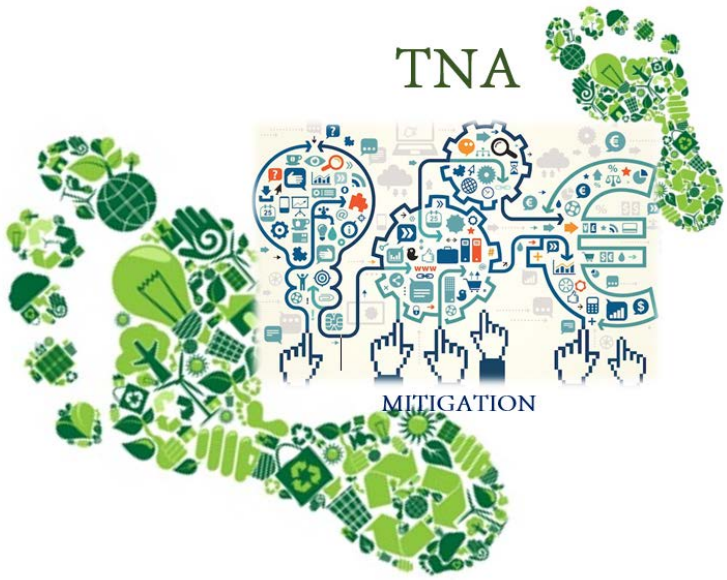
GOVERNMENT OF THE REPUBLIC OF ARMENIA

MINISTRY OF NATURE PROTECTION

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION



BARRIER ANALYSIS AND ENABLING FRAMEWORK

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TECHNOLOGY NEEDS ASSESSMENT REPORT

MITIGATION TECHNOLOGY BARRIER ANALYSIS AND ENABLING FRAMEWORK

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Foreword

Preface

Climate change has negative impact on natural ecosystems. Therefore, efforts are being made to further increase national capacities to combat with climate change. The aim of the Paris agreement adopted in 2015 is to reach the legally binding global agreement aimed at keeping global temperature increases below 2°C and pursuing efforts to limit the temperature increase to 1.5 °C. This is only possible by the combined efforts when every country, in line with its national capacities, will bring its contribution for tackling climate change and moving towards a green economy.

The Republic of Armenia (RA) signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 13, 1992 and ratified it as a non-Annex I country on May 14, 1993. On December 26, 2002 Armenia ratified the Kyoto Protocol to the UNFCCC. Armenia as a Non-Annex I Party to the Convention is regularly implementing obligations pursuant to its status.

The share of emissions of RA to global emissions is small, and it is currently estimated to be around 0.014% of the global level. The country associated to the Copenhagen Accord in January 2010. Armenia's association to "Doha Amendment to the Kyoto Protocol" was approved by RA Government.

Armenia's post-2020 climate policy under a new international agreement is formulated in "Intended Nationally Determined Contributions" (INDC) endorsed by the RA Government Protocol Decision No 41 from September 10, 2015 and submitted to the UNFCCC Secretariat on September 22, 2015. The INDC is based on the principle of "Green economy" and is compatible with the social and economic development goals of the RA. The timeframe for submitted INDC is 2015-2030 [**Ref 1**].

The Third National Communication (TNC) on Climate Change of the RA was developed in 2015 according to UNFCCC and the Guidelines for national communications of Non-Annex I Parties to the Convention. TNC covering the period of 2007-2012 has extended the studies on and assessments of climate change-related issues. TNC describes the position of the RA for addressing climate change issues and measures implemented and planned, as well as the country's needs for further steps and activities.

According to the Decision adopted by Conference of Parties (COP) the first RA Biannual Update Report (BUR) is submitted. The National Inventory of the RA BUR is updated as of 2012. According to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines, the RA Biannual Update National Inventory Report (NIR) consists of the following sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land (AFOLU) and Waste.

Armenia has integrated sustainable development principles in its policies and continues to act towards mainstreaming environmental issues in development programs in the context of the country's international environmental commitments.
Armenia is actively involved in Technology Need Assessment (TNA) that should ensure adequate technological support and create a favourable environment for technology development and transfer.

The present Report includes the outline and analysis of existing barriers and enabling framework for prioritized technologies in Armenia.

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Abbreviations

ADB	Asian Development Bank
ADS	Armenia Development Strategy
AIT	Asian Institute of Technology
AFOLU	Agriculture, forestry and other land use
AMD	Armenian Dram
AUA	American University of Armenia
BUR	Biannual Update Reports
CHP	Combined heat and power production
CJSC	Closed joint stock company
CNG	Compressed natural gas
COP	Conference of Parties
CTCN	Climate Technology Centre and Network
DTU	Technical University of Denmark
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
EIB	European Investment Bank
EU	European Union
EST	Environmentally Sound Technology
GGF	Green for Growth Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
HPP	Hydropower plant
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial process and product use
LPA	Logical Problem Analysis
MCA	Multi-criteria analysis
MENR	Ministry of Energy and Natural Resources
MNP	Ministry of Nature Protection
MSW	Municipal solid waste
NEEAP	National energy efficiency action plan
NGO	Non-governmental organization
NIR	National Inventory Report
NIF	Neighbourhood Investment Facility
NPP	Nuclear power plant
PSRC	Public Services Regulatory Commission of Armenia
PPP	Public Private Partnership
RA	Republic of Armenia
RE	Renewable energy
R2E2	Renewable Resources and Energy Efficiency Fund of Armenia
SREP	Scaling-up Renewable Energy Program
SCPEC	State Commission for the Protection of Economic Competition
SDP	Sustainable Development Program

SEUA	State Engineering University of Armenia
SNCO	State non-commercial organization
SPAN	Specially protected area of nature
TAP	Technology Action Plan
TNA	Technology Need Assessment
TNC	Third National Communication
TPP	Thermal power plant
TPES	Total Primary Energy Supply
UGSS	Underground gas storage station
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United National Industrial Development Organization
USA	United States of America
USD	United States Dollar

Units of Measurement

m^3	cubic metre
ha	hectare
Gg	gigagram (10^9 g)
t	tonne
toe	tonnes oil equivalent
TJ	terajoule (10^{12} J)
PJ	petajoule (10^{15} J)
kW	kilowatt (10^3 W)
kWh	kilowatt hour (10^3 Wh)
MW	megawatt (10^6 W)
GWh	gigawatt hour (10^6 kWh)
^0C	degree Celsius

Chemical Combinations

CO	Carbon monoxide
CO_2	Carbon dioxide
$CO_{2eq.}$	Carbon dioxide equivalent
CH_4	Methane
HFCs	Hydrofluorocarbons
PFCs	Perfluorocarbons
SF_6	Sulfur hexafluoride
N_2O	Nitrous oxide

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Executive Summary

This Report is the next phase of Technology Needs Assessment and Technology Action Plan (TNA/TAP) for Mitigation. The Report is the second out of four reports prepared for TNA/TAP.

This report aims to outline the analysis of existing barriers and enabling framework for prioritized technologies in Armenia. The document was elaborated based on developed by UNEP DTU Partnership the Second Edition of Overcoming Barriers to the Transfer and Diffusion of Climate Technologies guidebook [**Ref 2**]. It has two objectives: to identify barriers and understand addressing barriers to the transfer and diffusion of each selected technology, and based on these findings to establish an enabling framework for technologies of the same sector.

Based on provided TNA methodology and Multi-criteria analysis (MCA) approach [**Ref 3**], applied in the first report "Technology Needs Assessment", the following technologies (comprising consumer and capital goods, public provided and other market goods) receive the highest values and were prioritized and selected for further examination of barriers and enabling framework:

Energy sector:

- Cogeneration, Small Scale Combined Heat and Power production.
- Improving energy efficiency in multi-apartment buildings. Registry creation, development.
- Mandatory realization of the Industrial Energy Audit as a mitigation component.
- Reactive capacity (power) compensation in the RA electric energy system.
- Correspondence of natural gas tariff structure to the methodology approved by decision of Public Services Regulatory Commission (PSRC).

Industry sector:

- Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry).
- Production and usage of photo luminescent materials with long-term lightening.
- New type of Entirely Plastic solar water heater.

Land use sector:

- Degraded Grassland radical improvement.
- Sustainable Forest management.
- New technology of cultivation of Perennial plants.

Waste management sector:

- Utilization of methane form Yerevan city landfill for electricity and heat production.
- Existing Lusakert biogas plant operation and reissuance organizational technology.
- Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation.

Project activities were implemented in consultation with stakeholders, representatives from Ministries of Nature Protection, Energy, Agriculture, Economy, Research Institutions, Business, International Organizations NGOs, etc. The stakeholders were part of national teams divided into four working groups assigned to Energy, Industry, Land use and Waste management sectors.

For the organization of the barrier analysis process, a sectoral technology working group representing relevant stakeholders was formed. National consultants have applied a participatory approach for barrier analysis and identification of enabling measures in respective sectors.

The process started with the analysis of the barrier hampering the priorities of development and climate change mitigation in Armenia, followed by an overview and investigation of the specific sub-sectoral objectives, which are necessary to meet the national targets.

Afterwards, in order to identify the main motives and details why the discussed technology is not widely used at the moment, and why neither private nor the public sector have invested seriously in this as a first step in the process of barrier analysis, desk study of policy documents and other relevant documents was implemented. Further, the process of consultation was conducted with stakeholders through direct interviews and questionnaires.

Market mapping techniques were used in the initial stages of the barrier analysis process which involved several consultations between the parties concerned. The developed market maps for each technology continued to improve during the consultations, and served as a main input in the detailed categorization of the barriers and the subsequent identification of cross-technological relations (**see Annex I**).

In order to understand the fundamental problems in technology transfer, the working group of each sector has applied Logical Problem Analysis (LPA). The cause effect relations were prepared in Problem tree, having the main problem put as a starter problem, causes at the bottom of the tree and their effects in the upper part of the diagram. Using LPA the working groups were able to bring together the key features of problems, apply logical analysis of interconnected elements, and identify linkages between problem components and external factors. Thus, the Problem trees were used for understanding the causal relations of barriers and their linkages (**see Annex II**).

After compiling a long list of barriers, screening of barriers and grouping them under different categories were organized (information, social, technological, capacity building, economic and financial, policy and regulatory, etc.). For identification of most important barriers, a modest method was applied grouping them into basic and non-basic barriers and criteria such as starter, crucial, important, less important and insignificant barriers. Barriers related to technology implementation have been identified in twelve categories (**see Table 1**).

Table 1. Identified barriers' categories related to technologies implementation for the four priority sectors

Sectors / Barriers	Energy	Industry	Land Use	Waste Management
Economic, Financial	Yes	Yes	Yes	Yes
Market Failure and Imperfection	Yes	No	No	Yes
Policy, Regulatory	Yes	Yes	Yes	Yes
Institutional	Yes	Yes	Yes	Yes
Information, Awareness	Yes	Yes	Yes	Yes
Technology Issues	Yes	No	No	Yes
Capacity Building	No	No	Yes	No
Technical Issues	No	No	No	No
Social	No	No	Yes	No
Environmental	No	No	No	No
Human Skills	Yes	No	No	Yes
Network working	No	No	No	No

The next step of the Project was the identification of measures supporting technology transfer as actions that could be taken to enhance technology transfer. The process of identification and description of measures to overcome barriers was done by working groups of the four sectors {Energy [5 technologies (**see Table 2**)], Industry [3 technologies (**see Table 3**)], Land use [3 technologies (**see Table 4**)] and Waste management [3 technologies (**see Table 5**)]} in the same context as barrier analysis, applying the LPA. The working groups have considered the situations and set objectives for each technology, organizing them into the Objective tree. Proposed measures were discussed according to their financial and economic profile and encouragements used (**see Annex III**).

Afterwards, meetings with stakeholders were organized to present the Market maps, Problem trees and Objective trees, discuss and familiarize with the short-list of the barriers and measures to overcome barriers pre-selected and pre-analysed by working group, sector experts, expert team leaders and project coordinator. Over 40 stakeholders participated in the meeting held in Yerevan, at the conference hall of Bio Resources Management Agency of the Ministry of Nature Protection (MNP) of the RA on September 01 and 02, 2016, (**see Annex IV**), during which they have discussed the characters and categories of the barriers in the 4 prioritized sectors and approved Identified barriers and Proposed measures to overcome barriers to technology transfer in the 14 technologies. Besides, during the meeting the causal relations of barriers and linkages for enabling framework and appropriate measures were examined.

Stakeholders expressed also their interest for establishing a national inventory system for technologies in all spheres for climate change mitigation based on TNA. It may be a grid like National Network or Centre for Climate Technologies or National Directory, Catalogue of technologies and certainly it should be linked to the Climate Technology Centre and Network (CTCN).

All abovementioned prioritized technologies are described in the First Report “Technology Needs Assessment”. Moreover, all the discussed technologies are available for possible financing. Next steps in the TNA process will be the preparation of TAP.

Table 2. Identified barriers and Proposed measures to overcome barriers to technology transfer in the Energy Sector

Technology / Barriers Measures		Cogeneration, Small Scale Combined Heat and Power production	Improving energy efficiency in multi-apartment buildings. Registry creation, development	Mandatory realization of the Industrial Energy Audit as a mitigation component	Reactive capacity (power) compensation in the RA electric energy system	Correspondence of natural gas tariff structure to the methodology approved by decision of PSRC
Economic Financial	**Barriers**	1. Lack of financial support targeted programs for heating and hot water supply for the implementation of in-house infrastructure. 2. Artificially overstated values of the investment.	1. Lack of financial support mechanisms.	1. Lack of financial resources (cheap and soft).	1. Lack of investments in the energy system at all levels, including consumers. 2. Lack of economic incentive mechanisms.	1. Lack of financial support. 2. Insufficient financial resources of the Regulatory Commission to attract relevant specialists.
	Measures	1. Introduction of targeted financial support mechanisms. 2 . Ir values formation including design.	1. Creation of a mechanism for financial assistance.	1. Creation of revolving funds for the implementation of Energy audit.	1. Obtaining financial resources available. 2 .Establishment of mechanisms for economic incentives.	1. Provision of necessary financial support. 2.Proper implementation of the natural gas tariff setting process.
Market Failure and Imperfection	**Barriers**	1. District heating (up to 5 MW) thermal energy tariffs are not regulated.		1 Lack of market of energy audits implementing specialized organizations	1 . The absence of reactive power (power factor) registration	1 . Distortion of market principles by the current tariff structure
	Measures	1 District heating thermal energy tariffs sets and regulations. 2 Implementation of electricity tariff calculation based on useful heat demand.		1. Establishment of the market of the energy audit conducting specialized organizations.	1 Restoration of the function of the reactive energy metering 2. Definition of reactive energy tariff or other indicators of maintaining fairness principles.	1 . Undertaking a review of the structure and current natural gas tariffs in line with the methodology defined by the Commission.

Policy Regulatory	**Barriers**	1 The projects not being involved in the Energy Sector long-term Development Strategy. 2. Gaps in the regulatory framework, lack of appropriate methodology.		1 Lack of requirement in the RA Law of Energy Saving for Energy Audit mandatory implementation. 2.Lack of minimum EE standards for buildings, in RA construction norms.	1. Reactive power (energy) compensation issue of is not reflected in regulatory standards and market rules.	1 Necessity for initiating the process of revising the natural gas price structure.
	Measures	1 Including Combined heat and power production projects in the Energy Sector prospective development plans. 2 Improving the regulatory framework, adequate methodology creation.		1 Stipulation of Industrial Energy Audit mandatory implementation requirement in the RA Law of Energy Saving. 2. Seting of minimum standards for EE in buildings, in RA construction norms.	1 Define reactive power (energy) compensating issue in the regulatory norms and market rules.	1 Initiation and implementation of the harmonization of the natural gas price structure to the methodology.
Institutional	**Barriers**	1. Incomplete developed condominiums, residents` alienation of the buildings management process.	1. Information uncertainty due to the lack of registry 2. Indifferent attitude towards the expression of common property in apartment buildings.		1. Absence of the relevant requirements in “Electrical appliance rules” technical regulation.	
	Measures	1. Population active involved in the process of building management.	1. Registry creation requirement as a prerequisite to increase EE in apartment buildings. 2.Common ownership specification and clarification in multi-apartment buildings.		1. Setting the relevant requirements for reactive energy compensation in "Electrical appliance rules" technical regulation.	

Information Awareness	**Barriers**	1 .Insufficient public awareness on the efficient use of energy.	1 Insufficient awareness of technologies to increase EE in buildings.	1 .Lack of awareness among the Industrial companies.	1 . Lack of awareness on the technical staff of Transmission and Distribution and Industrial companies.	
	Measures	1 Public Awareness Raising.	1. Public Awareness Raising.	1 Industrial companies Awareness Raising.	1 .Awareness raising of the technical staff of Transmission and Distribution companies and Industrial companies.	
Technology Issues	**Barriers**	1 Technology transfer experience incomplete.	1. Lack of adequate software package for Registry hierarchy structure.	1 Lack of experience in the application of energy-saving technologies.	1 Absence of Reactive power new generation compensators in the local market.	
	Measures	1 Cogeneration technologies study practice.	1 .Creation of an appropriate software package for the registry hierarchical structure 2 Software portfolio investing in selected communities, technology appropriation.	1 .Energy-saving technologies experience and application research and domestication. 2.Demonstration (piloting) programs implementation and advertisement.	1 Need for imports of Reactive power new generation compensators.	
Human Skills	**Barriers**	1. Staff training needs of the regulatory authority.	1. Lack of specialists for setting up and maintaining the registry.	1. Lack of relevant experts and professional organizations.	1. Transmission and distribution networks, as well as industrial enterprises did not used the technology over 20 years. 2. New generation compensators used only in the external markets.	1. Lack of the necessary experience and capacity regulation.

	Measures	1. The regulatory body staff training in accordance with EU Directives.	1. Training of spesialists for the Registry creation and maintenance.	1. Adequate training and encouraging the establishment of professional organizations.	1. Appropriate training and preparation of professionals. 2. Study experience in EEC countries.	1. Regulatory experts training. 2.Application of Western European countries experience of setting natural gas tariffs, data acquisition, processing, etc.

