Government of Pakistan

Barrier Analysis and Enabling Framework for Climate Change Mitigation Technologies

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Technology Needs Assessments Report II

Barrier Analysis & Enabling Framework for Climate Change Mitigation Technologies

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Abbreviations and Acronyms

ADB	Asian Development Bank
AEDB	Alternate Energy Development Board
AIT	Asian Institute of Technology
ALGAS	Asian Least Cost GHG Abatement Strategy
AJK	Azad Jammu and Kashmir
BRT	Bus Rapid Transport
Btu	British Thermal unit
CC	Climate Change
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference of Parties
CSR	Corporate Social Responsibility
CTCN	Climate Technology Centre and Network
DFIs	Development Finance Institutions
DG	Director General
DTU	Technical University of Denmark
E&CC	Environment and Climate Change
EE	Energy Efficiency
EGTT	Expert Group on Technology Transfer
EMP	Environment Management Plan
ENDA	Energy Environment Development
ENERCON	National Energy Conservation Centre
EPA	Environmental Protection Agency
ESTs	Environmentally Sound Technologies
FIT	Feed In Tarrif
GCF	Green Climate Fund
GCISC	Global Change Impact Studies Centre
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHGR	Greenhouse Gas reduction
GoP	Government of Pakistan
IEE	Initial Environmental Examination
IGCC	Integrated gasification combined cycle
IRSA	Indus River System Authority
JICA	Japan International Co-operation Agency
KP	Khyber Pakhtunkhwa
kW	Kilo watt
kWh	Kilo watt hour
LED	Light emitting diode
LPG	Liquefied Petroleum gas
LULUCF	Land Use, Land Use Change and Forestry
MCDA	Multi criteria decision analysis
MNF	Multi-nutrient feed blocks
MtCDE	Metric Tons of Carbon Dioxide Equivalent
MoCC	Ministry of Climate Change
M TOE	Million tons of Oil Equivalent
MW	Mega watt
NAMA	Nationally Appropriate Mitigation Actions
NCS	National Conservation Strategy
NDMA	National Disaster Management Authority

NEAP	National Environmental Action Plan
NEPRA	National Electric Power Regulatory Authority
NEQS	National Environmental Quality Standards
N_2O	Nitrous oxide
NTDC	National Transmission Dispatch Company
NZET	Near Zero-Emission Technology
O_2	Oxygen
Pak EPA	Pakistan Environmental Protection Agency
PC	Planning Commission
PC-1	Planning Commission Performa-1
PEP	Pakistan Environment Program
PFBC	Pressurized fluidized bed combustion
PPP	Public Private Partnership
PV	Photo voltaic
SC	Super critical
TAP	Technology Action Plan
TEC	Technology Expert Committee
TNA	Technology Needs Assessment
TOE	Tons of Oil Equivalent
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
UNEP	United Nations Environment Program
USC	Ultra-super critical
WAPDA	Water and Power Development Authority

Foreword

Innovation is the key to knowledge, technology and creative outputs. Achieving global reduction of GHG emissions requires innovation to transform current technologies into cleaner, climate-resilient technologies. Hence innovation serves as the foundation for sustainable socio-economic and climate-resilient development.

Pakistan is in dire need of innovative technologies for arresting rapidly increasing GHG emissions and climate change impacts. During the past four decades, nine out of top ten natural disasters have been triggered due to climate change which is inflicting colossal damage to life, property, natural eco-system and economy of the country.

I am confident that the Technology Needs Assessment project initiated by the Ministry of Climate Change in partnership with the United Nations Environment Program (UNEP), Climate Technology Centre & Network (CTCN) and Technical University of Denmark (DTU) will play an effective role in reducing GHG emissions as well as increasing resilience against climate change vulnerabilities through transfer and diffusion of prioritized technologies and removing barriers in their adoption.

With collaboration / assistance of the implementing partners Pakistan will soon be able to implement these environmentally-sound climate-resilient technologies on the ground, so that Pakistan's capacity for climate-resilient measures and sustainable socio-economic development is enhanced.

The Ministry of Climate Change will take all necessary steps to streamline policies, legislation etc. to help transfer and diffusion of technologies prioritized by experts in the energy, agriculture and transport sectors. I am confident that the international community will also contribute to these efforts to address the climate change threat and the TNA process will facilitate access to funds and create an enabling environment for the transfer of priority technologies, which will improve climate resilience of the most vulnerable sectors of Pakistan.

(Zahid Hamid)
Federal Minister
Ministry of Climate Change

Acknowledgement

This Technology Needs Assessment (TNA) initiated by the Ministry of Climate Change in collaboration with the United Nations Environment Program (UNEP), Climate Technology Centre & Network (CTCN) and Technical University of Denmark (DTU) is a part of the strategic program on technology transfer by UNEP. We believe it is an encouraging step forward in the country's progress towards climate change adaptation and mitigation. The Ministry earnestly hopes that the TNA project will serve as a key step towards addressing our climate change concerns by providing an assessment of the priority technology requirements. I am sure that this exercise will trigger a process for making Pakistan climate resilient and usher an era of low carbon development.

My special thanks are due to the members of the Expert Working Group on Mitigation, especially Dr. Arshad M. Khan and Dr. M. Mohsin Iqbal (GCISC), Dr. Qamar-uz-Zaman Chaudhry, Dr. Muhammad Parvaz (HDIP), Dr. Saleem Janjua and Mr. Asad Mehmood (ENERCON), Dr. Zafar Mahmood Khalid (IIU),Mr. Muhammad Irshad Ramay (NCPC),Mr. Aqeel Jafri (AEDB),Ms. Munnaza Naqvi (UNDP-Pakistan),Mr. Bilal Anwar (COMSATS) and all other experts who contributed to the TNA process. I am grateful to the officers of Ministry of Climate Change especially Mr. Muhammad Irfan Tariq, Director General (Env & CC) and Mr. Imran Khan, Assistant Director.

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; their names are too numerous to register here.

Our special gratitude is extended to National Transport Research Center, Ministry of Communication, Hydrocarbon Development Institute of Pakistan, Alternate Energy Development Board, ENERCON, UNDP, National Cleaner Production Center, Pakistan Atomic Energy Commission, Islamic International University and Center for Climate Research and Development (CCRD) of COMSATS University. Further I also acknowledge the hard-work put in by the lead-expert Mr. Jawed Ali Khan and members of his team Ms. Yasmin Jawed Khan and Mr. Tayyab Shahzad in carrying out the TNA exercise.

I also wish to take this opportunity to extend my gratitude to the Global Environment Facility for its funding this TNA and UNEP and UNEP-DTU Partnership for implementing this project in collaboration with Asian Institute of Technology (AIT).

(Syed Abu Ahmad Akif)
Secretary
Ministry of Climate Change

Executive Summary

The Technology Needs Assessment (TNA) Report II presents barrier analysis and enabling framework for potential climate change mitigation technologies in the context of Pakistan's National Scenario. These technologies were identified and prioritized in the TNA Report I. The Barrier analysis and enabling framework Report includes the following sectors: (i) Energy, (ii) Forestry, and (iii) Transport. The technologies in the Energy sector include, (i) solar energy and (ii) micro hydropower plants; in the Forestry sector: (i) Sustainable Forest Management (SFM) plans for reducing emission from deforestation and forest degradation, and (ii) Social Forestry as carbon sink; and in the Transport sector include (i) Bus Rapid Transit System (BRT) and (ii) Vehicle Tune up.

The methodology adopted for this process included literature review and the work was further advanced by analyzing causal relation using root-cause analysis through preparation of Problem and Solution Trees and development of Market Maps for the relevant technologies. The analysis for the technologies was presented before the panel of experts represented in the working group on climate change mitigation constituted by the Ministry of Climate Change as well as other relevant experts and suppliers on the selected technologies.

The common barriers identified under the energy sector in solar PV system, solar geyser and MHP plants are high capital cost, difficulty to access finance, absence of energy rating labeling and standards, lesser information and awareness, government policy not containing required incentives for the promotion of renewables, strategy and regulations. There is a need to review the National Policy for Promotion of Renewable Energy focusing on diffusion of the technologies, creating window for grant of soft-term loan, encouraging private sector energy service companies to introduce leasing and installation of solar PV and micro-hydropower systems. Further, there is a need of awareness raising and certified technicians trained by accredited institution in the renewable energy technology sector. Diffusion of these technologies has a strong potential to offset the energy crisis in a relatively short span of time to boost economic growth and create social development opportunities in the country.

In energy sector, the total target from solar and small hydro source of energy is 5,500 MWs and 1,000 MWs, respectively. The solar PV market is picking up fast both in urban and rural areas. In Pakistan, solar PV panels are either imported or produced through assembling imported solar PV wafers. Solar geysers are another option to save natural gas in the current energy crisis. The government of AJK has a plan to install 10,000 solar geysers. Other provinces are also in the process of making such plans. In micro hydropower plant technology, cost effective electricity is produced from streams, and canals with a minimum water head of 5 feet.

Pakistan being an arid and semi-arid country has a forest cover of about 5 percent that is further depleting at the rate of 2.1 percent resulting in deforestation and forest degradation. The Government has initiated a program of SFM plan to be developed for 67,861 acres of forest cover. Under the global initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD+), the program will be implemented in three phases that is readiness, piloting and results-based payments. The Government has already initiated REDD+ Readiness Preparation project.

Pakistan plans to plant 1.5 billion trees over the next five years. Women, senior citizens, youth, progressive farmers and provincial Forest Departments, are major stakeholders in these programs.

The common barriers in SFM plans and social forestry include No economic incentive mechanism in place for SFM; scarce knowledge and awareness; and un-sustainable forest management. The sustainable forest management practices can reverse the trend of deforestation in the country by promoting principles of REDD+ which offers payment against protection and conservation of forest resources. The area under social forestry can be increased by mass awareness and educating public including farming community on benefits of social forestry; through intercropping of forest trees with non-timber forest products and agricultural crops and development of land resources.

Transport sector in Pakistan is one of the highest GHG emitter accounting for 21 percent of the total emissions. The Metro-bus or Bus Rapid Transport (BRT) service is in operation in three cities including Lahore, Islamabad and Rawalpindi and work in four other cities of Karachi, Peshawar, Multan, Faisalabad is in progress. The capital cost incurred in the establishment of the Metro -Bus service in Lahore and Islamabad is Rs. 1.11 billion and Rs.1.99 billion PKR per km, respectively, which is relatively much higher when compared to the conventional system. The technologies identified in this sector have only one common barrier of high capital cost.

The other barriers hindering promotion of BRT system are absence of national transport policy and employment loss for people working in the existing public transport system. The enabling framework to reduce such barriers include exploiting alternatives revenue generation sources; adoption of energy efficient measures; local manufacturing of efficient buses; and development of National Transport Policy supporting BRT.

The major barriers in diffusion of vehicle tune-up technology comprise limited dissemination of awareness raising information through print and electronic media, training and demonstration. The enabling framework to overcome barriers are soft-term loan facility; domestic manufacturing and installation of the computerized tune up equipment and machineries; wider demonstration, training and awareness. According to Prime Minister's Directive, respective fleet owners and managers/operators are required to ensure phased tune-up of vehicles to ensure energy conservation.

The implementation of these technologies will significantly reduce national GHG emissions, move towards low carbon growth trajectory and will contribute in the efforts of reduction of global warming.

Chapter 1. Background and Introduction

1.1. Background

In Pakistan the project on Technology Needs Assessment (TNA) commenced in June 2015 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 TNA project is to assist Pakistan in identification and analysis of its priority technology needs. This will form the basis for development of environmentally sound technology projects and programs to facilitate transfer and access technologies in accordance with Article 4.5 of UNFCCC. The main objectives of the project are:

1. 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.
2. Identify barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and
3. 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 with national relevance.

The project also aims to build capacity of Pakistan 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.

For implementation of TNA project in Pakistan and accomplishment of the above stated objectives, the UNEP has engaged the services of a National Mitigation Consultant. The Director General (Environment and Climate Change), Ministry of Climate Change, 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, forestry and transport sectors. The second report on "Barrier Analysis and Enabling Framework" has now been completed and submitted for feedback from the Ministry and the 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 draft 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, forestry and transport sectors. The technologies in the Energy sector include:

I. Solar energy and

II. Micro hydropower plants.

The prioritized technologies in the Forestry sector are:

I. Sustainable Forest Management (SFM) plans for reducing emission from deforestation and forest degradation, and

II. Social Forestry as carbon sink;

The Transport sector includes following technologies:

I. Bus Rapid Transit System (BRT) and

II. Vehicle Tune up.

1.3. Methodology

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

Barrier analysis

The process adopted for "Barrier analysis" included literature review, to develop understanding from the past interventions carried out in the area of the selected technologies in Pakistan 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) little 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 poor maintenance of solar system were decomposed into other barriers such as availability of accredited technicians and limited public awareness of the technology. A working paper for the meeting of Expert Working Group on Mitigation was prepared and circulated among the members of the group for their feedback and discussion in the meeting (Annex-XXI). The Working paper contained market maps, problem trees and solution trees, which contained long list of actors involved in the market, starter problem, causes of problems, effects of problems, solutions/ measures, and results/ long term impacts.

This method `was applied with the consultation of the Expert Working Group on Mitigation constituted by the Ministry of Climate Change (Annex-XX) and other relevant stakeholders. In Pakistan the main institutions dealing with climate change mitigation include Ministry of Climate Change, Ministry of Water and Power, Ministry of Science and Technology, Pakistan Council of Renewable Energy Technologies, Alternate Energy Developent Board, National Energy Conservation Center (ENERCON), Pakistan Atomic Energy Commission, academia, national and international NGOs. Representatives from these institutions were invited to be the members of the Expert Working Group on Mitigation.

The working paper was discussed in detail in the meeting covering elements like 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. 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

The process followed in development of "Enabling framework" involved literature review to learn from the success stories and best practices of the selected technologies within the country and abroad facing similar situations like Sri Lanka, Bhutan and India.

Logical Solution Analysis concerning 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, reflected in the lower side of the Diagram and the affect and impact of the identified solutions on the upper side of the Diagram.

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 constituted by the Ministry of Climate Change as well as other relevant experts and suppliers on the selected technologies (Annex-XX). The Solution Trees and Market Maps were finalized with the inputs of relevant stakeholders.

1.4. 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, forestry and transport sectors.

1.5. 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 Pakistan on the path of low carbon economy.

Chapter 2. Energy Sector

Meeting the energy shortfall is of fundamental importance to Pakistan'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 be to 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 thirteen technologies. Out of these two top ranking technologies namely solar energy and micro hydropower plants were prioritized for barrier analysis and preparation of Technology Action plan.

2.1. Preliminary targets for technology transfer & diffusion

Pakistan Vision 2025[1] aims to ensure uninterrupted access to affordable and clean energy for all to ensure economic growth and energy security of the country. The plan focuses on elimination of current electricity supply-demand gap by producing additional 5,000 MW of electricity in the grid system by 2018. This would be achieved through optimizing energy generation mix between oil, gas, hydro, coal, nuclear, solar, wind and biomass with reference to its indigenousness, economic feasibility, scalability, risk assessment and environmental impact. Moreover, in energy sector the overall plan is to cater to growing future demand by adding 25,000 MW by 2025. The Pakistan Vision 2025 and Integrated Energy Plan 2009-2022 recognize the suggested outcome of renewable energy as follows:

1) Establishment of renewable energy power projects to tap the immense potential of alternative and renewable energy in Pakistan
2) The suggested outcome of solar energy is 5,500 MWs. Of this 1,500 MWs is from on-grid; 2,000 MWs is from off-grid solar power generation (PV) and 2,000 from solar thermal.
3) For remote areas the plan is to encourage hybrid power generation system. Alternative renewable such as solar, wind or micro and small hydropower will be used for electricity generation and it will be coupled with the hydrocarbon only when the renewable source is not available.
4) Utility companies of natural gas are encouraging the promotion of solar geysers and are offering recovery of capital cost in instalments from consumers' monthly bills.
5) More than 1000 MW micro hydropower potential is available[2], which will be vigorously developed for hydroelectric power as per 'Vision 2025'.

Pakistan is targeting at least one million customers and adding approximately 3000 MW of solar power through net metering by 2025[3]. NEPRA Net Metering Regulations were approved

[1] Government of Pakistan; 2013; Pakistan Vision 2025; One Nation – one vision; Planning Commission; Ministry of Planning, Development and Reforms, Islamabad

[2] Alternate Energy Development Board, in collaboration with GTZ; 2005; Power Sector Situation in Pakistan. Pakistan Energy Business Day, Berlin, Page 8; https://www.solarwirtschaft.de/fileadmin/media/pdf/eu-pakistan/Pakistan-GTZ-power-sector-overview.pdf

[3] January 2016, A Solar Developer's Guide to Pakistan, Alternate Energy Development Board & IFC World Bank Group,

in 2015 and so far only two solar installations have been granted approval for the net metering facility. Under the Federal Policy for Development of Renewable Energy for Power Generation 2006, solar power project developers are allowed to enter into direct bilateral sales contracts with end-use customers to sell part of the power generated by them to their direct customers and the rest to the utility company for general distribution. For direct sales, they are required to pay wheeling charges for the use of the transmission/and or distribution grid network used to transport the power from the plant to the purchaser[4]. The targeted cumulative GHG emission reduction of the solar water heater option described by Alternate Energy Development Board, Government of Pakistan has been projected as 4.10 million tons of CO_2 by 2020. The saving in emissions will arise from reduced natural gas consumption for water heating in the domestic sector.

To overcome the energy challenge, the provincial governments have their own plans. The Punjab province has planned to install Quaid-e-Azam Solar-Power Park in Bhawalpur district for 1000 MW, which would be the World's largest Solar Park. Out of this, 200 MW has already been installed in the Solar-Power Park and is connected to the national grid. The work on remaining part of the plan is underway. The Punjab Government has successfully completed two phases of the Ujala Program and is in process of announcing phase 3 of the program. The Punjab Government is also undertaking projects for solarizing the irrigation pumps, schools and public sector buildings. The Sindh Government has issued Letter of Intents (LOIs) to 24 private sector companies to set up solar PV power projects of cumulative 1450 MW capacity. The Balochistan Government is also processing LOI requests of two companies for solar PV power projects with a view to generate green energy. The Balochistan Government also has signed an MOU with a Korean company to set up a 300 MW solar power plant. Further, Balochistan Government is also planning to convert existing electric and diesel operated irrigation water pumps to solar and electrifying remote areas of the province through solar PV home systems, particularly in areas where there is no conventional electricity option[5]. Khyber Pakhtunkhwa (KP) plans to supply solar power to 5,800 off-grid households in 200 villages[6].

The government of AJK plans to install 3000 solar home systems and 10000 solar geysers[7]. FATA is planning to solarize educational, health and technical institutes & drinking water supply schemes[8]. FATA is also planning solar energy for its 450 villages selected from 07 agencies and 06 frontier regions of fata[9].

In micro hydropower plant, the Provincial government of KP plans to implement 1,000 micro micro and small hydropower projects. The KP government will produce 214 MWs of

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http://www.ifc.org/wps/wcm/connect/b46619004b5e398cb8b5fd08bc54e20b/IFC+-+Solar+Developer's+Guide+-+Web.pdf?MOD=AJPERES

[4] A Solar Developer's Guide to Pakistan; International Finance Corporation, World Bank Group in collaboration with Australian Aid, Ministry of Foreign Affairs of the Netherlands and Government of Pakistan

[5] Solar power plant: Balochistan govt inks deal with Korean firm; http://tribune.com.pk/story/529000/solar-power-plant-balochistan-govt-inks-deal-with-korean-firm/

[6] Solar power for off-grid homes in KP; http://www.dawn.com/news/1164507

[7] Alternate Energy Projects: Solar Energy Projects. http://www.pmajk.gov.pk/web/solarEnergy.html

[8] Federally Administered Tribal Areas (FATA),Tenders; https://fata.gov.pk/tenders.php

[9] Digest of Mega Projects: Part V; FATA Development Authority; Project: Provision of solar energy system in FATA. Planning & Development Department; FATA Secretariat, Peshawar. http://www.waterinfo.net.pk/sites/default/files/knowledge/Digest%20of%20Mega%20Projects,%20Planning%20and%20Development%20Dept%20-%20FATA%20Secretariat.pdf

electricity through micro and small hydropower energy by 2018[10]. The short, medium and long term plan includes production of about 200 MWs, 626 MWs and 1418 MWs of electricity through micro-hydropower plants, respectively. The Punjab government has issued LoIs to private investors for establishment of ten (10) small hydropower projects with a cumulative capacity of 142 MW. Similarly Sindh Government has issued six (6) LoIs for small hydropower projects. The Alternate Energy Development Board (AEDB)/United Nations Development Program (UNDP) and Aga Khan Foundation (AKF) are implementing 103 micro hydro projects (15 MW) in Chitral under the CDM program of the UNFCCC.

2.2. Solar technology

2.2.1. General description

Solar Photovoltaic

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. The solar PV technology in Pakistan consists of:

(i) Battery based off-grid areas (Solar PV systems for homes & institutions);
(ii) Back-up support in Battery based on-grid areas during load shedding hours; &
(iii) Battery less Solar PV systems for Solar energy Parks that provide electricity to the Grid (Large scale).

Solar Systems provide households 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 fulfil 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.

As of 2016, 400 MWs are being produced through solar energy and the government plans to increase the production capacity up to 1556 MWs by 2018[11].

Solar Geyser

[10] The NEWS, 18 May 2016, https://www.thenews.com.pk/print/120828-Asad-Qaiser-says-3-power-projectsto-generate-56MW-electricity

[11] Government of Pakistan, Progress So Far Made In Solar Power Sector in Pakistan; Alternate Energy Development Board, Ministry of Water and Power, http://aedb.org/index.php/ae-technologies/solar-power/solar-current-status

Solar geyser is a consumer good. Evacuated-tube type solar geysers are more efficient than Flat-plate geysers. Evacuated-tube type solar geyser consist of four components: (i) Evacuated Tube (ET) that absorbs solar energy and converts it to usable heat. Vacuum between the two glass layers insulates against heat loss. (ii) Heat Pipe (HP): Copper vacuum pipe that transfers the heat from within the ET up to the manifold. (iii) Manifold: Insulated box containing the copper header pipe; and (iv) Mounting Frame.

The government has exempted solar water heaters from customs duty and sales tax as a result over 12,000 Solar Water Heaters (SWHs) have been imported till 2013[12]. The solar water heaters being produced by local manufacturers are in addition to this number. The SNGPL was launching 'solar geyser' program to help decrease the dependence of the heating equipments on natural. The geysers would be provided to the consumers on subsidized prices. The prices of the equipment would be recovered from the consumers in two-year installments[13].

2.2.2. Identification of barriers for solar technology

Solar Photovoltaic

The key barriers for Solar PV and grid based large solar PV power plant have been identified through literature review and bilateral meetings with the experts by the consultant and stakeholder consultations during meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-II and IV) and Market Map (Annex-I) for the technologies. .

In Pakistan at present the production or manufacturing of solar panels is almost negligible. The solar panels are either imported or assembled locally from imported solar PV wafers. The off-grid and on-grid solar PV 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 manyfinancial, 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 PV system such as charge controller and converter to convert solar Direct Current (DC) to Alternate Current (AC) electricity are partly imported and partly produced in Pakistan. For solar PV system deep discharge batteries are recommended which are not produced in Pakistan 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 PV systems installed in residential and commercial buildings.

The major barriers in the wide diffusion of solar PV are categorized under economic and financial and non-financial barriers.

2.2.2.1. Economic & Financial

i) High up-front cost

One of the most important barriers for installation of solar PV in both large and small scale is the high upfront capital cost. The upfront cost of small solar PV are approximately Pak Rs.150,000 per KW (US$1500[14]). For a 100 MW solar PV system installed in Pakistan, the

[12] AEDB initiates study for introducing solar water heaters, Pakistan Renewable Energy Society, http://www.pres.org.pk/2013/aedb-initiates-study-for-introducing-solar-water-heaters/

[13] First LNG terminal within two months: SNGPL, The Business Recorder, 1 January 2013, http://www.brecorder.com/fuel-a-energy/630:/1138724:first-lng-terminal-within-two-months-sngpl/?date=2013-01-01

[14] At the rate of 1US$ = Pak Rs.100

approximate cost is Pak Rs.12 billion. The National Electric Power Regulatory Authority provides a tariff of average Rs.14[15] and Rs. 11[16] per Kilo watt hour (KWH) for solar and furnace oil (Predominant conventional source for producing electricity), respectively

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 of loans at affordable rates of interest. Further, due to non-availability of certified trainers and technicians, the banks are hesitant to grant loans because of high risk factor. The Net Metering regulation 2015 is a recent legislation, hence the net metering is at its infancy in Pakistan.

2.2.2.2. Non-financial barriers

a) **Low awareness**

In general public have low level of awareness and low priority about solar PV in Pakistan. Due to low awareness there is absence of technical know-how 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 manpower to operate and maintain solar PV 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 and limited research and development efforts.

b) **No Quality Standards and labeling**

Solar products are sold in the market without standards and labeling. These are generally unbranded and have no warranty. In case of large solar PV, 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 2006 lays down the framework for large scale solar power projects but 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 Pakistan but due to absence of incentives and technology, the solar photo-voltaic are not being produced from silica and these are only being assembled from imported PV wafers. Thus the cost of solar PV 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. Taking approvals from AEDB for getting commensuration letter for tax and duties rebate in importing and issuing LoIs; Feed in Tariff (FIT) approval from NEPRA and grid connection approval by National Transmission & Despatch Company (NTDC) are time consuming.

d) Less Technological Skills

Lack of appropriate technological skills in respect of solar PV systems among the technicians because of the absence of any formal accredited training facilities hinders the dissemination of solar PV technology among the prospective consumers. Because of less

[15] 100MW solar power plant is the costliest project, https://www.thenews.com.pk/print/55454-100mw-solar-power-plant-is-the-costliest-project

[16] NEPRA, http://nepra.org.pk/Tariff/IPPs/Attock/2006/TRF-55%20Attock%20Gen%20%2004-09-06.PDF

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 PV 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.

Solar Geyser

The key barriers for Solar geyser have been identified through literature review and stakeholder consultations by analyzing causal relation using root-cause analysis (Problem Trees, at Annex- VI) for the technologies.

The role of the importer is crucial being the primary player in the solar market is faced with financial, institutional, policy barriers etc. The other important players are producer, assembler, retailer, whole-seller and the consumer at the receiving end. The major barriers in the wide diffusion of solar geyser are categorized under economic and financial and non-financial barriers.

2.2.2.3. Economic & Financial

i) High up-front cost and regular maintenance

One of the most important barriers for installation of solar geyser is the high upfront capital cost. The upfront cost of solar geyser are approximately Rs.60,000 (US$600) for 35 gallons water storage capacity.

There is no formal mechanism available for grant of loans at affordable rate of interest. Further, due to non-availability of certified trainers and technicians, the banks are hesitant to grant loans because of high risk factor.

2.2.2.4. Non-financial barriers

f) **Low awareness**

In general public have low level of awareness and low priority about solar geyser in Pakistan. Due to low awareness there is absence of technical know-how 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 labor to operate and maintain solar geyser 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 and limited research and development efforts.

g) **Absence of green labeling**

Solar products are sold in the market without standards and green or energy rated labeling. These are generally unbranded and have no warranty.

h) **No innovative strategies or incentives**

The high upfront cost, less scale of business and unavailability of spare parts require some government incentives such as zero duty and tax exemption and soft term loans for the promotion of the technology which are missing. The Policy for the Development of Renewable Energy for Power Generation 2006 lays down the framework for large scale

solar power projects but does not properly address innovative approaches that can boost diffusion of solar thermal technologies at small scale. There is less coordination and cooperation within and between various ministries, agencies, institutes and other stakeholders like accredited technicians delays and restrict the progress in renewable energy development and commercialization.

2.2.3. Enabling framework for overcoming the barriers for solar technology

The enabling framework for overcoming the barriers in Solar PV; grid based large solar PV power plant and solar geyser have been described in the form of Solution tree (Annex-III, V & VII).

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 Pakistan 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).

2.2.3.1. 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 federal and provincial levels as well as establishing certification system for solar PV and Solar Geyser trainers and technicians. The banks have indicated 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 has granted 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 PV system. Establishment of such facilities will increase income generating opportunities.

The State Bank of Pakistan has allowed provision of credit for Grid based solar systems and some of the commercial banks have already opened a dedicated credit line for Grid solar Independent Power Producers (IPPs).

b) **Business model**

Keeping in view the rapidly increasing demand for solar PV and solar geysers in Pakistan, 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 PV and Solar Geyser 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 photo-voltaic market.

2.2.3.2. Non-financial measures

a) **Establishment of Quality Standards & Labelling**

The solar energy quality standards, once established will guarantee availability of reliable product quality in the market. The labelled 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 general public can be improved through print, electronic and conventional methods. The results can be better achieved through development and implementation of behaviour change strategy. Barefoot consultants 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 general public regarding different components of the solar system and appropriate solar system required for their houses.

c) Strategy & Regulatory measures

Regulatory measures and approval procedures to streamline tariff determination by NEPRA and other departments can help in rapid promotion of solar technologies. 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 established

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 PV 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 PV importers and capacity of systems imported by NGOs and private sector organizations who come to a government institution, Alternate Energy Development Board (AEDB) for seeking approval of subsidy in duty or tax during imports of solar PV equipment and systems. This arrangement will the government to take a stock of unrecorded initiatives of solar PV installed in Pakistan through NGOs and private sector.

