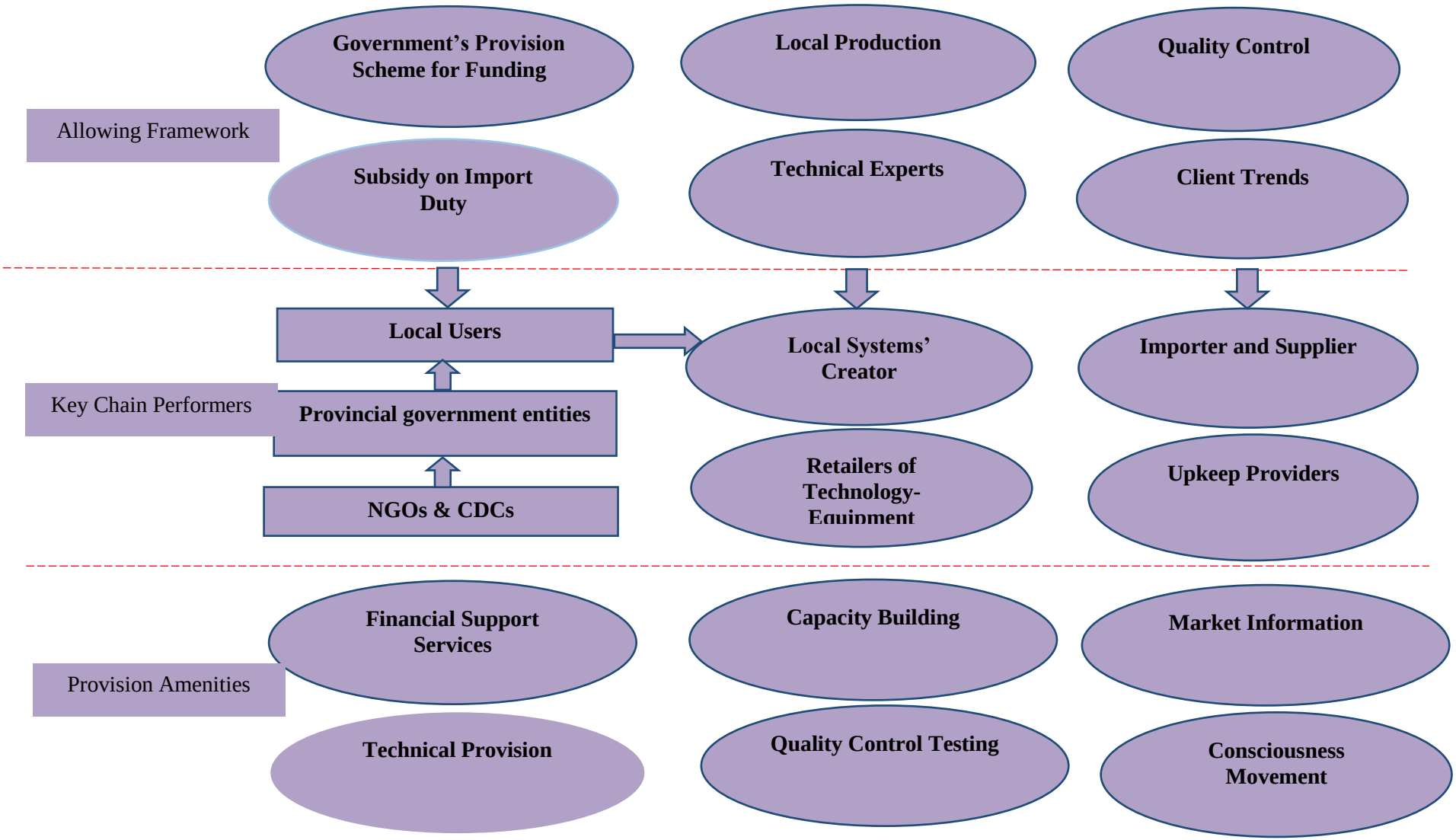