Table 3. Identified barriers and Proposed measures to overcome barriers to technology transfer in the Industry Sector

Technology / Barriers / Measures		Production of synthetic rubbers from butadiene instead of using natural gas (Chemical industry)	Production and usage of photo luminescent materials with long-term lightening	New type of Entirely Plastic solar water heater
Economic Financial	**Barriers**	1. Market demand and price uncertainty of the Synthetic rubber, as well as 8 other kind of production. 2. The need for financial resources for technology replacement and reissue. 3. Consequences of failure causes of the reissue attempts in previous years.	1. Uncertainties related to the regional and domestic market demand of photo luminescent materials. 2. Available financial resources for the proposed technology (extended composition materials) implementation . 3.Necessity for non-standard (unique) equipment preparation, in order to establish industrial volume production.	1. Uncertainties related to the production volumes. 2. Regional market restrictions, due to transport costs. 3. The lack of flexible funding mechanism for the promotion of sales.
	Measures	1. Market demand and price study of the synthetic rubber, as well as 8 other kind of production. 2.Re-analysis of the reasons for the failure of the attempts in previous years. 3.Provision of grants for technology replacement and reissuance, or access to interest-free loans (revolving funds).	1. Photo luminescent materials regional and domestic market demand study. 2 .Attracting financial resources for the proposed new technology (extended composition materials) implementation. 3. Preparation of non-standard (unique) equipment, in order to establish industrial volume production.	1. Given the easy installation of new types of water heaters, a well as considerably low price, those would become competitive not only in the domestic but also regional market. This will allow the product to identify the forecasts. 2.Creation of a flexible funding mechanism. Such financial mechanisms act on behalf of the Environmental revolving funds to various communities of Armenia.
Policy Regulatory	**Barriers**	1 Chemical industry recovery, non recognizing as a priority for economic development. 2.The lack of Natural gas and Electricity, favorable tariff policy for recovery in the chemical industry.		

	Measures	1 Recognition of chemical industry recovery as a priority for economic development. 2. Set of Electricity and Natural gas favorable tariff policy for chemical industry recovery.		
Institutional	**Barriers**	1 Absence of the Concept of Industry development and in particularly chemical industry.	1 .Necessity for product certification based on standards or technical conditions certificate.	1 Inadequate institutional capacity, due to the tough tax and customs policy.
	Measures	1 Elaboration of the Concept of development of chemical industry.	1. Product certification based on developed technical conditions certificate.	1. Introduction of tax and customs privileges applied to companies involved in production of technologies in the field of RE.
Information Awareness	**Barriers**	1. Low level of public awareness.	1. Insufficient awareness of urban and regional road traffic management organizations 2. Necessity for EE gains advertisement.	1.Potential beneficiaries (SME s and detached houses owners) are not sufficiently aware of the benefits (completely made of plastic and twice cheaper) of solar water heaters.
	Measures	1. Raising the level of awareness of civil society.	1. Raising awareness of urban and regional organizations involved in road traffic management. 2. Implementation of energy saving campaign.	1. Raising awareness on the benefits of solar water heaters among potential beneficiaries (new of the SMEs and detached houses owners). 2. Advertising potential beneficiaries simplicity of construction and affordability.

Table 4. Identified barriers and Proposed measures to overcome barriers to technology transfer in the Land Use Sector

Technology / Barriers Measures		Degraded Grassland radical improvement	Sustainable Forest management	New technology of cultivation of Perennial plants
Economic Financial	**Barriers**	1. Not efficient socio-economic situation of rural communities and households. 2. High expenses of remote pastures and animal husbandary. 3. Lack of infrastructures. 4. Overgrazing of pastures and degradation of meadows. 5. Insufficient financial resources for communities and households. 6. Limited market. 7. Low prices of agricultural products realization.	1. Forest cuttings-firewood and timber. 2. Lack of other heating sources (coal, charcoal) or high prices (electricity, gas). 3. The poor economic and financial situation of households. 4. The economic blockade of the country. 5. Lack of resources for forest restoration and forest management. 6. Unregulated economic exploitation of forestlands.	1. Small cultivated plots, the traditional method of cultivation of perennial plantations. 2. Lack of infrastructure, lack of irrigation water and limited markets. 3. Insufficient financial resources for communities and households. 4. Limited market. 5.Low prices of agricultural products.
	Measures	1. Enlargement of breeding. 2. Infrastructure establishment / restoration. 3. Application of separated pasture grazing and pasture-circulation methods. 4. Availability of accessable and target loans, subsidies of animal husbandary and loans for proper breeding techniques and equipment. 5. The market regulation and regulation of the producer-consumer chain.	1. Affordable tariffs of electricity and gas. 2. Limited forest cuttings. 3. Fundraising for reforestation and surface extension. 4. To attract private investment, privatization of some parts of the forest. 5. Development of tourism. 6. Other energy import opportunities. 7. Application of mechanisms and self-financing opportunities in forestry.	1. Enlargement of perennial, new technologies in cultivation. 2. Infrastructure creation, restoration. 3.Availability of accessable and target loans, subsidies for animal husbandary and loans for proper breeding techniques and equipment. 4.The market regulation and regulation of the producer-consumer chain.

Policy Regulatory	**Barriers**	1. Lack of soil conservation, maintenence and improvement activities. 2. Lack of republican, regional, and community level projects. 3. Not common and targeted management of implemented programs.	1. Not realistic policies and measures aimed at forest care and protection, expansion of the forest coverage. 2. Not sufficient level of comparability of national and international projects. 3. Forest inefficient management, lack of oversight and counting systems.	1 Lack of soil conservation, maintenence and improvement activities. 2. Lack of republican, regional and community level projects. 3. Not targeted use of lands.
	Measures	1 - Regulation in vegetation improvem e destruction and creation of new vegetation. 2.Assets accounting, classification, mapping and sustainable management programs. 3. One center management method in project implementation.	1 . Inve organizations. 2. Application of accounting, monitoring and oversight system.	1. Development of land preservation, care and improvement activities, and its mandatory use. 2. Development of Perennial crops cultivation strategy and obligatory and targeted use of lands.
Institutional	**Barriers**	1.Land privatization and low productivity pasture management. 2. Low fees charged for the use of meadows and pastures. 3. Lack of oversight, control.	1. Lack of surveillance and insufficient measures of care, tree planting and tree cultivation. 2. Sparate management of forest lands by various agencies. 3. Lack of vertical and horizontal relations in the management system. 4. Not sufficient compatibility of national and international programs. 5. Lack of cooperation between the public and private sectors and civil society, as well as opposite interests amongst them.	1.Land privatization and low productivity of cultivation. 2.Traditional irrigation systems. 3.Lack of procurement mechanisms and systems and its management. 4. Lack of accounting and oversight.
	Measures	1 Transfer of land management to a higher Institutional level. 2. Establishment of financial responsibility for the not efficient use of land. 3.Minimum investment requirement in parallel to land use.	1. Unified plan oversight and control measures for tree planting, forest establishment, maintenance and restoration. 2. One center management of forestland and creation of vertical and horizontal links in the structure and institutional bodies. 3. Ensuring the comparability of national and international projects.	1.Establishment of large farms. 2.Support to new irrigation systems and investment of technologies. 3.State regulation of product storage and realization/export. 4.Application of accounting and surveillance system at regional level.

Information Awareness	**Barriers**	1. Low level of awareness on actual condition of the soil, dangers and consequences. 2. Insufficient information on investment products, soils, markets. 3. Lack of communication between households and beneficiaries at regional and community levels.	1. Lack of reliable and complete information on the actual status of forest and individual species. 2. Insufficient awareness of the population about the threats, risks and consequences related to forest degradation and ecosystem destruction. 3. Lack of communication between the participants and beneficiaries.	1. Lack of information on new technologies for the cultivation of perennial crops. 2. Insufficient information on investment products, soils markets. 3.Lack of communication between households and beneficiaries at regional and community levels.
	Measures	1.Raising of population's awareness by the Ministry of Agericulture and self-governance authorities. 2 .C 3. Ensuring of relevant information on investment and realization markets.	1.Ensuring access to complete and reliable information by the ministries of Agriculture and Natural Protection. 2. Awareness raising amongst the population 3. Promotion to establishment of cooperations. 4. Ensuring information on investment and realization markets.	1. Raising of population's awareness by the Ministry of Agericulture and self-governance authorities. 2. Promotion of cooperations establishment. 3. Ensuring of relevant information on investment and realization markets.
Capacity Building	**Barriers**	1. Not sufficient financial and labour resources available at households and communities. 2 .Lack of specialists. 3. Lack of relevant consultancy.	1. Lack of qualified specialists and technical equipment. 2. Low salaries. 3. Not efficient resources, opportunities of forest accounting and management and old technologies. 4. Lack of forest management modern experience. 5. Not sufficient information on forest management.	1.Not sufficient financial and labour resources available at households and communities. 2. Lack of specialists. 3. Lack of relevant consultancy. 4. Not sufficient resources and possibilities for land cultivation. 5.Lack of planting material, fertilizers and machinery. 6. Lack of irrigation water.

	Measures	1. Creation of machinery and equipment state park in regions to serve communitiy owned machinery. 2. Fulfilling of existing advisory centers with specialists and ensuring access to information. 3.Effective cooperation of public and private sectors.	1. Training of specialists and increase of personnel management skills. 2. Efficient and effective use of resources. 3. Forest Management Concentration. 4. Purchaising of modern technologies on Inventorization, monitoring and control.	1.Creation of machinery and equipment state park in regions to serve communitiy owned machinery. 2.Fulfilling of existing advisory centers with specialists and ensuring access to information. 3.Nursery establishment, provision of planting material and fertilizers subsidies. 4. Creation of irrigation systems, access to irrigation water.
Social Issues	**Barriers**	1. Poverty. 2. Internal and external migration. 4. Health issues. 5. Stagnation of demographic situation.	1. Poverty. 2. Internal and external migration. 3. Hidh tariffs for gas and electricity. 4. Health issues. 5. Stagnation of demographic situation.	1. Poverty. 2. Internal and external migration. 3. Low incomes. 4. Health issues. 5. Stagnation of demographic situation.
	Measures	1. Impact of effective economic and social policies. 2. Demographic situation improvement. 3. Creation of intercommunity cooperation. 4. Access and availability of health services.	1. Impact of effective economic and social policies. 2. Demographic situation improvement. 3. Creation of intercommunity cooperation. 4. Access and availability of health services.	1. Impact of effective economic and social policies. 2. Demographic situation improvement. 3. Creation of intercommunity cooperation. 4. Access and availability of health services.

Table 5. Identified barriers and Proposed measures to overcome barriers to technology transfer in the Waste Management Sector

Technology / Barriers Measures		Utilization of methane from Yerevan city landfill for electricity and heat production	Existing Lusakert biogas plant operation and reissuance organizational technology	Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation
Economic Financial	**Barriers**	1.Lack of promoting and encouraging economic mechanisms. 2.Difficulties with investment acquisition. 3.Unfair competition.	1. Lack of economic promotion mechanisms. 2.Lack of financial means for the complex investment of the technology. 3. Insufficient amount of wastes. 4. Unfair competition.	1.Lack of calculation of the economic benefits, resulted by land recovery. 2.Lack of damage (economic, ecological, health etc) assessment.
	Measures	1. Establishment of economic boosters for production. 2.Establishment of costs reimbursement mechanisms. 3. Assessment of technology risks.	1.Establishment of economic booster mechanisms. 2.Establishment of mild conditions for aquiring finances for technology investment. 3. Provision of risk guarantees or insurance scheme.	1. Calculation of economic benefits of lands recovery. 2.Calculation of the damage resulted by solid waste. 3. Establishment of Civic Climate Investment Fund.
Market Failure and Imperfection	**Barriers**	1.Weak capital market. 2.Low protection of business interests. 3.Inequal market conditions and bariers. 4.Shadow economy.	1.Weak market and lack of competition, 2.Lack of competition in market. 3.Lack of understanding among market key actors.	1.Lack of scientific substantiation for solid waste use. 2.Market gaps in solid waste utilization sector. 3.Lack of information among market key actors.
	Measures	1.Market establishment and development for technologies investment. 2.Establishment of business interests protection mechanisms. 3.Establishment of equal competition conditions for all.	1.Establishment of business interests protection mechanisms. 2.Establishment of equal competition conditions for all.	1.Scientific research for solid waste reuse. 2.Fostering market development. 3.Clarification of market key actors roles.

Policy Regulatory	**Barriers**	1.Lack of political will and clear strategy. 2. Lack of prioritization of the sector. 3. Lack of legal regulation. 4. Fragmentation and overlapping of state authorities' functions.	1. Lack of the sector regulation. 2 Lack of political will among decision making authorities.	1.Lack of solid waste treatment policy. 2.Lack of agricultural lands rehabilitation strategy. 3. Weak regulation of mining. 4. Ignoration of technical norms.
	Measures	1.Strategy development. 2 Highlighting of the sector priorities in the policy and strategy papers, 3. Establishment of legal regulations for the sector.	1. Legal regulations in the sector. 2. Political will among decision making authorities.	1.Establishment of a clear policy on solid waste treatment. 2.Clarification of mining regulation mechanisms. 3. Development of agricultural lands rehabilitation strategy.
Institutional	**Barriers**	1. Lack of institutional regulations. 2. Distribution of the regulation activities among different departments. 3. Lack of cooperation. 4. Corruption risks.	1 Imperfect regulation procedures. 2. Weak cooperation between regulation authorities.	1.Weak cooperation between decision making authorities. 2. Subordination of agricultural sector to the business sector.
	Measures	1.Strenghtening cooperation between departments. 2.Assessment of corruption risks and development of procedures for elimination	1.Clarification of regulatory authorities actions and cooperation strenghtening.	1.Clarification of regulatory authorities actions and cooperation strenghtening. 2.Highlighting the role of the agriculture sector.
Information Awareness	**Barriers**	1.Media inactivity, lack of awareness. 2. Low level contiousness. 3. Lack of awareness at all levels. 4. Low level of interest among citizens.	1. Lack of awareness at all levels. 2. Media inactivity, lack of awareness.	1. Lack of scientific substantiations for solid waste use. 2. Lack of awareness on the impacts.
	Measures	1. Awareness raising campaign, involvement of Mass Media. 2. Distribution of information by all means and at all levels.	1. Distribution of information by all means and at all levels. 2 Raising awareness, involvement of Mass Media.	1. Development and distribution of scientific proposals. 2 Raising awareness.

Technology Issues	**Barriers**	1. Lack of support towards technologies investment. 2. Selection of the proper technologies and adaptation to local conditions. 3. Insufficient amount of methane recovered. 4.Unsufficient data.	1.Lack of counselling for technologies investment. 2.Wrong investment of technological procedures. 3.Difficulties with adaptation to the local conditions.	1.Lack of understanding of technologies 2.Poor information sharing betweeen stakeholders.
	Measures	1.Establishment of a favourable environment for technologies investment. 2.Fostering technologies investment. 3.Support in effective and efficient use of the means. 4.Development of a new data collection system.	1. Fostering establishment of technologies investment counselling organizations. 2.Adaption of technologies to local conditions. 3. Processing of the invested technologies.	1.Selection and use of locally acceptable and feasible technologies. 2.Organization of seminars, conferences and roundtables.
Human Skills	**Barriers**	1. Lack of corresponding skills at all levels. 2. Lack of knowledge.	1 Lack of knowledge and skills. 2. Lack of appropriate specialists.	1 Lack of corresponding skills at all levels. 2. Lack of knowledge.
	Measures	1. Trainings need assessment. 2. Development of trainings strategy. 3. Provision of training to specialists at all levels.	1. Training of specialists, qualification classes provision. 2.Increasing the professional interests.	1 Training of specialists, qualification classes provision. 2.Holding trainings on lands recovery and solid waste treatment. 3.Organization of awareness raising and education campaigns.

Armenia has integrated sustainable development principles in its policies and continues to act towards mainstreaming environmental issues in development programs in the context of the country's international environmental commitments. Armenia Development Strategy for 2014- 2025 (ADS) (Annex To RA Government Decree # 442 Ն on March 27, 2014) provides a major set of social and economic development priorities of the country, its objectives, main obstacles and limitations to development, key reforms, and policy mechanisms for the realization of priority goals. The Sustainable Development Program (SDP) had three sets of objectives [**Ref-4**]:

- Reduction of poverty to the extent that poverty will not be a problem of economic development, and extreme poverty will be totally eliminated.
- Elimination of human poverty and ensuring accelerated human development.
- Mitigation of disproportions of the territorial development and acceleration of economic growth.

Chapter 1. Energy sector

1.1 Preliminary targets for technology transfer and diffusion

Armenia has no domestic fossil fuel resources and strongly depends on imported fuel resources to meet its energy demand. Domestic primary energy resources (hydro, nuclear, wind, and biomass) provide 35% of the country's energy demand. In 2012, the Total Primary Energy Supply (TPES) amounted to 3,185.4 thousand toe, of which: natural gas share 60.4%, nuclear energy 18.9%, oil products 9%, hydro energy 6.2% and biomass 5.1%. Primary energy consumption per capita was 1.052 toe, the energy intensity of GDP was 0.320 toe/thousand USD.

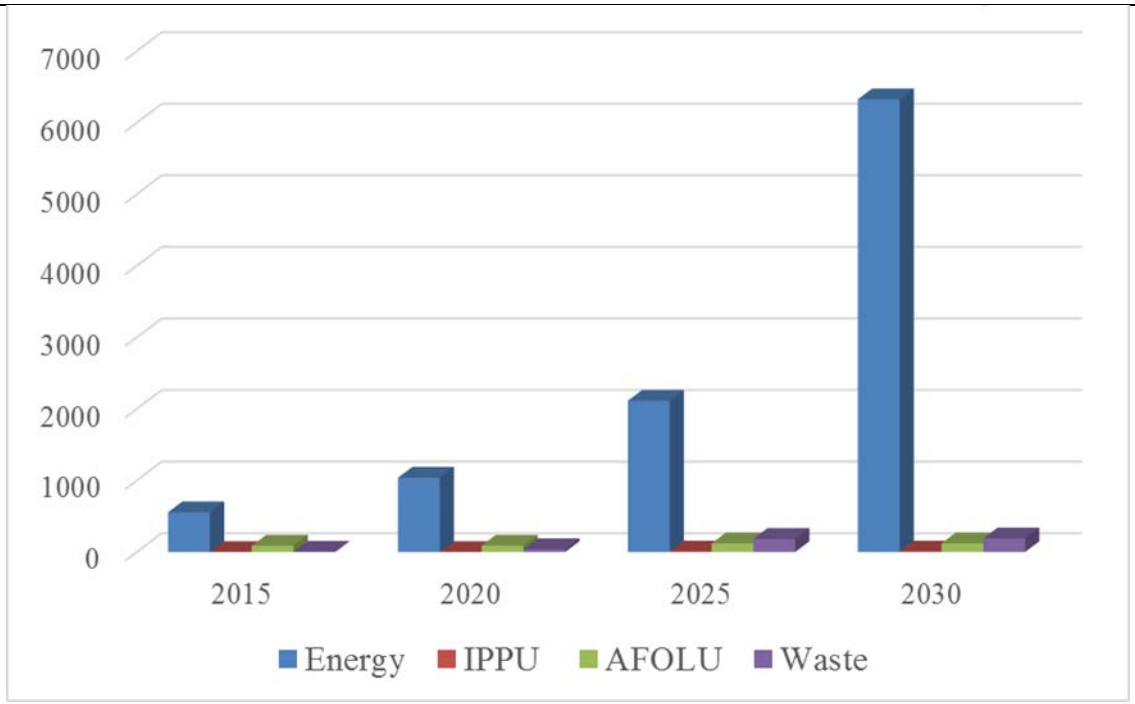
The Energy sector is the largest producer of GHG emissions, its share of the total emissions is 70.3%. The second-largest source of emissions was Agriculture with an emission share of 16.5% followed by IPPU and Waste sectors with shares of 6.7% and 6.4%, correspondingly.