2.2.4. 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:

2.2.4.1. More access to electricity

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

2.2.4.2. 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.

2.2.4.3. Better education

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

2.2.4.4. Better health coverage

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

2.2.4.5. More job opportunities

As energy is considered 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.

2.3. Micro hydropower plants

2.3.1. General description

In micro hydropower plant technology, moving water turns a turbine, the turbine spins a generator, thus electricity is produced without using of 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 hydro power 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.

2.3.2. Identification of barriers of Micro Hydropower (MHP) plants

The key barriers for MHP plants have been identified through literature review and bilateral meetings with the experts by the consultant, and stakeholder consultations during meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-IX) and Market Map (Annex-X) for the technologies.

The major barriers hindering diffusion of MHP 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 MHP plants and associated equipment are manufactured locally. The construction and assembling of MHP is done by technicians. The quality of locally manufactured turbines and equipment and construction and installation of MHP is a real concern. Other important market actors are retailer, middleman and the consumer.

2.3.2.1. Economic & Financial

a. **Initial High Capital cost:**

On an average a MHP plant of 100 KWs capacity costs between 1.5 million to 2.5 million PKR. This includes the cost of devices i.e. turbine, generator, load controlling device; settling basin; channel to divert water from the streams canals and natural water falls or water body to the forebay tank; penstock; powerhouse and electrical transmission line from turbine to household. The MHPs system can serve a cluster of 120 – 130 households. Average cost per household is around 20,000[17] PKR which is high considering the income level of the target population.

The potential areas of MHP 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 micro-credit institution do not provide loan facility to construct MHP plants. Due to this reason, the potential MHP sites remain unharnessed.

[17] 100 kW MHP generate 438,000 kWh in a year. Considering that average annual per capita electricity consumption is around 480kWh/year, and 7 persons make a household, the 100 kW MHP can suffice electricity requirement of 130 households

c. Lesser Consumer Affordability:

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

2.3.2.2. Non-financial barriers

a. No integrated policy and programs

The Federal Policy for Development of Renewable Energy for Power Generation 2006 does not adequately address the economic, financial and social barriers hindering diffusion of MHP plants. It is because the production of electricity from the MHP plants is in kilowatts which are produced in remote areas not connected to the grid. As the focus of the government is to increase electricity amount in the grid through exploitation of sources which produce energy in Mega watts to address the national energy crunch.

The local level concerned government institutions do not have 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 up-scaling of the MHP 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 MHP plants are hindering diffusion of the technology despite having a huge potential.

b. Poor quality of MHP plants due to absence of Quality Standards and labelling:

Due to poor quality of standards and labelling the MHP plants machinery and equipment are not of high quality. The MHP plants' machinery are generally unbranded and have 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 MHP 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 machineries, equipment and accessories required for MHP plant, their costs, and relevant agencies from where necessary technical and financial information and support can be obtained.

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

The Pakistan Meteorological Department (PMD) has lesser coverage of weather stations in remote areas that are the potential sites for MHP plants. As a result, necessary meteorological data on sites is not available. There is also a huge potential of installation of MHP plants on the canal networks that are being managed by respective Provincial Irrigation and Power departments who do not have the capacity for the installation of such plants.

Due to lesser information the responsible institutions and NGOs, face problems in proper designing of the MHP plants and sometimes the MHP 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 MHP plants business is very limited despite vast untapped potential due to absence of local industrial capacity to produce quality MHP plants' machinery at mass scale. Another factor limiting market is non-availability of locally trained MHP plants technicians and experts, especially certified from accredited institutions. Non-availability of certified technicians and trainers results in high risk factor, hence the banks are hesitant to extend loans for MHP plants.

e. Risk of disasters or reduced water flow:

Most of the potential sites for MHP plants are in ecologically fragile areas that are prone to disasters like floods; land slides; glacier hazards including glacier lake outburst floods, avalanches, mud flows 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 MHP plants.

2.3.3. Enabling framework for Micro-hydropower plants

The enabling framework for overcoming the barriers in micro 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 Pakistan 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.

2.3.3.1. Economic & Financial measures

a. Initial capital cost reduced

To reduce the initial capital cost and increase the diffusion of MHP plants, taxes and duties on different parts of the technology manufactured locally may be reduced or eliminated by the Government. There are mostly two type of taxes for the MHP plants which are being produced locally. One is sales tax (16 percent) and the other is services tax (which ranges from 15 to 30 percent based on the annual turn-over of the produced).

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.

b. Establishment of soft-term Credit line

Establish windows for grant of soft loans through banks or micro-finance institutions to the local communities to facilitate adoption and diffusion of the technology. The technicians for MHP plants need to be certified from some accredited institute which will help in building confidence of the banks and other lending institutions to give credit for MHP 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 MHP plants.

So far the credit line is not available, almost all the MHP plants have been constructed through local and international donors funding with local community participation. A new window of opportunity has emerged with the signing of Paris Agreement at Conference of Parties of UNFCCC (COP) 21. The world has recognized that there is a need to support

renewable energy technologies and dedicated funding windows like Green Climate Fund, Adaptation Fund have been initiated. The government may support the development agencies in accessing bi-lateral and multi-lateral donor funding and other international agencies. Government may encourage the private agencies to support renewable energy projects under Corporate Social Responsibility (CSR) and Public Private Partnership (PPP).

2.3.3.2. Non-financial measures

a. Policy and regulatory measures

The Federal Policy for Development of Renewable Energy for Power Generation (2006) may be revised to include necessary incentives for the promotion of micro 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 micro 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. The Khyber Pakhtunkhwa (KP) government has recently approved "KP Hydropower Policy 2016". For effective implementation of the policies at the federal and provincial levels, mechanisms for effective coordination among the line agencies should be ensured.

b. Development of Good Quality MHP plants

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

c. Information and Awareness Creation

The Pakistan Meteorological Department (PMD), Indus River System Authority (IRSA), Water & Power Development Authority (WAPDA) and Provincial Irrigation and Energy Departments need to increase coverage of their weather and hydrological data monitoring stations and generate necessary data required for proper designing of MHP plants and forecasting for future flows including disasters during the lifecycle of MHP plants. Capacity of staff, working in PMD, IRSA, WAPDA, provincial irrigation, and energy departments, local technicians and CBOs may be strengthened in the field of MHP plants for proper operation and maintenance at the local level. In addition to training and research, demonstration of efficient MHP plants at the local potential sites will also help in capacity building efforts and increase the public awareness on different components of the technology. 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 MHP plants. In addition the formal education system needs to include MHP plants technology in its curricula.

d. Market Development Services increased

To develop new markets and expand existing markets for MHP plants, the vendor needs to streamline timely availability of MHP 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.

e. Risk of disasters reduced & improved water flow

The Initial Environmental Examination (IEE) may be made mandatory prior to installation of MHP 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 MHP plants will help in installing MHP plants at the sites with sustained water flow. This would also ensure uninterrupted functioning and long life of the MHP plants. Under Environmental Management Plans (EMP), the MHP 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 Pakistan and meeting livelihood needs of communities.

2.4. Cross-cutting barriers

The barriers identified in the energy sector i.e. solar PV system, solar geyser and MHP plants have a number of common elements such as high capital cost, difficulty to access finance, absence of energy rating labelling and standards, remoteness of area causing less information and awareness, government policy do not contain required incentives for the promotion of renewables, 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 cross-cutting barriers are as follows:

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, solar geysers and MHP plants technologies in the country. The average cost per household for solar PV and MHP plants is around 500,000 PKR and 20,000 PKR, respectively. The average cost of solar geyser for 35 gallon water storage capacity is approximately 60,000 PKR. 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 machineries for power generation. Further, taxes on local fabrications, constructions, and recent steady depreciation of Pak Rupee have resulted in escalation of prices.

The potential sites for MHP 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 MHP plants. This is limiting the expansion and diffusion of the selected renewable technologies, due to low income of consumer.

2.4.2. Absence of energy rating labeling and standards

Energy products such as Solar PV, Solar Geyser and Micro 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. These products do not meet WHO standards.

2.4.3. No proper budget for information and awareness raising

In Pakistan, general public have low level of information and awareness about technical specifications of Solar PV, Solar Geyser and Micro 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, Solar Geysers and Micro 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.

2.4.4. Government Policy, Strategy and Regulations do not contain required incentives for promotion of renewables

The Federal Policy for the Promotion of Renewable Energy 2006 do not adequately address innovative approaches that can boost diffusion and creation of enabling environment for solar PV, Solar Geyser, Micro 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 and duties rebate in importing and issuing LoIs; FIT from AEDB, NEPRA and NTDC are time consuming.

2.5. Enabling framework for overcoming the barriers

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 Micro-finance banks. The State Bank of Pakistan 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 Micro Hydro power plants. This objective can also be achieved by establishing Revolving Funds at the federal and provincial levels. Establishment of such facilities will increase coverage of recipients of soft-term loans at the grassroots level and will also result in increasing income generating opportunities.

2.5.2. Commencement of energy rating labelling and standards

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

2.5.3. Information & awareness raising

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.

2.5.4. Government policy strategy and regulations

There is a need to revise the National Policy for the Promotion of Renewable Energy (2006) to create an enabling environment for the diffusion of renewable energy technologies particularly solar PV, solar geysers and MHP 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.

Chapter 3. Forestry Sector

The landscapes in Pakistan range from ocean, islands, beaches, deltas, rivers, floodplains, deserts, plateaus and the mountain ranges of the Himalayas, Karakorum and Hindu Kush. The combinations of great variations in relief, landscape and climate have given rise to a large number of ecosystems including alpine, sub alpine, forest, wetland, agriculture, desert, deltoid, coastal and marine ecosystems with high diversity of species in each of these. Pakistan being semi-arid and arid has about 5 percent of its area under forest cover. The main forest types present in the country include sub-alpine, dry and moist temperate, sub-tropical pine and evergreen broadleaved thorn, dry tropical thorn, juniper, chilghoza (Pinus gerardiana forests), riverine and mangrove forests and 21 different types of wetlands. All these ecosystems have played a crucial role in meeting the needs of local communities as well as in economic development and growth of the country. Forest ecosystems are major source of carbon sink and play a major role in climate change mitigation.

The forest cover is depleting at the rate of 2.1 % per annum, which is the highest in Asia due to which Pakistan is ranked at 110 in forest cover of the world[18]. The main causes of deforestation and forest degradation include population pressure; no land use planning, intensification of agriculture, increased settlements and industries. It is further aggravated by poverty, affordable alternatives are not available at remote areas, livelihood activities and climate change. The direct and indirect drivers resulting in high rate of deforestation of prevailing forest ecosystems in Pakistan are given at Annex-XIX. The ecosystem services include provisioning/ productive services like wood products; regulating services like climate change control through carbon storage; supporting services like nutrient cycle and cultural services like recreational benefits.

The Expert Group on Climate Change Mitigation (Annex-XX) prioritized the following two thematic areas for barrier analysis and preparation of Technology Action Plan for climate change mitigation, which are quite appropriate for use in Pakistan for the forestry sector. These are: (i) Sustainable Forest Management (SFM) plans for reducing emissions from deforestation and forest degradation and (ii) Social forestry as carbon sink.

3.1. Preliminary targets of SFM Plans & Social Forestry

It has been recognized in the Pakistan's Vision 2025 that deforestation and forest degradation pose serious risks to Pakistan's environmental protection and climate change mitigation efforts. Pakistan plans to plant 1.5 billion trees over the next five years under the Federal Government's Green Pakistan program, provincial targets for spring and monsoon tree plantation and Tsunami one billion tree plantation program. These programs will help in reducing emissions by afforestation, reforestation and social forestry through sustainable forest management. Women, senior citizens, youth, progressive farmers and provincial Forest Departments, are major stakeholders in these programs.

As per draft National Forest Policy, the Federal Government shall sponsor mass afforestation programs in FATA and Gilgit-Baltistan that would be implemented by Forest Departments, concerned line departments, community based organizations and farmers. All Provincial, territorial and local governments shall provide incentives for promoting farm forestry,

[18] Abubakar, S.M; 2015; Climate change issues, save falling trees; http://wwf.org.pk/blog/2015/02/03/save-falling-trees/

commercial and industrial forestry by encouraging private investments for increasing area under forests and plantations.

The Government, under the global initiative on reducing emissions from deforestation and forest degradation (REDD+), has planned to provide positive incentives for protection of forests to the legal owners and right holders, thus providing global service of capturing carbon dioxide from the atmosphere for the carbon sink. The program will be implemented in three phases that is readiness, piloting and results-based payments. Readiness phase has already been initiated. Piloting phase is planned to be initiated by 2018-19. In phase three, which is likely to start in 2020, forest communities will get results-based payments under REDD+ for quantified and verified emissions reduced by the saved forests and carbon sequestration by new plantations.

The federal government's present initiative under the Sustainable Forest Management (SFM) plan focuses on protection of critical forest habitat, conservation of forest ecosystems and biodiversity, and securing carbon benefits. The SFM project of the federal government will embed these elements of SFM into forest management plans being developed by provincial and territorial forest departments to deliver SFM of 67,861 ha of critical forest habitats by 2020, conserving globally important biodiversity, as well as secure carbon benefits totalling 9,908.1 KtCO2-eq, calculated for a period of 30 years.

3.2. SFM plans for reducing deforestation & forest degradation

3.2.1. General Description

Introduction of sustainable forest management (SFM) Plan[19] will benefit conservation and protection of forest resources as well as provision of sustainable ecosystem services[20]. Supporting an integrated approach of managing forest ecosystems will help in achieving socio-economic and multiple global environmental benefits, including those related to the protection and sustainable use of biodiversity, climate change mitigation and adaptation and combating land degradation.

Reforestation and reducing forest degradation practices will help in increasing forest cover and sequester carbon by taking CO_2 out of the atmosphere through photosynthesis and store it as organic carbon in above-ground biomass (trees and other plants) and in the soil through root growth and the incorporation of organic matter. Thus, the process of release of more CO_2 to the atmosphere can be reversed, at least partially, through growing more trees and protecting of already existing forest cover that serves as a sink for CO_2. Shading crops and the rhizosphere by the trees would significantly reduce evapo-transpiration (ET) of the cropped area. The soil organic carbon content increases in the top 10 cm depth of an improved forestry plantation. Additionally, degraded lands are used and reclaimed by the plantations of

[19] The main elements of SFM include conservation of forest resources; biological diversity at ecosystem level; maintaining health and vitality of forests by reducing risks and impacts of unwanted disturbances, including wildfires, airborne pollution, storm felling, alien invasive species, pests, diseases and insects; maintaining productive, protective and socio-economic functions of forest resources. Legal, policy and institutional framework constitutes another important element of SFM the other elements of SFM as well as it ensures participatory decision making, governance, law enforcement, monitoring and assessment of progress of SFM. (Reference: Green facts, Facts on the health and the environment; Box 1.1 Thematic elements of sustainable forest management; Published under the authority of the GreenFacts Scientific Board. http://www.greenfacts.org/en/forests/toolboxes/box-1.htm)

[20] FAO; Sustainable Forest Management; http://www.fao.org/forestry/sfm/en/

indigenous species and specific trees. Regeneration of forest on degraded or deforested lands help in removing CO_2 from the atmosphere through the build-up of biomass, making forest lands a sink of greenhouse gases. The activity addresses both issues of emission reduction and enhanced removal of greenhouse gases.

3.2.2. Identification of barriers of SFM Plans

The key barriers for SFM plans for reducing deforestation & forest degradation have been identified through the following procedure by analyzing causal relation using root-cause analysis (Problem Tree, at Annex XI). Further, it was also supported by inputs from the experts.

The key barriers for SFM plans have been identified through literature review and bilateral meetings with the experts by the consultant, and stakeholder consultations during meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-XI) for the technologies.

3.2.2.1. Economic and financial

a. No economic Incentive mechanism in place for SFM

Resource users and landowners are not rewarded for resource conservation as no funding and economic incentive mechanism exist to cover opportunity costs related to sustainable use of forests. As in Pakistan, compensation payments for watershed protection or sustainable forest management in upstream areas are not borne by downstream territories, even though the latter are the direct beneficiaries from such actions. Institutional and regulatory frameworks are not effective in supporting Payment for Ecosystem Services (PES) or REDD+. The barriers related to eligibility measures for REDD+ payments include absence of Measurement, Reporting and Verification (MRV) system, national level Reference emission level; Development of REDD+ Strategy and Action plan; Multiple Benefits, Impacts, Governance and Safeguards system and feedback and grievance redress mechanism.

3.2.2.2. Non-Financial

a. Policy & regulatory measures not supportive to SFM

The present policy in-vogue requires preparation of working plans but the guidelines of the working plans lack emphasis on elements such as protection and preservation of non-timber forest products, requirements for re-plantation and protection of the vacant and cleared sites to provide enough time for regeneration of the trees and other vegetation and other parameters of sustainable forest management. Thus, the working plans in practice do not contain sustainable forest management measures in holistic terms. The present working plans divide the forest area into different circle on the basis of nature of management like protection circle, wildlife circle, working circle for forest tree cutting etc. The policies have shortcoming of spelling out working plans with clear robust standards & realistic criteria for SFM, as mentioned above; limited financial resources for SFM, unclear community rights on forest resources and shortage of downstream infrastructure like depots for protection, sustainable utilization and provision to the local communities as per their rights of timber and non-timber forest resources including medicinal plants. It also lacks independent third party monitoring and assessment. Another barrier is the less coordination among the line departments like

Forest and Wild life departments, provincial and federal line agencies which weakens implementation of policy and regulatory measures.

Hence, non-supportive policy & regulatory measures are major barriers for sustainable forest management. Absence of the National Forest Policy, and non-supportive Provincial forest policies and regulatory framework impedes sustainable management of forests.

b. Low capacity of staff for development of SFM plans

The line departments responsible for forestry at provincial, local level and communities do not get proper training and refresher courses for updating their knowledge and practices related to SFM so they can not benefit from value of forests, forest ecosystem services. As a result they are not able to demonstrate good practices giving due consideration to SFM.

c. Limited participation of community in decision making

The decisions of the Forest Department are based on top-down approach. The management passes their decisions to the local staff regarding the management of the forests. Since the most of the provincial laws lack provision for involvement of local communities in making decisions regarding forest management hence the socio-economic safeguards and timber, fire-wood and other rights of the local communities are not taken into consideration while making decisions regarding forest management. This leads to illegal logging by the local communities to meet their needs. This provides a room for illegal logging for commercial purposes also.

Due to limited participation of local communities in forest management planning Further, due to erosion of traditional and tribal systems of governance for the protection of forests, the rate of deforestation and forest degradation has increased.

d. Alternate strategies in case of disasters & forest fires not defined

There are no strategies to save forests from natural and man-made disasters, especially long duration droughts, GLOFs, landslides, river bank erosion in different ecosystems. In Pakistan due to forest fires, every year a large proportion is destroyed, especially in conifer forests.

There is infrequent weather related forecasts because of limited resources and capacity of Pakistan Meteorological Department (PMD), which results in increased loss of life and property. Another barrier is ineffective dissemination of timely weather forecasts at the grassroots level.

3.2.3. Enabling framework for overcoming the barriers of SFM Plans

The enabling framework for overcoming the barriers in SFM plans for reducing deforestation & forest degradation have been described in the form of Solution tree (Annex XII). These were further discussed and finalized after stakeholder consultations.

3.2.3.1. Economic & Financial

a. Economic Incentive mechanism in place for SFM

The REDD+ and Payment for Ecosystem Services (PES) plays a vital role in providing incentives to the resource users and landowners for resource conservation to cover opportunity costs related to sustainable use of forests. The federal government has launched

the REDD+ Readiness Preparatory Project which has following main components: (i) National REDD+ Strategy and action plan; (ii) National level Reference Emissions Levels; (iii) Measurement, Reporting and Verification (MRV) System; (iv) REDD+ safeguards; (v) Grievance redress mechanism. Different projects related to REDD+ have been initiated at the provincial levels. Compensation payments for watershed protection or sustainable forest management in upstream areas need to be borne by downstream territories, as the latter are the direct beneficiaries from such actions. This could proposal could be actualized by providing provision in the national and provincial forest policies and regulatory frameworks. Once this provision is made, the institutions like Water and Power Development Authority (WAPDA) managing the large dams and fresh water bodies and National and Provincial Disaster Management Authorities may enter into agreement with the owners of the watershed areas like local communities or Provincial Forest Departments for plantation and other soil conservation measures in the watershed areas. These arrangements will help in actualizing the compensation payments to the owners of the watershed areas.

3.2.3.2. Non-Financial

a. Sound policy & regulatory measures

To ensure sustainable forest management a sound forest policy is essential. A forest policy should assure balanced forest use and conservation with agriculture and other sectors. Policies should also reflect development patterns for the country as well as the provinces and territories. A basic feature for sustainable management is a firm and consistent commitment, including management plans and budgetary support planned in a disciplined manner, by the government. The policy should guide and clearly spell out development themes with effective coordination among line departments.

Laws and regulations comprising forest legislation are the legal instruments that are necessary to put into effect to facilitate implementation of the forest policy. The laws translate policy objectives into specific legal provisions affecting both forest use and forest land and the way forest resources affect the ecosystem and development of communities. Forest legislation enacted by the government should reflect the principle of sustainability in order to support implementation of forest policy. Forest regulations should include following provisions for ensuring sustainable forest utilization and management:

- Maintaining or enlarging the amount and regional distribution of forest cover needed to secure a stable environment and to provide a basis for sound economic and social forest development.
- Protecting in a network of protected areas representative examples of all natural forest ecosystems in order to maintain an acceptable level of biological and landscape diversity.
- Preparing sustainable forest management plans for all type of state forests and for other community forest lands.
- Establishing and supporting a viable and multi-functional forest economy, combining ecological conservation and economic resource utilization[21].

b. Enhanced capacity of staff for development of SFM plans

To prepare SFM plans, the capacity of line departments responsible for forestry at provincial and local level and local communities need to be enhanced to achieve sustainable forest management. Training and successful demonstrations of good practices will also facilitate

[21] FAO Corporate Document Repository; Principles of sustainable tropical forest management where wood production is the primary objective; Guidelines for the management of tropical forests ; http://www.fao.org/docrep/w8212e/w8212e04.htm

gainful opportunities related to sustainable forest management (SFM). Further, sufficient knowledge and recognition of values of the ecosystem services will allow determination of optimal management objectives, and sustainable financing options for SFM.

c. Adequate participation of communities in decision making

Ensuring adequate participation of communities in decision-making will enable the achievement of effective and enduring two-way communication between forest managers and forest communities. It will help in promoting improved livelihoods of rural communities, especially those who have a traditional dependency upon forests, through more effective management of tree and forest resources. To prevent illegal logging, community based organizations have to be strengthened and given an appropriate role in forest resources management. Reinforcing effective traditional and tribal systems of governance will also improve the forest management and will reduce the rate of deforestation and forest degradation. Following three features will encourage rural community participation in sustainable forest management:

- A clear recognition and respect for the rights of indigenous peoples who live in the forests or have a traditional dependence on tropical forests.
- Promoting collaboration amongst people and institutions who are involved in the various aspects of forest management, including wood production, integrating professional skills and training with traditional knowledge and resources of local populations in order to more effectively support the needs of rural communities and to minimize or avoid conflicts in forest management.
- Enhancement of the well-being of forest workers and local communities[22].

d. Alternate strategies in case of disasters & forest fires defined

The increasing intensity and frequency of disasters due to climate change impacts call for putting in place alternate strategies to combat disasters including forest fires in SFM plans. The strategy should also address adequate measures such as weather forecasts and capacity building of PMD and other line departments.

Emissions of greenhouse gases from forest land are reduced by slowing down the rates of deforestation and forest degradation. Removals of greenhouse gases (specifically CO2) from the atmosphere can be achieved through various forest management options, such as afforestation on non-forested lands, replanting degraded or deforested areas or enrichment planting in riparian buffer/zones like river banks, streams and wetlands.

3.3. Social Forestry as Carbon Sink

3.3.1. General description

Social Forestry means development of forests by the community to meet fuel, fodder and timber needs. The other benefits of Social forestry are to increase tree cover to conserve biodiversity, reduce soil erosion, protections against disasters, protect aquifers and watershed areas and sequester carbon. The tree cover absorbs CO2 out of the atmosphere through photosynthesis and stores it as organic carbon in above-ground biomass (trees and other plants) and in the soil through root growth and incorporation of organic matter. Thus, the

[22] FAO Corporate Document Repository; Principles of sustainable tropical forest management where wood production is the primary objective; Guidelines for the management of tropical forests ; http://www.fao.org/docrep/w8212e/w8212e04.htm

process of release of more CO2 to the atmosphere are reversed, at least partially, through growing more trees and protecting of already existing forest cover which serves as a carbon sink. Shading crops and the rhizosphere by the trees also reduces evapo-transpiration (ET) of the cropped area. The organic carbon and nitrogen contents in the soil increase in the top 10 cm depth of an improved forestry plantation. The activity addresses the issue of emission reduction.

There is active participation of women, and youth in this sector. The main objective of social forestry is to involve the rural communities in creation and maintenance of woodlots or raising tree plantations along with agricultural crops or shelter-belts on community lands, private lands and in homestead23.

In Sindh, state forestland has been leased out by the forest department (FD) for agro-forestry to raise forest trees on 20% of the leased area and use the remaining area for cultivation of agricultural crops. In most cases, the Forest Departments have neither achieved these objectives nor recoverd the leased lands after the expiry of leases. The practice and efficacy of agro-forestry leases needs evaluation and corrections, if needed to ensure that these leased out lands are used for their intended purpose.

3.3.2. Identification of barriers of Social Forestry

The key barriers for Social forestry have been identified through literature review and stakeholder consultations by analysing causal relation using root-cause analysis (Problem Tree, at Annex XIII).

3.3.2.1. Economic and financial

a. Return from forestry require a long period of time

One of the biggest impediments hindering the promotion of social forestry is that the return from forestry requires a longer period of time. There is competition between forest trees and agricultural crops. Moreover, agricultural crops provide early return. From an economic point of view, access to capital and technical capability are stressed as basic conditions for long-term plantation investments. Un-employment and population pressure are also barriers retarding conservation and protection of forests.

b. In adequate funds for forest tree plantation

The farmers need to incur investments right from the beginning of procurement of forest tree seedlings from the nurseries or establishing their own nurseries. Thereafter, to ensure good survival and early growth, major costs are incurred in purchase of quality seedlings, site preparation, gap filling, irrigation and drainage, fertilization, and weeding. All these investments require funds for undertaking and managing forest tree plantations. The farmers in most of the potential forest areas are poor and cannot afford such investments whose return require several years to pay back. Hence, absence of funds and non-existence of credit facility on soft-term basis are among the critical barrier to the diffusion of social forestry practices. Clash of interests among the communities on the use of communal land for forestation also hinders forest plantations.

[23] Social Forestry and Farm Forestry (Item No. 6);
http://www.tnrd.gov.in/reports/Jain_Report/english/index4_6.pdf

c. No Incentives for social forestry

Resource dependent communities and land owners are not rewarded for resource conservation as no funding and sharing mechanisms exist to cover their opportunity costs related to forest plantation. Social forestry schemes, as well as plantations for watershed protection and other resource conservation purposes, have been driven by production or commercial motives and not for carbon sink. The existing forest policies do not provide enabling environment for undertaking social forestry, as these do not address incentives like favourable tax treatments, subsidies and concessional financing to bridge the gap for long-term investment returns from forests[24]. The policies also lack measures that create opportunities for making forest plantations a competitive land use option.

3.3.2.2. Non-financial barriers

a. Unsustainable forest management

The SFM is complex and difficult to manage viz a viz traditional forestry is mostly for timber or firewood production. Forest products are marketable but many forest services such as water, biodiversity, regulation of flood water are not yet priced and marketable. The complicated procedures for utilization and transportation of trees raised on private lands, especially in the mountainous and conifer forest zone are demotivating for the owners.

In general, the local communities are unaware about the benefits of sustainable forest management (SFM) and the real value of forests, forest ecosystem services and Payment for ecosystem services. This leads to unsustainable harvesting and illegal felling of trees and non-timber products. Forests are grown as a source of income generating activity and woodlots are sold due to high demand for timber and fuel-wood sold even before these are fully matured. This phenomenon is further aggravated due to absence of affordable alternatives. Grazing in regeneration and planting areas and overgrazing elsewhere which is not allowing establishment of natural regeneration and plantations also results in loss of tree saplings, biodiversity and reduced carbon sequestration.

b. Use of unhealthy and low quality seedlings and alien invasive species

Due to lesser knowledge and awareness about appropriate trees for a particular area and poor research and extension, certain alien and invasive species like Eucalyptus, Mesquite (Prosopis juliflora), Paper mulberry and Lantana species, are spreading wildly. Such species cause severe disturbances to natural ecosystems. Direct effects of alien invasive species occur through processes such as the competition with, pathogen and parasite transmission to indigenous plants, eventually leading to population declines and species extinctions. People living in and around invaded forest areas may also suffer allergic or other negative reactions from the alien invasive species themselves or to the measures used to control them such as chemical pesticides and biological control. Use of unhealthy, low quality seedlings inappropriate for the area are taken from the forest nurseries and grown. The negative effects of unsuitable forest plant species starts appearing after a long period of time when there is little opportunity to replace them.

c. Unavailability of land resources for forestry

Pakistan being in arid and semi-arid country, suffers from acute water scarcity in most of its areas. In addition, availability of land for forest cultivation in areas where water is available is

[24] The Economic Environment For Plantations In Developing Countries: Making Plantation Forestry A Viable Land Use Option; Proceedings of the International Conference on Timber Plantation Development, FAO Corporate Documentary Repository; http://www.fao.org/docrep/005/ac781e/AC781E04.htm

a challenge because of its competition with the agricultural crops and encroachment of forest area for extension of cropland. There is lesser knowledge of intercropping of suitable trees with the agricultural crops, which can be simultaneously cultivated for better economic returns. In undulated areas like Potowar and rodh kohi areas, there abrupt rains in monsoon season result in enhanced flooding and soil erosion. This leads to degradation of the ecosystem and unavailability of productive land resources. Poor planning and strategy lead to using land for agricultural crops that give quick return on investments hence the availability of land for social forestry becomes limited.