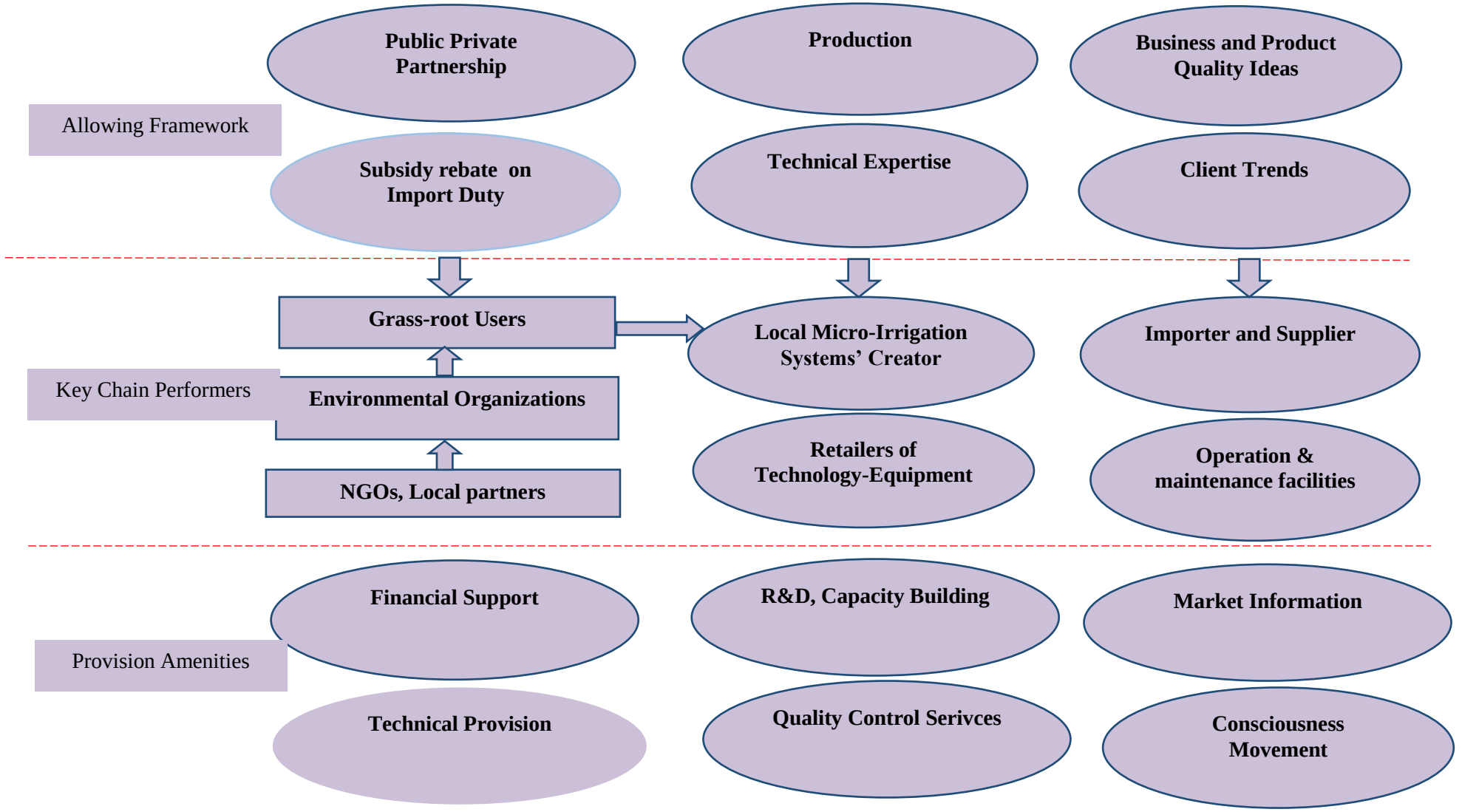