The Energy sector produced the prevailing part of all carbon dioxide emissions, about 95% in 2012. The majority of CO_2 emissions were from electricity generation based on the combustion of natural gas as well as from road transport and residential sector. IPPU accounted for 5% of total CO_2 emissions.

Methane emissions were also mostly from the Energy sector 48.1%, 34.7% were from the AFOLU sector and 17.2% from the Waste management sector. [**Ref 5**]

The second largest source of emissions in the Energy sector is Fugitive emissions of natural gas subcategory that was conditioned by sharp increase of natural gas import due to increased power generation by thermal power plants. Consequently, the major Mitigation potential is in the Energy sector (see **Figure 1**).

Figure 1. Mitigation potential by sectors for 2015 – 2030, Gg $CO_{2\ eq.}$



GHG emissions and Mitigation potentials for 2012 – 2030 were assessed based on the energy consumption forecast according to ADS a long-term development strategy program of RA. The Energy sector development scenarios up to 2030 were developed in compliance with the Armenia Government strategy in the energy sector aimed at increasing the country's energy security and provision of affordable, qualitative, reliable and environmentally friendly energy supply. This strategy is reflected in the most recently adopted strategic papers (2013-2015) and international agreements signed by the country, which along with the demand side EE, energy saving and RE projects and programmes formed the basis for assessing the Energy sector development scenarios [**Ref 6**]. One of the most recently adopted strategic paper is the Second National Energy Efficiency Action Plan (NEEAP). The goal of the NEEAP is to assess the effectiveness of ongoing efforts by the Government, donors, international financial institutions and the private sector to improve the efficiency of energy use since 2010, when Armenia's first NEEAP was developed. The second NEEAP also identifies barriers to more extensive efforts in this direction, proposes measures to overcome these barriers, and offers additional EE improvement measures for the period covering 2015–2020.

The key pillars of the second NEEAP are:

- Reducing energy demand by improving the efficiency of energy end use;
- Improving national energy security by reducing the need for imported energy resources;
- Decreasing the energy content of the key economic outputs to reduce costs and raise the competitiveness of output;
- Addressing growing energy affordability concerns through EE solutions (instead of relying on social aid); and
- Providing impetus for behavioural change by decoupling growth from energy use, and thus enhancing the quality and sustainability of development through the introduction of knowledge and traditions for resource efficiency and smart growth [**Ref 7**].

As mentioned in the First Report the two highly significant for climate change mitigation aspects in Armenia are Nuclear energy and RE further development. The priority of mentioned two spheres is adopted on the highest level in RA, and therefore is out of discussion in the current Report.

Considering the tremendous role of the Energy Sector five technologies were prioritized in the First Report. Preliminary targets for prioritized technologies under energy sector are provided below.

Cogeneration, Small Scale Combined Heat and Power production technology (Capital good)

Restoration of civilized heating supply in RA may be achieved via small-scale cogeneration CHP. Combined Heat and Power generation is a highly efficient form of energy conversion and it can achieve primary energy savings of approximately 40% by compared to the separate purchase of electricity from the national electricity grid and a gas boiler for onsite heating.

The Concept for Ensuring Energy Security includes tasks: to promote energy saving in buildings, to upgrade thermal energy facilities by introducing gas and combined cycle thermal and electric energy generation (co-generation) systems, and to reduce energy losses in networks/the grid.

The technology belongs to "Capital goods" category. The application of the technology includes machinery and equipment used in the production of other goods, e.g. consumer goods, boilers, motors, water heaters or pumps. May also be termed "producer goods". The diffusion of capital goods is predominantly influenced indirectly by politically changed market conditions. Governments have only indirect influence over the transfer and diffusion of technologies in capital goods, which are market-based.

Improving energy efficiency in multi-apartment buildings. Registry creation, development technology

(Other non-market good)

*Due to efficient use of energy resources, environmental protection and the need to reduce GHG emissions: energy saving and EE of the apartment buildings considered a priority policy for the government [**Ref-8**]. More than 36.1% of electrical energy (1.93 billion kWh) generated and up to 25.6 % of Natural Gas (515.4 million m3 or 4.9 billion kWh) imported to the RA are consumed in the housing sector and more than 1,082.8 Gg CO_2 or 20.4% of CO_2 emissions in "Energy" sector [**Ref-9**]. The measures to reduce GHG emissions in the buildings are significantly linked to availability of multi-structured and accurate data on technical specifications of buildings through the creation of housing register (may be the first step).*

The necessity of Registry establishment is defined in the Government Decree on September 29, 2011, resolution multi-protocol N38 on housing management, maintenance and operation of the five-year strategic improvement plan. There are more than 18.0 thousand apartment buildings (27.0 million square m a total area of 435 thousand apartments) in RA. The technology belongs to "Other non-market goods" category. The application of the technology comprises both small-scale and large-scale projects, the software dominates those and orgware components of the technology. Donors and public entities often finance those technologies. The category of other non-market goods comprises three groups: technologies provided by institutions, the creation of new institutions and behavioral change. The diffusion of these technologies is in general financed and facilitated by development actors, such as donor organizations and NGOs, and the main barriers to starting these projects are access to finance and studies for project preparation. On the other hand, the barriers to successful long-term operation are complex and various. The category of other "Other non-market goods" comprises three groups. The first group comprises technologies provided by public institutions. This group greatly resembles publicly provided goods, but usually they are free of charge. The second group comprises the creation of new institutions with the objective of reducing vulnerability. The third group comprises behavioral change at the individual level.

Mandatory realization of the Industrial Energy Audit as a mitigation component technology (Other non-market good)

More than 23.2% of electric energy (1.24 billion kWh) and 12.5% of Natural Gas (252.1 million m3 or 2.4 billion kWh) are consumed in the sector. Manufacturing Industries and Construction and Commercial/Institutional subsector generates 916.2 Gg CO2 or 17.3% of CO2 emissions in "Energy" sector.

Mandatory Energy Audit implementation for the larger enterprises classified by their energy intensity, thermal energy and power consumption will highly contribute to EE and GHG reduction polices. The benefits seems to be Formation of EE and energy saving culture, Decrease of expenses, Increase of the production competitiveness. As well as, Reduction of primary fuel expenses, consequently reduction of GHG emissions.

Reactive capacity (power) compensation in the RA electric energy system technology (Other non-market good)

Reactive Power is a By-product of Alternating Current (AC) System.

Using compensating reactive power technologies in the chain from manufacturers to consumers will bring to: Reduction of active energy losses, Increased efficiency of producing generators and transmission lines usage, Increased conductivity of transmission lines and transformers reduction of voltage falls.

Compensating reactive power for energy consumers in the RA energy system is not regulated, meanwhile it has a significant potential for increasing EE (reducing active power losses). Reactive power is not registered/metered in energy consumers.

Correspondence of natural gas tariff structure to the methodology approved by decision of PSRC technology (Other non-market good)

Natural gas is the main component in fuels, accounting for more than 70% of GHG emissions from fossil

fuels. This is due to the fact that access to natural gas is fairly high in the country about 95%. Natural gas is also largely used in road transportation as it is 2.5 times cheaper than gasoline and there is a developed compressed natural gas (CNG) filling stations network in the country.
Methane fugitive emissions in Armenia occur from operation of natural gas delivery system (accidental leakage, emissions because of maintenance works, technological losses). According to official data natural gas fugitive emissions from transmission and distribution systems accounted for 5.5 - 6.5%. Natural Gas tariffs has a threshold of 10,000 m^3 monthly consumption. Consumption less is paid by 146.7 AMD / m^3 (both revised since 01.07.2016), and more: 257.56 USD/ 1,000 m3 [or 122.3 AMD / m^3 (exchange rate 1 USD =475 AMD, September 2016)]. So it is obvious that a grey zone is formed where the current tariffs structure does not contribute to the realization of energy saving measures by the Natural Gas consuming facilities. The aim is to encourage Armenian State Policy Authorities to reject the current tariffs structure and to base on the methodology adopted in 2004 (Decision #168A) by PSRC that will led to more fair and justified tariffs for Natural Gas.

Main stakeholders related to Energy sector in Armenia are Public Administration Bodies like Ministry of Energy and Natural Resources (MENR), PSRC, MNP, Ministry of Industry, "Armenian Settlement Center" CJSC, Electro power system operator CJSC, "Environmental Project Implementation Unit" State Institution, Academic/Research Institutions like Scientific Research Institute of Energy, American University of Armenia (AUA), State Engineering University of Armenia (SEUA), International Organizations like United National Development Programme (UNDP), Renewable Resources and Energy Efficiency Fund of Armenia (R2E2 Fund), United National Industrial Development Organization (UNIDO), NGOs like "Technology Transfer Association", "Khazer", Private Enterprises like "Shtigen" LLC, "Energocor" LLC, etc. (**see Annex IV**).
Some technologies prioritized in the Energy Sector by the help of MCA method in the first phase of the Project implementation were widely and effectively applied in Armenia's in Soviet Union times. As a way to identify the reasons for the cessation of the use of such technologies, arrangement of informal discussion format among authoritative experts (worked in Soviet Union era, like Robert Tsovyan and Sergey Abrahamyan) in the field was chosen and applied. In order to identify, analyze and conduct study on market barriers and clarify enabling framework for technology diffusion in the Energy sector, working groups were selected. Professional working groups were formed consisted of 3-4 members, comprising relevant experienced specialists (with good knowledge of the exact technology), as well as young professionals with knowledge of international experience (like Vahagn Atayan and Mesrop Kharibyan), in addition representatives of the scientific community were involved. In some cases the discussions were carried out with the technology proposers and authors. Discussions were also held informal club atmosphere, where participants had the free opportunity to exchange ideas, identifying the existing barriers for the rehabilitation of technologies applied over 40 years ago, and the reasons of regress. Expert opinion was formed due the discussions, while appropriate justifications and calculations were presented to the beneficiaries, beforehand developing the agenda of the meetings. The discussions brought together the relevant employees in the management and regulation of state authorities (Ministries of Energy and Natural Resources, Urban development, Economy, Environment, Social affairs, Transport, Health as well as PSRC), specialists, representatives of non-governmental and international organizations.

1.2 Barrier analysis and possible enabling measures for Cogeneration, Small Scale Combined Heat and Power production technology

Strategic plan for long-term development for energy supply sector has not been specified, whereas in densely populated urban areas is beneficial to implement a centralized heating options, based on the most energy-efficient technologies.

According to the Energy Low the areas of production of electricity and thermal energy (except small heat only systems up to 5.8 MW) are under regulation of PSRC and are directed by adopted decisions. Involvement of private investment is not realistic in the absence of favourable tariff setting. It is necessary to define the appropriate methodology to regulate as well as electric and thermal energy tariffs for the population at least.

It is necessary to raise the level of awareness about the benefits of district heating, security, health, comfort, and environmental benefits. Market Mapping of Small Scale CHP is presented in **Figure AI-1**. In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, tariff policy and finance policy, standards, PSRC decisions, energy efficiency programs, import tax exemptions and subsidies. Market actors are main electricity producers Metsamor NPP, Yerevan and Hrazdan TPP, CHP in Avan District of Yerevan and various district heating companies that are absent in now nays but were very significant players in Soviet times on one hand, and residential buildings, public commercial institutions, industrial and manufacturing facilities on the other hand. Among other market actors natural gas suppliers i.e. branches of "Gazprom Armenia" CJSC, "Electric Networks of Armenia" CJSC, Boiler importers and maintenance providers, heat transmission and distribution companies (absent in now nays but were very significant players in Soviet times) and private or public investors in CHP. In the figure collapse and lack of district heating systems in now days, low awareness, high cost of finance, low quality of products and need for research and development are presented as issues. Service providers are government agencies, PSRC, Ministry of Energy, ESCOs, UNDP, R2E2 Fund from one side, and mass media, energy auditors, banks, CHP design entities, Power system operator and donors from the other side. The figure demonstrates the interactions between enabling environment, market actors and service providers.

1.2.1 General description of the technology

The generation of electricity based on useful thermal energy production is known as cogeneration, which is the energy saving technology with a large potential. Cogeneration stations may generate electric and thermal energy using modern gas turbines and aggregates with the cumulative Efficiency Coefficient of 90-92 %: 42-44 % for electric energy, and 48-50% for thermal, accordingly.

There is an inaccurate perception among the society and some experts that the replacement of the power generated on fossil fuel should be restored only with the help of stations based on RE resources. However, from the perspective of organic fuel economy, it has been found that cogeneration stations do not miss, but even exceed the well-known technologies working on the resources.

Thus, 1kW power of a congregation station may annually generate at least 7,500 kWh electricity and accordingly 8,200 kWh thermal energy. Annual average fuel saving will be about 1,100-1,300 m^3 of Natural Gas. Yet, stations with RE resources have less working hours annually, small Hydro Power Plant (SHPP) average 3,000 hours, solar stations 1,800 hours. Estimates show that 1 kW power of a SHPP will save about 1,000 m^3 of natural gas annually, whereas for Solar and Wind power stations the saving does not exceed 800 m^3 of Natural Gas. How great is the demand of useful thermal energy (especially in densely populated urban areas) more obvious are advantages of this technology.

1.2.2 Identification of barriers

Identifying barriers is the process of determining the reasons that hinder the transfer and diffusion of technologies. These include the identification of any missing measures that could have sustained the diffusion.

Obstacles identified in the analysis of CHP technology are conditioned to the vague strategic development projects, which often are based on unrealistic scenarios of economic development. Those overstated RE and ignored the role of developing traditional, efficient technologies. All this is combined with unclear government and the regulatory authority policy and the distrust of citizens in the future. Also that we need to overcome the inferiority complex, which developed this technology introduction in Yerevan, Avan district. Problem Tree based on LPA for CHP is presented in **Figure AII-1.**

1.2.2.1 Economic and financial barriers

Availability to attract financial resources is a prerequisite for the introduction of Environmentally Sound Technology (EST) represented, due to the fact that the provision of design conditions and achievement of the parameters and quantities of the useful heat demand will require some period of time. Consequently, the high rate of interest (business loans offered by the local banks are within the 12-14%) severely complicate the implementation of projects with technology involved. The finance policy and legislation define duties and taxes that lead to the rise of additional costs. This environment is not conducive to create attractive investment climate and ultimately expressed as the high investment cost or lack of access to cheap capital.

1.2.2.2 Non-financial barriers

A serious obstacle for the introduction of cogeneration technology i.e. CHP based on the useful heat demand is the need to change the heat supply ideology in the country formed after collapse of the Soviet Union (with high rate of centralized heating).

In contrast to the RE stations, not a single legal act ensures obligatory purchase of the energy generated by the CHP units as well as there are no certain principles for tariff formation.

One of the major impediment for the restoration of the centralized heating supply using cogeneration stations is the absence of the legal framework for the corresponding field. Energy sector strategy is not comprising heating sector programs and precise setting of priorities. There is a lack of energy audits to recognize and promote the advantages of EST. Besides, poor infrastructure for EST support is another barrier. A serious barrier is the deficient formation and insufficient degree of condominiums development, as an administstive and government body. As a result of analysis the identified barriers have a very negative impact on business environment. The absence of a clear methodology for tariff setting is an additional uncertainty for potential investors and present a serious problem for ongoing programs.

1.2.3 Identified measures

National stakeholders and TNA project implementing team members involved and based on experience obtained during consultations in working group and workshops gather long list of measures identified and proposed. It is necessary to reflect the results of the studies in the field of cogeneration technology investment projects in the country, aimed to develop a conceptual approach and fix it in the development strategic plans of the Energy sector.

It's preferable to eliminate the separate production of electricity in the fossil fuel based energy projects, in which the useful heat demand is exactly available. The policy of promoting the use of RE resources should be

equally distributed on providing electricity and heat production in combined cycle projects. Clear methodology for the determination of tariffs for electric and heat energy production in combined cycle should be established. In addition, reasonable financial interrelations should be ensured. Objective Tree based on LPA for CHP is presented in **Figure AIII-1.**

1.2.3.1 Economic and financial measures

Main economic and financial measures are ensuring reasonable transaction costs, no duties for technologies, new equipment and techniques import and low investment costs.
Small Scale CHP Projects producing electricity and heat in the combined cycle for local use may receive economic support from communities by co-financing or the provision of the necessary lands and territories, liberation of local taxes, exempt from taxes, providing interest-free loans of community or civil revolving funds.

Similarity to the RE stations, a legal act ensuring obligatory purchase of the energy generated by the CHP should be adopted. Certain principles and methodology for tariff formation should be developed.

1.2.3.2 Non-financial measures

It is necessary to undertake comprehensive measures aimed at the revision of the strategic plan for the development of the heating sector, reinforce the ideology of the of electricity and heat combined production and adoption of policy, enhancing introduction of this EST. Non-financial measures identified during working group meetings and workshops seems to be more essential at this stage. Measures developed by the help of LPA are the following: promotion the centralized heating supply options using small CHP stations,
Non-financial measures include sufficient awareness raising among communities and residents, implementation of energy audits to recognize and promote the advantages of the centralized heating and CHP technology (district heating and local for one or several residential building), development of infrastructure for project support, as well as formation and development of homeowners associations and condominiums. The planned amendment to the Law on Energy and adoption of appropriate methodology for setting tariffs will create an enabling framework and favorable environment for technology diffusion.

1.3 Barrier analysis and possible enabling measures for Improving energy efficiency in multi-apartment buildings. Registry creation and development technology

As of 2012, the RA housing stock included 19 thousand multi-apartment buildings (436.6 thousand apartments), including 12 thousand multi-apartment buildings (63%) in urban communities, 7 thousand multi-apartment buildings (37%) in rural areas, as well as 423.6 thousand detached houses, including 154.6 thousand (36%) in urban communities and 269 thousand (64%) in rural communities. 25.2% of multi-apartment buildings and 53.7% of the living area of the multi-apartment buildings accounted for Yerevan city [**Ref 5**]. Market Mapping of Registry creation and development technology is presented in **Figure AI-2**. In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, tariff policy, standards, Customs Union urban regulations and at the same time EU building directives, RA construction norms, energy efficiency programs. Market actors are the main energy suppliers: “Electric Networks of Armenia” CJSC and “Gazprom Armenia” CJSC, firewood and LPG suppliers on one hand, and energy consumers: residential multi-apartment buildings, on the other hand. As a Non Market Good technology, the central role among market actors is given to the Ministry of urban development, meanwhile Yerevan city municipality, condominiums, communities, Ministry of administration and development have

their certain missions. Service providers are energy auditors, design and construction organizations UNDP office in Armenia that is interested in information campaigns, registry software creation, finance services may be financed by civil foundations. The figure demonstrates the interactions between enabling environment, market actors and service providers.

1.3.1 General description of the technology

It is proposed to develop and implement a computerized registry model demonstration project with pilot version of the 3 cities with different climatic zones. The model will be a four-layered: 1) Apartment building, or Apartment building Management body, 2) Local administration, 3) Territorial government, 4) domain authority, the Ministry of Urban development.