3.3.3. Enabling frame work for overcoming the barriers for Social Forestry

The enabling framework for overcoming the barriers in Social forestry have been described in the form of Solution tree (Annex XIV). These were further discussed and finalized after stakeholder consultations.

3.3.3.1. Economic and financial

a. Sustainable return from forestry

Sustainable returns from forestry can be achieved through introduction and implementation of supporting policies, laws, rules and regulations. Diversification of economic opportunities from forests in the form of intercropping of forest trees with non-timber forest products like medicinal plants and vegetables would be a source of return from the forest before the wood is matured and ready for sale. Further, extraction of products from standing trees like gums, seeds, honey, silk cocoons can be additional source of income. These opportunities will lead to reduction of encroachment of forest for cultivation of agricultural crops, unemployment and meeting the expanding population needs.

b. Funds available for forest tree plantation

Funds for forest tree plantation can be made available through introduction of private financing mechanisms include microfinance, out-grower schemes, foreign direct investment, remittances for owning a woodlot. Microfinance has played an increasingly important role in financing small enterprise activities and rural development in Pakistan over the past 30 years. Microfinance for forestry sector investment should be characterized by low interest rates, long loan maturity periods and expanding its network for increased rural outreach so that it can provide bridge financing during long gestation periods for plantation activities. Out-grower schemes, also referred to as contract farming, represent a form of integrated value-chain financing, whereby a buyer higher up the chain provides financing for a producer lower down the value chain. Out-grower schemes provide a response to the constraint of long gestation periods. Furthermore, government policies aimed at regulating private sector investment in the forestry sector may help provide a framework that promotes smallholder or community benefits in out-grower schemes. Partnership of local communities will encourage recognition of long-term socio-economic incentives from trees.

Foreign direct investment (FDI), Payment for Environmental Services (PES), designed to "capture" the non-market values of environmental services through appropriate economic transaction. This process is half-way between a public and private funding mechanism, exposed to the vagaries of changing donor priorities and capacities, and a private funding mechanism. Carbon finance and REDD+ are fast growing markets to support forestry at global level. Ecotourism can be seen as a kind of voluntary environmental service payment in as much as the resource managers receive benefits in return for protecting the scenic beauty

and biodiversity of the forests where they live. All forest financing mechanisms need to operate in an enabling environment in order to be able to function well and generate benefits[25].

c. Incentives for social forestry

In the forest policy, there is a need to design fiscal and financial incentives to encourage forest plantations, such as special fiscal treatments, subsidies, revolving funds and concessional financing. Special fiscal treatments may include policies that favour forest land value, favourable tax treatments etc. To support farmers growing forest trees government, DFIs and banks may offer concessional loans: loans with an interest rate that is lower than the market rate, or a repayment schedule where interest is not paid for a period of time[26]. Such facilities will reduce clash of interest among community members leading to increased availability of community land for social forestry without affecting their livelihood and income sources.

3.3.3.2. Non-financial measures

a. Sustainable forest management

There is a need to aware the community with respect to the preparation of SFM plans with successful demonstration of good forestry practices and capacity building of line agencies as well as the communities. Adoption of principles of SFM will ensure the sustainable growth of forest trees planted under social forestry and reduce its mortality rate. The SFM helps the communities in meeting their livelihood needs, income generation and employment creation. Furthermore, it contributes to important services such as carbon sequestration, water, soil and biodiversity conservation. Controlling grazing in regeneration and planting areas and making affordable alternatives like fuel-efficient stoves, brickets made with available biomass and coal, plywood, hardwood will lead to reduced burden on forests and sustainable use of forest resources.

b. Use of healthy and high quality seedlings/ indigenous species

Dissemination of Knowledge and awareness about appropriate trees for a particular area and negative impacts of alien and invasive species will support appropriate decision making in selection of healthy and high quality seedlings of indigenous trees. This helps in sustaining natural ecosystem of the area and increasing carbon sequestration as carbon sink. Further, research and extension helps in tackling climate change variations, rainfall patterns and temperature. Protection from alien species of trees would help people living in and around forest areas from allergic or its other negative health impacts.

c. Availability of land resources for forestry

Availability of private land resources for forestry can be increased by growing forests through water resource development and management in the form of micro catchments etc. in the forest, intercropping with high value crops, vegetables and medicinal plants appropriate for the area. In this way, the private land owners will have the opportunity to get quick as well as long-term benefits from the same land. Hence, they would be ready to spare their land for establishing and maintaining forests. Introducing activities like bioengineering with

[25] Existing and Potential Forest Financing Mechanisms for Smallholders and Community Forestry in West Africa; Food and Agriculture Organization of the United Nations; http://www.fao.org/forestry/29388-08ff0e4c2d32fe144bcd715dfb44a4fd7.pdf

[26] The little forest finance book; file:///C:/Users/jawaid%20ali%20khan/Downloads/little-forest-finance-book.pdf

indigenous trees whose root network has better capacity to hold the soil coupled with erosion control structures will result in ecosystem rehabilitation and soil erosion control.

Appropriate SFM planning, strategy and its implementation would further help the communities in getting maximum benefits from their forest area.

3.4. Cross-cutting barriers

The common barriers in SFM plans for reducing deforestation and forest degradation and social forestry include no economic incentive; scarce knowledge and awareness; and non-sustainable forest management.

3.4.1. No economic incentive

The local communities are not fully aware of the socio-economic, environmental and ecosystem services which can be harnessed from forest resources through sustainable forest management practices. The existing forest policies do not provide enabling environment for undertaking forestry on a large scale as these do not provide incentives like favourable tax treatments, subsidies and concessional financing to bridge the gap for long-term investment returns from forest[27].

3.4.2. Scarce knowledge and awareness

In both the cases of SFM plans and social forestry; the major barrier behind unsuccessful outcome is lesser knowledge and awareness about appropriate trees for a particular area; invasive alien and indigenous species etc. Another discrepancy is about the quality nursery raising practices which results in use of unhealthy and low quality seedlings. The people are also ignorant about the health impacts of deforestation and inappropriate afforestation. There is a need for further research and extension to tackle the emerging issues from the impacts of climate change.

3.4.3. Unsustainable forest management

Unsustainable forest management is due to absence of training and successful demonstrations of good practice, including inappropriate cross-sectoral plans and governance weaknesses. Local communities and line departments are unaware of the damage being caused to the infrastructure and the ecosystem by indiscriminate destruction of tree cover. In many cases forest users do not have the understanding of sustainable forest management. Forests are grown for the purpose of selling the woodlots to get the income. The forest trees are cut and sold even before these are full matured.

3.5. Enabling frame work for overcoming the barriers

For protection of forest cover in Pakistan having its maximum area under arid and semi-arid climatic conditions, it is vital to take all possible measures for the protection of the forest ecosystem; reduce deforestation and forest degradation. The common enabling framework focuses on the following major measures:

[27] The Economic Environment For Plantations In Developing Countries: Making Plantation Forestry A Viable Land Use Option; Proceedings of the International Conference on Timber Plantation Development, FAO Corporate Documentary Repository; http://www.fao.org/docrep/005/ac781e/AC781E04.htm

3.5.1. Creation of economic incentives

Economic incentives can be enhanced through launching of demonstration projects; introducing mechanisms like Payment for Ecosystem services and REDD+. Economic incentives from both state and private forest lands can be enhanced through intercropping of non-timber forest plants, honeybee keeping and eco-tourism, which can multiply the benefits and raise the socio-economic wellbeing of the local communities. In the national and provincial forest policies, a mechanism of Payment for Ecosystem Services may be introduced to create incentives for the upper riparian communities for protection of fragile ecosystem and watersheds by the lower riparian communities. The REDD+ process has just started in Pakistan. The REDD+ methodology should also be adopted in the recently launched Prime Minister's Green Pakistan initiative as well as Tsunami One Billion Tree Plantation Project. This will reinforce the REDD+ preparatory phase and result in pilot testing that can be up-scaled on sound footings.

3.5.2. Wide dissemination of knowledge and information

Through introduction and implementation of policies, there is a need to increase awareness of protection of existing forests and creation of new forests among local communities and line departments. Forests are major resource for improvement of livelihood and ecosystem; protection and conservation of biodiversity including endangered species; recreational benefits and mitigation and adoption of climate change effects to reduce global warming.

3.5.3. Promotion of Sustainable forest management

National and Provincial policies, laws, rules and regulations should focus on promotion of sustainable forest management in the country. The SFM is a way of conserving forest resources; biological diversity at ecosystem level especially the endangered species of fauna and flora; reducing risks and impacts of unwanted disturbances in forests; maintaining productive, protective and socio-economic functions of forest resources. Communities' needs of livelihoods, income generation and employment can be met through preparation and implementation of Sustainable Forest Management Plans. Furthermore, it contributes to important ecosystem services including provisioning services such as food and water; regulating services such as flood and disease control, reduction of global warming; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth[28].

[28] Ecosystem and their services; Ecosystems and human wellbeing: a framework for assessment; http://www.unep.org/maweb/documents/document.300.aspx.pdf

Chapter 4. Transport Sector

The transport sector includes all modes of transport (road, rail, aviation and marine). The road transport comprises of 2-wheelers, 3-wheelers and cars, pick-ups, buses and trucks etc. In Pakistan, the transport sector contributes 21 percent to the national carbon emissions, and is responsible for more than half of the oil consumed. As the population and economy have grown, the number of vehicles has increased from 2.7 million in 1990 to 9.8 million by 2010[29]. The numbers of registered vehicles are 15.168 million in 2014. In terms of population, Pakistan is 6th largest country of the world and has inefficient public transport system to provide efficient and cost effective mode of transportation to the commuters as well as reduce its contribution to greenhouse gas emissions and global warming. The quality of maintenance and up-keeping required for a vehicle not only determines its lifespan and frequency of major breakdowns but also its fuel efficiency. Maintenance practices, especially engine tune-up directly affect the level of emissions produced by the vehicles as well as the fuel efficiency.

Under the transport sector, the Technology Needs Assessment report identified three technologies. Out of these two top ranking technologies, namely BRT and Vehicle Tune-up were prioritized for barrier analysis and preparation of Technology Action plan.

4.1. Preliminary targets for technology transfer & diffusion

The Pakistan Vision 2025 sets the target to provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons. A number of initiatives are being taken in the transport sector, which include streamlining passenger transportation through improvement in public transport system and pollution prevention in vehicles[30].

The Metro-bus service is in operation in three cities including Lahore, Islamabad and Rawalpindi. To improve public transport, work on Metro-bus system is in progress in Karachi, Peshawar, Multan, Faisalabad and the system will be in operation in 2017. Plan for extension of Multan Metro-bus service with District Muzafargarh, Shujaabad and Jalalpur pirwala tehsils of Multan and District Bhawalpur is also in progress.

The government has launched the National Automotive Development Policy 2016[31], which among other measures, pledges to promote pollution mitigation measures to protect public health and property. The vision of the policy is to develop a modern, competitive and viable automobile and auto-parts industry capable of meeting national and regional demand by 2021 through inter alia establishment of infrastructure for quality, safety and environmental standards[32]. The policy will promote regulatory and enforcement mechanisms for quality, safety and environmental standards including development of regulations based on United Nations Regulations (UNRs). This will enable Pakistan to conform to the global safety and environmental standards and capture regional and global automobile market for export. Motor

[29] Registered vehicle data by country; 2011; http://apps.who.int/gho/data/node.main.A995
[30] Government of Pakistan, Pakistan Vision 2025, Planning Commission, page 15 & 49, Islamabad http://www.pc.gov.pk/wp-content/uploads/2015/05/Pakistan-Vision-2025.pdf
[31] Government of Pakistan, Automotive Development Policy 2016-21, Engineering Development Board, Ministry of Industries and Production, Islamabad http://boi.gov.pk/userfiles1/file/AutoPolicy/AP.pdf
[32] ibid, page 73

Vehicles Rules 1969[33] and Euro II Emission requirements[34] have be reviewed from the standpoint of safety of human life, environmental protection and sustainable growth of motorization growth in Pakistan and new regulations on "Pakistan Environmental Protection Motor Vehicle Regulations 2016[35]" have been approved. Revision of Motor certification/ Motor Vehicle Examination System, accreditation of testing facilities and mandatory periodic vehicle inspection are the other areas mentioned in the policy.

Regarding vehicle tune up, The Prime Minister of Pakistan has issued a "Strategic Policy Directives of Government of Pakistan". According to this Directive, "Respective fleet owners and managers/operators shall ensure phased tune-up of vehicles as well as other energy efficient driving practices to be employed to ensure conservation of energy". In addition, "Vehicles fitness certification facilities with tune-up centers shall be established at selected outlets and filling stations of the oil distributing companies in Pakistan in order to provide efficiency support to the transport sector". As per the National Energy Conservation Center of Pakistan (ENERCON), vehicles need to be tuned up regularly after every 15,000 Kms[36].

4.2. Bus Rapid Transit

4.2.1. General Description

Metropolitan cities are growing so rapidly, that their transport systems are hardly able to keep up pace with emerging urbanization challenges. This has led to increased transport problems. The Bus Rapid Transit (BRT) systems launched in Lahore, Rawalpindi and Islamabad has enabled these cities to optimize their transport infrastructures for local public transport relatively in a shorter span of time.

A Bus rapid transit system (BRT) is a high-capacity low cost transport system with its own right of way. The key technology is energy efficient engine, minimum Euro-II/ Pak-II compliant diesel engines that emit less CO_2 and have good fuel burning efficiency. Permissible noise levels are maximum 85 dBA[37].

The BRT system in Pakistan has following features, which has made it efficient: The BRT system has barrier-controlled, off-board fare collection, a service interval of less than 2 minutes during peak hours, stations with well-designed signage and information systems and a precision bus docking system.

The technology is changing the trend of modal shifts towards public transportation, thereby bringing about a range of benefits, including reduced congestion, air pollution, greenhouse gases and better service to poor people. A BRT system has the capacity to take in one direction approximately 10,000 passengers per hour per direction in peak hours. The Lahore BRT system is running at an average speed of 26 km/hour[38].

[33] Government of Pakistan, The Motor Vehicles Rules 1969, http://nasirlawsite.com/laws/mvr.htm
[34] Draft Working Paper – National Environmental Quality Standards for Vehicular Exhaust & Noise, Pakistan Environmental Protection Agency, http://www.environment.gov.pk/PRO_PDF/WPAPER-VES.pdf
[35] Government of Pakistan, Pakistan Environmental Protection Motor Vehicle Regulations 2016, Pakistan Environmental Protection Agency, Ministry of Climate Change, Islamabad http://environment.gov.pk/information-services/
[36] Transport Sector – ENERCON; www.enercon.gov.pk/enercon.php?mc_id=24
[37] National Environmental Quality Standards for Motor Vehicle Exhaust and Noise, https://www3.opic.gov/environment/eia/pakistanpower/110711%20R1V08STR-A%20-%20Part%20III.pdf
[38] Lahore Metro Bus, https://en.wikipedia.org/wiki/Lahore_Metrobus

4.2.2. Identification of barriers for BRT

The key barriers for BRT have been identified through literature review and bilateral meetings with the experts by the consultant, and stakeholder consultations during meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-XV) for the technologies.

4.2.2.1. Economic & Financial

a) High Capital cost

The capital cost incurred in the establishment of the BRT (which is known as Metro-Bus service in Pakistan) in Lahore and Islamabad is 1.11 billion[39] and 1.99 billion[40] PKR per km, respectively, which is much higher when compared to the conventional system. The Conventional system consists of public bus and Toyata-HIACE service. Due to the high cost, this network has been established only in the most congested areas of the city and could not be expanded to ease the traffic flow in other parts of the city. The other reasons limiting the expansion include absence of programs to provide technological knowhow as well as facilities for assembling and manufacturing efficient buses for the BRT system locally. In Islamabad-Rawalpindi Metro-bus service, the average operating cost for a bus trip is around 9,100 PKR. The average revenue for the same trip earned by the Authority is 2,600 PKR, recording a loss of 6,500 PKR on every trip[41]

b) Non-availability of soft-term loan facilities for Private investors

About 2000 public transport vehicles[42] have lost business opportunity due to its replacement with Metro-bus service in Islamabad-Rawalpindi. In addition to this loss, a large number of employment opportunities of service providers have also been affected. The return from the BRT system takes longer time. Further, no soft-term loan facility from commercial banks is available for the system. Therefore private investors are neither able to invest in the business of BRT, nor in establishing the feeder routes.

4.2.2.2. Non-financial barriers

a) No national policy supporting BRT

The National Transport Policy is still being drafted. While the National Automotive Development Policy 2016-21 has been approved but it does not cover the subject of BRT[43]. Hence, the BRT system is operating without a comprehensive policy framework. Due to absence of policy guidelines, focus on research and development, institutional capacity building and mechanism for feedback from stakeholders have not adequately developed.

[39] Metro Bus Service: Punjab pays Rs.5 million per day as subsidy; The Express Tribune; Sunday, 1 May 2016, http://tribune.com.pk/story/780840/metro-bus-service-punjab-pays-rs5m-per-day-as-subsidy/
[40] Rawalpindi-Islamabad Metrobus; https://en.wikipedia.org/wiki/Rawalpindi-Islamabad_Metrobus
[41] Economically unviable: Metro Bus - a white elephant painted red; June 29, 2015;
[42] Salman, A; Public transporters to be banned from Metro route; The daily Dawn, December 15, 2016; http://tribune.com.pk/story/911493/economically-unviable-metro-bus-a-white-elephant-painted-red/
[43] Government of Pakistan, Automotive Development Policy 2016-21, Engineering Development Board, Ministry of Industries and Production, Islamabad http://boi.gov.pk/userfiles1/file/AutoPolicy/AP.pdf

b) Opposition from existing transport operators & other affected parties

The existing transport operators are the strongest lobby against the expansion of the BRT system because it directly affects their businesses as well livelihoods of the people associated with the public transport sector and their service providers. In addition, there are other affected parties whose livelihoods have been affected due to demolition of shops, houses etc. to make BRT route[44].

4.2.3. Enabling framework for overcoming the barriers for BRT

The enabling framework for overcoming the barriers in BRT have been described in the form of Solution tree (Annex XVI). These were further discussed and finalized after stakeholder consultations.

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 Pakistan 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). The Metro Bus Service or BRT in Lahore and Rawalpindi were discussed in respect of total cost of the system, possible ways to reduce this cost such as through commercial activities and kiosk at Bus stands, advertisement boards at the routes etc. Possibilities of public private partnership, and mechanism for resolution of grievances of affected parties were also discussed. There was a proposal for development and approval of a National Transport Policy focusing on measures and timelines for promotion of BRT andf other modes of mass Transit System in the country.

4.2.3.1. Economic & Financial

a) Reduced capital cost

The government need to exempt duties and taxes on import of BRT buses to make it affordable for the private sector to expand the BRT network at reduced capital cost. The improvement in infrastructure network like building of signal free corridors with dedicated lane for BRT will promote public private partnership in expanding the BRT network. There is also a need to enhance facility of assembling and manufacturing of efficient buses for the BRT system. Technical knowhow of the professionals and technicians involved in the business may also be enhanced through launching training programs and refresher courses through accredited institutions.

b) More opportunity for private investors

To create more opportunities for involvement of the private sector in the BRT system, special window for providing soft-term loans to the potential investors may be opened to encourage their participation. This will facilitate expansion of BRT network throughout the city as well as increase feeder routes for the system. Such measures would result in bringing down high operating cost to a manageable level and getting return from the system in much shorter

[44] Fizza Batool, 2012-14, Environmental Impact Asserssment of Construction of alternate route to circular road from new Azadi chauk to Masti gate, Thesis: Lahore School of Economics, http://121.52.153.178:8080/xmlui/bitstream/handle/123456789/13711/Fizza%20Batool%20Revised%20thesis.pdf?sequence=3

period of time. The promotion of BRT will also improve environment through reducing greenhouse gases.

4.2.3.2. Non-Financial

a) National policies support BRT development

The Government should initiate to develop and approve a National Transport Policy. The policy should focus on measures and timeline for promotion of BRT and other modern mass transit systems in the country. The development of policy should be taken on priority basis as Pakistan is going to be pre-dominantly urbanized by 2030. A mechanism must be developed to streamline coordination among relevant institutions and continuous feedback from stakeholders to review and improve the BRT system. It must also be backed up with research, demonstration and capacity building of relevant institutions to effectively run and expand the BRT network in the major populated cities of the country.

b) Resolution of grievances of affected parties

A mechanism should be established to provide alternative business opportunities to the existing transport operators and other businessmen affected by the BRT system. These may include allotment of tea stalls, tuck shops and market based compensation to the affected parties. The public transporters who have lost business due to its replacement with Metro-bus service should be provided alternate route permits either from the Metro-bus station to the feeder route areas or on the new routes.

4.3. Vehicle Tune-up

4.3.1. General Description

The National Energy Conservation Center (ENERCON) has facilitated the private sector in establishing computerized tune-up centers throughout the country. The computerized tuning of the engine increases fuel-efficiency by about 10% and reduces emission of noxious exhaust gases (CO, NOx, SO_2) and CO_2 by approximately 60%. This helps in reducing air pollution and greenhouse gas emissions as well as increases efficiency and life of engine[45].

Engine tuning is an adjustment, modification of the internal combustion engine or its control unit to yield optimal performance, increase an engine's power output, economy and durability. A vehicle needs tune-up when its average fuel consumption drops by 10-15 percent or after each 15,000 kms of running of vehicle[46].

4.3.2. Identification of barriers for Vehicle tune-up

The key barriers for Vehicle Tune up have been identified through literature review and bilateral meetings with the experts by the consultant, and stakeholder consultations during meeting of Expert Working Group on Mitigation by analyzing causal relation using root-cause analysis (Problem Trees, at Annex-XVIII) for the technologies.

[45] Government of Pakistan, Transport Sector, Promotional Material, http://enercon.gov.pk/
[46] Government of Pakistan, Transport Sector, Promotional Material, http://enercon.gov.pk/

4.3.2.1. Economic & Financial

a) High Capital cost of computerized tune-up facility

The computerized tune up have high capital cost due to high price of the machineries and equipment. The cost of computerized tune-up facility ranges from Rs.2 million to Rs.4 million. This includes only the equipment cost. Salaries of staff, space, rent etc. are additional costs. The payback depends on the type of equipment installed. The cost of vehicle check up is Rs.400 to Rs.600 per vehicle. The return on the investment requires long period of time and soft term loan facility is not available.

4.3.2.2. Non-Financial

a) Computerized tune up equipment and machineries not locally available

The computerized tune up equipment and machineries are not locally manufactured and are imported from abroad. Due to lesser capacity of trained manpower and unavailability of requisite infrastructure, the country at present cannot produce locally. Furthermore, the demand of these units is also less, therefore its local production cannot compete with the international market prices.

b) Limited demonstration of computerized tune up

There is limited facility available for demonstration of computerized tune-up because of absence of national transport policy, legal framework, rules and regulations. Further, there is no law that makes the vehicle tune-up mandatory. Under UNDP and Global Environment Facility (GEF) sponsored "Fuel Efficiency in Road Transport Project", 50 demonstrations tune up centers were established throughout Pakistan in 2005[47]. The demonstration resulted in replication effect which was further supported by the Energy Conservation Fund by facilitating procurement and installation of the Tune-up centers. Few hundred tune-up centers have been established throughout the country. There is no published reference of exact number of tune-up centers.

The legal basis for motor vehicle fitness, examination and fitness certification exists in the Motor Vehicles Ordinance1965, under Rule-35 of the M.V. Rules1969. Apart from the legal requirement, there is a complete void, in terms of any detailed operational standards or an effective regulatory framework that can comply with international emission standards of vehicle fitness testing and certification.

Currently, vehicle fitness certification is periodic requirement for Inspection and Certification of only commercial vehicles. The Motor Vehicle Examiner (MVE) is neither trained nor equipped for the functions of testing and certification. The systems, tools and knowledge that are required for inspecting and testing simply do not exist. Hence, the Motor vehicle Examiner does not check the emission of gases from the engine. Thus the demand for computerized tune up is not picking up among the general masses.

c) Lesser information and awareness raising programs

Under "Fuel Efficiency in Road Transport Project", National Energy Conservation Center (ENERCON) conducted training of 895 workshop owners and 2075 mechanics in vehicle tune up and related matters as of 2015[48]. After the completion of the project, ENERCON

[47] Government of Pakistan and United Nations Development Program, 2005, Evaluation of UNDP/GEF Project: Fuel Efficiency in the Road Transport Sector (PAK/92/G31) Report of the Final Evaluation Mission, page 13

[48] Government of Pakistan and United Nations Development Program, 2005, Evaluation of UNDP/GEF Project: Fuel Efficiency in the Road Transport Sector (PAK/92/G31) Report of the Final Evaluation Mission, page 13

coordinated only a few training events which is less as compared to the growth of the transport sector in Pakistan.

There is less awareness and credible information among the general public regarding the importance and benefits of computerized tune-up. This leads to a number of negative impacts both on environment as well as on the fuel consumption and life of the vehicle. There are no accredited institution and training manuals for training and accreditation of technicians. There is no mechanism for receiving feedback from the stakeholders on vehicle tune-up.

4.3.3. Enabling framework for overcoming the barriers in Vehicle tune-up

The enabling framework for overcoming the barriers in Vehicle Tune-up have been described in the form of Solution tree (Annex XVIII). These were further discussed and finalized after stakeholder consultations.

4.3.3.1. Economic & Financial

a) Initial capital cost of computerized tune up facility made affordable

The establishment of soft-term loan facility from the commercial banks and DFIs will increase the affordability of the investors for procuring computerized tune up systems and help in capturing wider market. This will reduce time in recovering the cost at medium term level.

4.3.3.2. Non-Financial

b) Computerized tune up equipment & machinery locally available

Increased demand of computerized tune up systems will encourage domestic manufacturing and installation of the computerized tune up equipment and machineries. This will also lead to generation of employment opportunities in the country and reduction in air pollution.

c) Wide demonstration of computerized tune up

Introduction of National Transport Policy, legal framework and regulations focusing on more research and demonstration of the computerized tune up systems will build trust among the vehicle owners to save fuel consumption and increase engine efficiency by adopting the technology. In addition, the policy may include the provision of mandatory check up of all vehicles at regular intervals to determine their road worthiness and emission levels within the prescribed vehicle emission standard.

The Motor Vehicle Examiners need to be trained in examination of vehicles as per national standards for vehicular emissions and level of emissions of greenhouse gases from the smoke emitted from the vehicles. In addition provision in the regulatory framework should be introduced to outsource Motor Vehicle Fitness system to private sector with all necessary support and facilities.

d) Training and awareness enhanced

Curriculum of Technical training and Vocational institutions should include special courses on computerized tune up technology. Training manuals on computerized tune up should be

developed and disseminated widely, to encourage private training institutions to impart training on computerized vehicle tune up skills.

Programs should be launched to increase awareness of general public through wide dissemination of credible information. A feedback mechanism from stakeholders should also be established to improve the quality of training.

4.4. Linkage of the barriers identified

The common barriers in the transport sector are high initial cost, absence of national transport policy and regulatory framework which is hindering the diffusion and adoption of the BRT and vehicle tune up technologies.

4.4.1. High initial cost

High initial cost is the common barrier in BRT and computerized vehicle tune up facilities. This is limiting the participation of the private sector in BRT. The computerized vehicle tune-up facilities are already run by the private sector investors on a limited scale. Absence of the availability of soft-term loans to the private investors for BRT and computerized vehicle tune up facilities are also restricting the participation of the private entrepreneurs.

4.4.2. Absence of National Transport Policy & regulatory framework

Absence of National Transport Policy and regulatory framework are the root-causes of inefficiencies in public transport system. The vehicle maintenance system on scientific lines involving computerized vehicle tune up is also limited. It is leading to adverse environmental and economic impacts on the country. Formulation and approval of National Transport Policy and regulatory framework will help in establishing cost-effective BRT system to meet the growing and dynamic demand of public transport. This will also facilitate in improving the road worthiness and compliance of vehicle emission standards through computerized vehicle tune-up facilities established throughout the country. In general, such measures will minimize exposures to risks by ensuring safety and security of commuters as well as providing a better environment.

4.5. Enabling framework for overcoming the barriers

Mobility of people and goods contributes to productivity, economic growth and employment by providing access to resources, products, markets and jobs. Transport is the seventh pillar of Pakistan's Vision 2025 as such the government has initiated work on materializing the Vision into a strategic roadmap – the first step of which is the development of a holistic national transport policy. The common enabling framework for overcoming the barriers to efficient transportation includes reduced capital cost and national policy supporting BRT and Vehicle tune up.

4.5.1. Reduced capital cost

Establishment of special windows for grant of soft-term loans and creation of enabling environment will attract national and international investors to invest in transport sector. This will lead to modernization of transport infrastructure in the country. The establishment of computerized tune up facilities through grant of soft term loans will also lead to diffusion and dissemination of the technology.