Figure 16: Solution tree for non-financial measures for Biogas Technology

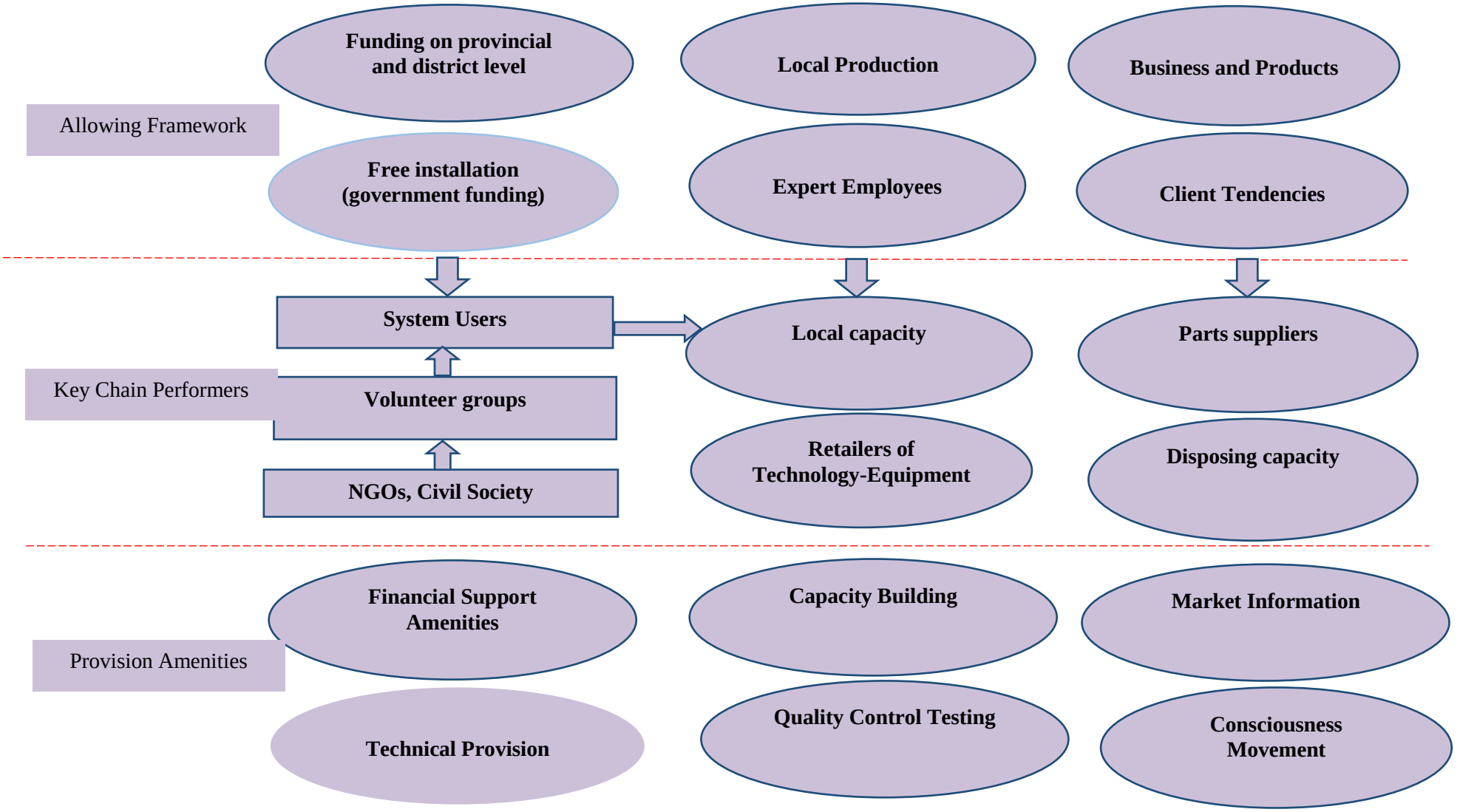