The necessity of Registry establishment is defined in the Government Decree on September 29, 2011, resolution multi-protocol N38 on housing management, maintenance and operation of the five-year strategic improvement plan.

It is assumed that the Registry will be included among the buildings of indicators characterizing the economic, technical and energy parameters and data. The program should use the opportunity to choose the "best available technology". The Registry contains information should be transparent, accessible and affordable for the population.

1.3.2 Identification of barriers

Barriers identified by the analysis of Improving EE in multi-apartment buildings, Registry creation and development technology are categorized in 5 groups (instead of 7 identified for the sector) those are financial, institutional, information awareness, technology issues and human skills. The lack of selection methodology of the indicators including Registry Optimization Software which are important in terms of performance and particularly aimed at reducing GHG is one of the main obstacles.

Analysis implemented indicates that like with the previous technology non-financial barriers have superior weight and are more actual at current stage.

Problem Tree based on LPA for Registry creation and development technology is presented in **Figure AII-2.** Market research revealed that enabling framework for this technology is adequate as the institutional background for the creation of the Registry is available and is formed in accordance with relevant Government decisions.

1.3.2.1 Economic and financial barriers

Lack of financial support mechanism is the main financial barrier for the technology. The main Market actors in this case are Ministry of Urban Development, Territorial Administration and Development Ministry, Yerevan City Municipality, other Municipalities, Condominiums and Communities. The technology is categorized as other non-market good and the core barriers should be addressed to the mentioned governmental bodies.

Financial support would be much heavier after implementation of the first stage and creation of the Registry when the inventory of the building stock and the energy saving and GHG emission reduction potential would be completed and available, subsequently the desirable investment for meeting the requirements of construction norms multi-apartment buildings of RA would be visible. As the main barrier identified is the lack of choice of the GHG reduction targeted registry software in terms of optimization criteria, set of parameters, financial indicators, etc.

1.3.2.2 Non-financial barriers

Non-financial barriers for current technology are more actual for this stage, starting from willingness of the governmental bodies to act and including Building technical and energy saving potential information uncertainty due to the lack of registry, problems with the common property management (lighting, heating, envelope, elevator, basements, etc.) in apartment buildings, etc. Insufficient awareness of technologies to increase EE in buildings and the lack of adequate software package for Registry hierarchy structure are another package of barriers.
Barriers regarding the unskilled technical personal and inadequate training are also critical for the technology. Lack of Building Energy Audit specialists and insufficient awareness of technologies to increase EE in buildings are vital.

1.3.3 Identified measures

The registry is aimed at using new technologies to create an integrated information system that will serve as an effective tool for identifying and selecting the priority buildings (for demonstration and pilot projects) that have adequate organizational and technological capacity and the potential for EE measures and GHG emissions reduction.
Taking into consideration that implementation of EE measures in the housing sector has great social importance and great potential for reducing GHG emissions, and given that this sector requires a large-scale and long-term investments, which have realistic pay-back period due to high energy saving potential, thus to implement the program is getting possible and reasonable by using revolving financial resources and engagement of civil funds. Objective Tree based on LPA for Registry creation and development technology is presented in **Figure AIII-2.**

1.3.3.1 Economic and financial measures

Creation of a mechanism for financial assistance and available financial support are the financial measures that will push the process of Registry creation and development of technology aimed at improving EE in multi-apartment buildings. In current case, this is backed by the experience that governments, civil funds and donors that finance non-market technologies have in many cases invested in infrastructure that the beneficiaries would find useful and targeted.
The Registry framework will be included indicators and data characterizing economic, technical and energy parameters of the buildings that will make possible to differentiate and calculate the investments in the building stock. It would be clear and exact to report on the mitigation action implemented in the Residential subsector, and easy to avoid potential double counting of savings/emission reductions with the calculated savings of the EE measures targeted. Funds raising in grants is the primarily issue for this technology introduction and selection of the appropriate methodology and software.

1.3.3.2 Non-financial measures

Registry creation requirement is a prerequisite to increase EE in apartment buildings. On the one hand the main non-financial measures are Public Awareness Raising, Common ownership specification and clarification in multi-apartment buildings, Creation of an appropriate software package for the registry hierarchical structure, Software portfolio investing in selected communities, technology appropriation. And on the other hand that may not be realized without Training of spesialists for the Registry creation and maintenance as well as Building energy audit spesialists preparation and systematically skills upgrading.

1.4 Barrier analysis and possible enabling measures for Mandatory realization of the Industrial Energy Audit as a mitigation component technology

Along with the collapse of the Soviet Union existing administrative levers through which the state and society exercise control over the EE of industrial enterprises were eliminated. While, large enterprises in the developed states, not only publish information on the energy consumption of unit production, but undergo an energy audit and implement measures aimed at increasing EE and GHG reduction.

Energy audits in the RA are implemented in accordance with the RA law "On Energy Saving and Renewable Energy" adopted as HO-122-N of November 9, 2004 and amended as HO-130-N of April 14, 2011 and HO-67 of June 3, 2016. The general procedure of implementing energy audit is specified by "Energy Audit Implementation Procedure" approved by decision #1399-N of August 31, 2006 of the Government of the RA and edited by decisions #1105-N of August 4, 2011 and #1026-N of September 10, 2015.

Energy audit Implementation in RA is voluntary; however, there is a list of measures of EE and energy saving for mandatory application in facilities being constructed with the state funding, as approved by decision #1504-N of December 25, 2014. Energy audit in Armenia can be implemented by state accredited certification bodies (amended HO-67 of June 3, 2016). Market Mapping of Mandatory realization of the Industrial Energy Audit as a mitigation component technology is presented in **Figure AI-3**. In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, national standards, energy tariff policies, PSRC decisions and Energy subsidies, energy efficiency programs, EU Directives and Russian Federation regulations on Energy Audit. Market actors are the main energy suppliers: "Electric Networks of Armenia" CJSC and "Gazprom Armenia" CJSC, Petroleum fuel importers on one hand and energy consumers: large industrial organizations and SME on the other hand. The central role among market actors is given to energy audit providers, that are surrounded with main players that should create the enabling environment i.e. Ministry of energy, Scientific Research Institute of Energy CJSC, The National Institute of Standards, Ministry of Economy, Accredited certification bodies. Service providers are ESCOs, EE technology providers, UNDP in Armenia that have developed two National Standards (ArmST 362-2013 Building energy passport, Basic rules. Standard form and ArmST 371-2016 Methodology for performing energy audit in residential and public buildings), energy efficiency funds from one side, and information campaigns, financial services providers, technical design companies and international organizations as well from the other side. The figure demonstrates the interactions between enabling environment, market actors and service providers.

1.4.1 General description of the technology

More than hundreds of energy audits were implemented in Armenia in the last five years, mainly of residential and public buildings, heating systems, street lighting and industrial sectors. Energy audits are mainly carried out in the frames of the following EE related projects financed/implemented by international organizations.

In the frames of "Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 project, energy audits of more than 10 multi-apartment buildings were implemented. Based on National Standard on Building Energy Passport energy passports (AST 362-2013) for 15 buildings compiled. (http://www.nature-ic.am/improving-ee-in-buildings-reports-and-publications/; http://www.nature-ic.am/wp-content/uploads/2013/10/Avan-DSK-Audit-Report-ENG.pdf). Within activities of "Green Urban Lighting" UNDP-GEF/00074869 project energy audits of street lighting systems in seven cities/towns were completed. (http://www.nature-ic.am/publications-and-reports-gul-project /)

Specialists of R2E2 performed energy audits in public buildings in the regions of Armenia to determine their eligibility for a loan from the World Bank for improving building energy performance. (http://r2e2.am/en/2011/06/r2e2-projects-2/). The Habitat for Humanity Armenia in the frames of the projects procured building energy audit services (http://www.habitat.am/index.php/en/).
As per industrial audits, loan contracts recently signed can be highlighted: of Green for Growth Fund (GGF) with three Armenian banks (AraratBank, InecoBank, ACBA-Credit Agricole Bank) and of ADF (French Development Agency) with Armenian First Mortgage Company. The goal of the credit tool is to finance energy saving loans that are given based on energy audit results.
Currently National Standard AST 371-2016 "Methodology for performing energy audit in residential and public buildings" is developed in the frames of "Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 project based on EU standard EN 16247-2.
Energy audit is a key decision-making tool for energy management. It attempts to balance total energy inputs with use, and identifies all the energy streams in a facility. Industrial Energy Audit is a comprehensive investigation that seeks to identify all cost-effective investment opportunities through a combination of engineering analysis of energy-using systems and economic analysis of possible energy-saving measures. Both energy and non-energy investments are rated against a single set of financial criteria. The projected operating savings from the implementation of energy projects should be developed to provide a high level of confidence and guaranteed savings as well. Audit should rely on a complete engineering study in order to detail the technical and economic issues necessary to justify investments.

1.4.2 Identification of barriers

Industrial Energy Audit should undergo institutional changes, new set of EE targets and minimum energy saving requirements are necessary. Lack of the obligatory requirement of enterprise energy related activity results annual publication for large industrial enterprises, as well as the rate/extend should be defined to mandatory requirement for realization of the Industrial Energy Audit as a Climate Change mitigation measure.
Serious obstacle is the fact that Armenia has not energy audit certified and accredited organizations, simultaneously the existing companies do not have enough experience. Therefore, in the initial phase, financial support will be required for Energy Audit market formation. On the one side to avoid the unreasonable price for Energy Audit and on the one side to ensure reasonable profit for the Energy Auditors.
Problem Tree based on LPA for Mandatory realization of the Industrial Energy Audit as a mitigation component technology is presented in **Figure AII-3**.

1.4.2.1 Economic and financial barriers

Lack of the Specialized Market for Energy Auditors and lack of financial support mechanisms to stimulate the diffusion of Energy Audit in the industrial and other enterprises is the main economic and financial barrier for the technology difusion. Another financial obstacle for large industrial enterprises may be the payment (depending on the amount) requirement for mandatary energy audit (especially on not market based prices). There is also a lack of introduction of Energy Service Performance Contracting (ESPC) and other financing tools in the Industry and other spheres.
Financial barrier for Energy Auditing Company is also considered to be the need to purchase expensive audit portable and durable control tools and metering equipment. Measuring devices for ultra-sound flow or heat meters, energy analyzers, infrared cameras, gas analyzers, etc. are rather expensive and require experienced operators.

1.4.2.2 Non-financial barriers

Non-financial barriers of the technology are absence of Requirement in the Energy Law for Energy Audit Mandatory Implementation, Lack of sufficient Technical Regulation and National Standards (developed revised and harmonized) for Minimum Energy Efficiency Requirements, deficiency of Technology Experience, Lack of Relevant certified Experts and Professional Organizations [Energy Service Companies (ESCOs) and Energy Service Providers (ESPs)], Insufficient Awareness of Industrial Companies.
Industrial companies are not classified by the energy intensity criteria and requirement of publishing the specific indicators of production as well as prescribed measures (revealed during periodically executed Energy Audits) implementation schedule.

1.4.3 Identified measures

Identifying relevant measures is the procedure of analyzing necessary activities to be taken in order to overcome current barriers to the implementation of prioritized technologies. For the identification of appropriate measures, detailed analysis of current practices at national and international level was provided.
The institutional framework should be upgraded, defining a requirement for large energy consumer enterprises to public a reliable and transparent information about absolute and specific energy consumption data. Major industrial enterprises classification by energy indicators should be undertaken.
Financial support for companies subject to audit/assessment should be provided (by means of grants, interest-free loans, soft loans, etc.). The tax and customs privileges for companies operating in the energy industry, or making the initial stages, should be applied
As an important measure is offered to strengthen the implementation of the state financed programs for expert's trainings. These measures should have sustained the diffusion of the EST. Objective Tree based on LPA for Mandatory realization of the Industrial Energy Audit as a mitigation component technology is presented in **Figure AIII-3.** The amendments to the Law on Energy Efficiency and Renewable Energy, definition of audit procedure and regularity by Government decisions based on developed ArmST, adoption of technical regulations will create an appropriate enabling framework, which in its turn will provide the necessary conditions for the implementation of the proposed technology.

1.4.3.1 Economic and financial measures

In order to overcome existing economic and financial barriers to the implementation of the Industrial Energy Audit technology, the following measures should be provided: Establishment of the market of the energy audit conducting by specialized organizations and financial support that may be organized by means of Creation of revolving funds for the implementation of Energy audits. Government also should support the activities in this field by implementing different monetary, fiscal and tax policies providing through different funds, private sources, and commercial banks long-term and low-interest loans for implementation of the EE measures discovered during periodically executed Energy Audits. International funds and organizations should continue supporting existing (and transfer new ones) EE programs and creativities. Implementation of the financial incentive mechanisms (tax and customs incentives, low-interest loans aimed at improving energy efficiency) for the introduction of technology would be a sufficient condition (along with necessary ones) that would lead to success.

1.4.3.2 Non-financial measures

In order to overcome existing non-financial barriers to the implementation of Industrial Energy Audit technology, the following measures should be provided: Stipulation of Industrial Energy Audit mandatory implementation requirement in the RA law "On Energy Saving and Renewable Energy", Setting of minimum standards for EE in buildings (industrial and production processes), in RA construction norms (industrial standards), Energy-saving technologies experience and application research and domestication, Demonstration (piloting) programs implementation and advertisement, Adequate training and encouraging the establishment of professional organizations. Industrial companies Awareness Raising, etc. Mandatory energy audit for industrial enterprises may be set only by institutional changes, as shown in the diagram for market mapping analysis.

1.5 Barrier analysis and possible enabling measures for Reactive capacity (power) compensation in the RA electric energy system technology

Compensation of reactive power, seems to be excluded from the Energy regulatory area. Reactive energy flows available in the energy system are taken into account when calculating the energy losses, but no measures are undertaken (technical, institutional, etc.) to minimize their negative consequences.
After collapse of the Soviet Union energy system reactive power compensation at the consumers side is not regulated in any way, whereas contains significant potential for EE (reducing active power losses).
Reactive energy is not metered and recorded at the consumer side and therefore the accurate information on values of the power factors are absent. Market Mapping of Reactive capacity (power) compensation in the RA electric energy system technology is presented in **Figure AI-4.** In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, energy tariff policy, PSRC decisions, standards, finance policy, tax policies, energy subsidies and energy efficiency programs. Market actors are energy generation stations NPP, TPPs and HPPs, power transmission "High Voltage Electrical Networks" CJSC, electricity distribution "Electric Networks of Armenia" CJSC on one hand, and energy consumers: public commercial consumers and industrial manufacturing facilities on the other hand. As a Non Market Good technology, the central role among market actors is given to the Ministry of Energy and Scientific Research Institute of Energy CJSC, meanwhile maintenance providers; reactive power compensator whole sellers and importers have their significant role. Facilitation of linkages between certain actors, provision of financial service and information campaigns should be arranged and created with participation of energy efficiency funds, "Settlement Center" CJSC, "Electric power system operator" CJSC and technical design companies, lead and regulated by PSRC. The figure demonstrates the interactions between enabling environment, market actors and service providers.

1.5.1 General description of the technology

Modern compensator (adjuster) represent the condenser battery, whose capacity can be automatically changed smoothly, depending on the amount of reactive power and compensate the latter.
It is well known that capacitive reactive power that is generated in the energy transmission network high-voltage lines in some regimes may exceed the inductive power/capacity. In this case, operation of the additional capacities at consumer's side may cause problems in energy system, leading to an unacceptable voltage rise.
Notably, that in the case of small values of power factor (cos φ) active power losses in the transmission lines caused in both cases, inductive and capacitive natures of reactive power.

The solution of this problem is to implement a package of measures, on one hand reactive power with capacitive nature is compensated by means of controlled reactors in the energy system, and on the other hand inductive nature reactive power is compensated by installation of automatic controlled condenser batteries at consumer's side.

1.5.2 Identification of barriers

As in the previous cases, the initial step in the process of barrier analysis, was desk study of policy papers and other relevant documents conducted in order to identify the primary reasons why the EST is not currently implemented. The main reasons seems to be both technical and financial barriers.
The main explanations appears to be that there is no any requirement for registration and compensation of the reactive energy in the existing Technical regulations. As well as no provisions regarding reactive energy management (incentives, sanctions, etc.) or tariff-setting mechanisms are established. Problem Tree based on LPA for Reactive capacity (power) compensation in the RA electric energy system technology is presented in **Figure AII-4.** Up to 35% of total electricity in RA is generated by fossil fuel combustion. Therefore, appropriate institutional changes (Government decisions, Technical regulations PSRC settings, National Standards,) will create an enabling framework for technology implementation and benefit of the reduction of emissions.

1.5.2.1 Economic and financial barriers

After compiling a long list of barriers, screen and analyzing the barriers during the discussions, the working group comprehend that for technology implementation financial support may be needed for some inevitable expenses, e.g. for the technology introduction will be required of to acquire and install the appropriate equipment (compensators, reactors, etc.). Financial support can be needed for best practice research and adoption, localization and adaptation. Other barriers are the need for investments in the energy system at all levels, including consumers. Lack of economic incentive mechanisms for the technology is another obstacle.
At certain intervals the need would arises to carry out calculations in the power grid control points/centers to determine the optimal values of coefficients that would also need expenses, and may be classified as a financial barrier.

1.5.2.2 Non-financial barriers

Institutional framework for reactive energy (power) compensation is absent in the RA. No normative document defines reactive energy metering, and the metering arrangements as well. Determination of desired values for power coefficients and those maintenance requirements, methodology issues and periodically implementation are also of great importance.
Among the impediments should be mentioned the lack of specialized human resources, lack of technology experience and low awareness within electricity consumers. The absence of regulation of reactive power compensation (institutional barrier) leads to the fact that the reactive power is nor metered nether considered, and therefore cannot be neutralized (compensated) those negative effects on the technological losses of energy system.

1.5.3 Identified measures

For the implementation of reactive power compensation technology (power) it is necessary to fix the requirement in the technical regulations, and to define the mechanisms and responsible persons and entities

for its implementation, develop and establish a timetable for implementation, as well as describe the required values for the capacity coefficients and their maintenance requirements.
The introduction of technology in the energy sector are clearly separated the duties of operators, the requirements for reconstruction and further develop new customers, defining the relevant provisions.
For ensuring EST implementation, responsibilities and contributions between power system operators/actors should be clearly distinguished and fixed. New and renewed consumer requirements should be elaborated in accordance with the provisions set.
Regulator should define regulations and requirements for reactive energy metering, from producer to consumer. Tariff setting adequate methodology should be developed and set acceptable rates/tariffs for reactive energy for consumer groups.
Objective Tree based on LPA for Reactive capacity (power) compensation in the RA electric energy system technology is presented in **Figure AIII-4.**

1.5.3.1 Economic and financial measures

Regarding economic and financial measures, it could be mentioned the establishment of mechanisms for economic incentives and assumption of reactive energy tariffs.
Implementation of the planned measures will require investments in transmission and distribution companies appropriate to their field of responsibility, for acquisition and installation of equipment purchased for reactive power compensation. It will also require certain costs associated with the technology transfer, technology experience and international best practices study, as well EST adaptation and harmonization. The enabling of financial support mechanisms (leasing, customs and other privileges) relating to the acquisition of necessary equipment (compensators) will also facilitate the creation of a favorable environment.