4.5.2. National policy supporting BRT and Vehicle tune up

Pakistan's strategic position demands establishment of rapid mass transit system. It will happen only if the requisite investments are made in regional connectivity, economic corridors and transport and communications infrastructure, including rail and road networks to Central Asia, China and India.

The special emphasis of the draft National Transport Policy[49] on Provision of safe, reliable, effective, efficient, affordable, accessible, sustainable and fully integrated transport system will support the promotion of BRT and vehicle tune up services in the country. The policy and strategy should be finalized and implemented. Furthermore, it should be backed-up by laws, rules and regulations to create enabling environment for expanding the network of BRT and Vehicle tune up in the country.

Chapter 5. Conclusion

The Technology Needs Assessment (TNA) Report II, is the follow up report which builds on the results of the identified and prioritized climate change mitigation sectors and technologies presented in TNA Report I.

Through literature review and root cause analysis, the report analysed the barriers and developed measures for enabling framework to facilitate diffusion and transfer of prioritized technologies in the energy, forestry and transport sector. The purposes for selecting these tools were to develop understanding from the past interventions carried out in the area of the selected technologies in Pakistan as well as in other developing countries. Further, the application of root cause analysis was to establish causal relation through preparation of problem and solution trees and development of market maps for relevant technologies. The outcome of these analyses were discussed with the stakeholders as well as presented in the expert working group constituted by the Ministry of Climate Change.

The barrier analysis focused on economic and financial, and non-financial barriers followed by identification of measures to overcome these barriers. The common barriers identified in the energy sector i.e. solar PV system, solar geyser and MHP plants are high capital cost, difficulty to access finance, absence of energy rating labelling and standards, remoteness of the area resulting into lesser information & awareness, government policy not very supportive for promotion of renewables, strategy and regulations.

The barriers in SFM plans for reducing deforestation and forest degradation and social forestry include no economic Incentive mechanism in place for SFM; scarce knowledge and awareness; and unsustainable forest management. The draft National Forest Policy is still awaiting approval. Non-supportive provincial policies and regulatory framework is impeding sustainable management of forests. It is also affected by low level of capacity of staff and limited participation of local communities in decision making. The sustainable forest management practices can reduce the trend of deforestation in the country by promoting principles of REDD+ which offers payment against protection and conservation of forest resources. The area under social forestry can be increased by mass awareness on benefits of

[49] Government of Pakistan; Ministry of Communication, National Transport Research Centre; 2009; National Transport Policy; http://www.ntrc.gov.pk/downloads/NTP.pdf

social forestry and educating on intercropping of forest trees with non-timber forest products and water and land management.

The common barriers in the transport sector are high initial cost, absence of national transport policy and regulatory framework. The other barriers hindering diffusion of BRT include non-availability of soft-term loan facilities for Private investors, effects of BRT on livelihood of transport operators and other businesses. The additional barriers for vehicle tune-up are computerized tune up equipment and machineries not locally manufactured limited demonstration of computerized tune-up as well as the Motor Vehicle Examiners are neither trained nor have any back-up facility of testing vehicular emissions.

The measures identified to overcome the barriers primarily include revision of National Policy for Development of Renewable Energy 2006, particularly highlighting commitment of the Government towards promotion of renewable energy sources particularly Solar PV and Micro Hydro sources. The policy need to make provisions for availability of soft term credit facilities, exemptions in duties and taxes, energy rating labelling standards, accredited trainers and technicians in the field of Solar PV and Micro Hydro and other renewable energies. Similarly the Forest Policy and Transport Policy needs to be developed with clear commitments from the Government. The Forest should focus on protection and conservation of forest with built in incentives for increased forest cover. The Transport Policy should address promotion of BRT and other mass transit systems as well as making mandatory for periodic vehicle tune up examination and verification.

The proposed enabling framework need to be integrated with other relevant sectoral policies and strategies. These measures will facilitate removal of barriers and diffusion, adoption and transfer of prioritized technologies to reduce greenhouse gas emissions and place Pakistan on low carbon economic growth path.

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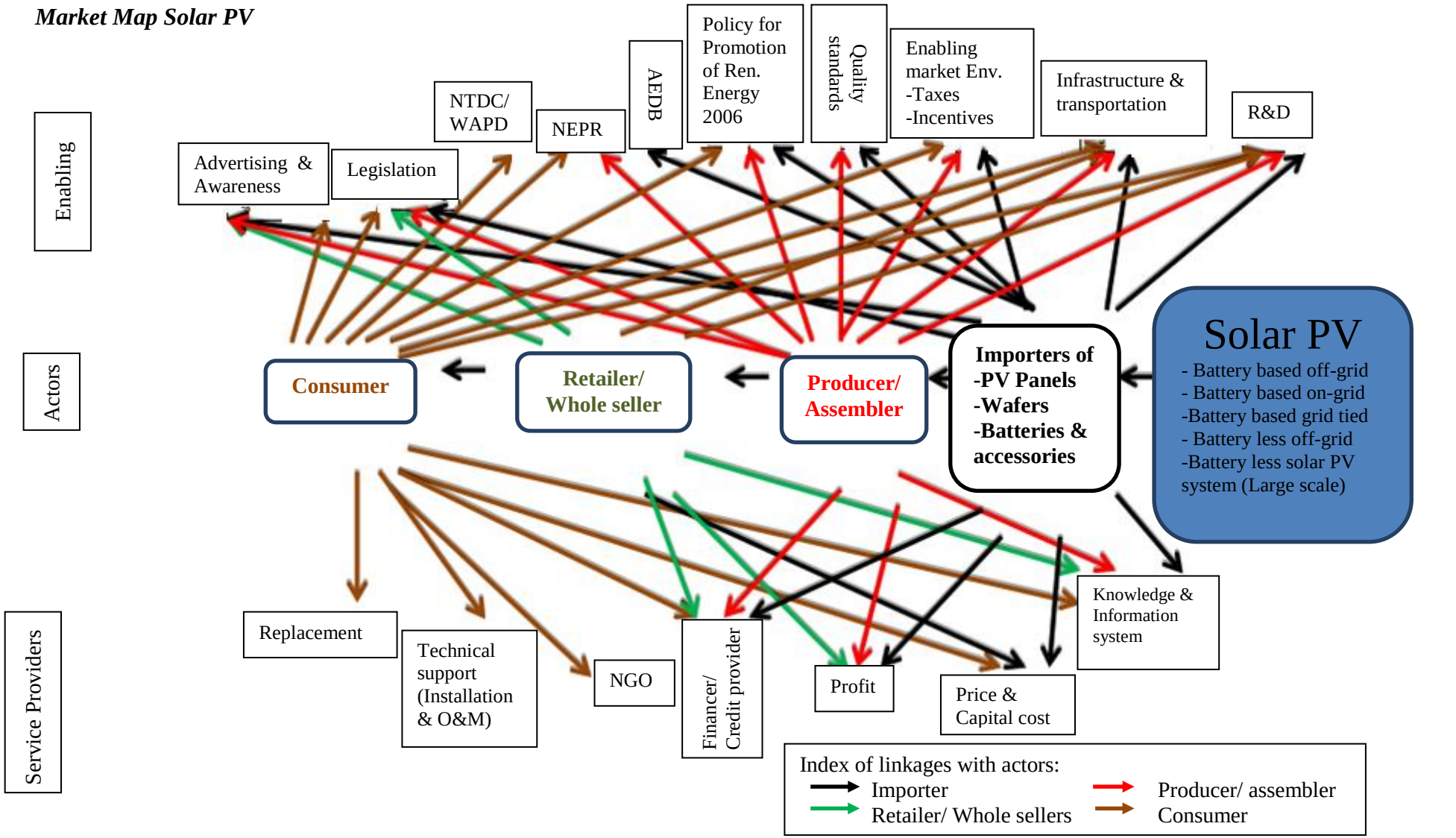
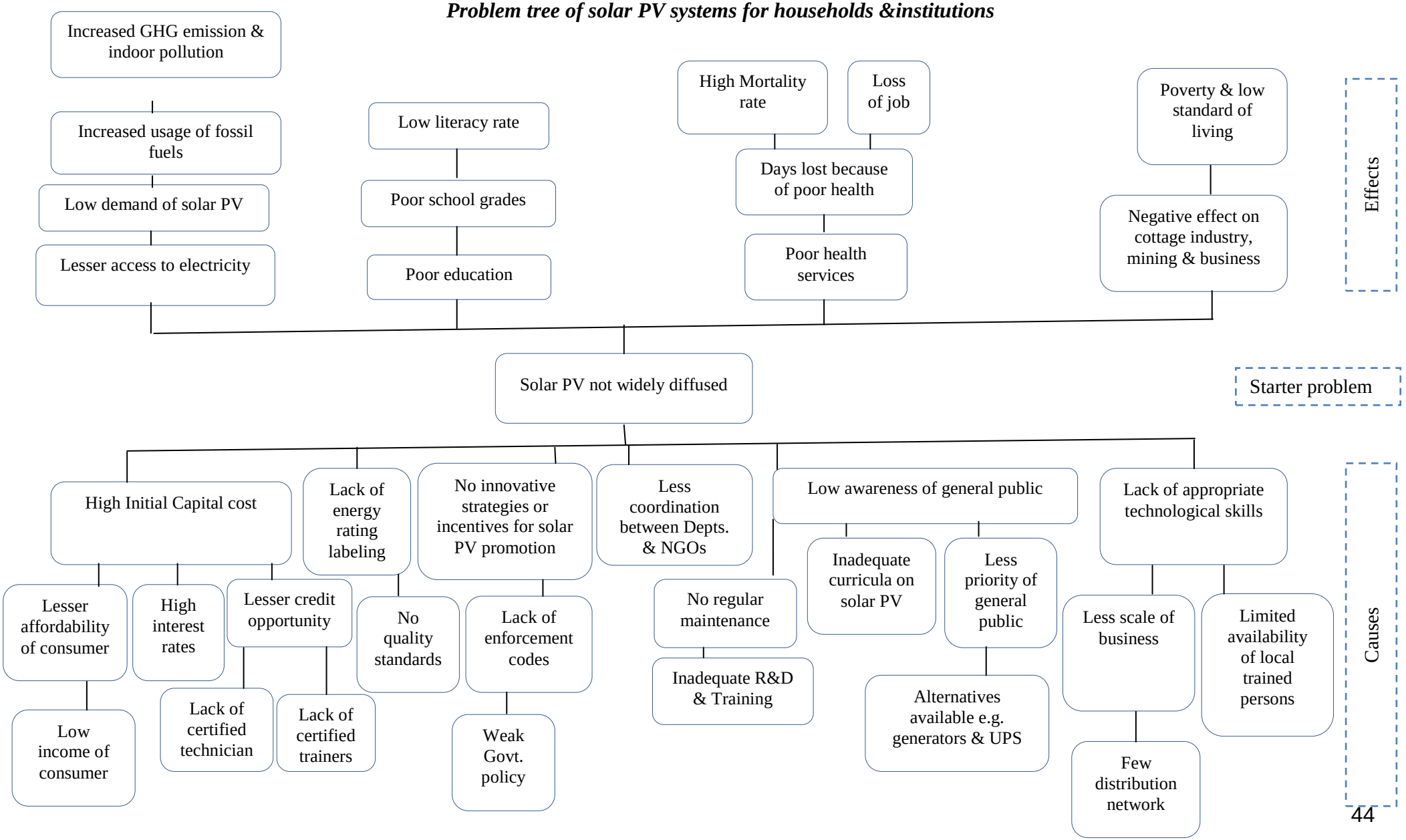
Annex – I