ANNEX V: MARKET MAP - SMALL HYDROPOWER



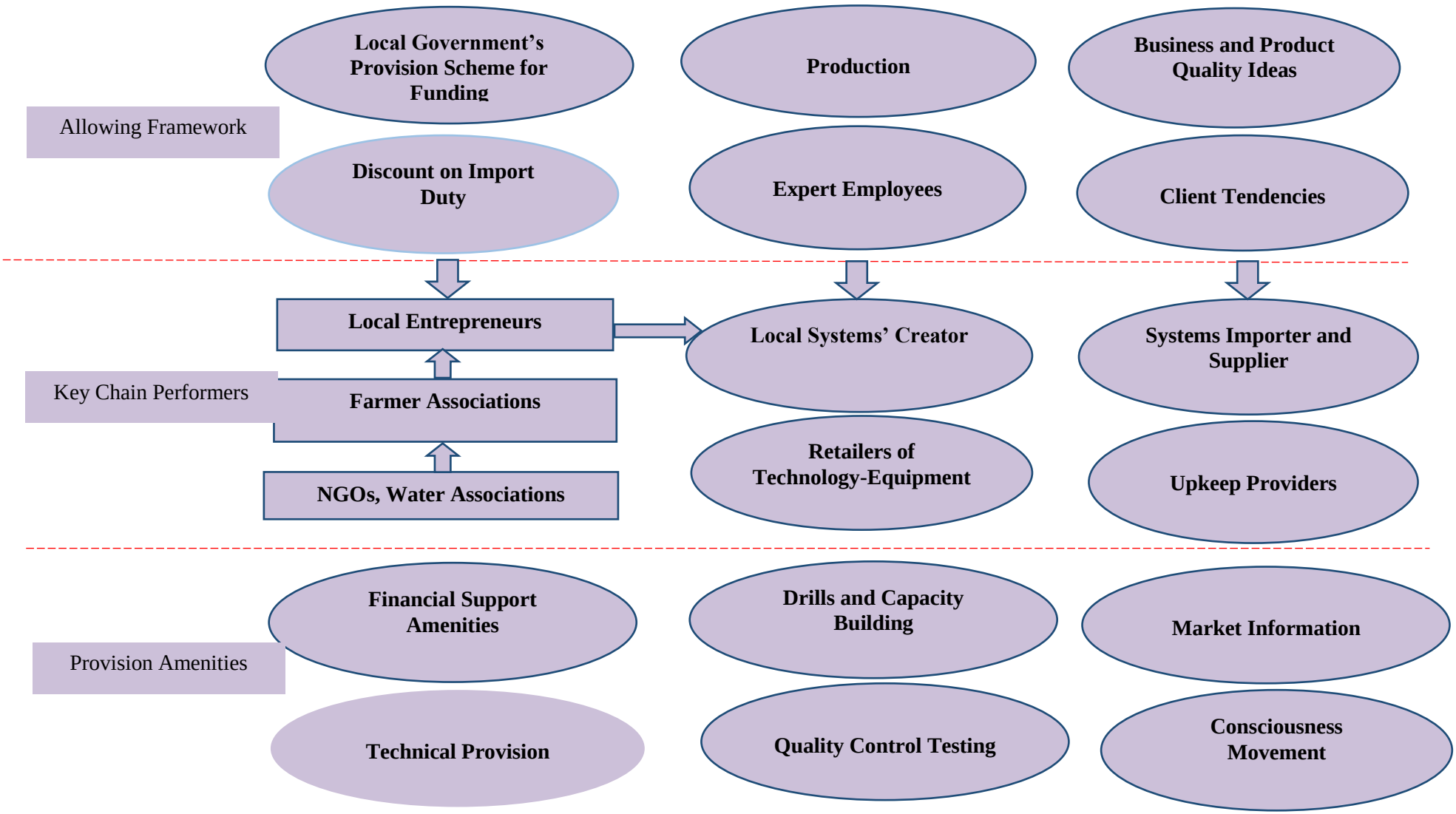
ANNEX VI: MARKET MAP- SOLAR ENERGY (PV)