1.5.3.2 Non-financial measures

In order to overcome existing non-financial barriers to the implementation of Reactive capacity (power) compensation technology the following measures should be provided and implemented: the distribution of functions between the entities involved in the process of compensating reactive power (by the ministry responsible in the sector), set of the appropriate market regulations arrangements (by PSRC), as well as the compensation claim set in the “Electrical appliance rules” technical regulation. RA Grid Rules need to be developed, which will launch the adoption of reactive energy compensation process in RA.
Awareness raising of the technical staff of Transmission and Distribution companies and Industrial companies is another vital measure. Appropriate trainings and preparation of professionals, Study of the experience in developed countries. Import of Reactive power new generation compensators is one of the main Non-financial measures for the technology diffusion.

1.6 Barrier analysis and possible enabling measures for Correspondence of natural gas tariff structure to the methodology approved by decision of Public Services Regulatory Commission (PSRC) technology

The main issue that was discussed and observed during the working group and stakeholder meetings was the extensive work that has to be planned and implemented within the framework and in accordance with the methodology established by the RSRC decision for new tariff structure recognition.
The methodology requires extensive data collection, processing and introducing new formats of information. Classification of consumer groups based on the annual actual consumption, transmission and distribution natural gas pipeline structure and information analysis should be undertaken. Furthermore, tariffs should be

calculated and adopted, based on these groups as well as the respective volumes of annual natural gas annual consumption.
Naturally there will be a need to study the international best practices and adaptation to the local conditions with international experts' engagement.
Implementation of this amount of work for the PSRC staff, along with carrying out its daily functions seems to be impossible. Therefore, it will be necessary to involve specialists with the appropriate experience, which will require additional financial costs. Market mapping of natural gas tariff structure technology is presented in **Figure AI-5.** In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, national standards, energy tariff policies, PSRC decisions, Energy subsidies and energy efficiency programs. Natural gas is the main component in fuels accounting for over 80% of GHG emissions from fossil fuels. This is because access to natural gas is high in the country about 95%. Therefore, market actors are "Gazprom Armenia" CJSC with 15 regional gas distribution branches, natural gas transportation "Transgas LLC", "AEG Service" LLC domestic gas supply systems maintenance in the entire territory of the RA from one side, public commercial consumers, industrial large consumers, small and medium size boiler houses from the other side. As a Non Market Good technology, the central role among market actors belongs to PSRC and International consulting companies. Research and development, transmission and distribution losses, inadequate maintenance of networks, fugitive emissions (accounted for around 6% of imported gas) are presented as issues. Service providers are energy auditors, energy efficiency funds, information campaigns, international donor organizations, technical design companies (calculation normative losses) UNDP in Armenia (one of the initiators of the problem and GHG inventory implementing agency). Information campaigns should be arranged, Natural gas tariff structure methodology should be created and enforced. The figure demonstrates the interactions between enabling environment, market actors and service providers.

1.6.1 General description of the technology

Methodology established by the PSRC decision is scheduled to perform a selection of the structure of tariffs for natural gas supply system (transmission, distribution and dispatching tariffs, as well as the retail prices of consumer groups), to classify customers according to consumer groups (population and household, commercial consumers, compressed natural gas filling stations, thermal power plants, large industrial consumers, etc.).
Large-scale information should be obtained and analyzed by the predetermined directions and distribution of expenditure by consumer groups should be performed.
Acceptable and fair tariffs for all participants, i.e. consumer groups and the supplier should be determined.

1.6.2 Identification of barriers

The main difficulty is the limited resources of the PSRC staff working for the introduction of technology, which in turn causes the need for financial support for the development of information and best practices research, as well as for the implementation of the core activities. Problem Tree based on LPA for natural gas tariff structure technology is presented in **Figure AII-5**. The existing institutional framework for initiating any way impairs the tariff review process. Described framework is favorable for the introduction of technology in all aspects: adequate institutional framework, public demand and need for natural gas tariff structure that enhances energy efficiency.

1.6.2.1 Economic and financial barriers

As a financial problem to consider the fact that the budget does not provide funding for such large-scale work of the PSRC, which is holding back the initiative.
In this regard, a good incentive for financial assistance from international donor organizations should be used to start the process of revising the tariff structure.
The need for financial support, lack of sufficient financial resources of PSRC to attract relevant specialists and the current tariff structure misrepresents market principles, in some cases, to waste gas becomes economically profitable. Mentioned barriers were emphasized by the sector professionals during consultations and by the stakeholders during the workshops for Economic and financial, as well as Market Failure and Imperfection categories.

1.6.2.2 Non-financial barriers

The main serious obstacle mentioned impeding to expect the best results is the lack of experience in market based tariff system establishment. In this regard, there is need for the involvement of international consultants.
In natural gas tariff calculations many components are participating, starting from the country border (import from Russia through Georgia and from Iran) transmission pipeline, underground gas storage station (UGSS) and distribution network, up to consumers categorized in different groups.
Besides, considering the country's gas supply network structure and physical-chemical parameters of the imported natural gas many other factors like investments and loans, currency rate, operation costs, actually imported and predicted volumes, losses in gas transmission and distribution networks etc. should be taken into account. The new tariff system, in turn, will need to adopt new regulations and review the numerous guidelines, which also hampers the implementation of this technology.

1.6.3 Identified measures

After PSRC advance negotiations with international donor organizations, the annual work program, for the implementation of the natural gas tariff setting, shall provide a timetable for the review of the arrangement and the new tariff structure categorized consumer groups.
It should be developed and implemented according the new format for reporting of information outlined in the approved methodology (PSRC decision 168-A of 21.12.2004), while taking the necessary actions to ensure the accuracy of the information.
Service providers and end-users tariffs calculations (annual based) should be agreed (in discussions format) with interested parties and the state body in the field of energy policy (Ministry of Energy).
Objective Tree based on LPA for natural gas tariff structure technology is presented in **Figure AIII-5**

1.6.3.1 Economic and financial measures

By means of financial assistance of international donor organizations an experienced consultant in the relevant sphere should be selected who should carry out the direct participation and initiated the process of revising the tariff structure. As of analysis the identified barriers: insufficient staff resources of the PSRC, the need to study the global experience and engage international consultants, can be overcome within the framework of international cooperation.

1.6.3.2 Non-financial measures

In order to overcome existing non-financial barriers PSRC should (after receiving the support and financial assistance) implement a large-scale of work for the introduction of a new tariff system. After adoption of the tariff system the numerous regulations and guidelines should be reviewed and new ones should be developed as well. In addition, trainings for regulatory experts should be organized. Developed countries experience of setting natural gas tariffs, data acquisition and processing should be applied.

1.7 Linkages of the barriers identified

Barriers related to technologies implementation in the Energy sector have been identified in seven categories: 1) Economic, Financial, 2) Market Failure and Imperfection, 3) Policy, Regulatory, 4) Institutional, 5) Information, Awareness, 6) Technology Issues, 7) Human Skills (**see Table1**).
Market mappings of Energy Sector technologies are presented in **Figures AI-1, AI-2, AI-3, AI-4, and AI-5.**
Combining the identified barriers in the energy sector some particular regularity is notable. Barriers identified are profound, complex to recognize and difficult for perception.
It is noteworthy that all technologies of the sector to some extent were implemented in all the republics of the former Soviet Union. And after collapse of the latter preserved only in a certain amount only in those independent states where Energy reforms were conducted without unnecessary haste and with minimum shocks (Russia, Ukraine, Kazakhstan, and Belarus).
The nature of the barriers, mainly are considered to be institutional and regulatory those are conditioned by forms of ownership, change in management systems, lack professionalism the upper echelons of these systems, etc.
Identified barriers are also conditioned existence of other many current issues requiring urgent solution The daily workload with such issues leads to situational management, overriding strategic objectives, postponing solutions .
The identified obstacles in the sector are linked to the extent that they are caused by the vagueness of the strategic plans adopted by the government, lack of legislative regulations, implementation of the requirements are not legally stipulation and lack enforcement as well.
Problem Trees based on LPA for Energy Sector five technologies are presented in **Figures AII-1, AII-2, AII-3, AII-4, and AII-5.**

1.8 Enabling framework for overcoming the barriers in Energy Sector

Identified barriers and proposed measures to overcome barriers to technology transfer in the Energy Sector are summarized and presented in **Table 2**.
The effective way to overcome barriers to identify technology, in the Energy sector is to study and check the international best practices and adaptation, harmonization.
All the technologies are successfully used in developed countries, contributing to the development of the national economy.
This experience was reviewed and investigated by the country's government, research institutions, as well as by individual experts.
Results of checks are provided with government agencies, as well as the general public and wider community.
As a favourable factor should be mentioned the readiness of the government for participation to climate change mitigation international agreements and efforts for approval and adaptation.
Important factors for creation encouraging environment is the country's engineering, technical and scientific potential, as well as the effective assistance of relevant international organizations.

Objective Trees based on LPA for Energy Sector five prioritised technologies are presented in **Figures AIII-1, AIII-2, AIII-3, AIII-4, and AIII-5.**

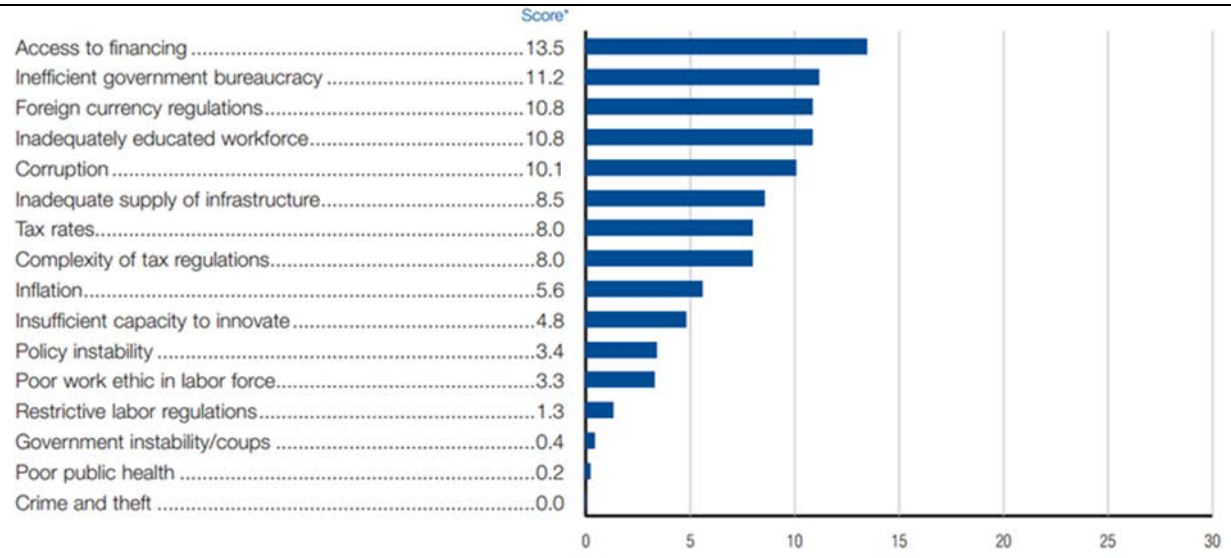
Chapter 2. Industry sector

2.1 Preliminary targets for technology transfer and diffusion

After the collapse of the Soviet Union followed by the sharp economic downturn (53%) of 1991-1993, Armenia managed to overcome the difficulties of the transition period and to ensure economic growth. During 1995-2000, Armenia's GDP increased annually by 5.4% and between 2001-2006 the average annual GDP growth amounted to 12.4%. This annual growth slowed to 2.2%, on average, during 2007-2010 due to the worldwide financial crisis. The average annual growth for 2010-2013 was 4.4%. The average annual growth of industrial production in 2000-2005 and 2006-2012 was 8% and 3% respectively. After the sharp decline of GHG emissions in 2009 from IPPU sector there was a some increase in construction volumes and cement production and consequently GHG emissions in 2010 while increase of emissions in 2011 and 2012 from IPPU sector (in 2012 the emissions were 21.8% higher than in 2010.) was due to the increase of F-gases (HFC, PFC, SF_6) emissions [**Ref 10**].

The most problematic factors for doing business in Armenia according to the World Economic Forum is presented in **Figure 2.** From the list of factors, respondents were asked to select the five most problematic for doing business in the country and to rank them between 1 (most problematic) and 5. The score corresponds to the responses weighted according to their rankings.

Figure 2. The most problematic factors for doing business in Armenia according to the World Economic Forum: Global Competitiveness Report 2015-2016



http://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf

Industrial production in Armenian by types of economic activities as of 2012 had the following structure: processing industries (62.3%), mining industries (17.2%), electricity, gas, and steam supply (18.9%), water supply, sewerage and waste management (1.6%). The processing industries included the following sectors: food (54%), metallurgy (23.5%), construction materials (6.9%), chemical (4.1%), machine building (4.4%), jewellery (1.5%), light industry (1.1%) and other (4.5%) [**Ref 10**].

Economic growth ensure is vital for RA. Economic growth would have positive impact on society, provide crucial benefits like reduction in poverty, increased standards of living, etc.

Considering the leading industries and their strategic importance three technologies were prioritized in the First Report for Industry sector including the chemical industry. Production and usage of photo luminescent materials with long-term lightening and solar water heaters seems to be attractive taking into account the potential scale of the application, it will significantly reduce energy consumption and GHG emissions as well. Preliminary targets for prioritized technologies under Industry sector are provided below.

Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry). technology (Publicly provided goods)

Chemistry is of strategic importance to the country, that is why the importance to revive chemistry. Huge positive impact on Republic economy development, economic growth ensure and creation of new jobs, comprising good prospects for small-scale chemistry development. The new EST will reduce CO_2 and other GHG emissions.

The technology belongs to "Publicly provided goods" category. The application of the technology includes technologies characterized by large investments, general public ownership, and production of goods and services available (free or paid) to the public or a large group of persons. The diffusion of publicly provided goods is influenced directly though political decisions taken by governments and public entities regarding the implementation of specific projects. The projects in the publicly provided goods category are often large in scale and usually the hardware element is high in this category. The concept of "publicly provided goods" should not be confused with the concept of "public goods", which in conventional economics denotes non-excludable goods (such as wind, sunlight, etc.). Technologies from this category are often financed by donors and public entities. Governments usually take decisions on investments in technologies in this category. This limits the barriers to taking decisions on the implementation of these technologies to difficulties of access to finance and the low level of information available for establishing a decision base, such as feasibility studies, cost-benefit analyses and environmental impact assessments.

Production and usage of photo luminescent materials with long-term lightening technology (Consumer goods)

Marking the roads, boards, underground crossings and building entrance stairs with photo luminescent materials will increase the safety level for pedestrians and drivers. Taking into account the potential scale of the application, particularly for urban economy, it will significantly reduce energy consumption and capital costs. GHG emission reduction as a result of EST implementation.

The technology belongs to "Consumer goods" category. The application of the technology includes goods and products specifically intended for the mass market; households, businesses and institutions and purchased by (private) consumers. The diffusion of consumer goods is predominantly influenced indirectly by politically changed market conditions. Governments have only indirect influence over the transfer and diffusion of technologies in consumer goods, which are market-based. The scope for government interventions to promote a particular consumer goods technology is related to the broad enabling framework conditions.

New type of Entirely Plastic solar water heater technology (Consumer goods)

Proposed plastic solar water heaters will allow the low-income people to buy and use these systems and to obtain hot water in summer time for washing and for everyday use. The price of entirely plastic solar water collectors is much cheaper and will be incomparably available to a wider population. Besides, the market analysis shows that there is a great demand in such systems for food processing facilities, restaurants, hotels, schools, chemical enterprises as well. Solar water heaters are considered as

environmentally clean because no fossil fuel is required for their operation.

Main stakeholders related to Industry sector in Armenia are Public Administration Bodies like Ministry of Industry, MNP, MENR, PSRC, Environmental Project Implementation Unit State Institution, Academic/Research Institutions like AUA, SEUA, Scientific Research Institute of Energy, Armenian National Agrarian University, International Organizations like UNDP, UNIDO, REC Caucasus, NGOs like Technology Transfer Association, Khazer, Private Enterprises like, Nairit CSJC, Tesla Kristals LLC, Arevik LLC, Vink LTD, Zettalumen LLC, Shtigen LLC, etc. (**see Annex IV**).

In order to identify mitigation technologies against the effects of global climate change, analyze and conduct study on market barriers and clarify enabling framework for technology diffusion in in the Industry sector, two working groups were selected. Those methodically studied the nature of the issues: first in suggested (Publicly provided goods) Chemical industry or Production of synthetic rubbers from butadiene instead using natural gas technology and the second in two technologies (Consumer goods): Production and usage of photo luminescent materials with long-term lightening technology and New type of Entirely Plastic solar water heater technology.

Barriers identification and clarifications on enabling framework working group for the Chemical industry or Production of synthetic rubbers from butadiene instead using natural gas technology includes the leading technologists and skilled technicians, professionals (Tigran Sargsyan, Norik Sukiasyan, Bayandur Ohanyan, Karlen Grigoryan) of the Chemical industry plants for various years, as well as specialized lawyers in the field of property rights.

Discussions on the investment markets and clarifications on enabling framework for the two technologies diffusion were united in one working group due to the fact that there was a common global problem i.e. specification of sales markets of goods produced, and selection of scope for highly effective realization. To this end, a working group were involved with experts on market promotion and formed a group of 6 persons (comprising the authors of the technologies Ashot Margaryan founder of Tesla Kristals LLC and Onik Gasparyan director of Arevik LLC).

Proposals elaborated during the discussions were presented to the stakeholders meeting by the experts and primarily approved.

2.2 Barrier analysis and possible enabling measures for Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry) technology

In the Soviet times, Armenia used to be the republic with highly developed chemical industry. The largest plants (the most important among which is, certainly, “Nairit”), chemical complexes in Vannadzor, Kapan etc. provided with their products not only the Soviet Union, but also the countries all over the world. A lot of chemical plants and plants in other branches of industry were known to operate based on core plants production. There were seventeen large enterprises working on the basis the largest plants outputs and production residues. Specifically, in 1987, the plant accounted for a large share of global synthetic rubber production. The plant was shut down in 1989 and restarted operations at a smaller capacity in 1993. Several attempts were made to re-commission the plant to its full capacity, but most of these attempts failed given the underlying economics. The plant has not been operational since 2011 and is in major financial distress.