Market Map Solar PV



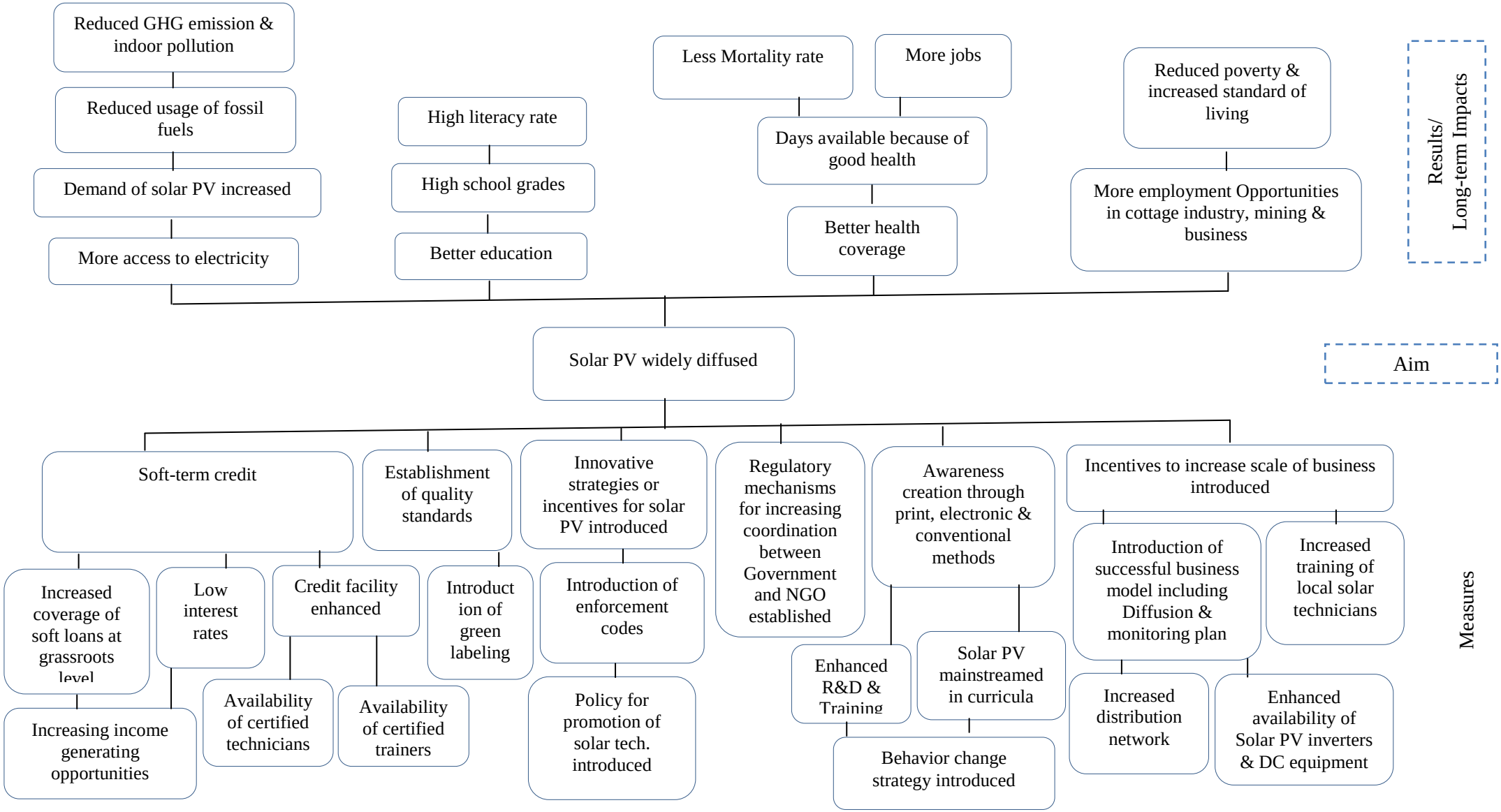
Annex - II

Problem tree of solar PV systems for households &institutions



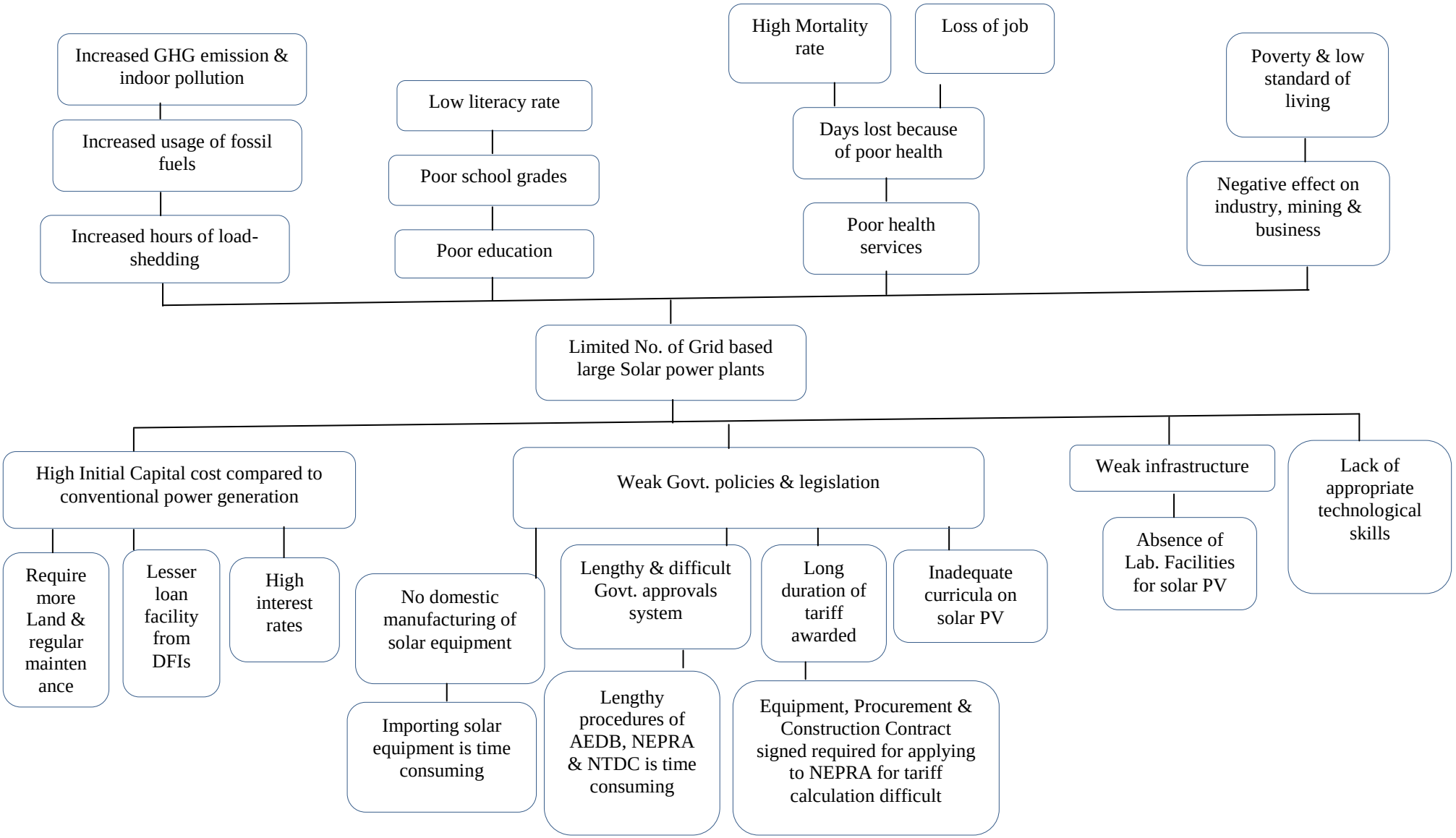
Annex III

Solution tree of solar PV systems for households & institutions



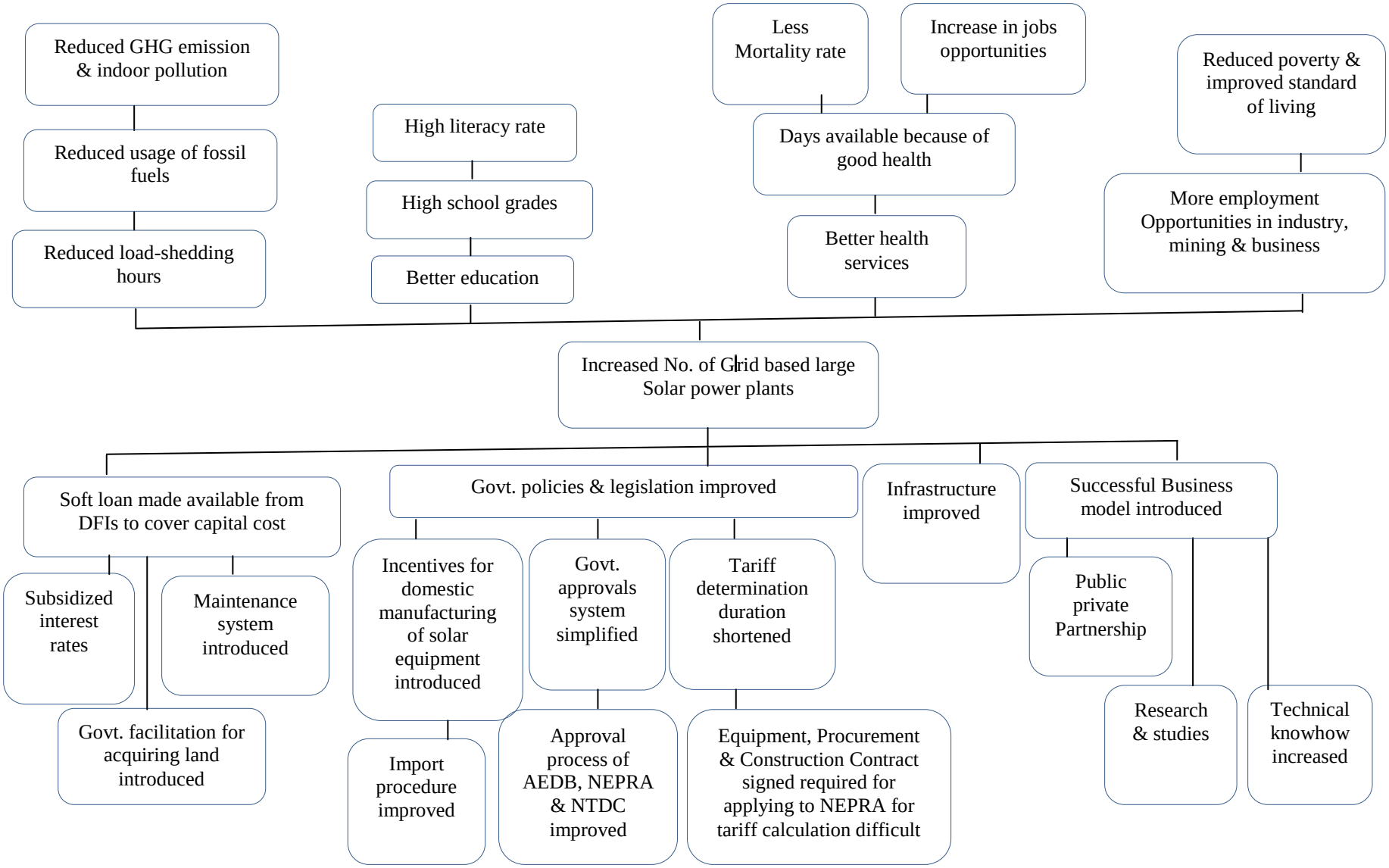
Annex – IV

Problem tree of Grid based large Solar power plants



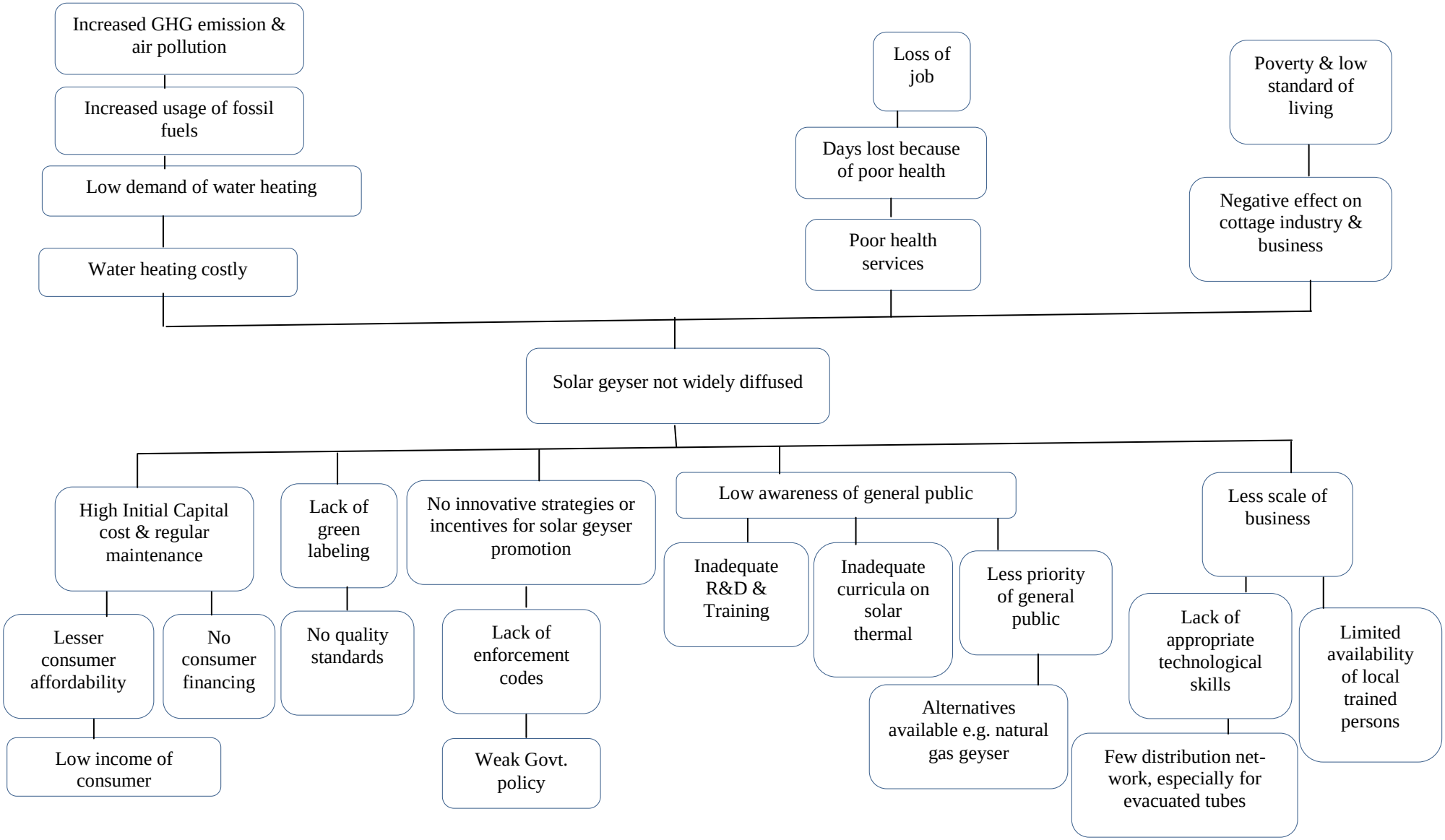
Annex – V

Solution tree of Grid based large Solar power plants



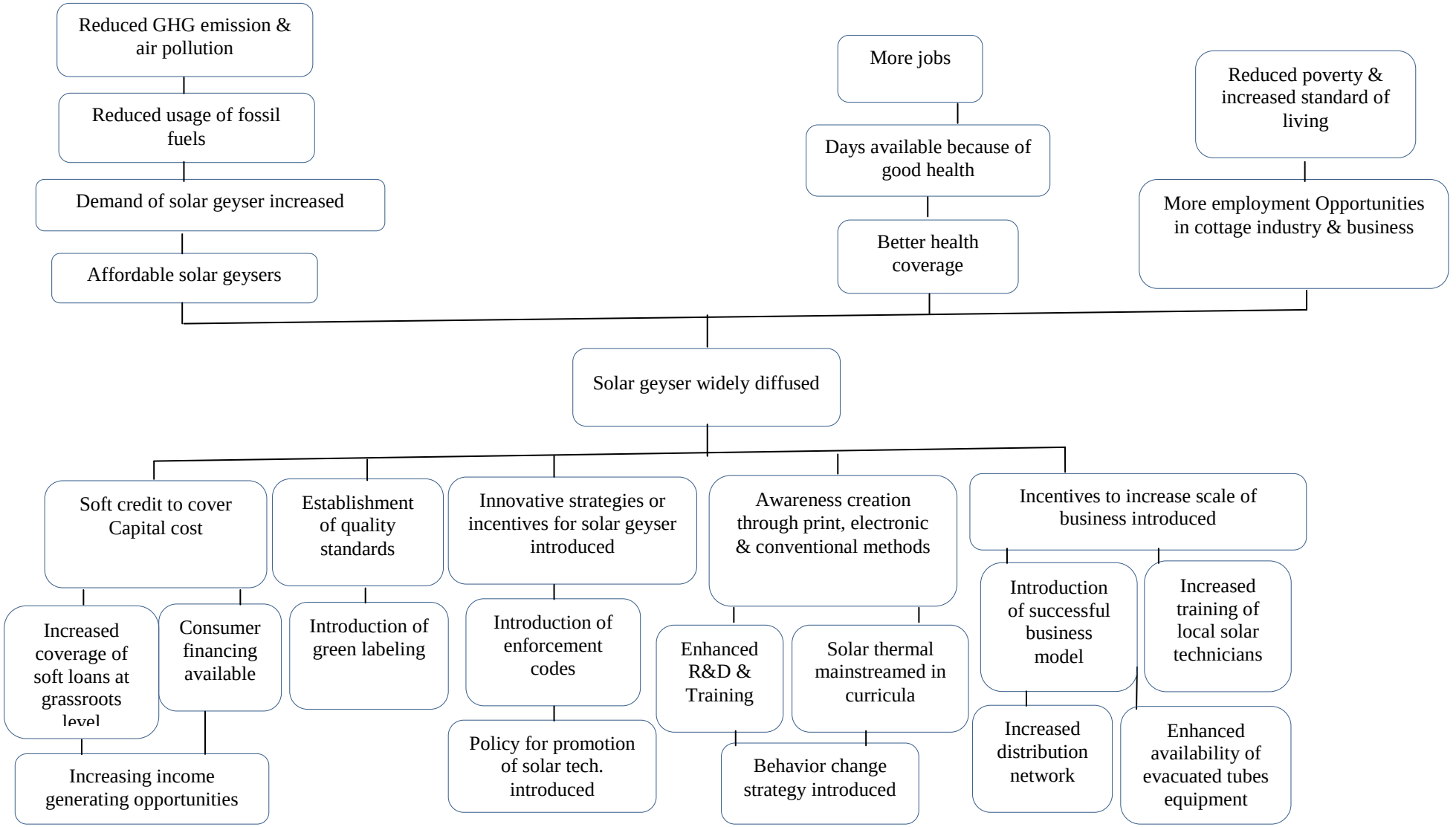
Annex – VI

Problem tree of solar geysers

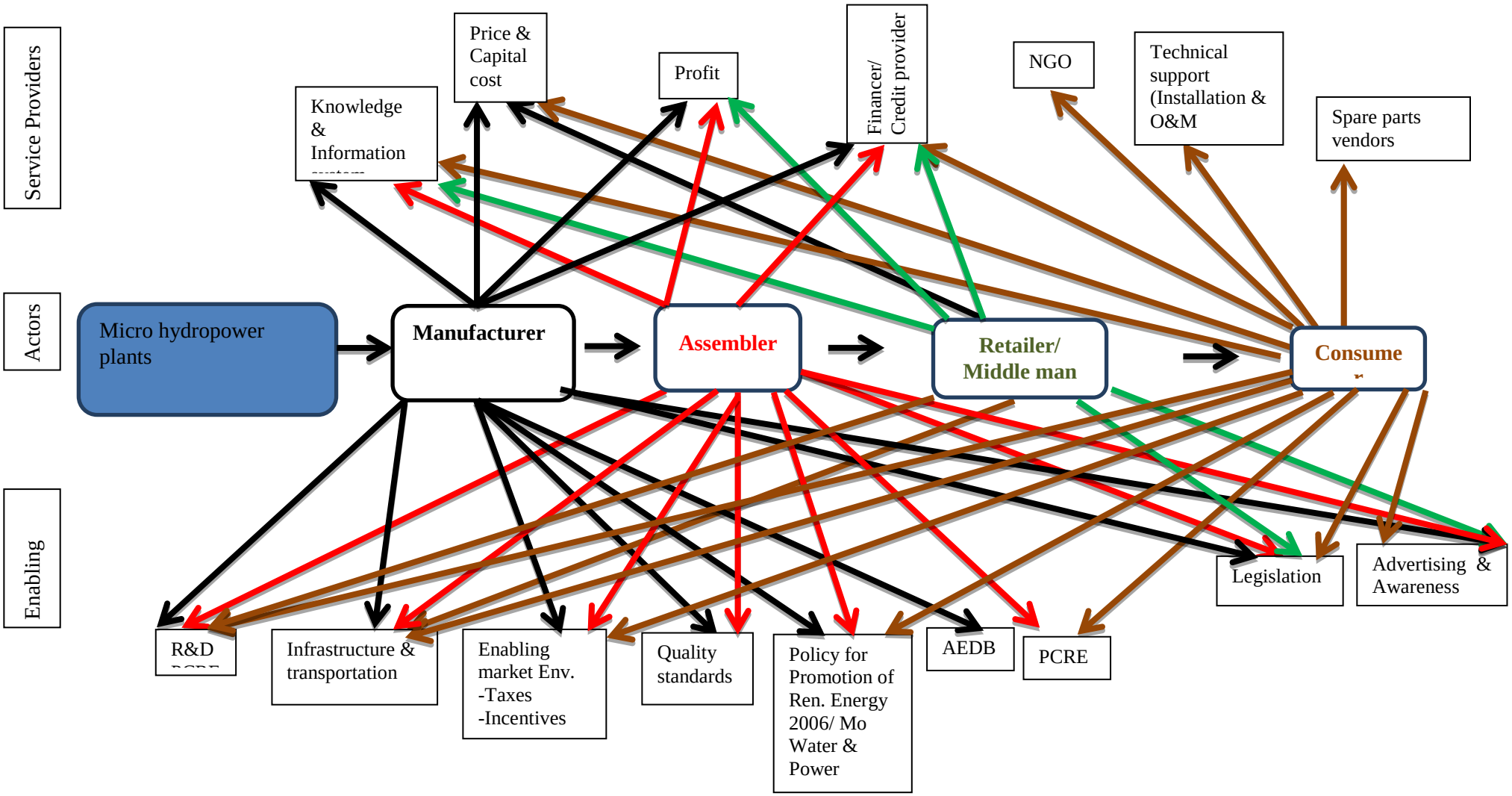


Annex – VII

Solution tree of Solar geysers

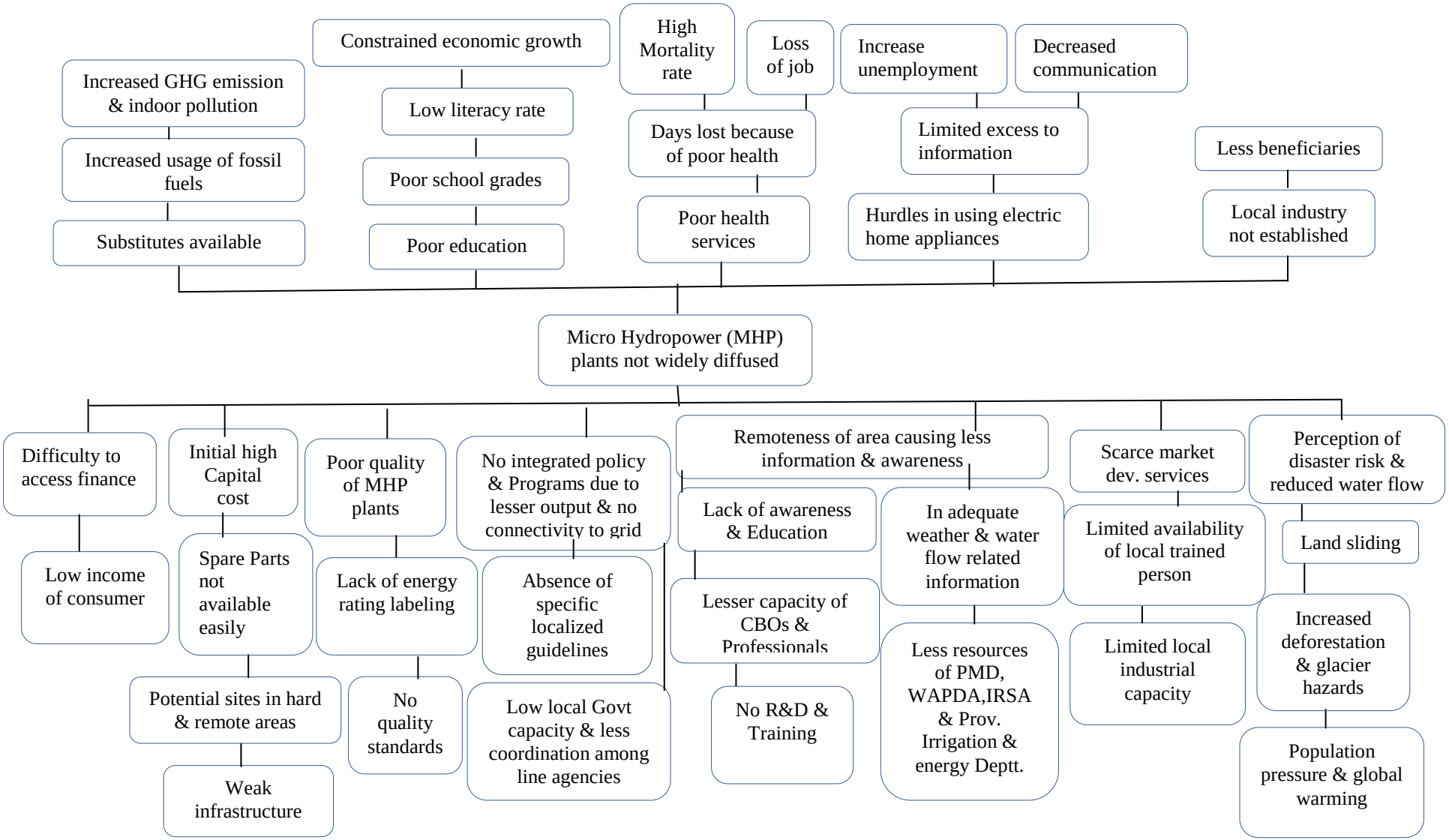


Annex – VIII Market map MHP plants



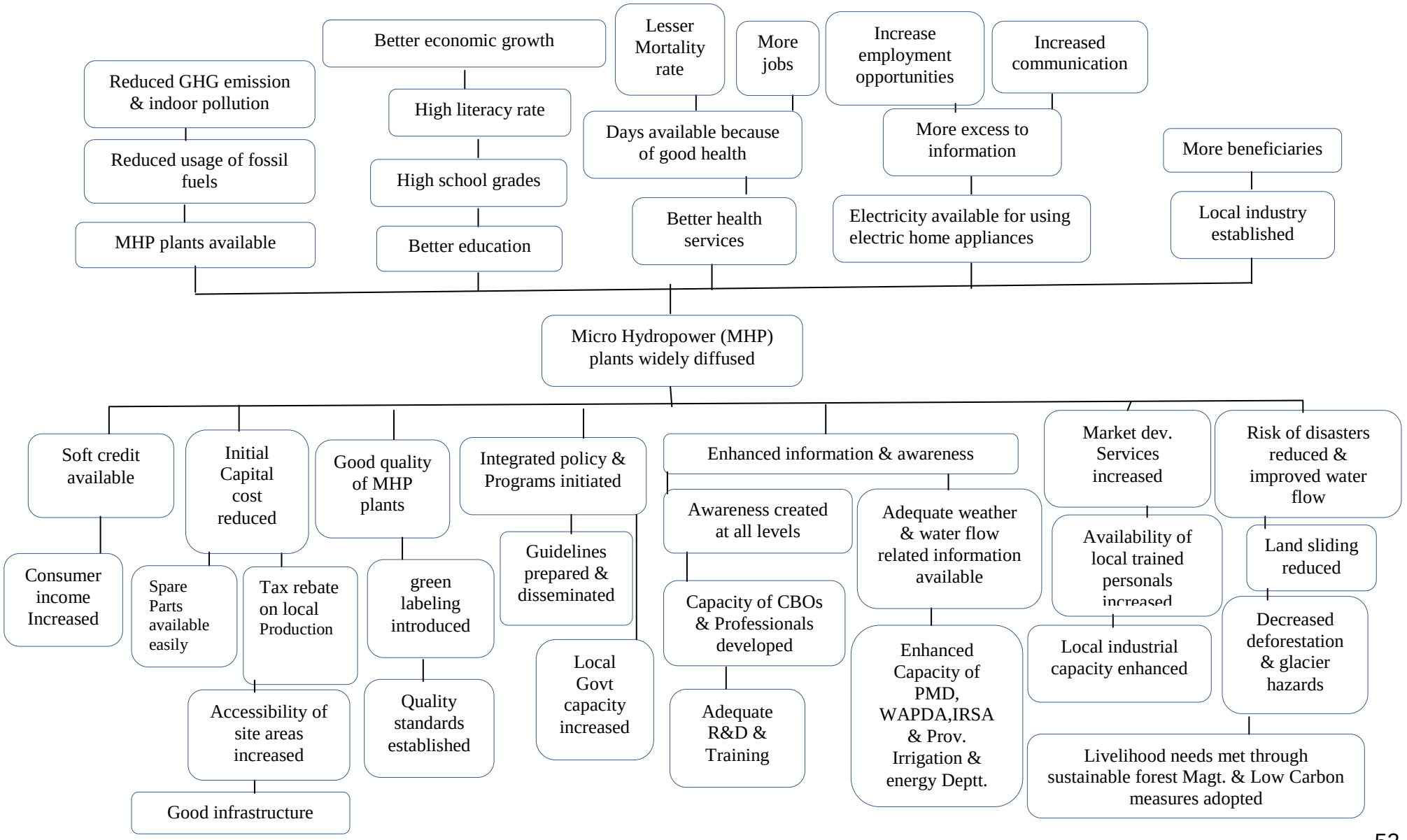
Annex – IX

Problem tree of Micro hydropower plants



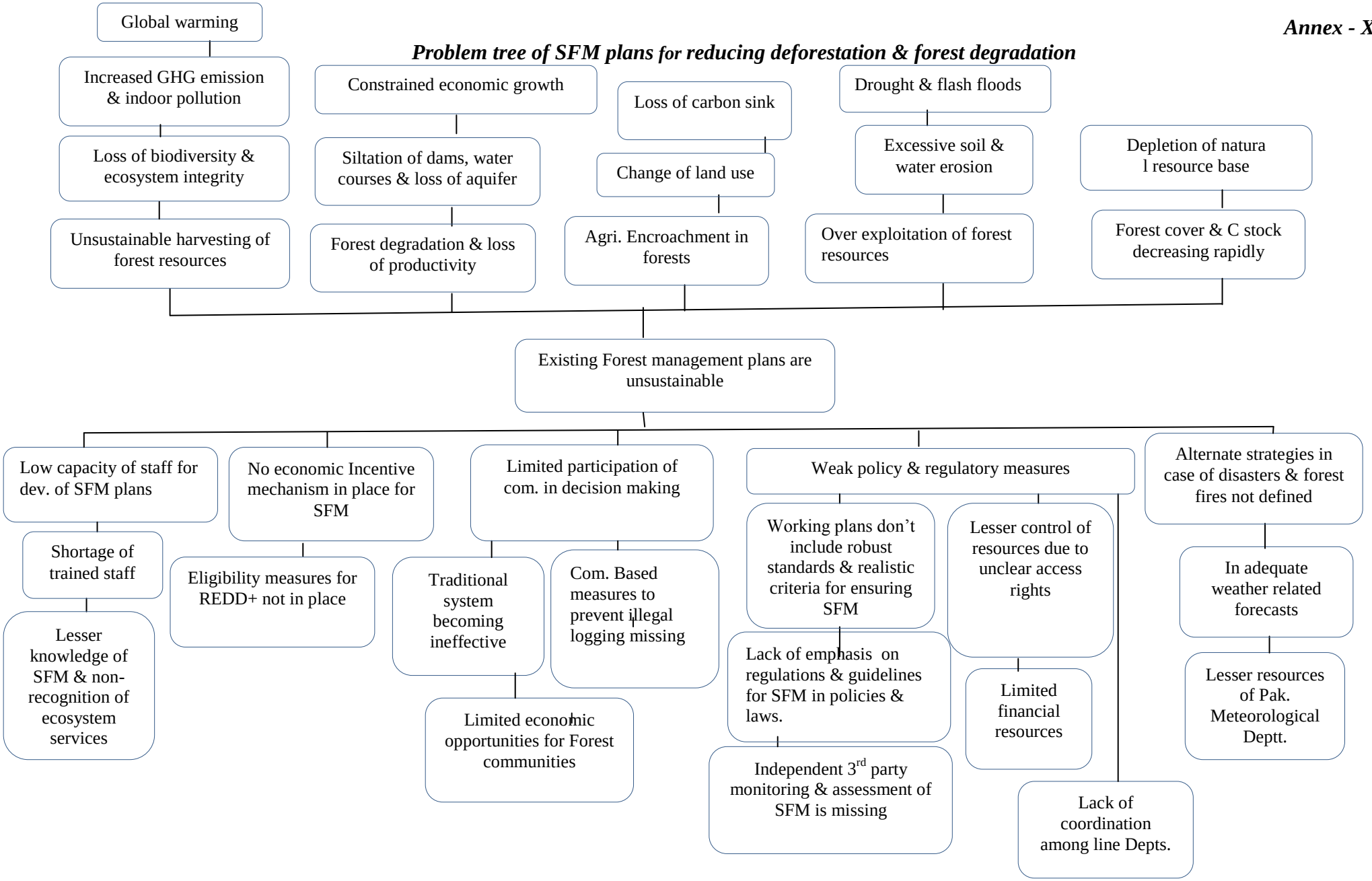
Annex – X

Solution tree of Micro hydropower plants



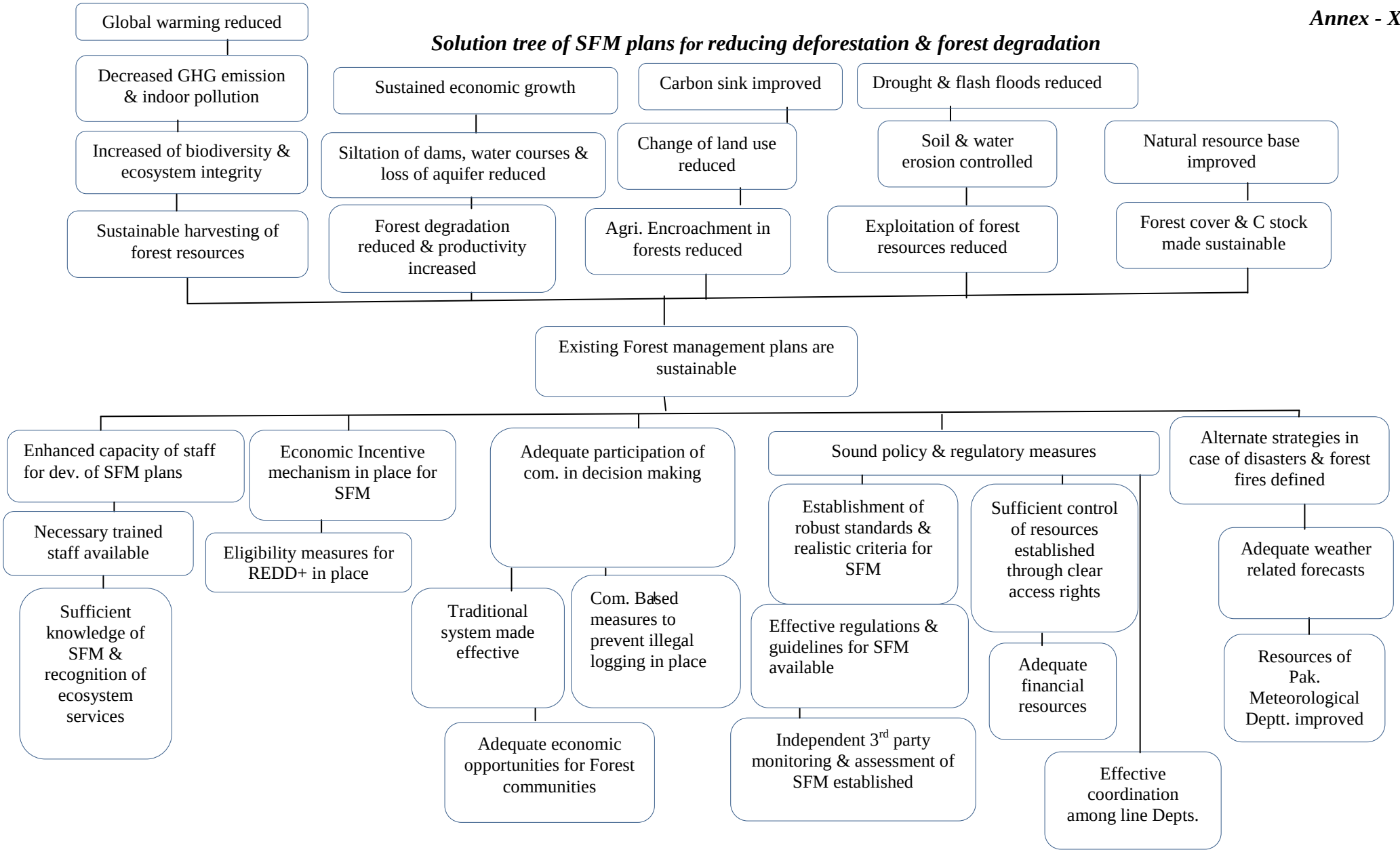
Annex - XI

Problem tree of SFM plans for reducing deforestation & forest degradation



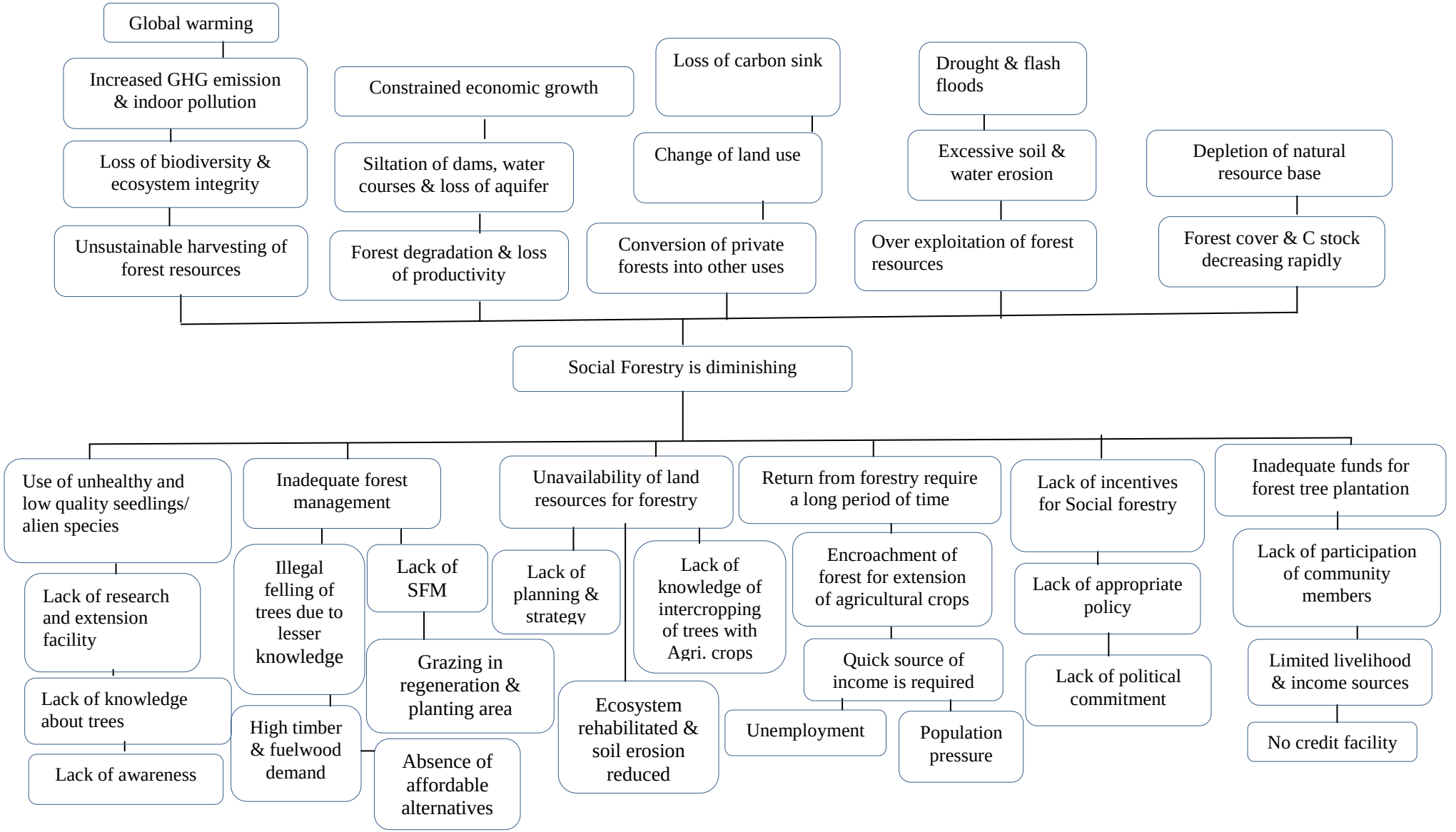
Annex - XII

Solution tree of SFM plans for reducing deforestation & forest degradation



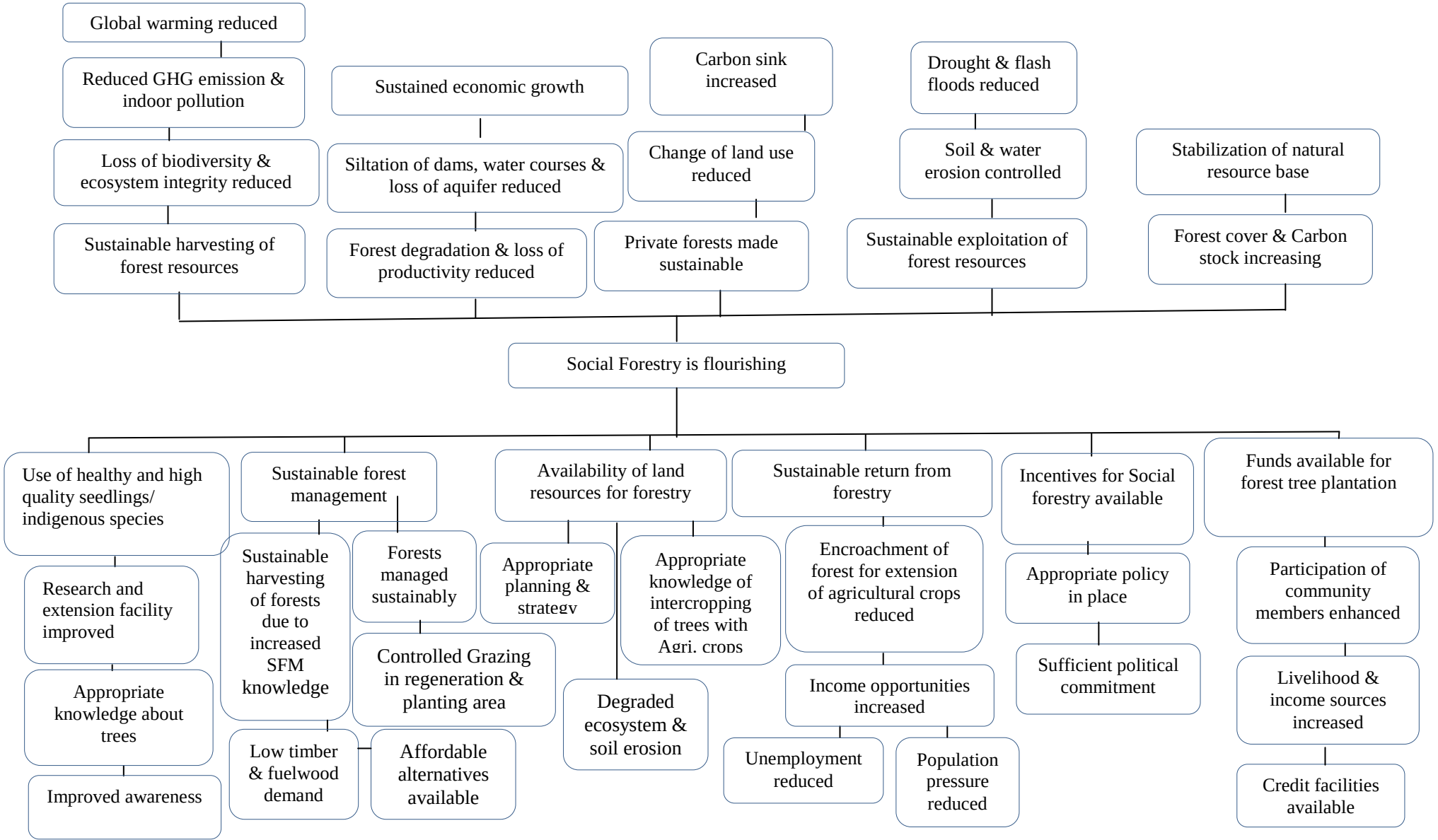
Annex – XIII

Problem tree of Social Forestry



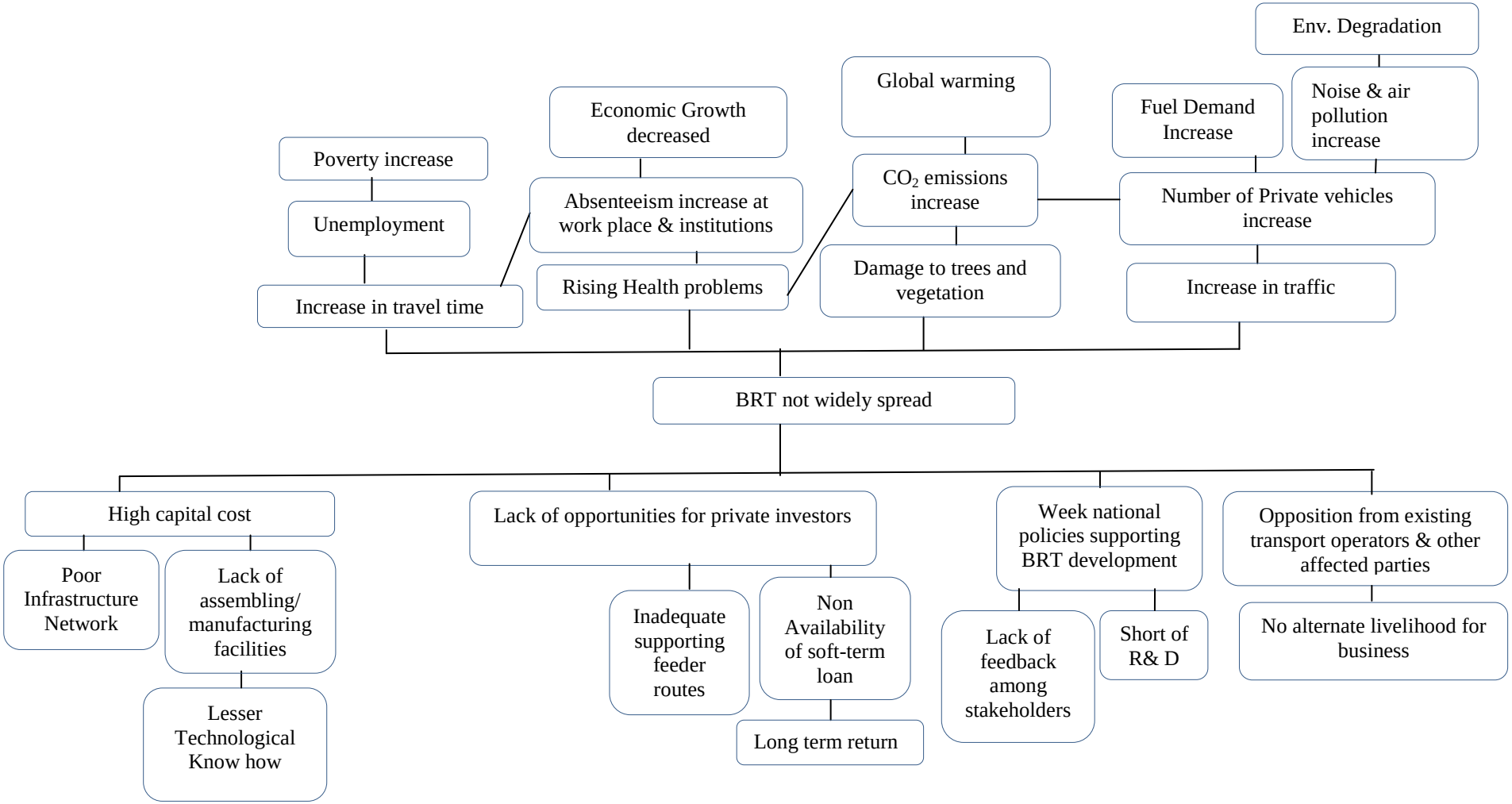
Annex – XIV

Solution tree of Social forestry



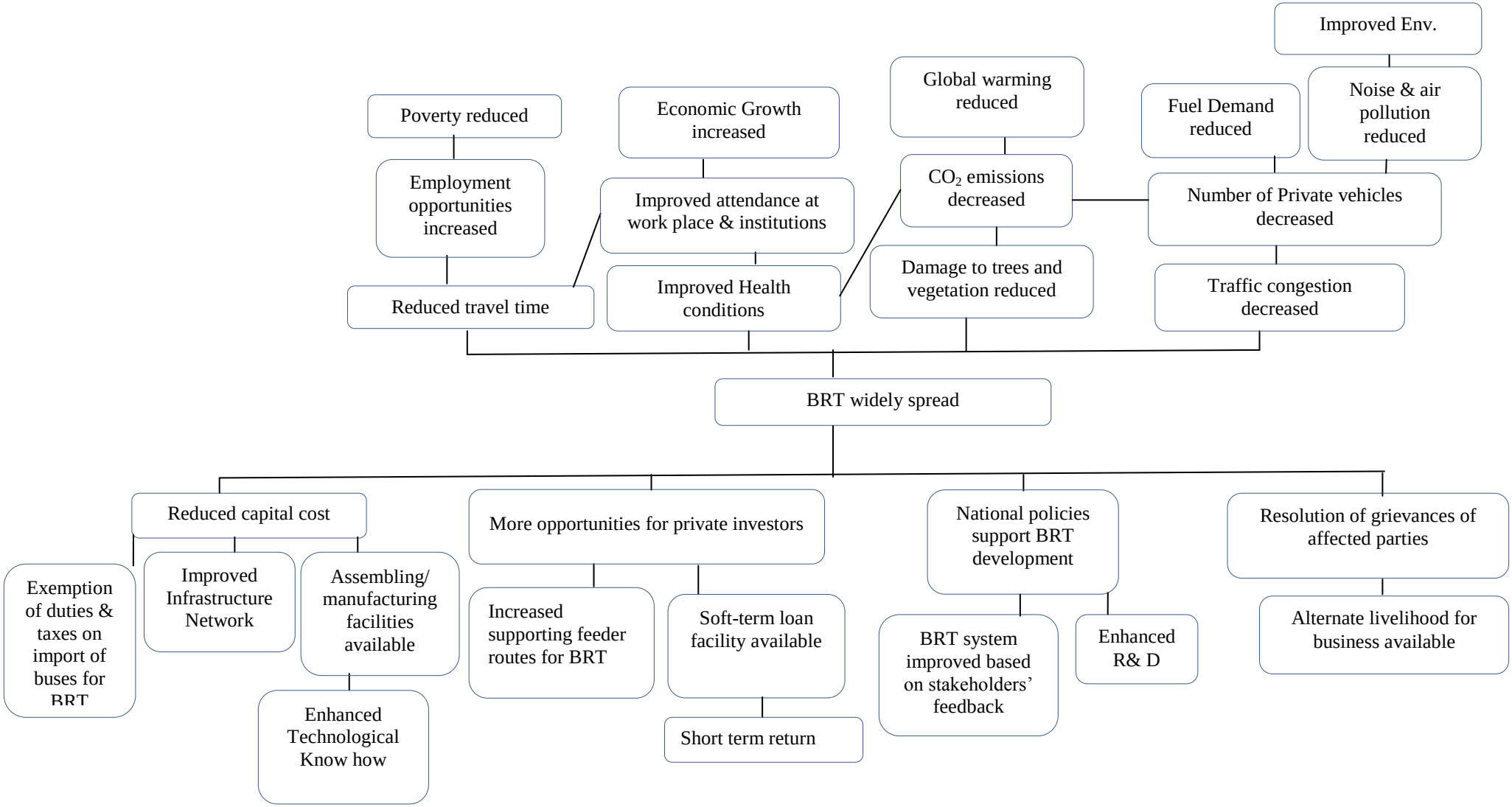
Annex-XV

Problem tree of BRT



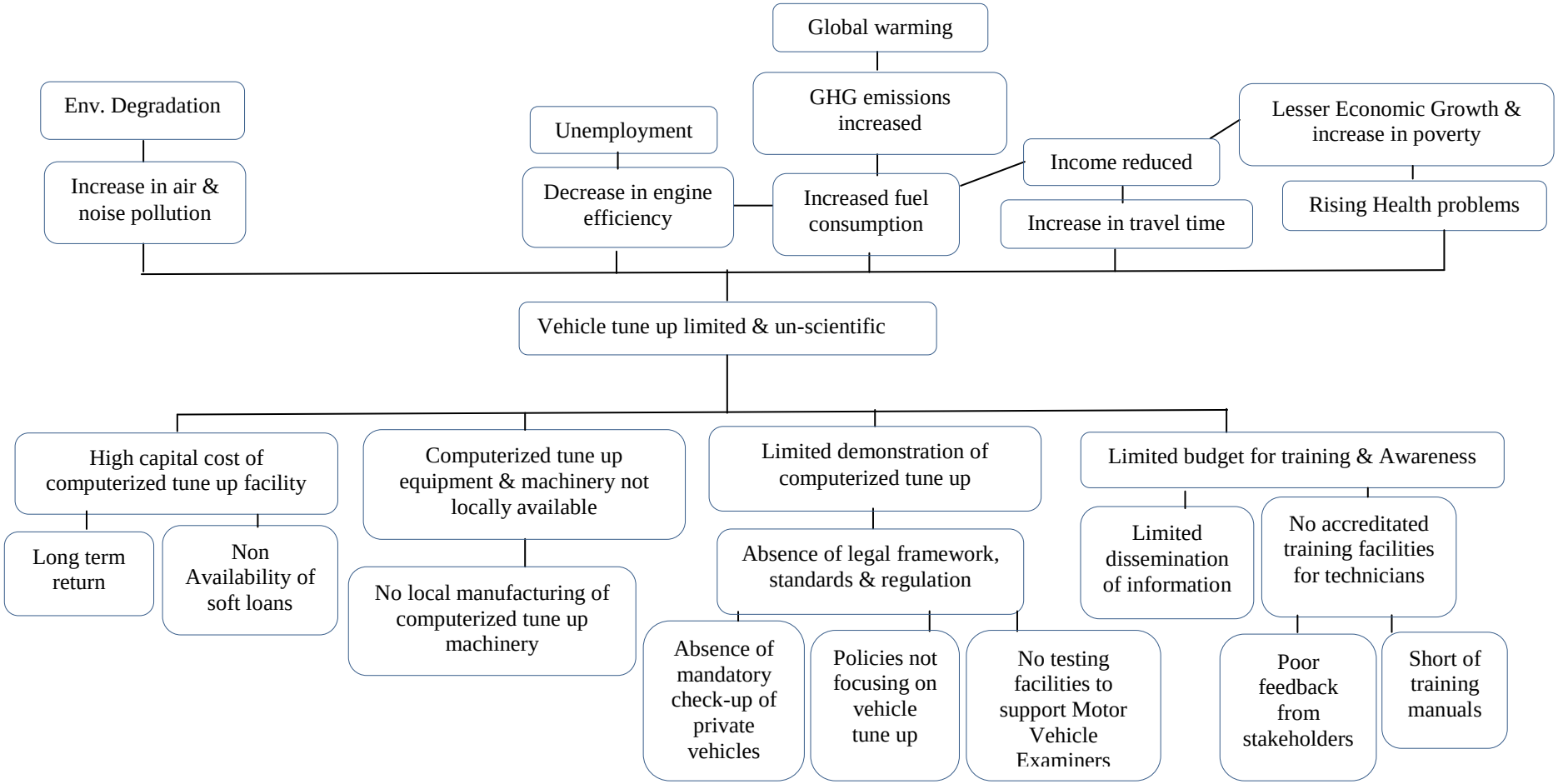
Annex-XVI

Solution tree of BRT



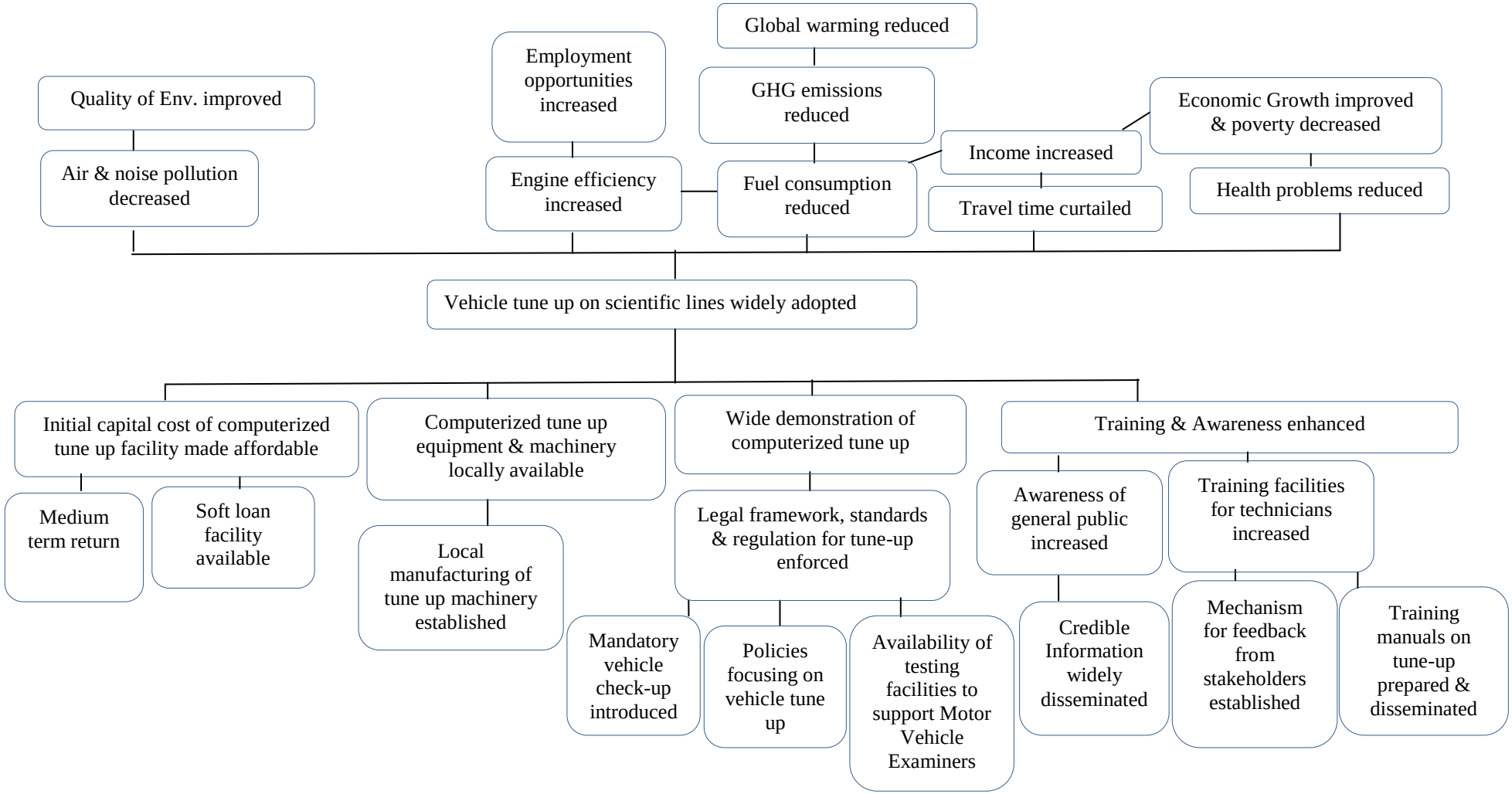
Annex-XVII

Problem tree of Vehicle Tune-up



Annex-XVIII

Solution tree of Vehicle Tune-up



Annex-XIX

Direct and Indirect Drivers in different forest types in Pakistan

Forest type	Indirect drivers	Direct drivers
Dry temperate	Scarcity of water, Shortage of funds, natural calamities, poverty, unemployment, political influence, nomads, shortage of staff	Demand of fuel wood, fodder and timber, drought, grazing and browsing pressure
Moist temperate and Chir Pine Forests	Poverty, unemployment, population pressure, alternatives not available in remote areas, Unwise use of timber, Revenue based management, lesser budget resources for awareness, Political influence, unplanned urbanization, Shortage of human and financial resources, legal constraints, Absence of monitoring, Issues of land tenure, non-execution of mgt plans, in-effective execution of laws, law and order situation, shortage of energy, land tenure issues, urbanization, alternatives not available in remote areas	Demand for fodder, fuel wood and timber, Conversion of forest land to agricultural land and infrastructure (roads and buildings). Flood, landslides, forest fire, diseases, timber smuggling, overgrazing,
Scrub	Poverty, unemployment, population pressure, alternatives not available in remote areas, lesser budget resources for awareness, bad governance and policy making, political influence, Urbanization on forest lands,	Demand for fuel wood, fodder and timber, conversion to agricultural land, forest fires especially during summer, land sliding and soil erosion, diseases and drought, leasing of mining sites within the forest area, over grazing, over exploitation by timber contractors
Riverine	Poverty, Political influence, population pressure, unemployment, scarcity of water (excessive taping of underground water), upstream barrages and dams leaving less water for downstream riverine forests, shortage of facilities, shortage of funds, lesser budget resources for awareness, no research, lesser education, shortage of staff, alternatives not available in remote areas, natural hazards, bad law and order, misuse of forest land lease policy, grazing pressure by nomads	Demand for timber, fuel wood and fodder, charcoal making, overgrazing, diseases, forest fire, drought, lease, Illegal use of forest land for agriculture, agriculture expansion,
Mangroves	Absence of rights of communities(mangroves are state own forests), increase in salinity, sea intrusion, sea pollution, lesser ownership, less regeneration activities, shortage of fresh water flow, increase population (migration towards delta and coastal areas),	Demand for fuel wood, fodder, browsing and trampling especially by camels, algal growth, conversion of forests to agriculture land

Annex-XX

List of Participants of meeting of Expert Working Group on Mitigation
on barrier analysis and enabling framework

Date: 6 May 2016

1. Muhammad Irfan Tariq, Director General (Environment & Climate Change), Ministry of Climate Change, Government of Pakistan, Islamabad (Chair)
2. Dr. Sohail Zaki, Director General, Pakistan Council of Renewable Energy Technologies, Ministry of Science and Technology, Government of Pakistan, Islamabad
3. Asif Sahibzada, Director Policy, Ministry of Climate Change, Government of Pakistan, Islamabad
4. Aqeel Jafri, Director Policy, Alternate Energy Development Board, Ministry of Water and Power, Government of Pakistan, Islamabad
5. Ijaz Ahmed, Deputy Chief Engineer, Pakistan Atomic Energy Commission, Government of Pakistan, Islamabad
6. Usman Yaqoob, Deputy Secretary, Ministry of Water and Power, Government of Pakistan, Islamabad
7. Asad Mahmood, Manager (Technical), National Energy Conservation Center (ENERCON), Ministry of Water and Power, Government of Pakistan, Islamabad
8. Imran Khan, Assistant Director, Ministry of Climate Change, Government of Pakistan, Islamabad
9. Ms. Janet Salem, Program Officer, Sustainable Consumption and Prodction, United Nations Environment Program
10. Muhammad Irshad Ramay, Coordinator, National Cleaner Production Center, Islamabad
11. Bilal Anwar, Senior Manager, Center for Climate Research and Development, Comsats University, Islamabad
12. Mahboob Elahi, Former D.G. (Environment), Ministry of Environment, Government of Pakistan, Islamabad
13. Abdul Latif Rao, Chairman, Rao Sustainable Development Consulting Services, Islamabad
14. Dr. Bashir A. Wani, Former Inspector General (Forests) Ministry of Environment, Government of Pakistan, Islamabad