ANNEX VII: MARKET MAP - 3RS TECHNOLOGY



ANNEX VIII: MARKET MAP - BIOGAS TECHNOLOGY



ANNEX IX: TNA TECHNICAL GROUPS FOR ENERGY AND WASTE SECTORS

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ANNEX X: TNA TECHNICAL GROUPS FOR ENERGY AND WASTE SECTORS

Working paper of Meeting of Expert Working Group on Mitigation

Barrier Analysis & Enabling Framework for Selected Climate Change Mitigation Technologies

Technology Need Assessment Project

Date: September 22, 2020

National Environmental Protection Agency (NEPA) of Afghanistan being the national focal point for UNFCCC has initiated Technology Need Assessment (TNA) project in collaboration with the United Nations Environment Program (UNEP), Technical University of Denmark (DTU) partnership, Asian Institute of Technology (AIT), Climate Technology Centre & Network (CTCN) and Global Environment Facility. The purpose of TNA project is to assist Afghanistan in identification and analysis of its priority technology needs for development of environmentally sound technology projects and program to facilitate transfer and access of technologies in accordance with Article 4.5 of UNFCCC. The main objectives of the project are to:

- Identify and prioritize through country driven participatory processes the technologies that can contribute to mitigation and adaptation goals of the participating countries while, meeting their national sustainable development goals and priorities.
- Identify barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and
- Develop Technology Action Plans (TAP) specifying activities and enabling framework to overcome the barriers and facilitate the transfer, adoption and diffusion of selected technologies in the priority areas of national relevance.

The project also aims to build capacity of Afghanistan to effectively meet the obligations under the UNFCCC for mitigating GHG emissions, to reduce vulnerability of sectors, and to protect livelihoods of the communities exposed to the adverse impacts of climate change. The task of identification and prioritization of technologies for Technology Need Assessment - Mitigation has been completed. After completion of the task of Barrier Analysis and Enabling Framework; Technology Action Plan will be prepared in due course as per agreed work program.

The meeting of Expert Working Group on Mitigation to discuss Barrier Analysis & Enabling Framework for Selected Climate Change Mitigation Technologies was scheduled on September 22, 2020. Due to Covid-19 pandemic interaction and discussions with the members was conducted via zoom application. The meeting has been convened to discuss the work carried out by the consultant and his team in connection with the analysis of barrier hindering the acquisition, deployment and diffusion of prioritized technologies in energy, forestry and transport sectors.

Discussion points:

Agenda point (1)

Presentation on analysis of barrier hindering the acquisition, deployment and diffusion of prioritized technologies (Problem tree) and enabling framework (Solution tree) for selected technologies in Climate change mitigation – Energy Sector

The technologies prioritized in the energy sector included (i) Solar PV and (ii) Micro hydropower (SHP) plants. In connection with the analysis of barriers, market mapping; problem tree and enabling framework (Solution tree) for selected technologies has been prepared and will be presented by the Consultant and his team for the feedback from the Experts of the Mitigation Working Group. Market mapping of solar technologies and SHP plants have been prepared as these technologies fall in the category of market goods.

The presentation on Agenda item 1 was followed by discussion and inputs from the experts on the identified barriers and enabling framework.

Agenda point (2)

Presentation on analysis of barrier hindering the acquisition, deployment and diffusion of prioritized technologies (Problem tree) and enabling framework (Solution tree) for selected technologies in Climate change mitigation – Waste sector.

Based on the inputs from the experts the Consultant will prepare the draft report on Barrier Analysis and Enabling Framework. The report will be submitted to the NEPA for circulating among the members of the Expert Working Group on Mitigation and onward transmission to UNEP-DTU and AIT for their feedback.