"Nairit" was the only plant in the entire Central and Eastern European region for polychloroprene rubber. At present, the plant is shut down and additional investment is required before production may be resumed [**Ref-11**]. Market mapping of Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry) technology is presented in **Figure AI-6.** In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, standards, tariff policies and tax policies, PSRC decisions, energy efficiency programs, decisions of the state commission for the protection of economic competition and subsidies. Market actors on one hand are natural gas and electricity suppliers, butadiene suppliers, R&D institutions, commercial and service infrastructure, other manufacturers and exporters of synthetic rubber and civil society as well. In the middle are Synthetic rubber production facility, international consulting companies and private and public investors that are surrounded with other producers of Synthetic rubber byproducts (Chloroprene rubber and Latexes, Acetic, Propionic, Formic, Hydrochloride, acids, Liquid chlorine, Caustic soda, Sodium chloride, Dimetil Vyniletinyl Carbinol, etc.). On the other hand, export and local markets are situated as well as Local chemical product producers based on synthetic rubber production and Niche markets. Service providers are logistic service providers (product diversification, market information), international finance institutions, international organizations, commercial banks (financial services), Ministry of Energy and Ministry of Economy (responsible governmental agencies). The figure demonstrates the interactions between enabling environment, market actors and service providers.

2.2.1 General description of the technology

The salt water solution (NaCl) obtained at the salt mine near Abovyan (city in Armenia, near to Yerevan) is subjected to electrolysis, by direct current impact. Obtained chlorine gas will be liquefied and then evaporated for the purpose of obtaining pure chlorine. The caustic soda and chlorine mixed in water will be forwarded to the special reactor where under the temperature 270 ^{0}C both components will react together with the butadiene vapor. The resulting mixture of vapor called dichlorbutenes (DCB) will be separated in order to extract the dichlorbutenec to be delivered into the isomerization reactor, where after using of catalyst and under the temperature, 115^{0}C cupric naphtenate 1.4-DCB-2 will be transformed into 3.4-DCB-1.

The reaction mixture will be also separated by rectification and product named as 1.4-DCB-2 will be returned into the process while other product named as 3.4-DCB-1 will be for dehydrochlorination under the temperature 90^{0}C. This process of de-hydrochlorination will be conducted in the reactor together of caustic soda and water.

The obtained product (mixture from reaction) will be sent to rectification and the 3.4-DCB-1 that did not participate in reaction will be returned into the process, water and sodium chloride will be separated, the obtained chloroprene will be cleaned, rectified and sent forward for polymerization.

Polymerization of chloroprene takes place in closed system consisting of emulsifiers, polymerization initiator, regulators, stabilizers, etc. Result of polymerization is water-dispersed solution of polychloroprene, called as "latex" and which contains up to 40% of polymer to be extracted from latex by coagulation and freezing. End product is in form of granules and named as "Nairit". Butadiene is a versatile raw material used in the production of a wide variety of synthetic rubbers and polymer resins as well as a few chemical intermediates. When the word butadiene is used, most of the time it refers to 1.3-butadiene with the chemical formula C4H6. Butadiene is a colourless, noncorrosive liquefied gas with a mild aromatic or gasoline-like odour. Butadiene is soluble in alcohol and ether, insoluble in water and polymerizes readily, particularly if oxygen is present. Butadiene is a commodity product of the petrochemical industry which is both explosive and flammable because of its low flash point [Ref-11].

2.2.2 Identification of barriers

There are several serious barriers restraining the development of the project discussed for several times with project main stakeholders, Academic/Research Institutions, Initiative group for factory reissue, by initiative and active participation of TNA national coordinator. In order to identify the existing barriers, consultations with key stakeholders as well as previously leading specialists of the facility in the working groups and individually were conducted. Those barriers were divided into economic/financial and non-financial blocks. Financing of the project requires a significant investment of funds, specification of markets, as well as long-term forecasts of sales prices. For this reason, the negotiations with commercial banks are actuality delayed. Another barrier for the technology implementation is the company's property form decision, as well as the problems associated with registration. Problem Tree based on LPA for Complex processing of Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry) technology is presented in **Figure AII-6**. The study carried out extensive discussions on the investment market for this technology, given the intended wide range of technology products, the necessity of partly maintaining the current technology, uncertainty of ownership and the current bankruptcy. There is a number of problems in the institutional field, including the most essential issue regarding the uncertainties associated with the company's form of property. After clarification, the main issues and making decision for rehabilitation of the production the need would be for the favorable institutional framework and the appropriate changes to reduce the cost of the main product. Negotiations are currently under way aimed at attracting investments.

2.2.2.1 Economic and financial barriers

The economic, in particular financial barriers bear a serious challenge for the implementation of the project. Those barriers refer mainly to 1) the need for financial resources for technology replacement and reissue, 2) Market demand and price uncertainty of the Synthetic rubber, as well as 8 other kind of production, 3. The need to overcome the consequences of failure causes of the reissue attempts in previous years.
Another group of economic and financial barriers is 1) unfavorable tariff policy and in particular lack of natural gas and electricity favorable tariff policy for the sector, 2) unfavorable credit policy, 3) the need for financial resources for technology replacement and reissue.

2.2.2.2 Non-financial barriers

Non-financial barriers refer to policy and regulatory issues. These issues include 1) Chemical industry recovery non-recognizing as a priority for economic development in RA. 2) The lack of favorable tariff, tax and subsidy policies for recovery in the chemical industry. The sector is not regulated by any policy or legislation except the activity of the State Commission for the Protection of Economic Competition (SCPEC). The objectives of the SCPEC of the RA are: Protection and promotion of economic competition in order to bring about the development of businesses and protection of consumer rights; Provision of appropriate environment for fair competition; Prevention, restriction and distortion of anti-competitive practices; Control over competition protection practices. Anyway, no legislative acts have been developed for Chemical industry recovery. Lack of political will among decision making authorities also is a barrier.
Second group of non-financial barriers include institutional issues and mainly the Inadequate institutional capacity conditioned by absence of the Concept of Industry development and in particularly chemical industry restoration. In these terms the project faces faulty regulation procedures and weak cooperation between regulation authorities.
Another group of non-financial barriers is information and awareness related issues. The project faces lack of awareness at all levels, starting from public awareness up to decision makers. Regarding the issue, media has

a crucial role. As well as information sharing such as sessions, meetings and roundtables between different stakeholders regarding technical and political issues should be supported in order to address lack of understanding and finding the optimal solutions.

2.2.3 Identified measures

During the continuous consultations and discussions with key stakeholders, aggressively initiated by TNA national coordinator solutions for overcoming the existent barriers were discussed. A holistic comprehensive approach was introduced trying to integrate all the key actors and address their concerns. Those measures actually were divided into economic/financial and non-financial clusters. The measures were classified in accordance with identified barriers. Objective Tree based on LPA for Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry) technology is presented in **Figure AIII-6**.

2.2.3.1 Economic and financial measures

Economic and financial measures include market demand and price study of the synthetic rubber, as well as 8 other kind of production. As a general common sense rule "the higher the price of a particular product the lower will be the demand for it". The higher the price, the greater the quantity that suppliers will be willing to supply to the market. Such issues in this case should be scrupulous investigated as are related to world markets [USA, Germany (butadiene being produced from grain alcohol), Mexico, Argentina, Romania, Poland and China (all of these plants have been shut down since the 1990's) and Russia, Central & Eastern Europe and North America (butadiene is produced as a by-product of the ethylene production)].
Besides, re-analysis of the reasons for the failure of the attempts in previous years should be conscientiously implemented.
Furthermore, cost repayment mechanisms development plays an important role. Provision of cheap financing mechanisms for technology replacement and reissuance, or opportunity to access interest-free loans (revolving funds) and establishment of economic boosters to promote the chemical industry rehabilitation technology. Additional significant factor is the introduction of risk assessment mechanisms.
Establishment of a favorable environment for technologies investment should be another priority for the state authorities. In that sense new finance tools should be introduced, such as subsidies, tax reduction and exemption, grants and loans.

2.2.3.2 Non-financial measures

The preliminary market research shows that there is need for the production of rubbers from butadiene in the world market and the output will be realized.
Non-financial measures concern legal regulations in the sector, such as laws, secondary legislative acts technical regulations, national standards, etc. Besides, favorable national policy should be developed. In particular, Chemical industry recovery should be recognized as a priority for economic development. Simultaneously, law enforcement mechanisms should be in position.
Other issue is the development of electricity and natural gas favorable tariff policy for chemical industry recovery, as well as taxation and fiscal favorable polices.
Non-financial measures include institutional changes, such as development of the concept of rehabilitation and expansion of chemical industry in the country.
Another group of non-financial measures comprises of information and awareness related actions. Necessary steps to be taken are distribution of information by all means and at all levels and raising the awareness of civil society, involving of mass media and other means.

In the frame of the project National TNA coordinator, UNFCCC focal point in RA Mr. Aram Gabrielyan has special meetings with "Nairit" Chemical Plant management. He has personal meetings with well-known specialists in chemical industry of RA, chemistry development professionals in Yerevan and Vandzor cities Mr. Patvakan Voskanyan and Mr. Vardan Vardanyan. Many essential issues for the industry rehabilitation and growth were discussed, transition opportunities from large chemistry to small one, development perspectives, chemical production wastes utilization, creation of inter sectoral issues. All those topics are also subject for discussion within Arm CTCN as well.

2.3 Barrier analysis and possible enabling measures for Production and usage of photo luminescent materials with long-term lightening technology

Production of photo luminescent materials with long-term lightening seems to be attractive taking into account the potential scale of the application, particularly for urban economy, it will significantly reduce energy consumption and capital costs. Marking the roads, boards, underground crossings and building entrance stairs with photo luminescent materials will increase the safety level for foot-travelers and drivers. Market mapping of Production and usage of photo luminescent materials with long-term lightening technology is presented in **Figure AI-7.** In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, standards, tariff policies and tax policies, energy efficiency programs and subsidies. Market actors are from one side Alkaline earth aluminates and silicates importers, row material local producers, from the other side regional markets, public buildings, institutional consumers and road, traffic design units. Long term lightening photo luminescent material production facility and private or public investors are main actors surrounded by service organizations, R&D institutions, road signs, traffic service organization and local authorities. Service providers are energy auditors, energy efficiency funds, international financial institutions, commercial banks, technical design companies. Product diversification, information campaign and financial services are important issues to be arranged and provided. The figure demonstrates the interactions between enabling environment, market actors and service providers.

2.3.1 General description of the technology

The new extended content of the suggested photo luminescent materials (based on alkaline earth aluminates and silicates) and their production technology is not poisonous or explosive. Those are fire resistant, do not melt or decompose at the temperature up to 1,500 ^{0}C, and do not contain radioactive elements, hard metals and other harmful components. They are environment-friendly and safe for the environment.
The duration of the lightening of photo luminescent materials produced through the mentioned technology (8-12 hours) as well as their relatively low cost may contribute to its wide usage in various fields of economics. Dashes from photo luminescent materials may be used for high-rise buildings, shops, hotels, to mark the emergency exits of other buildings of social importance, road signs and marking as well as other design elements. In comparison to LED solutions for this problem. Dashboards and marks made from photo luminescent materials do not use electric energy at all. Yet, taking into account the absence of necessity to install energy transmission lines, the capital expenses significantly decrease.

2.3.2 Identification of barriers

There is a number of barriers delaying the production and usage. For the identification of the existing barriers, discussions with key stakeholders in the working groups were conducted and results are presented in the current chapter. Those barriers were divided into economic/financial and non-financial blocks. Problem Tree based on LPA for Complex processing of Production and usage of photo luminescent materials with

long-term lightening technology is presented in **Figure AII-7**. Based on the specifics of the application of technology as the main barrier was identified the lack of adequate security requirements in public places. The photo luminescent materials could be successfully used in natural dark environment for road markings, signs and other warning.

2.3.2.1 Economic and financial barriers

A serious financial barriers for technology industrial investment is the absence of orders/requests for the substance on the state or local (municipality, enterprise) levels. These orders may provide the required financial support necessary for the production of photo luminescent materials with long-term lightening materials.
Absence of technical regulations, necessity for product certification, as well as regional and domestic market demand uncertainty of photo luminescent materials and need for non-standard (unique) equipment preparation, in order to establish industrial volume production are also barriers for the technology application.

2.3.2.2 Non-financial barriers

Discussions with stakeholders and NGOs in the frame of the TNA project revealed the public interest in the possibilities of using photo luminescent materials with long-term lightening. Incomplete definition of safety requirements in public places, absence of requirements for usage of photo luminescent materials in dark environment for road markings, signs and other warning notes. Insufficient awareness of urban and regional road traffic management organizations and necessity for EE gains advertisement.

2.3.3 Identified measures

During the consultations with key stakeholders, solutions for overcoming the existent barriers were discussed. A holistic approach was introduced trying to integrate all the key actors and address their concerns. Those measures were divided into economic/financial and non-financial groups. The measures were classified in accordance with identified barriers. Objective Tree based on LPA for Production and usage of photo luminescent materials with long-term lightening technology is presented in **Figure AIII-7**. The enabling framework is related to the improvement of the institutional framework, driven by urban or municipal authorities, based on civil society initiative. So public awareness of the energy efficiency potential of this technology is prioritized as a prerequisite for creating a favorable environment and diffusion of the technology.

2.3.3.1 Economic and financial measures

Economic and financial measures include Photo luminescent materials regional and domestic market demand study, attraction of the financial resources for the proposed new technology (extended composition materials) implementation and preparation of non-standard (unique) equipment, in order to establish industrial volume production.
The next financial measure may be the formation of regular orders/requests for the Photo luminescent materials on the federal and municipal levels. These orders would provide the required financial support necessary for the production of photo luminescent materials with long-term lightening materials.

2.3.3.2 Non-financial measures

Definition of safety norms and other measures (aimed at reducing the risk of possible injuries of population) for markings, warning signs and posts in the dark environment, will give an impetus to EE directly related measure like Production and usage of photo luminescent materials with long-term lightening technology.
The next measures is product certification based on developed technical conditions certificate. As well as raising awareness of urban and regional organizations involved in road traffic management and implementation of energy saving advertisement.

National TNA coordinator, UNFCCC focal point in RA Mr. Aram Gabrielyan has meetings with authorities from Minister of Emergency Situations of RA as technology may play essential role during military operations and emergency situations.

2.4 Barrier analysis and possible enabling measures for New type of Entirely Plastic solar water heater technology

Armenia and the entire region are favourable conditions in terms of widespread use of solar energy. The average annual radiant flux per 1 m2 of flat surface stands at 1,720 kWh/m2 (the European average is about 1,000 kWh/m2). The development of the solar potential in Armenia is chiefly following two routes: the manufacture and installation of photovoltaic converters; and the manufacture and installation of flat-plate solar collectors for water heating. Financial analysis of the cost of solar thermal technologies suggests that they are currently cost-competitive with electric hat water supply and heating in Armenia, and may be competitive with natural gas thermal energy options. [**Ref 12**]. Market mapping of new type of Entirely Plastic solar water heater technology is presented in **Figure AI-8.** In the market mapping, enabling environment is presented by laws, government decisions, technical regulations, standards, tariff policies and tax policies, energy efficiency programs, decisions of the state commission for the protection of economic competition and subsidies. Market actors are from one side Solar water heater importers, auxiliary equipment importers and auxiliary equipment local producers, from the other side the potential customers of the Entirely Plastic solar water heaters are public buildings, institutional consumers, SMEs, detached private houses

New type of Entirely Plastic solar water heater production facility and private or public investors are main actors surrounded by service organizations, R&D institutions, solar water heater local assembler (based on the imported and locally produced elements) and local utility services. Service providers are energy auditors, energy efficiency funds, international financial institutions, commercial banks, technical design companies. Product diversification, information campaign and financial services are important issues to be provided. The figure demonstrates the interactions between enabling environment, market actors and service providers.

2.4.1 General description of the technology

Market studies show that lack of demand for solar panels use is only due to the relative high costs of the traditional solar water heaters or because of low the level purchasing power of the population. The proposed technology is completely made of plastic solar water heaters and about 3.5 times as much affordable and easy deployment perspective. Mentioned advantages and market research to establish confidence in the rise of industrial production volumes.

Arrangement of new type of Entirely Plastic solar water heaters production would allow the low-income people to buy and use these systems and to obtain hot water in summer time for washing and for everyday use. All components of theses collectors, pipes, the transparent glazing, etc. are made from plastic materials. This is especially important because the cost of gas and electricity hikes.

2.4.2 Identification of barriers

The project implementation, i.e. production arrangement and organization seems to be profitable (IRR up to 16-18%) conditioned that 100 thousands and more panels should be produced and sold with appropriate prices during a year. However, more realistic it is considered that in the initial period, demand should be rather small, something near to 25 thousands units per year. Therefore, the main barriers seems to be the necessity to attract low-interest loans or grants, as well as undertake continuous measures to raise the awareness of potential clients. Problem Tree based on LPA for New type of Entirely Plastic solar water heater technology is presented in **Figure AII-8.** Like any new technology, this one also needs a wide range of advertising, in order to make available the obvious benefits.

2.4.2.1 Economic and financial barriers

The most significant obstacle for large scale introduction of the technology lies in the fact that small-scale production significantly affects product pricing, reducing the most important attractiveness of plastic water heaters, i.e. the low price. On the other hand, for large-scale production need to build a production line, which provides for financial assistance, preferable in the form of interest-free loans or grants.
As a financial and economic barrier may be considered as well, the necessity for ongoing costs associated with the need to ensure the regional market potential consumers' awareness of this technology.
Regional market restrictions, due to transport costs and the lack of flexible funding mechanism for the promotion of sales are also in the line of the main economic and financial barriers.

2.4.2.2 Non-financial barriers

Non-financial barriers include the need to improve the institutional framework, providing customs privileges for import of raw materials necessary for the production and export of ready-made water heaters.
Potential beneficiaries (mainly SMEs and detached houses owners) are not sufficiently aware of the benefits (completely made of plastic and more than twice cheaper) of solar water heaters.

2.4.3 Identified measures

During the consultations and considerations in the working groups, solutions for overcoming the existent barriers were settled. A comprehensive approach was introduced trying to integrate all the key actors and address their concerns. Those measures were divided into economic/financial and non-financial groups. The measures were classified in accordance with identified barriers. Objective Tree based on LPA for New type of Entirely Plastic solar water heater technology is presented in **Figure AIII-8**. In its initial production stage, some financial assistance would contribute to sustainable low-priced product sales (for compensation conditioned by high self-costs due to small-scale of initial production).

2.4.3.1 Economic and financial measures

New type of solar water heaters completely made from plastic raw materials should occupy their unique place in the market. Advantages are the low cost, being extremely lightweight, self-deploy and maintain (or no operation and service costs) feature. These advantages need to inform the public through advertising, considerable finance and organizational efforts should be involved. In fact it should be advertised in regional markets. The small-scale production, based on individual orders, is not conducive to a fair sale price formation and diffusion of energy efficient technology. Access to financial available resources, or grant the relevant provision and promotion measures will contribute to the objective demand formation and organization of mass production of water heaters. This will allow the product to identify the forecasts. Creation of a flexible funding mechanism on behalf of the Environmental revolving funds maybe an option. Customs and tax privileges offered during the study would provide a valuable addition to the formation of an enabling framework for investments in technology.