15. Hafiz Muhammad Bukhsh, Project Coordinator, WWF-Pakistan
16. Haroon, Sociologist, National Cleaner Production Center, Islamabad
17. Muhammad Naveed, Sociologist, National Cleaner Production Center, Islamabad
18. Jawed Ali Khan, Consultant-TNA Mitigation, Islamabad
19. Ms. Yasmeen Jawed, Freelance Consultant, Islamabad
20. Tayyab Shahzad, Freelance Consultant, Islamabad
21. Adil-Bin-Zahid, Freelance Consultant, Islamabad
22. Faiqa Aziz, Freelance Consultant, Islamabad
23. Ayesha Ghazanfar, Student, Quaid-e-Azam University, Islamabad
24. Amine M. Irshad, Student, Quaid-e-Azam University, Islamabad
25. Muhammad Saqib, Student, ND University, Islamabad

Annex-XXI

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: 6 May 2016

Introduction

The Ministry of Climate Change, Government of Pakistan 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 Pakistan 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:

1. 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.

2. Identify barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and

3. 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 Pakistan 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.

Themeeting of Expert Working Group on Mitigation to discuss Barrier Analysis & Enabling Framework for Selected Climate Change Mitigation Technologies is scheduled on 6 May 2016 at 0900 hours in ChandniHall, Islamabad Hotel**.** 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. The meeting will be chaired by the Mr. Muhammad Irfan Tariq, Director General (Environment & Climate Change), Ministry of Climate Change, Government of Pakistan.

Agenda of the meeting, market mapping, problem and solution trees for the prioritized technologies are attached as Annex – I to Annex – XIX.

Agenda Item 1: Welcome remarks by the Chair

Agenda Item 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 – Energy Sector

The technologies prioritized in the energy sector included (i) ***Solar PV and solar geyzer; (ii) Micro hydropower (MHP) 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 MHP plants have been prepared as these technologies fall in the category of market goods, attached at Annex-II and IX, respectively.

Problem tree of solar PV battery based for individual households usage; Grid based large Solar power plants and solar geysers are at annex III, V and VII; while solution trees are at Annex IV; VI and VIII, respectively. Problem and solution trees of MHP plants are placed at annex X and XI, respectively.

The presentation on Agenda item 2 will be followed up by discussion and inputs from the experts on the identified barriers and enabling framework.

Agenda Item 3: 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 – Forestry Sector

The selected technologies in the Agriculture, land use change and forestry sector included (i) ***Social/ farm forestry as carbon sink; (ii) Reducing deforestation & forest degradation through sustainable forest management (SFM) plans.*** Problem trees of social/ farm forestry as carbon sink and reducing deforestation & forest degradation through sustainable forest management (SFM) plans are at annex XII and XIV and solution trees are at Annex XIII and XV, respectively.

The presentation on Agenda item 3 will be followed up by discussion and inputs from the experts on the identified barriers and enabling framework.

Agenda Item 4: 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 – Transport Sector

In the transport sector the technologies prioritized included (i) ***Bus rapid transport; and (ii) Vehicle tune up.*** The problem trees of Bus rapid transport; and Vehicle tune up are placed at annex XVI and XVIII and solution trees are at XVII and XIX, respectively.

The presentation on Agenda item 4 will be followed up by discussion and inputs from the experts on the identified barriers and enabling framework.

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 Ministry of Climate Change for circulating among the members of the Expert Working Group on Mitigation and onward transmission to UNEP-DTU and AIT for their feedback.

Annex - I

AGENDA FOR
Meeting of Expert Working Group - Mitigation on Barrier Analysis & Enabling Framework for Selected CC Mitigation Technologies

Technology Need Assessment Program

Date and time: 6 May 2016 at 9:00 Hours

Venue: Chandni Hall, Islamabad Hotel

Time (Hours)	Items	Resource person
9:00-9:20	Registration of Participants	Faiqa Aziz and Adil
9:20 – 9:25	Recitation from Holy Quran	Mr. Imran Khan
9:25 – 9:40	Welcome Remarks and introduction to barrier analysis and enabling framework component of TNA Program	Mr. Irfan Tariq, DG, Ministry of Climate Change and Coordinator UNEP-DTU TNA Program
9:40 – 10:10	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: i. Solar PV & solar geyser ii. Micro hydropower plants	Jawed Ali Khan, Consultant and TayyabShahzad, Technical Expert
10:10-10:30	Discussion and inputs from members of Expert Working Group on Mitigation (EWGM) - Energy Sector	
10:30 – 10:50	Tea break	
10:50 – 11:20	Presentation on barrier analysis and enabling framework for selected technologies in Climate change mitigation – Forestry sector: i. Social/ farm forestry ii. Reducing emissions from deforestation and forest degradation through sustainable forest management plans	Jawed Ali Khan, Consultant and TayyabShahzad, Technical Expert
11:20 – 11:40	Discussion and inputs from EWGM - Forestry Sector	
11:40 – 12:10	Presentation on barrier analysis and enabling framework for selected technologies in Climate change mitigation – transport sector: 1. Bus Rapid Transport 2. Vehicle tune-up	Jawed Ali Khan, Consultant and TayyabShahzad, Technical Expert
12:10 – 12:30	Discussion and inputs from members of EWGM) - Transport Sector	
12:30 -12:45	Way forward & closing remarks by the Chair	Mr. Irfan Tariq, DG, MoCC
12:45	Lunch break	

Annex – II

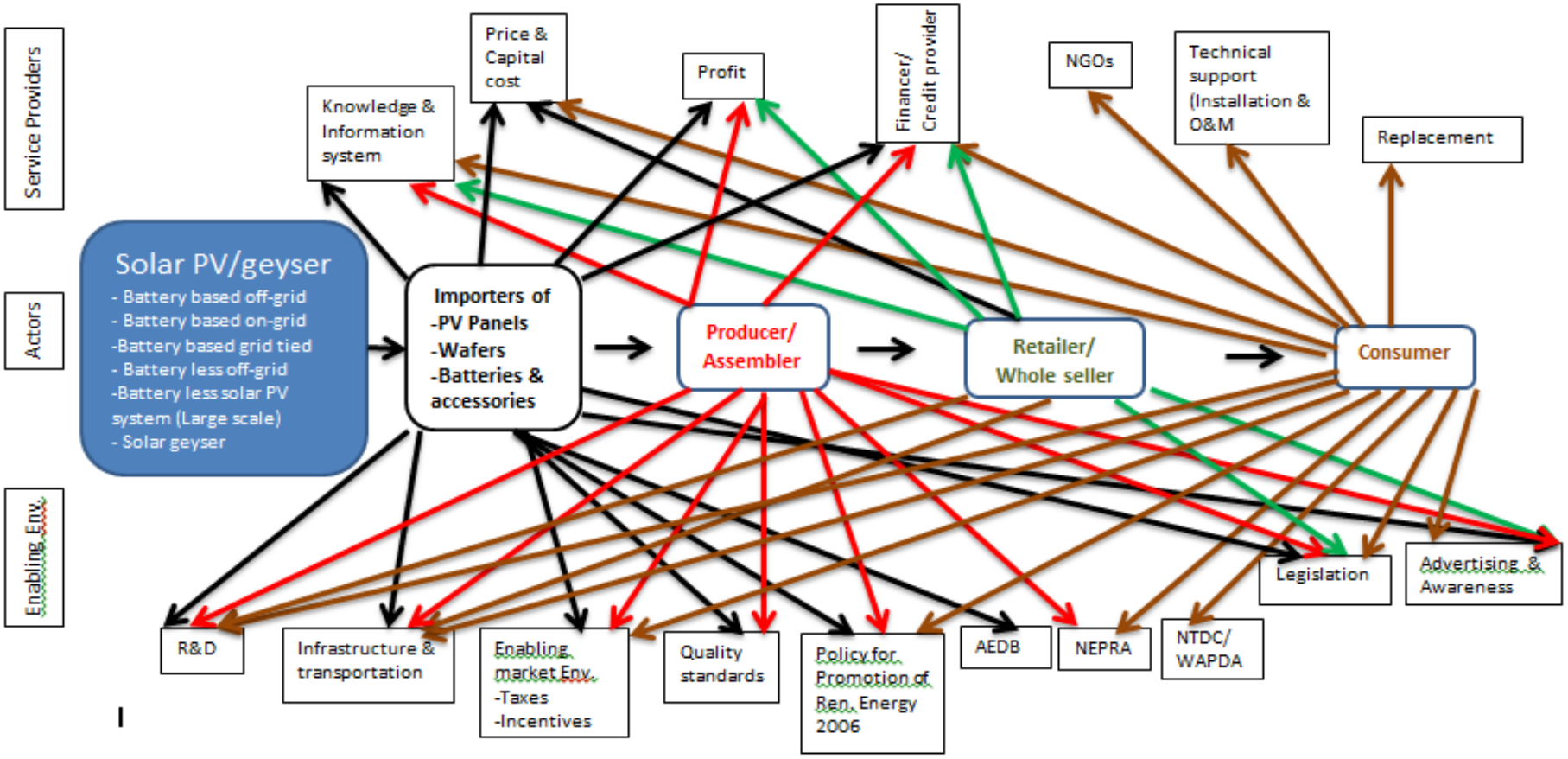
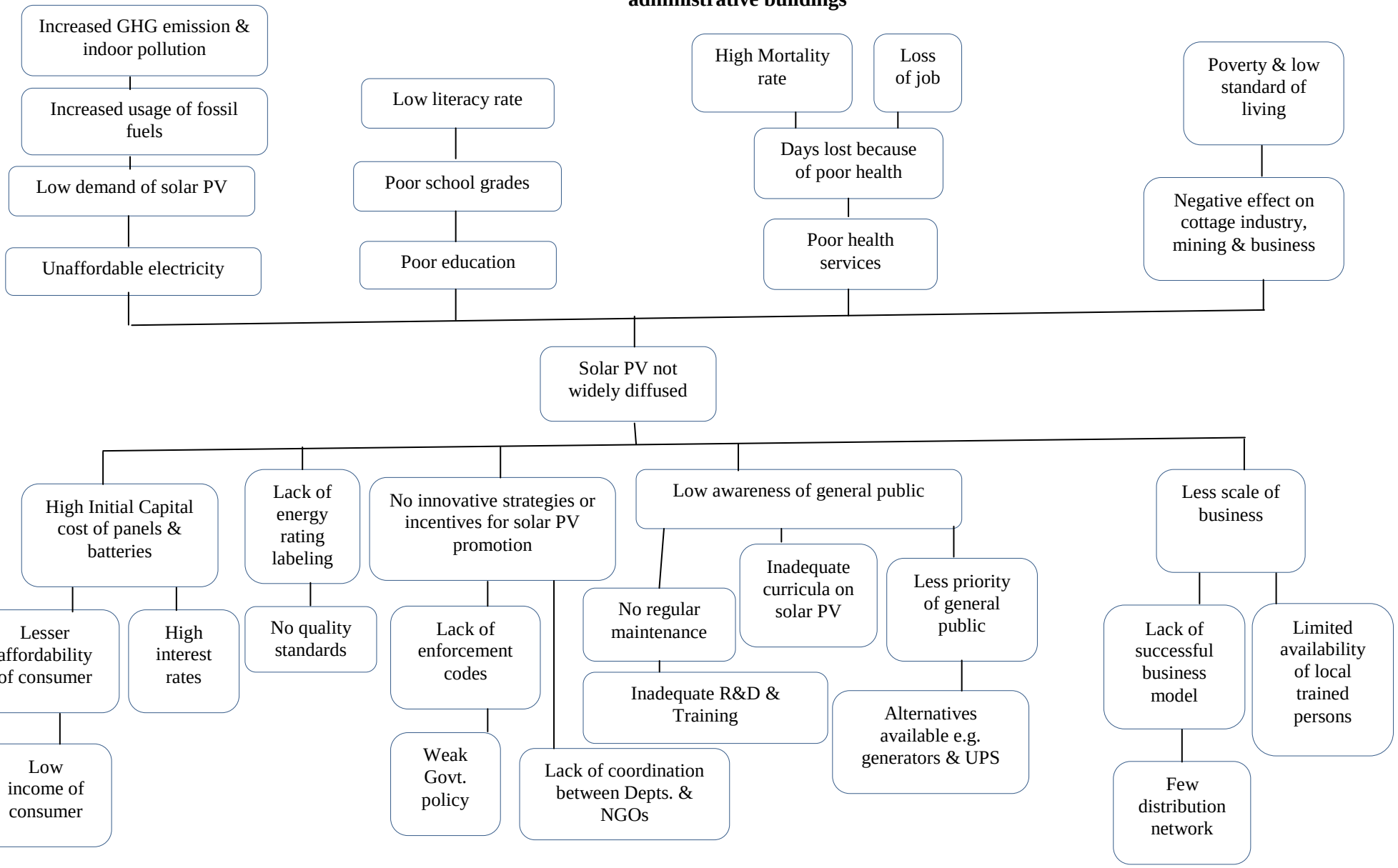