2.4.3.2 Non-financial measures

Tax and customs privileges applied to companies involved in production of technologies in the field of RE. As well as, raise awareness of potential beneficiaries (SMEs and detached houses owners) on the benefits of the completely made of plastic and much more available solar water heaters. Social advertisements emphasizing the simplicity of construction and affordability of the product for potential beneficiaries. Objective Tree based on LPA for New type of Entirely Plastic solar water heater technology is presented in **Figure AIII-8.**

2.5 Linkages of the barriers identified

Barriers related to technologies implementation in the Industry sector have been identified in four categories: 1) Economic, Financial, 2) Policy, Regulatory, 3) Institutional, 4) Information, Awareness (**see Table1**).
Market mappings of Industry Sector technologies are presented in **Figures AI-6, AI-7, and AI-8.**
The technologies analyzed in the Industry sector are somewhat unique or better to say not common, especially in the chemical industry technology rehabilitation. All technologies are interconnected in extend, that overcoming the identified obstacles should begin by clarifying the sales markets of the products. To overcome the identified barriers, active participation expected from the state. Efforts are anticipated to ensure the financial resources available for fundraising, or the formation of the state orders. Institutional support for industry technologies is a secondary issue as compared to the previous sector. However, in general policy and legislation issues are also not key factors, preventing the projects.
Problem Trees based on LPA for Industry Sector three technologies are presented in **Figures AII-6, AII-7, and AII-8.**

2.6 Enabling framework for overcoming the barriers in Industry Sector

Identified barriers and proposed measures to overcome barriers to technology transfer in the Industry Sector are summarized and presented in **Table 3.**
The technologies presented in the Industry sector are exceptional in terms of their innovation and their implementation can be based only on their own knowledge and experience. The technologies presented in the sector are exceptional in terms of their innovation and their implementation can be based only on their own knowledge and experience. In the case of implementation/accomplishment each of the technology, the produced goods could be successfully exported to regional and international markets. It is favourable

circumstance that being developed in Armenia those technologies do not required to prepare new professionals and training of specialists for accomplishment of these technologies, as well as scientific research import from other countries. The formation of each of these technologies can be a new start for the development of new branch of industry in Armenia (especially chemical industry rehabilitation).
Objective Trees based on LPA for Industry Sector three prioritised technologies are presented in **Figures AIII-6, AIII-7, and AIII-8.**

Chapter 3. Land use sector

3.1 Preliminary targets for technology transfer and diffusion

Agricultural lands in Armenia occupy 2,052.4 thousand ha, including croplands (448.4 thousand ha, 21.9%), perennial plants (33.4 thousand ha, 1.6%), hayfields (121.6 thousand ha, 5.9%), pastures (1,056.3 thousand ha, 51.5%), and other lands (392.7 thousand ha, 19.1%). Armenia practices irrigated agriculture, more than half of agricultural lands is irrigated. Main agricultural crops include: cereals, potato, fruits, grapes, and vegetables. Animal husbandry mainly includes cattle, as well as sheep and goat. The annual average growth of agricultural output in 2000-2006 and 2007-2012 accounted for 7.7% and 2.2% respectively. In recent years the share of plant growing and animal husbandry accounted for 60% and 40% respectively in gross agricultural production. As of 2012, the total area of Armenia's forest land was 457 thousand ha, forest covered lands 11.2% of the country territory. In the period of 1992-1999 extensive illegal logging of forests led to extremely negative impact on forest ecosystems. Intensive efforts are required to ensure afforestation and reforestation. 2,150 ha of area underwent reforestation and afforestation activities in 1998-2006, and 2,754 ha in 2006-2012.
The prevailing part of nitrous oxide emissions (84.2%) in 2012 were from the AFOLU sector, "Waste" sector produced 10.3% and "Energy" sector 5.4% of nitrous oxide emissions.
The increase of GHG emissions from AFOLU sector in 2012 was mainly because of the increase of the number of cattle [**Ref 10**]. GHG projections/removals in Forestry sector is based on implementation of forest protection, reforestation and afforestation measures envisaged by the Forest Management Plans and RA National Forest Programme (2005) contributing to CO_2 removals, as well as taking into account the volumes of timber removal estimated according to the 10-year management plans [**Ref 5**].
Three technologies were prioritized in the First Report for Land use sector.
Preliminary targets for prioritized technologies under Land use sector are provided below.

Degraded Grassland radical improvement technology (Other non-market goods)
Because of the technology implication natural growth of biomass and effective management of natural pastures will contribute to the effective management of storage resources, accumulation of organic carbon, particularly carbon stocks sequestration level in the soil will increase. Positive impact on natural ecosystems and biodiversity, protection of a number of plants and animals, land protection and decertification risk reduction, reducing the risk of floods and landslides, positive impact on the circulation of water resources. Implementation of EST will contribute to the increase in employment in agriculture rural population incomes, which also implies decrease in migration and poverty reduction in rural communities. The EST will contribute to the development of cattle breeding, which will consequently contribute to the development of other sectors and infrastructures based on the given subsector.
The technology belongs to "Other non-market goods" category. The application of the technology includes transfer and diffusion of non-tradable technologies under non-market conditions which will take place by strong cooperation between the government, public or non-profit institutions, international donors and

NGOs. The technology is not to be transferred as part of a market but within a public non-commercial domain. Funding will be provided by the government and/or donors.

Sustainable Forest management technology (Other non-market goods)

Positive impact on forest and other ecosystems and biodiversity, climate improvement, decrease of dust content in atmosphere, land protection and decertification risk reduction, reducing the risk of floods and landslides. Technology will ensure additional stocks/reserves of construction materials and firewood. The full implementation of EST will contribute to the increase in relevant areas of jobs.

New technology of cultivation of Perennial plants (Other non-market goods)

Full implementation of technologies will contribute to the employment and income growth in agriculture, which implies the reduction of rural poverty and migration. Community budget incomes will increase and agricultural production will grow, promoting food processing production development. Competitive and environmentally friendly agricultural products and processed food will be exported to other countries. Additional financial flows for community development are foreseen. The project will have positive impacts on natural ecosystems and biodiversity and on water resources circulation, will reduce land erosion and desertion risks, floods and landslides.

Main stakeholders related to Land use sector in Armenia are Public Administration Bodies like Ministry of Agriculture, MNP, Environmental Project Implementation Unit State Institution, Bioresources Management Agency, Scientific Center of Agriculture SNCO, "Hayantar" SNCO, Local Administration Bodies like Yerevan Municipality, Paruyr Sevak Community, Ararat Marz, Rind Community, Vayots Dzor Marz, Ijevan Forest Enterprise, Academic/Research Institutions like Armenian National Agrarian University, Research Center for Soil Science, Agrochemistry, and Land Reclamation, Armenian National Agrarian University, AUA, International Organizations like UNDP, UNIDO, REC Caucasus, NGOs like Technology Transfer Association, Union of Public Advocates, Green Lane, Biosophia Healthcare, Environment, and Agriculture Development Center, Private Enterprises like, Eco technology LLC, Vink LTD, etc. (**see Annex IV**).

In order to identify mitigation technologies against the effects of global climate change, analyze and conduct study on market barriers and clarify enabling framework for technology diffusion in the land use sector, working groups were selected, which thoroughly studied the nature of the questions in suggested land use sectors. Quantitative and qualitative indicators of land resources, as well as current situation in land management related to grasslands, perennial plantings and forest resources, were presented. The working group members identified the factors, hampering the growth of the sector, and developed technologies, introduction of which will contribute to improvement of agricultural projects level, enhancement of the socio-economic situation of workers involved in the sector and solution of environmental issues, as well as mitigation of the negative effects, caused by global climate change.

3.2 Barrier analysis and possible enabling measures for Degraded Grassland radical improvement technology

Given the poor socio-economic condition of households, the fact of pastures' remote location, pastures' overgrazing and insufficient condition of grassland vegetation, the technology discussed offers to implement radical improvement of degraded pastures and hayfields: elimination of vegetation of degraded grasslands, located near the community; creation of vegetation through sowing grass plants and further management; introduction of rotational or targeted method of animal grazing and provision of animals with water during pasture rotation.

The working group on grasslands management consisted of 5 members (Hunan Ghazaryan, Anhzela Mkrtchyan and Suren Hunanyan from the Research Center for Soil Science, Agrochemistry, and Land Reclamation, named after H. Petrosyan, Armenian National Agrarian University; Robert Grigoryan and Samvel Sahakyan from the Land Registry Department), which analyzed the current situation of grasslands and stated that the term "grassland" refers to pastures and hayfields. While discussing the grasslands condition, they noted that in terms of crop yields grasslands' condition is still far from being satisfactory, since they were degraded (plant cover was depleted, soils exposed to erosion). In order to improve land management efficiency and minimize vulnerability, surface (fertilization and dangerous plant removal) and radical (elimination of invasive plants, sowing of perennial legume crops and mixed herbs, watering) improvements should be carried out. In order to prevent soil erosion, planting of greenery and general phyto amelioration activities should be implemented, thereby promoting high crop yields from pastures and hayfields, and ensuring high quality forage and livestock products.

Technology transfer and diffusion would be piloted in Paruyr Sevak community (Ararat marz) as well as organization of breeding cooperation or its enlargement. Mentioned community is target community in terms of degraded grasslands (pastures and hayfields). The goals of the technology are: introduction of pasture rotation and pasture division methods and organization of radical improvements of grasslands (sowing perennial grass plants, pasture irrigation, etc.) in order to improve the socio-economic condition of the community inhabitants. Market mapping of Degraded Grassland radical improvement technology is presented in **Figure AI-9.** In the market mapping enabling environment is presented by laws, government decisions, technical regulations, finance policy, competition policy, food safety regulations, tax policy and subsidies. Market actors are consumers, communities, food processing industry enterprises on one hand, and farms, large agricultural companies and slaughterhouses on the other hand. Among other market actors export organizations, agricultural market resellers, private investors, importers of livestock products, water supply companies and companies importing agricultural machinery are mentioned as well. In the figure low awareness, high investment costs, lack of infrastructures, high cost of products and old technology are presented as issues. Service providers are government agencies, Ministry of Agriculture, Ministry of Nature Protection, SCEC, UNDP and funds from one side, and mass media, food safety, banks, scientific institutions, Water Consumers Union and donors from the other side. The figure illustrates the interactions between enabling environment, market actors and service providers.

Enabling environment for application of the degraded grassland radical improvement technology includes:

- Provision of low-interest or interest-free loans,
- Development of flexible pricing policy for realization of livestock products,
- Signing of contracts between processors and producers with clear definition of the obligations,
- Development of relevant legal framework regulating relations of agricultural producers and processing organizations by the Government and the National Assembly between the,
- Provision of subsidies from Ministry of Agriculture for obtaining necessary equipment, fertilizers and seeds for farmers,
- Provision of professional consultancy to raise awareness among the population.

3.2.1 General description of the technology

Sustainable management of natural pastures implies not only rehabilitation of natural ecosystems but also implication of such formats of management and implementation of measures which will significantly contribute to the restoration of quality properties and protection of those ecosystems and effective use of

these systems for economic purposes. As a primary precondition for sustainable management it is necessary to 1) Conduct an inventory of natural pastures and classification of pasturelands and grasslands by degradation type (erosion and desertification), degree and reasons/factors, 2) Select relevant improvement method for each particular area (deeper/in general), 3) Develop and implement complex activities of sustainable management for each area. Main activities are: 1) Radical improvement of degraded wetlands nearby to communities (destruction of natural vegetation and new grass seeding on the creation of new vegetation) and the effective management, 2) Targeted combination and application of ways in either freely and irregular, or “by turn” or “grazing area distribution” ways of animals grazing, 3) Introduction of grazing periodicity method in pasture utilization practice.

3.2.2 Identification of barriers

The barriers were identified as follows: the distance between pastures and hayfields, lack of fertilizers, pasture and hayfields low-usage fees. In order to mitigate sparseness of vegetation in grasslands and low crop yields, along with sowing legume crops in these areas it is necessary to organize specific fertilization works, especially with phosphoric and potassium fertilizers. Problem Tree based on LPA for Degraded Grassland radical improvement technology is presented in **Figure AII-9.**

3.2.2.1 Economic and financial barriers

The main economic and financial barriers are limited market, low sale prices for agricultural products, high costs for use of remote pastures, not sufficient activities for soil conservation, care and improvement . Law sale prices are conditioned with fact that farmers cannot purvey and sell their products. They are forced to sell their products to middlemen at low prices.

Another barrier is lack of affordable loans. Previously, soil care, fertilization works were carried out since necessary means and opportunities were provided by the state. Currently, obtaining of new machinery and equipment remains not affordable for communities.

Limited community budgets are another barrier. Community budgets are barely enough to carry out the operational expenditures of the Community. Therefore, for the implementation of the mentioned activities, financial resources are expected to be raised

3.2.2.2 Non-financial barriers

Together with insufficient financial resources, there are also non-financial barriers, mostly related to organizational issues.

Among non-financial barriers, lack of region-wide programs should be mentioned, which is explained by non-proper implementation of overall strategically processes.

Another issue is insufficient level of inventory and mapping of natural pastures. In the past, there were several institutions that were taking soil samples, analyzing them and according to the results, conducting mapping. Currently, due to lack of funds communities do not order such activities and mapping works are not implemented. This is another reason for lack of awareness among the community inhabitants.

Poor organization of relations between farmers and realizing organizations also is a barrier. Realizing organizations don’t usually assume contractual obligations with farmers and when assuming, they don’t fulfill contractual obligations in the timely manner.

Lack of professionals and not envisaging corresponding positions (agrotechnicians, plant protectors, agrochemists, stockbreeders) in the village results in staff scarcity in communities, which in turn brings to low awareness among village inhabitants.

3.2.3 Identified measures

In order to increase the efficiency of degraded pastures and hayfields in the Community, it is necessary to sow seeds for vegetation, organize pasture rotation and emergency seed fields in the hayfields. In order to provide livestock with drinking water and hayfields with irrigation, water supply works should be implemented (reconstruction of drinking troughs, rehabilitation and expansion of irrigation network). Objective Tree based on LPA for Degraded Grassland radical improvement technology is presented in **Figure AIII-9**.

3.2.3.1 Economic and financial measures

As an economic and financial measure, market regulation was identified, meaning regulation of farmer-to-consumer chain, excluding or minimizing the number of middlemen. Presence of middlemen makes food expensive two or three times, resulting the products less competitiveness and damaging farmers.
Providing affordable loans, animal husbandry subsidies and loans for purchase of necessary equipment and machinery will be another solution.
In order to improve the quality of pasture forage, it is necessary to organize sowing of legume crops.
Lower prices of farm products' sales realization, high costs for use of remote pastures, insufficient measures for land protection, care and improvement

3.2.3.2 Non-financial measures

Contracts should be signed between farmers and realizing organizations with clear implementation of contractual obligations.

Since pastures are state/public property, communities should be provided with adequate financial resources from the state budget, in order to carry out inventory and mapping of pastures.

As a result of improved grasslands land management productivity of pastures and hayfields will increase, which will contribute to the improvement of the production of livestock products, intensification of activities in the field of producing and processing organizations, creation of new enterprises, increase of employment among rural population, preventing migration and generally improving the socio-economic status of the population.

3.3 Barrier analysis and possible enabling measures for Sustainable Forest management technology

In terms of sustainable forest management (tree planting, cultivation and tree care) Ijevan forestry of Ijevan forest enterprise is suggested as a target primary organization. For better forest land management it is necessary to implement activities, aimed at tree care, expansion of conservation area, development of tourism and reforestation. In order to limit logging in the forest, expand reforestation areas and develop tourism, it is necessary to establish a nursery to produce saplings, rehabilitate sparse forests and expand forest areas. At the same time it is necessary to conduct awareness raising activities to population on the dangers and risks from the forest degradation and elimination.

Sustainable forest management working group consisted of 4 members (Lusine Matevosyan, representative of "Scientific Center of Agriculture" SNCO, Ministry of Agriculture; Samvel Kroyan and Albert Markosyan, from Research Center for Soil Science, Agrochemistry, and Land Reclamation, Armenian National Agrarian

University; Suren Manukyan, Ijevan Forest Enterprise) who after studying the current situation of forest resources, their care, conservation and land management, during the discussions proposed to restrict forest logging, expand reforestation areas to increase the effectiveness of forest areas and ensure the absorption of greenhouse gases, at the same time to organize gathering of wild edible plants and fruits and their processing to attract additional financial resources, as well as designing tourist routes to explore the forest flora and fauna. The working group members also recommended that in order to mitigate the negative effects of climate change while designation of reforestation campaigns in forest management plans there is a need to make such selection of planting stock, biological features of which will be able to adapt to conditions resulted by global climate change and at the same time will be resistant to pests and diseases (walnut, chestnut, cornel).

Due to the introduction of sustainable forest management technology tourism sector will be intensified which is declared by the Government as a priority. In addition, the gathering and processing of edible wild plants and fruits will contribute to job creation and the reduction of deforestation and expansion of reforestation areas will enhance the stability of forest ecosystems, as well as the reduction of greenhouse gas emissions caused by global climate change.

Enabling environment for application of the sustainable forest management technology includes:

- Improvement of enforcement mechanisms of existing of laws,
- Monitoring of forest areas and creation of opportunities for targeted land use in forest areas,
- Creation of nurseries, where selection of varieties will be determined by consideration of the effects of global climate change mitigation, as well as varieties resistant to pests and diseases,
- Creation of necessary conditions for collection and processing edible wild plants and berries that will be backed by appropriate legislation,
- Development of tourist routes in the forestry area.
- Provision of professional consultancy to raise awareness among the population.

Market mapping of Sustainable Forest management technology is presented in **Figure AI-10**. In the market mapping enabling environment is presented by laws, government decisions, technical regulations, finance policy, forest management, strategies, tax policy and subsidies. Market actors are consumers, communities, industrial companies on one hand, and households, electricity producing companies and wood sellers on the other hand. Among other market actors exporters, “Electric Networks of Armenia”, private investors, “Gazprom Armenia”, water supply companies and companies importing agricultural machinery are mentioned as well. In the figure low awareness, high investment costs, lack of infrastructures, high product costs and old technologies are presented as issues. Service providers are government agencies, Ministry of Agriculture, Ministry of Nature Protection, “Hayantar” SNCO, forest companies, UNDP and funds from one side, and mass media, environmental NGOs, banks, scientific institutions, Water Consumers Union and donors from the other side. The figure illustrates the interactions between enabling environment, market actors and service providers.

3.3.1 General description of the technology

Forest sustainable management ensures the complex implementation of the technologies and activities described below. Forest inventory and continuous monitoring are considered as the first precondition of forest sustainable management. Main components of the EST are: 1) Forest maintenance, protection and management, 2) Forest recovery and re-generation. 3) Rehabilitation of degraded forests and forest building,

4) Creating buffer zones of specially protected areas, 5) Optimal forest building, expansion of forest areas, 6) Implementation of forest preservation measures, including the fight against pests and fires. Main activities of the sustainable management are: enlargement of main surface of forest under the management, assistance to forest natural regeneration and rebuilding, implementation of appropriate trees species' growing, new forests planting and care, provision of water supply and control over the landslides, forest protection from illegal cuttings, forest protection from grazing, farming activities, etc.