Fig: Market map of Solar PV system

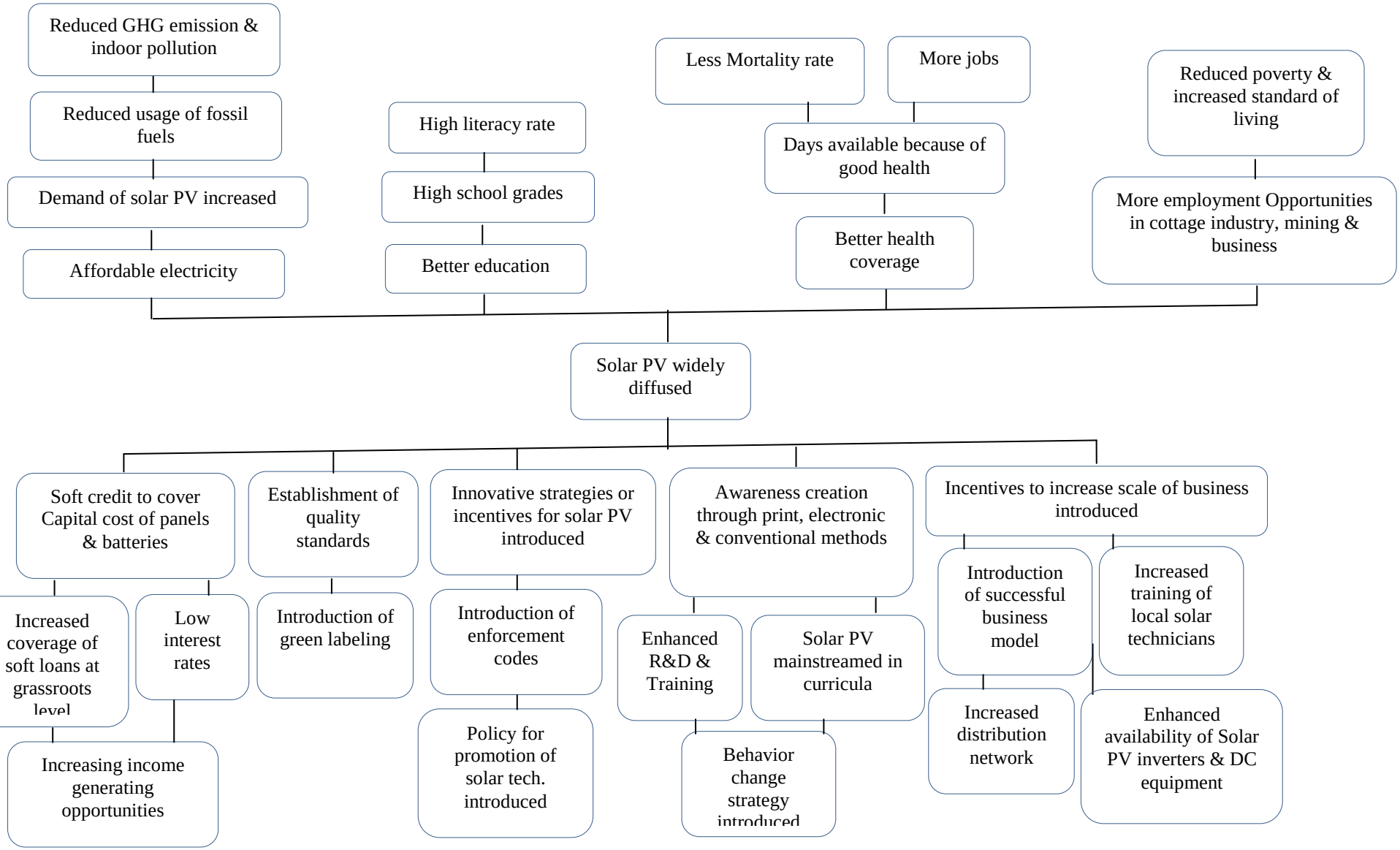
Annex - III

Problem tree of battery based off or on-grid solar PV systems for individual consumers for households usage; institutions such as schools, health centers and administrative buildings



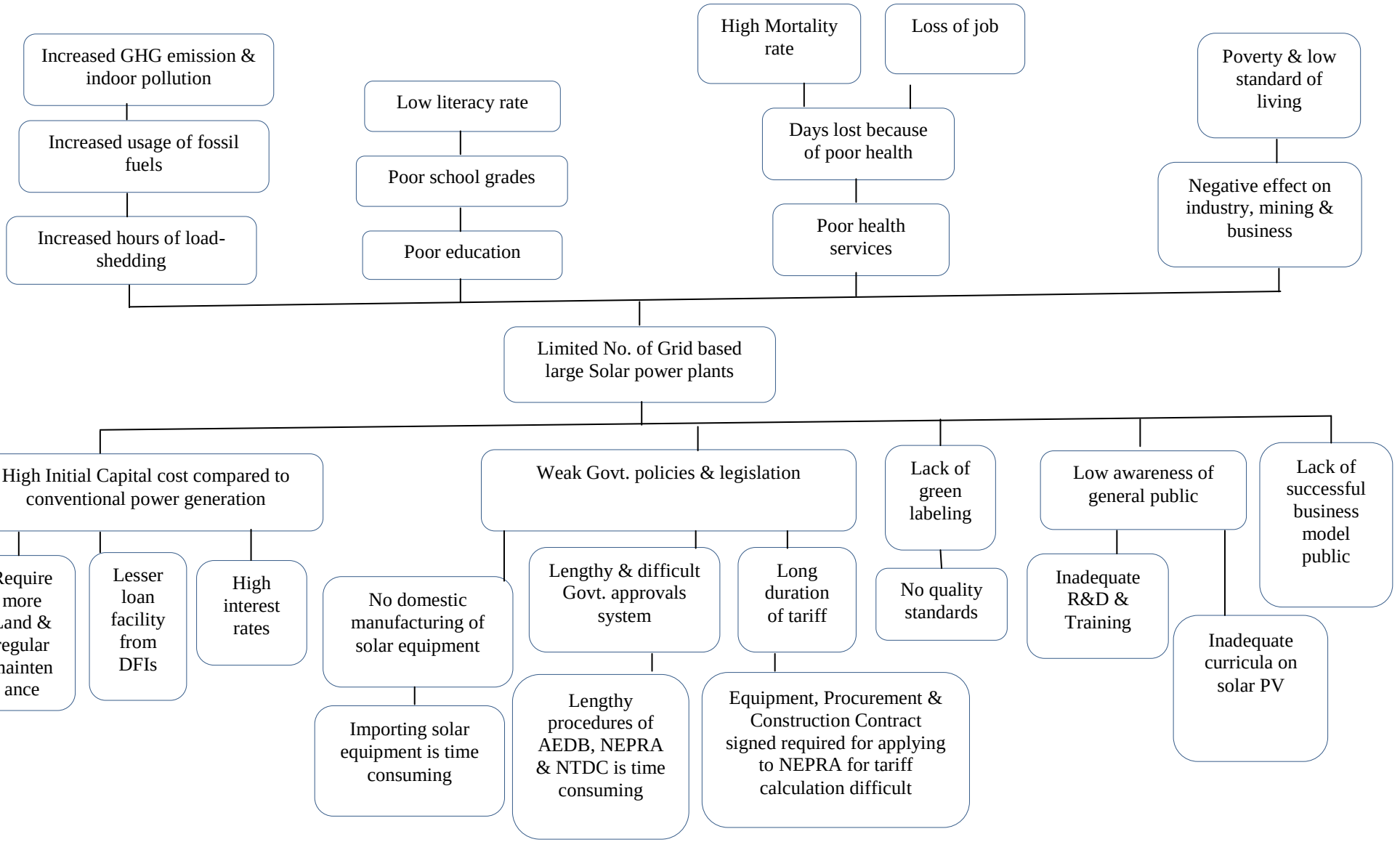
Annex - IV

Solution tree of battery based off or on-grid solar PV systems for individual consumers for households usage; institutions such as schools, health centers and administrative buildings



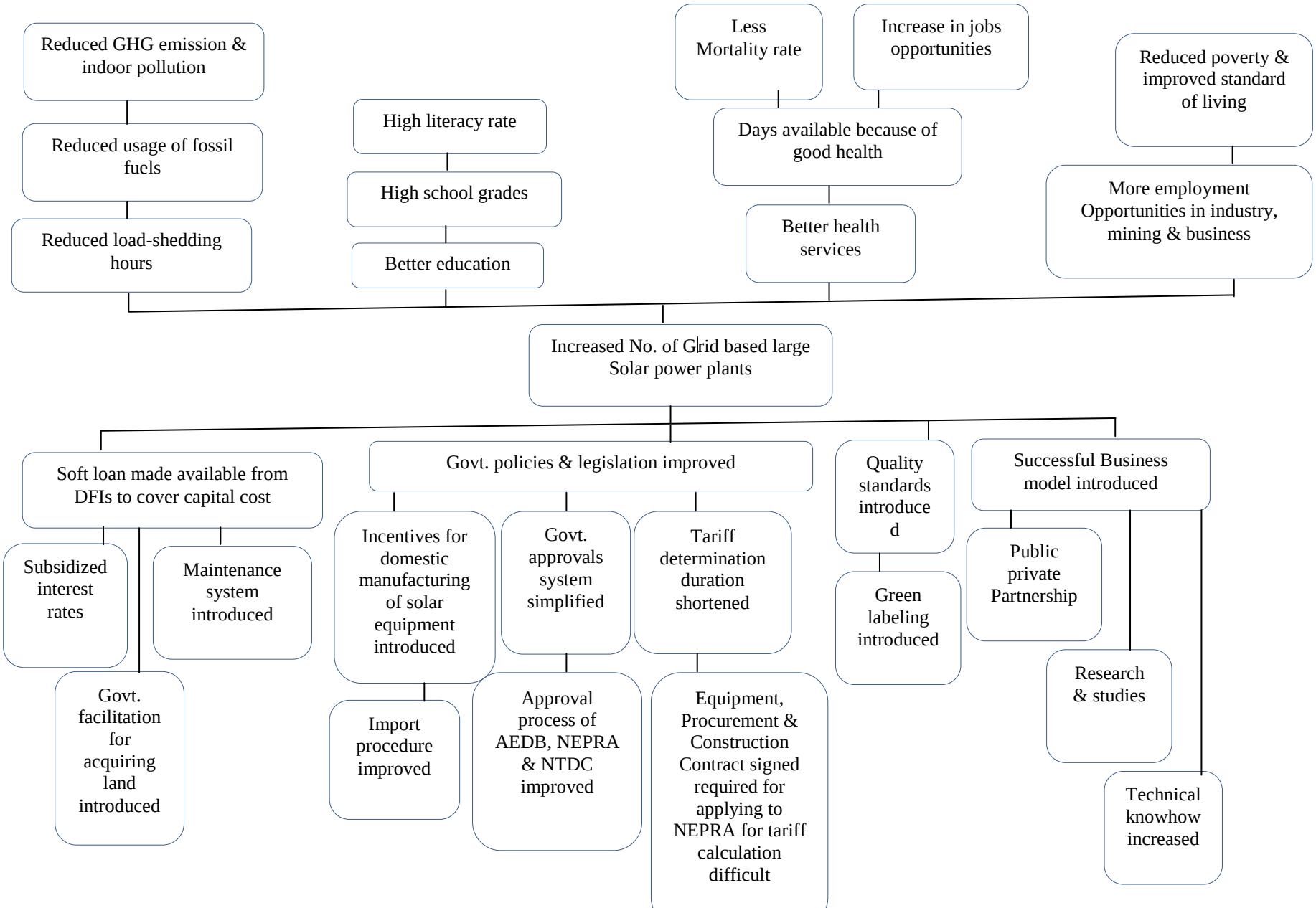
Annex - V

Problem tree of Grid based large Solar power plants



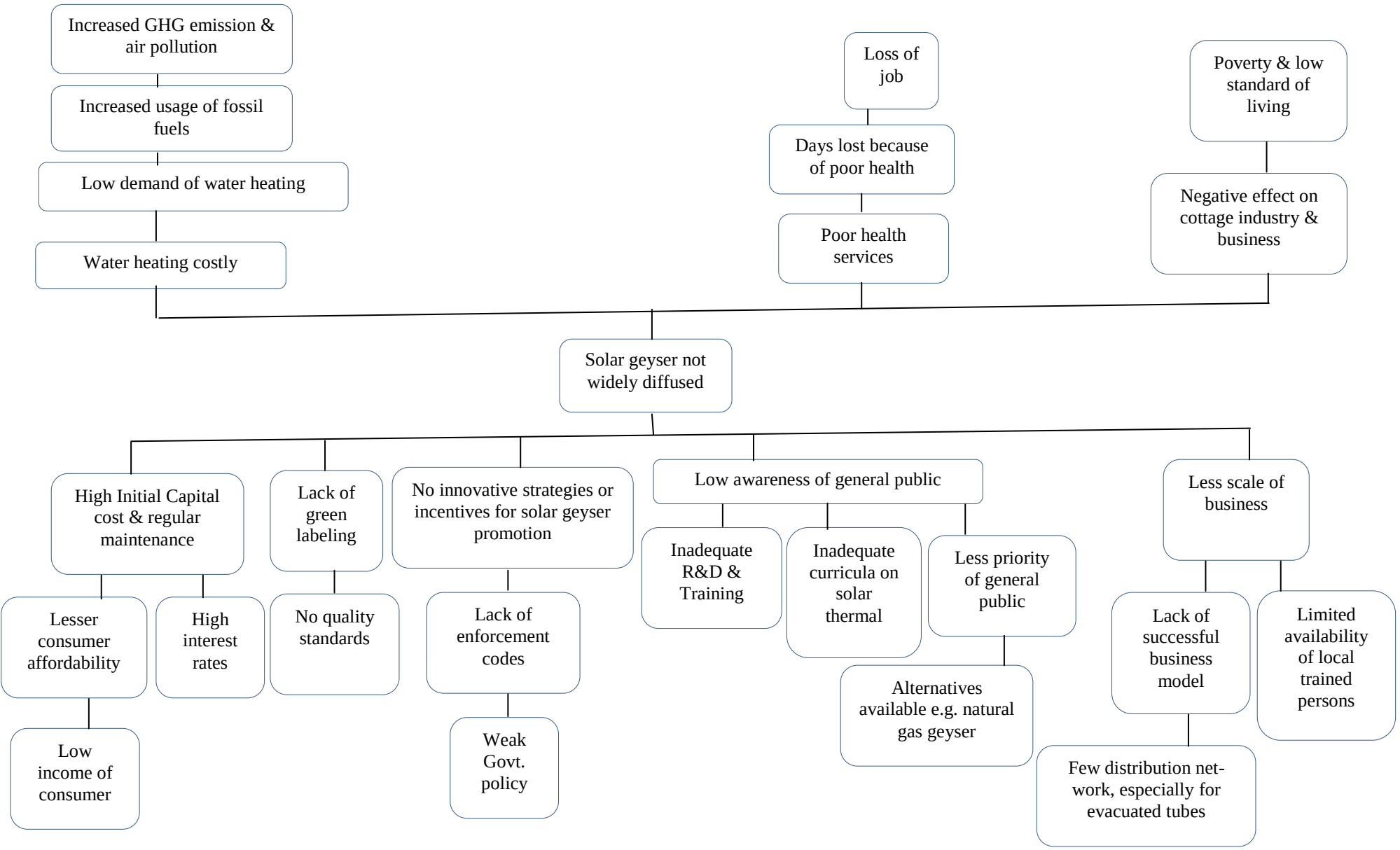
Annex - VI

Solution tree of Grid based large Solar power plants



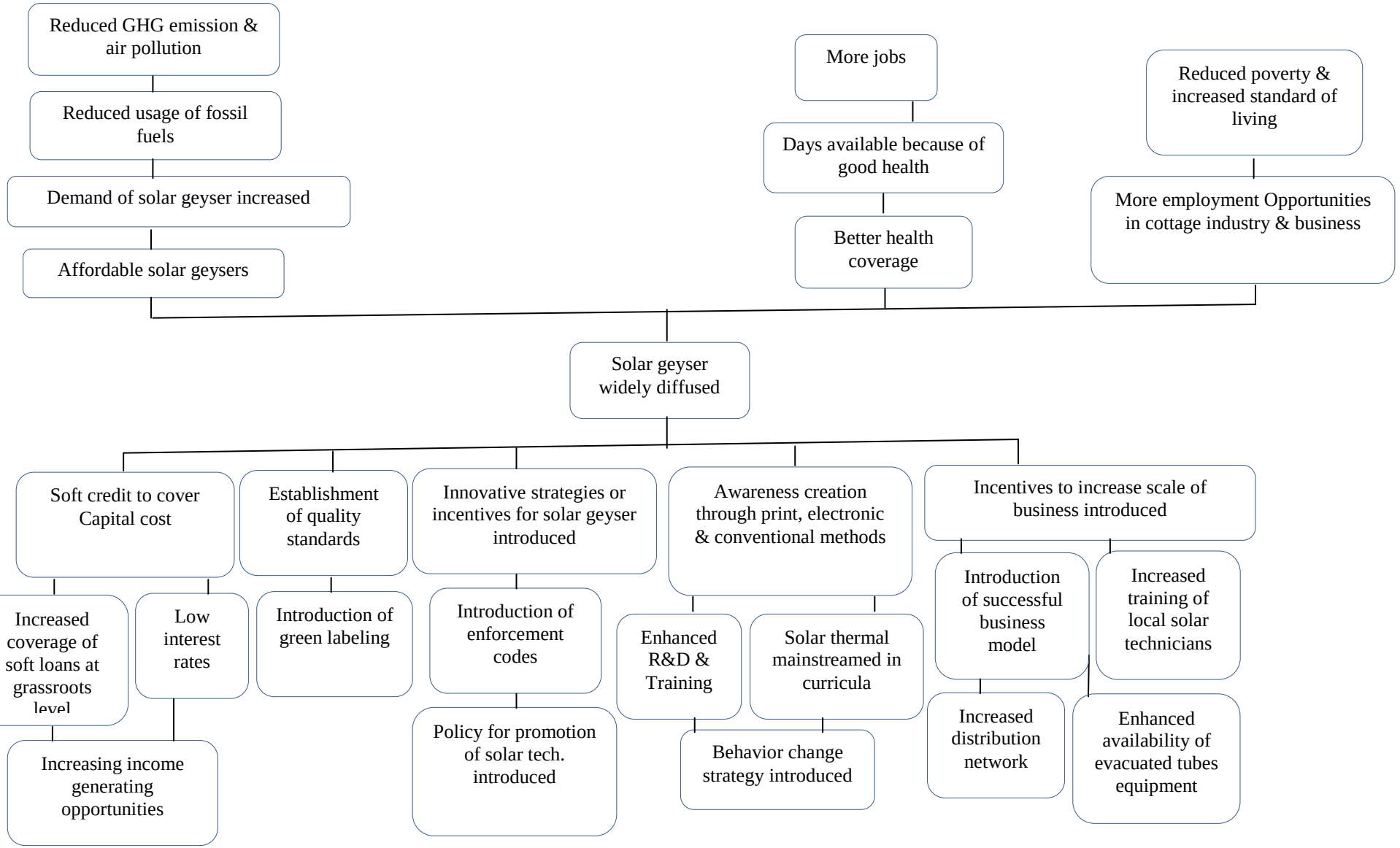
Annex - VII

Problem tree of solar geysers



Annex - VIII

Solution tree of Solar geysers



Annex - IX

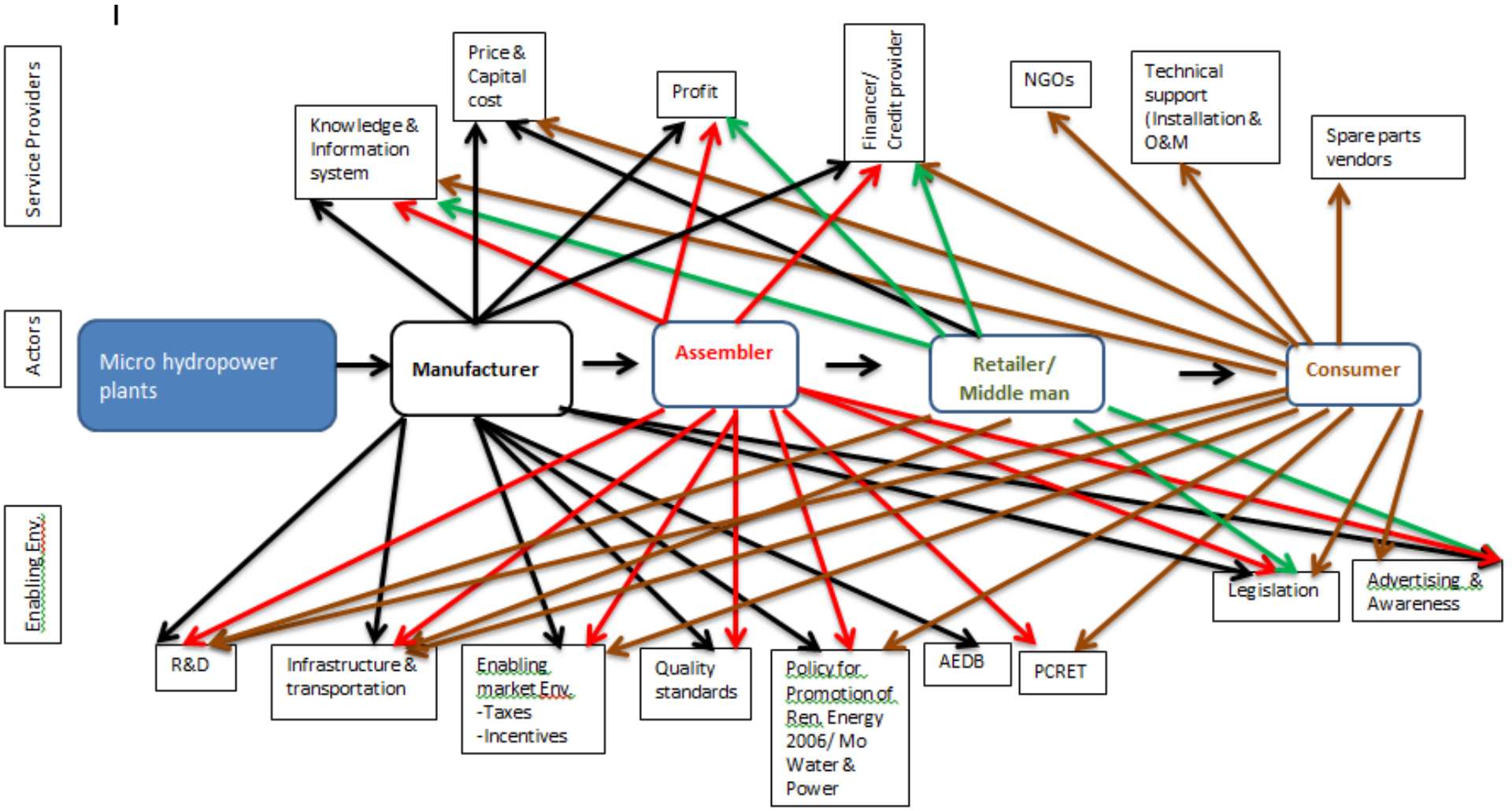
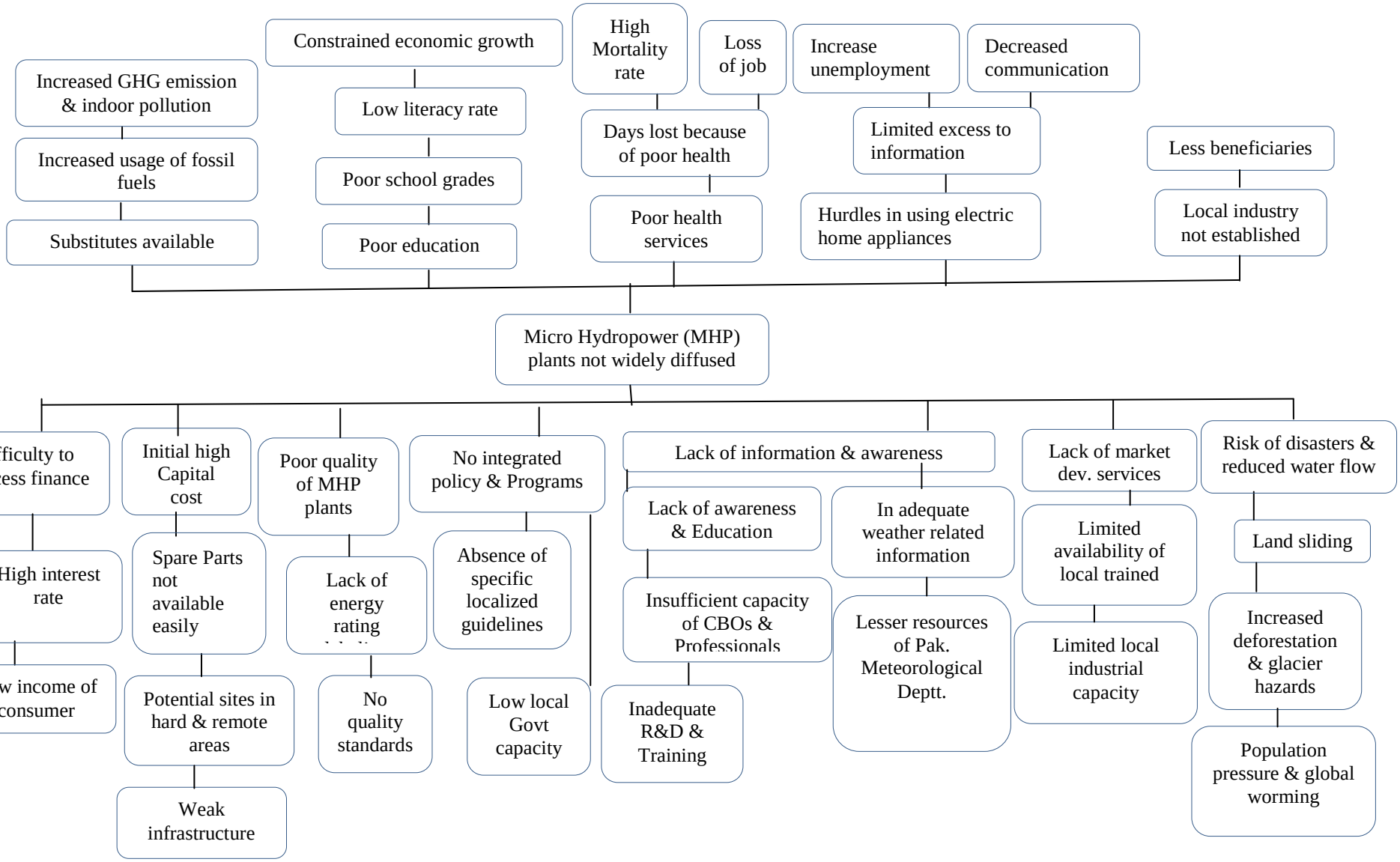


Fig: Market map of Micro hydropower plants

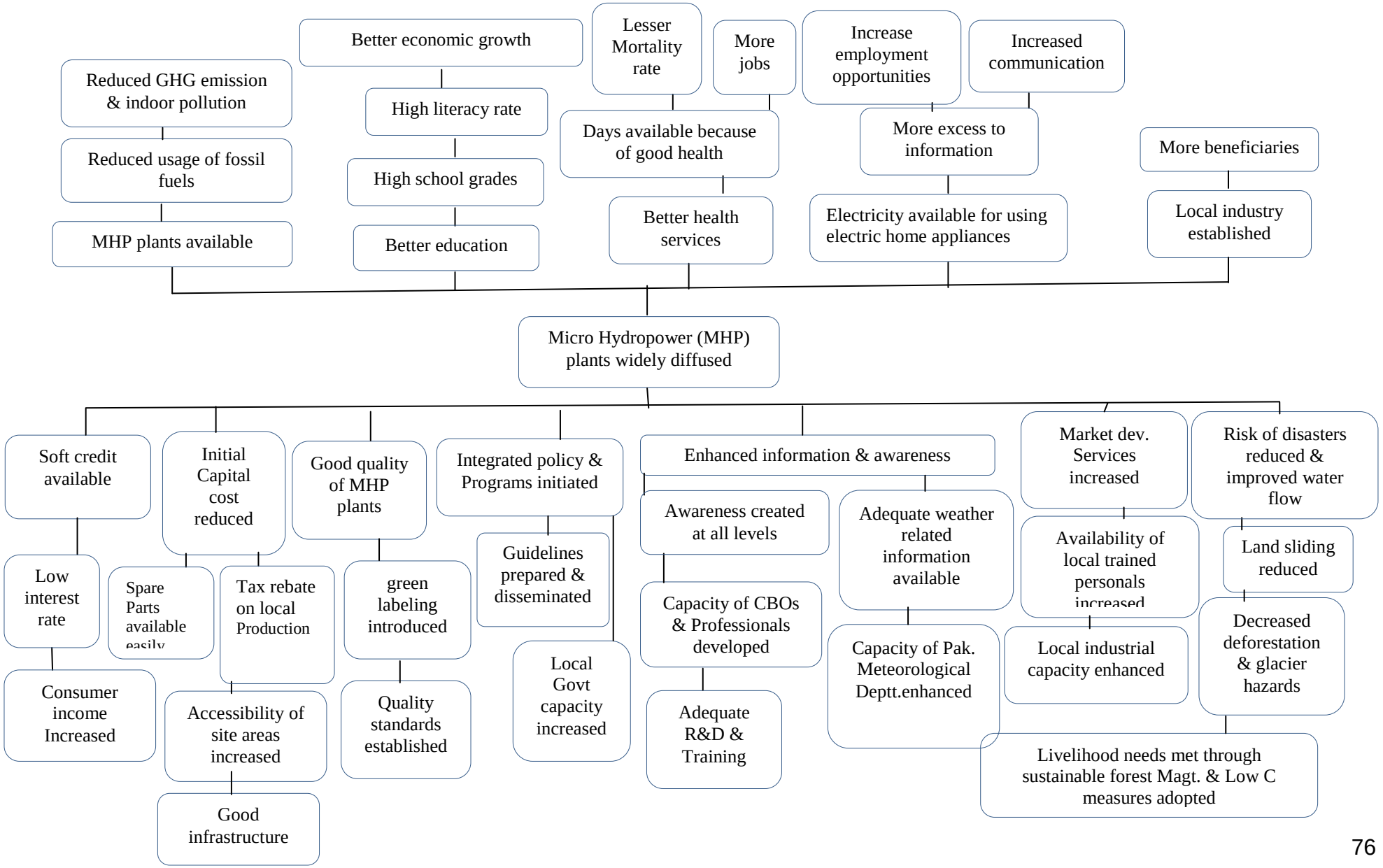
Annex - X

Problem tree of Micro hydropower plants



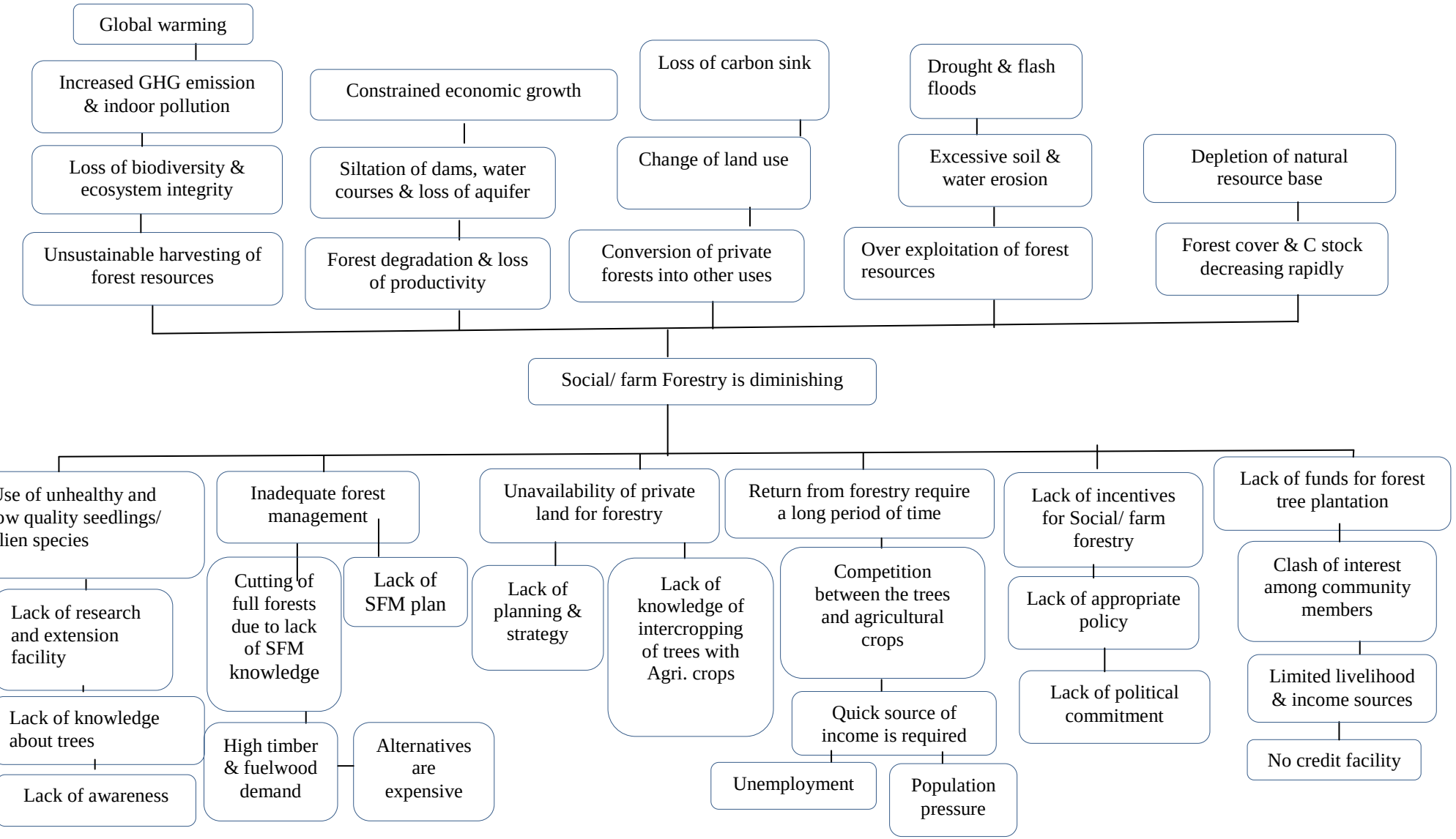
Annex – XI

Solution tree of Micro hydropower plants



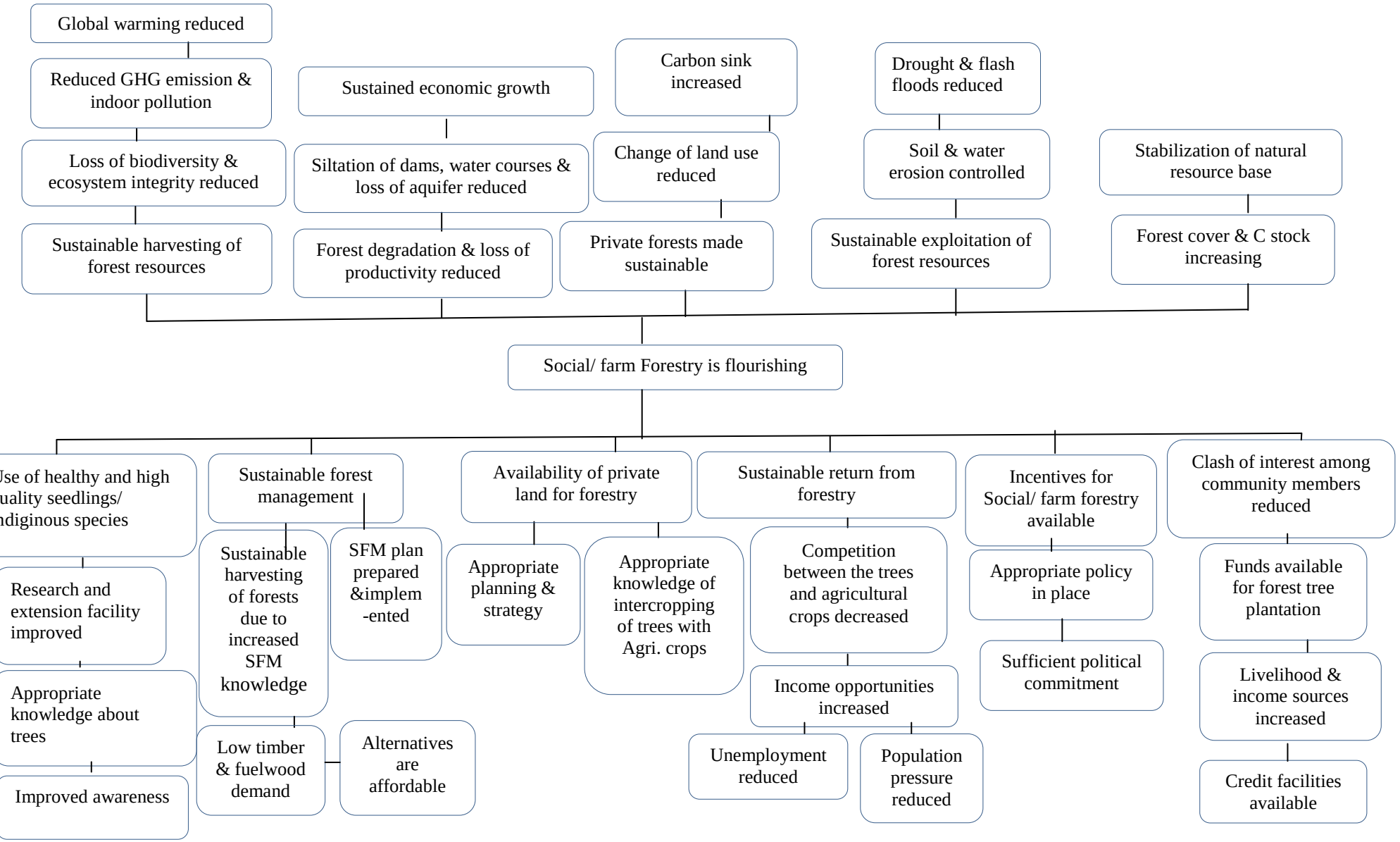
Annex - XII

Problem tree of Social/ Farm Forestry



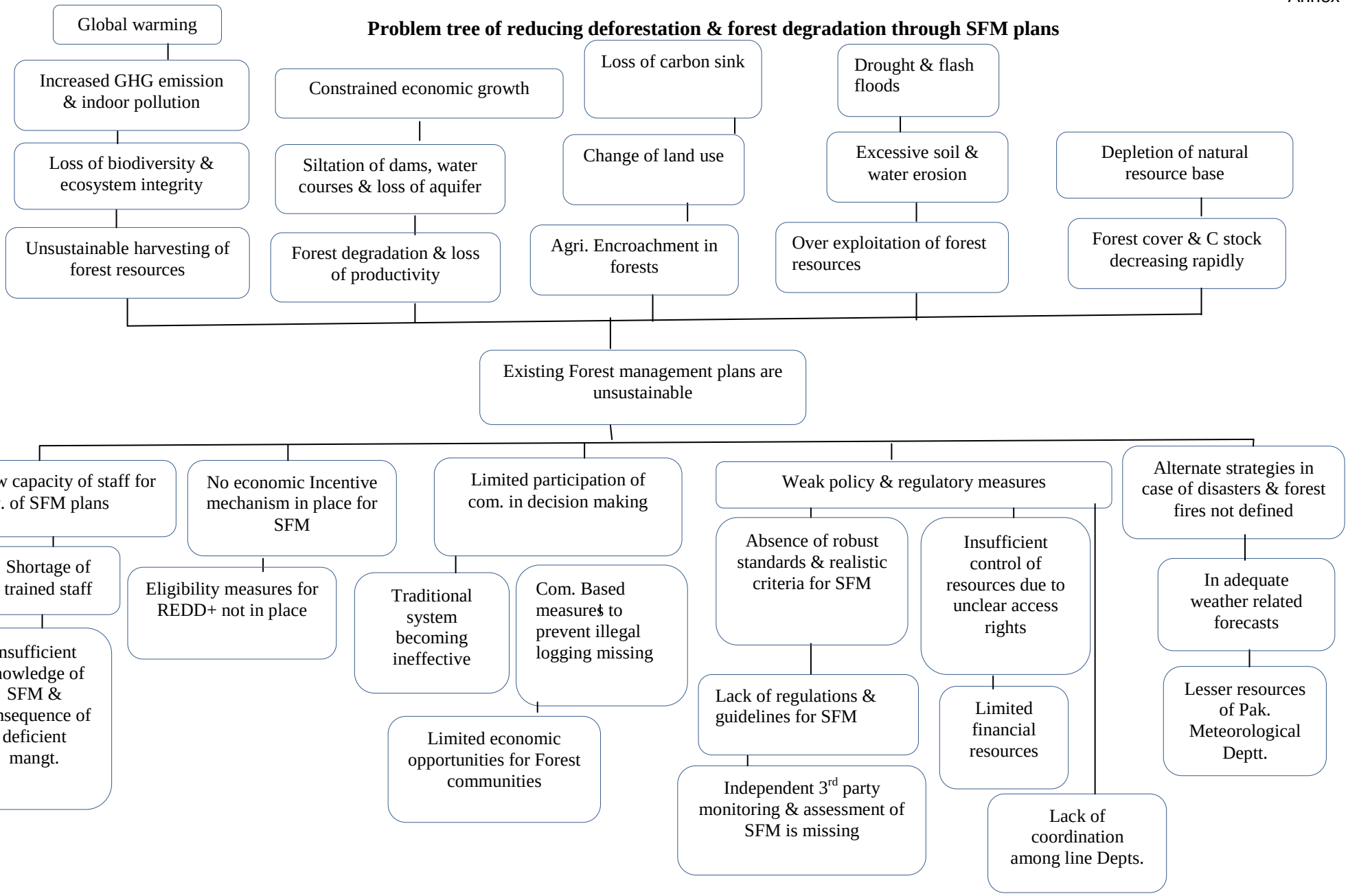
Annex - XIII

Fig: Solution tree of Social/ Farm forestry



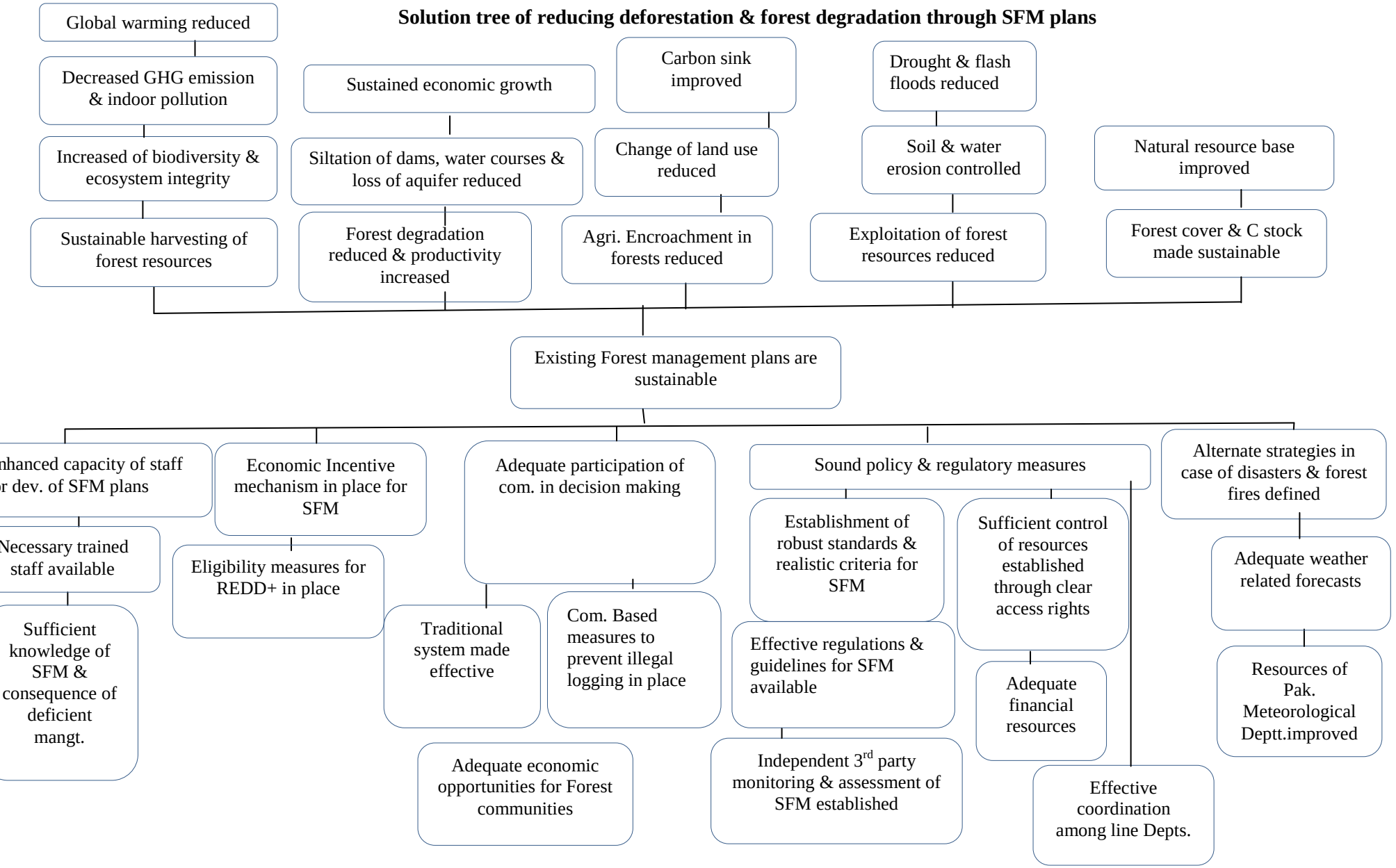
Annex - XIV

Problem tree of reducing deforestation & forest degradation through SFM plans

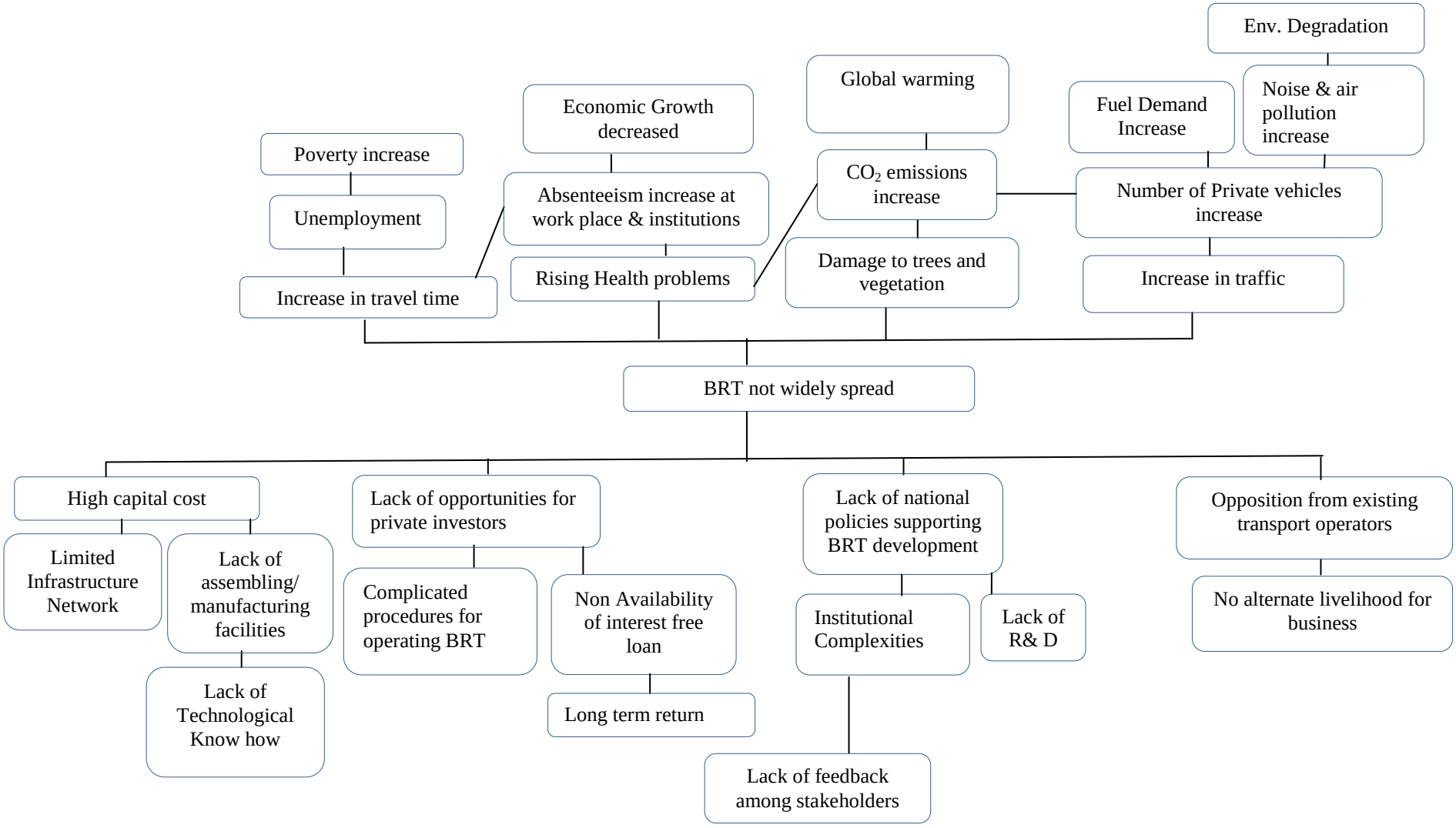


Annex - XV

Solution tree of reducing deforestation & forest degradation through SFM plans

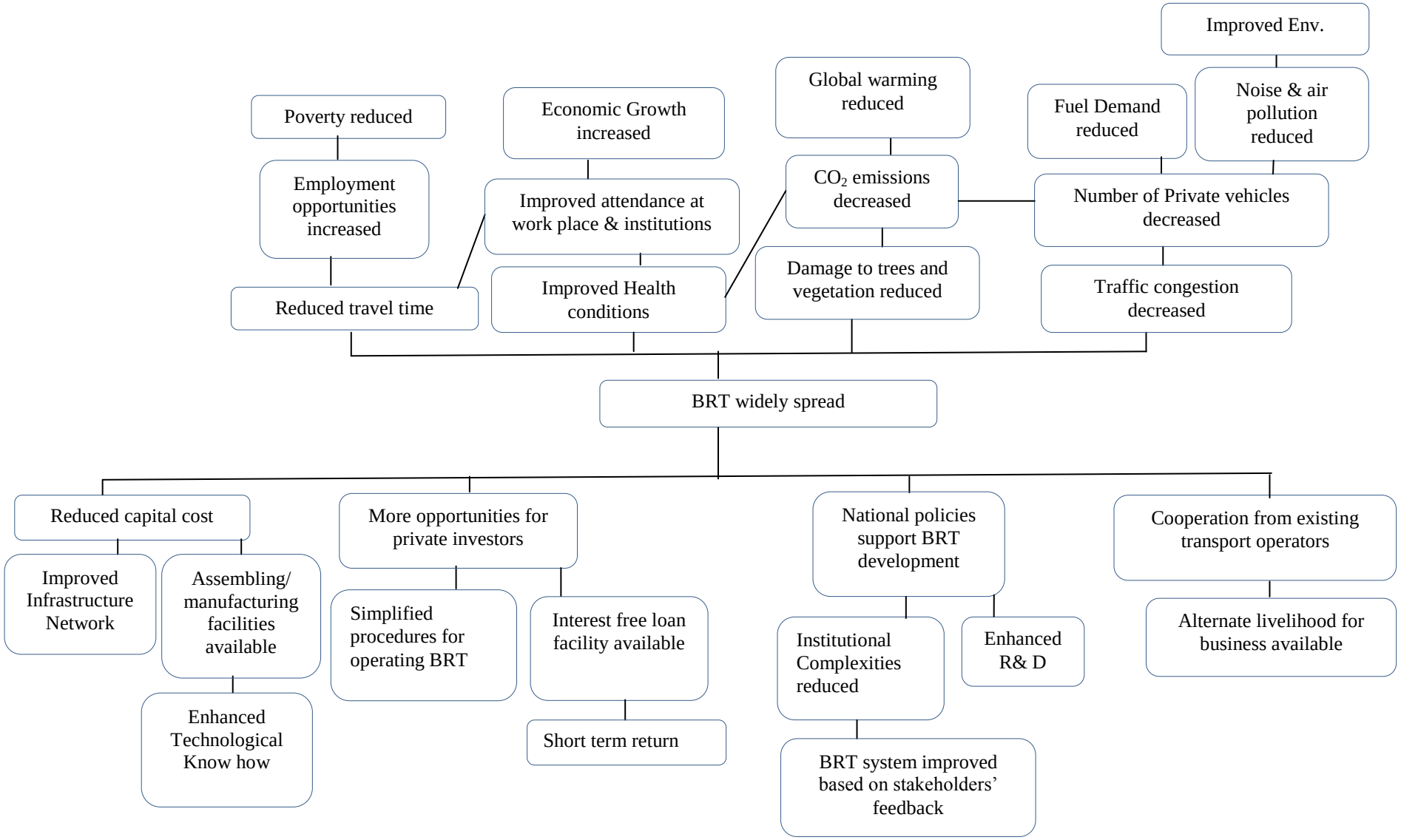


Problem tree of BRT Annex-XVI



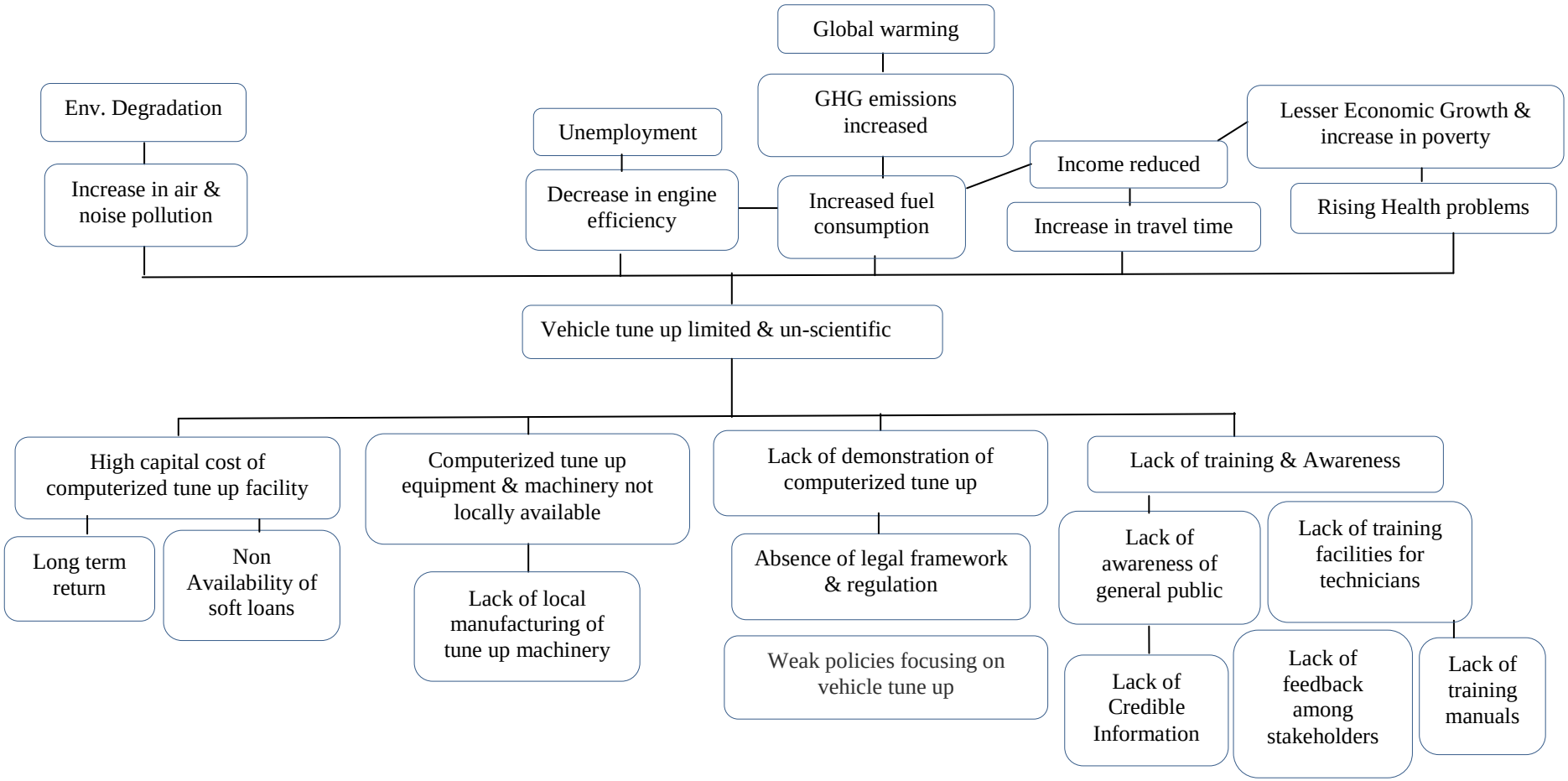
Solution tree of BRT

Annex-XVII



Problem tree of Vehicle Tune-up

Annex-XVIII



Solution tree of Vehicle Tune-up Annex-XIX