3.3.2 Identification of barriers

In order to carry out forestland sustainable management in the forestry it is required:

1. It is revealed that in the non-forest areas according to the usage pattern (arable land, hayfield, pasture, perennial plantings) there are significant discrepancies such as assignment of areas, located in the forest depths and having no road access, as pastures, registration of trees with walnut density of 0.5-0.6 as forest orchards, registration of low-power non-irrigated areas as arable lands, which creates serious problems in terms of the existing tax legislation as well. Therefore, in the result of afforestation, corrections according to land categories were made, which should be fixed at the relevant state authorities.
2. For forest protection and prevention of the lowering of the forest upper edge, 200 meters' width layer (regardless of the land usage pattern) was considered as forbidden zone for agricultural purposes' usage.
3. In the result of the failure to perform the required agro-technical works and activities to combat diseases and pests, perennial apple tree plantings, founded on 13.8 hectares of non-forest land, were almost deprived of crop yields. It is suggested to write out 45 years old orchards, located on 7 hectares, and carry out rehabilitation activities, in order to create walnut, chestnut and cornel orchards that are adapted to forest communities and resistant to pests and diseases.

Problem Tree based on LPA for Sustainable Forest management technology is presented in **Figure AII-10**.

3.3.2.1 Economic and financial barriers

Economic and financial barriers include economic blockade of Armenia, which limits import opportunities of fuel (gas, oil, diesel fuel, petrol), which in turn affects costs of production.

Next barrier is lack of financial resources for reforestation. Given the fact that there are no nurseries, sapling organization works are missing. In addition, no works for the increase of the forest territory or densification of sparse forests are carried out.

Lack of other means for the heating (coal, charcoal) residential buildings or their high prices.

Unregulated economic exploitation of forest land. There are areas in forest where the cultivation of crops or cultivation without alteration takes place.

For implementation of mentioned works, fundraising is expected from /financial resources should be provided from the Ministries of Agriculture and Territorial Development and from financial donors as well to implement works properly in the forestry and in that way contribute to the organization and expansion of ecotourism.

3.3.2.2 Non-financial barriers

Among non-financial barriers, poverty should be mentioned. Due to the lack of employment opportunities, 31.7 % of the population in Armenia is considered extremely poor: the minimum wage does not provide the value of minimal consumer basket.

Internal and external migration in another barrier. This takes place due to lack of employment opportunities in the country, as well as in the regions.

Insufficient technical equipment and shortage of qualified professionals are considered as barriers as well. This is explained by the lack of positions for specific forest professionals and by not hiring young employees. Low wages and severe personnel shortage due to the lack of forest management experience are also hindering. For instance, there is no technique in place for planting saplings. The cars and equipment used were produced more than 40 years ago and performance coefficient is extremely reduced. Insufficient awareness of the forest is also a barrier.

3.3.3 Identified measures

In order to perform mentioned activities appropriately, not only financial investments are necessary, but also it is essential to ensure forest enterprise with qualified specialists for forest inventory, identification of resources and capabilities and target use. Objective Tree based on LPA for Sustainable Forest management technology is presented in **Figure AIII-10.**

3.3.3.1 Economic and financial measures

It is necessary to implement measures to ensure affordable tariffs for electric power and gas, resulting restrictions in forest logging. In the long run perspective, development of alternative energy sources (solar, wind) also should be considered.

Reforestation and forest area expansion activities should be implemented through provision of saplings from nurseries and fundraising.

It is important also to get obtain certain financial flows from organizing tourism activities and in that way contribute to the improvement of forest management.

Properly organized public awareness raising, training of sectoral specialist, targeted and effective use of resources are also very important for ensuring sustainable forest management.

3.3.3.2 Non-financial measures

It is extremely important to carry out monitoring and inventory work by sector workers. For implementation of those activities, almost no financial resources are required. It is necessary to provide jobs to young professionals with high wages, equating the latter with salaries of professionals with longer work experience salary, in order to ensure staff stability. Another measure is organization of cooperatives, which will contribute to increasing of employment opportunities and to the improvement of the workers' social situation. The cooperative may be engaged in woodworking activities, or accumulation of secondary production from woodworking and sale. The cooperatives can produce furniture, gather and sell forest berries.

3.4 Barrier analysis and possible enabling measures for New technology of cultivation of Perennial plants

For use of new technology for cultivation of perennial plantings and sustainable land management, as a target community Rind village of Vayots Dzor Marz is suggested. The main measures, intended by the technology

are: expand field baskets of local and selective fruit and grape varieties through expansion of collector orchards, focus the grape selection activities on creation and introduction of frost-resistant, high-quality, transportable, table and technical new varieties. A new EST for fruit (especially apricot) orchards establishment by using smaller spaced between tree lines, should be applied.

Perennial plants cultivation working group was composed of 5 members (Meruzhan Galstyan, Marine Markosyan and Lilit Simonyan from the Armenian National Agrarian University, Husik Sahakyan, head of Rind community of Vayots Dzor region, and Edik Stepanyan, head of Paruyr Sevak community of Ararat region) who having previously studied the perennial plants' present situation and their vulnerability issues, suggested to introduce a new technology for orchards establishment by using smaller spaces between tree lines. With this technology it is possible to plant up to a thousand trees on a hectare (instead of 156 trees per hectare in the traditional way), which promotes the efficient land use, increases productivity for 3-4 times and increases biomass of trees, thus contributing to absorption of greenhouse gases caused by global climate change. In the result of studies and discussions the working group has also suggested to organize agricultural insurance, thanks to which agricultural sector will be the most insured against damage caused by natural disasters. Introduction of agricultural insurance mechanism will also result in increase of financial protection for farmers and improvement of their socio-economic situation.

Introduction of new technology for cultivation of perennial plantings will allow to organize cooperatives, which will promote land consolidation and agricultural activities will be carried out on scientifically sound principles, thus saving material (fertilizers, pesticides) and financial resources. In addition, carpophagous range will be expanded: there will be ample opportunities for supplying raw materials to processing companies. As a result of the introduction of the technology employment opportunities will be increased and socio-economic condition of workers in the field will be improved. Introduction of insurance will reduce the vulnerability of the agricultural sector.

Enabling environment for application of the cultivation of perennial plants technology includes:

- Expansion of the grape and fruit selection activities and orchard territories, and introduction of frost-resistant, transportable, table and technical new varieties,
- Provision of low-interest or interest-free loans,
- Introduction of agricultural insurance system to compensate the damages caused by natural disasters,
- Development and application of plans of agricultural development strategies,
- Development of legislative framework, regulating relations between producers, processors and exporters,
- Provision of subsidies by Ministries of Agriculture and Finance to implement scientifically grounded orchard cultivation activities and purchasing fertilizers, planting material and equipment,
- Facilitation of the acquisition of certificates and export management processes for exporting agricultural products (particularly EU countries),
- Provision of professional consultancy to raise awareness among the population.

Market mapping of new technology of cultivation of Perennial plants is presented in **Figure AI-11**. In the market mapping enabling environment is presented by laws, government decisions, technical regulations, finance policy, agricultural development strategy, EEU decisions, favorable export conditions and market, tax policy and subsidies. Market actors are consumers, communities, and food processing industry enterprises on one hand, and farms, large agricultural companies and dried food producers on the other hand. Among other

market actors exporters, export organizations, agricultural markets, resellers, private investors, importers of fruit and grapes, water supply companies and companies importing agricultural machinery are mentioned as well. In the figure low awareness, high investment costs, lack of infrastructures, high costs of products and old technologies and habits are presented as issues. Service providers are Government, Mayor of marz, head of the community, Ministry of Agriculture, Ministry of Territorial Development and Administration, SCEC, UNDP and funds from one side, and mass media, food safety, banks, scientific institutions, Water Consumers Union and donors from the other side. The figure illustrates the interactions between enabling environment, market actors and service providers.

3.4.1 General description of the technology

As a result of various factors, 29% or 130 thousand hectares of arable land are not used for target purposes, so implementation of land use effectiveness program is a strategic priority. Main activities of the suggested technology are: 1) To expand field baskets of local and selective varieties of fruit and grape by expansion of collector orchards, by purchasing of samples of Armenian origin from other countries genetic samples banks, and through the enrichment of orchards, 2) Focus of grape selection works to frost-resistant, high-quality, transportable, universal directions and creation of new varieties, 3) Apply of new EST for fruit (especially apricot) orchards establishment by using smaller spaces between the tree lines, with thickness of 5 m x 5 m or plantations. For example, in Armenian case in 1 ha of the old (public) orchards was planted 156 tree (this management system is still preserved), now the new method of cultivation of 1 ha of trees implies planting of up to 1,000 trees. The biomass, which is 8 x 8.8 x 6, or 7 x 4 meters of density of 100 trees is the same as in dense plantings of 1,000 trees, but on which the biomass generated not in 20 years, but within 5 years, 4) Reinstatement of field protecting forest areas and planting of new ones.

3.4.2 Identification of barriers

Effective introduction of the technology will notably increase agricultural production volume. However, underdeveloped agriculture market, low level of consuming, small domestic demand and lack of relevant infrastructure could fail the process effective implementation.

The next serious challenge is low access to financial resources, which is grounded by high credit rates and duration of agricultural loans. Other challenges could be as follows:

- Insufficiency of risk mitigation measures and lack of an insurance system,
- Resistance of farmers toward the innovations, new technologies, knowledge understanding and its introduction,
- Underdeveloped infrastructure, such as roads, unreliable irrigation systems, etc.

Problem Tree based on LPA for New technology of cultivation of Perennial plants technology is presented in **Figure AII-11**.

3.4.2.1 Economic and financial barriers

As a result of the introduction of new technology for vineyards and fruit cultivation carbon absorption will increase in this category of land use due to the rapid growth in biomass. Stock of organic carbon in soil will increase and improve soil quality. The economic and financial barriers are:

- Small arable lands, where it is impossible to introduce mechanisms to operate,
- Limited market,
- Low prices for agricultural products,
- Lack of professionals and appropriate consultancy,

- Lack of planting stock, fertilizers and equipment,
- Weak irrigation system.

3.4.2.2 Non-financial barriers

As a non-financial barrier the absence of storing system and appropriate mechanisms can be mentioned.
Full implementation of technologies will contribute to the employment and income growth in agriculture, which implies the reduction of rural poverty and migration. Community budget incomes will increase.
Role of civil society in community administration and management process will increase as well. Sufficient resources will be available to solve community's social issues.

3.4.3 Identified measures

Establishment of large farms and cooperatives will be an effective measure that will result in enlargement of land plots, ensuring high efficiency of machines and mechanisms that in turn will contribute to increasing the quality and quantity of the crop yield.
Instead of traditional technology of irrigation systems, new methods should be introduced that will envisage subsoil water and drip irrigation. In that way irrigation water will be saved, and method will foster the process of perennial plantings watering.
In order to improve storing and realization of agricultural products it is necessary to arrange implementation of contractual obligations between producing and procuring organizations, minimizing the role and number of middlemen.

- Growth of agricultural production, development of food processing production,
- Competitive and environmentally friendly agricultural products and processed food will be exported to other countries,
- Additional financial flows for community development.

Objective Tree based on LPA for New technology of cultivation of Perennial plants is presented in **Figure AIII-11**.

3.4.3.1 Economic and financial measures

The main share of expenses for introduction of the technology will be borne by the state budget, reducing funding to the economic and social development. There will be need to involve financial donors since the community budget is not enough for those activities.

3.4.3.2 Non-financial measures

Non-financial measures include designing positions for specialists in the community such as orchard men, viticulturists, in order to provide professional advice to farmers and raise public awareness.
Another measure is establishment of nurseries and planting stock production, as well as other organization of bio humus production, using animal and poultry manure (if no mineral fertilizers are in place) in order to improve soil fertility and perennial plantings' high crop yields.

3.5 Linkages of the barriers identified

Barriers related to technologies implementation in the Land use sector have been identified in six categories: 1) Economic, Financial, 2) Policy, Regulatory, 3) Institutional, 4) Information, Awareness, 5) Capacity Building, 6) Social **(see Table1**).

Market mappings of Land use Sector technologies are presented in **Figures AI-9, AI-10, and AI-11.**

Related to land management in degraded grasslands (pastures and hayfields), activities, aimed at introduction of grassland rotation, creation of seed fields in the hayfields, sowing perennial grass plants, irrigation, fertilization and organization of breeding cooperation, should be organized in the target community. For the cultivation technology of perennial plantings and sustainable land management, in the target community, in order to establish orchards, the method of smaller spaces between tree lines should be applied; agricultural (fruit-growing) cooperatives should be organized; necessary quantities of planting stock, fertilizers and machinery should be provided and insurance service should be organized and introduced. For the sustainable management of forestry land, activities, aimed at organization of the tree planting (establishment of a nursery), care and sanitation pruning, expansion of reforested areas, tourism development, replacement of old trees and raising public awareness on the threats from the forest degradation, should be implemented in the target community.

In general, to implement sustainable land management in degraded pastures, hayfields and forests, in the frame of proposed initial target organizations and communities, soil resources monitoring should be constantly made, studies on soil agrochemical indicators should be carried out and according to their results, scientifically grounded agronomic and phyto amelioration measures should be implemented.

The continuous implementation of such measures will foster improvement of soil fertility, increase agro enosis productivity and stabilization of socio-economic conditions of the population in pilot communities and in the republic.

Problem Trees based on LPA for Land use Sector three technologies are presented in **Figures AII-9, AII-10, and AII-11.**

3.6 Enabling framework for overcoming the barriers in Land use Sector

Identified barriers and proposed measures to overcome barriers to technology transfer in the Land Use Sector are summarized and presented in **Table 4**.

In the result of introduction new technologies for degraded grasslands, forested areas and perennial plantings, carbon absorption will fundamentally increase in the discussed land use category, thanks to the rapid growth of biomass. The stock of organic carbon in the soil will increase and soil quality will be improved. The complete application of the technologies will contribute to the growth of employment and incomes in agriculture, which supposes the reduction of migration and poverty levels in rural areas. Incomes of municipal budgets will significantly increase. The role of civil society will increase in the governance of the community. There will be sufficient measures to solve social problems in communities.

There is a favourable environment for the implementation of the technologies, in particular the Government of RA has developed and adopted several strategies that refer to the balanced regional development, rural and agricultural development, which provide sufficient ground for political goals set for the introduction of this technology.

As an effective opportunity for introduction of this EST can be the development of multiple forms of agricultural cooperatives on a voluntary basis and multifunctional approaches due to which per household land.

At the same, application of the technologies will contribute to the growth of agricultural production and development of processing industry. During current food crisis, environmentally safe and competitive agricultural products will be exported to the states of the Eurasian Customs Union and additional financial flows, needed for community development, will increase.

Objective Trees based on LPA for Land use Sector three prioritised technologies are presented in **Figures AIII-9, AIII-10, and AIII-11.**

Chapter 4. Waste management sector

4.1 Preliminary targets for technology transfer and diffusion

Municipal solid waste (MSW) is collected and disposed in 48 municipal landfills with total area of 137.5 ha. In none of the landfills waste is classified or sorted before disposal. In 2012 total waste amounted to 650.3 thousand tonnes, while the amount disposed in landfills was 461.3 thousand tonnes (70.9%).

All landfills, except the largest one in Yerevan, are not managed. The decomposable organic carbon in MSW reaches 50-60%. In 2012 due to reduction of population the amount of MSW decreased by 20% compared to 1990. However, the change of MSW amount per urban dweller is insignificant.

Municipal wastewater includes household, commercial and partly industrial wastewaters. As of 2012, annual volume of water disposal amounted to 431 million m^3. The volume of wastewater discharged into sewerage system totalled to 86.6 million m^3. Until 1990, there were 20 wastewater treatment stations operating in Armenia with total capacity of 958 thousand m^3/day. Currently these stations are in extremely poor technical conditions. Four new mechanical municipal wastewater treatment stations were put into operation in 2012-2014.

The mitigation scenario considered in the country is based on strategic program to improve the solid waste management system which is currently is under phased implementation in Kotayk marz and in the city of Yerevan. Projection of GHG emissions from livestock are estimated according to the 2015-2025 Agriculture Development Strategy of RA and are based on the projected livestock population and livestock species.

As a mitigation measure manure management and utilization was considered for biogas production and for power generation by biogas power plants.

GHG emissions in "Waste" sector originated from the following categories: methane emissions from solid waste disposal; carbon dioxide, methane and nitrous oxide emissions from incineration and open burning of waste; methane and nitrous oxide emissions from domestic wastewater treatment and discharge; and nitrous oxide emissions from industrial wastewater treatment and discharge.

In 2012 solid waste disposal (methane emissions) was the key source of emissions accounting for 4.3% of the total emissions. Increase in emissions in this sector in 2012 compared to 2010 was insignificant [**Ref 5**].

Based on proposed TNA methodology, a long list of possible technologies in Waste management sector was prepared and technologies prioritization was conducted. The projects were selected for further discussion.

Three technologies were prioritized in the First Report for Waste Management Sector in RA.

Preliminary targets for prioritized technologies under Waste Management sector are provided below.

Utilization of methane form Yerevan city landfill for electricity and heat production technology (Publicly provided goods)

Positive impact on natural ecosystems and biodiversity of the landfill area, protection of a number of plants and animals, land protection, positive impact on the circulation of water resources. Creation of new jobs for the management of the advanced technology process and operation of the units. Formation of a new culture of SDW landfills management. The project aims at substituting the imported fuel, reducing GHG emissions, improving sanitary and energy situation. EST will contribute to: the increase in employment, the improving the atmosphere in Yerevan, the reducing diseases, etc. Elimination of stench and irregular surface combustion products from areas adjacent to landfills will ensure a natural development of those areas that is very important for such a land-poor country as Armenia.

The technology belongs to "publicly provided goods" category which means that the technology is procured and diffused by public entities to a large population of users and beneficiaries (in this case population of Yerevan City). Technologies in this category are therefore also traded in a market place, but

the market is often not very liquid, as the public entities purchase their goods through a tendering process, which may be restricted to a limited number of invited national and international construction companies and technology suppliers (Shimizu Corporation, Japan). The technology is publicly owned, and production of goods and services are available to the large group of persons (population of Yerevan). The application of the technology requires large investments from government/donor funding. The technology is heavily dependent on existing infrastructures and policies.

Existing Lusakert biogas plant operation and reissuance organizational technology (Capital goods)

GHG emission reduction as a result of technology implementation. EST will contribute to: prevention of environmental pollution, elimination of stench, prevention of water and land resources from pollution. Economic benefits of technology implementation should be: organic fertilizer production, other economic activities, additional sources of fuel and energy. The project aims at: the creation of new jobs requiring professional qualifications, improving of the working conditions of factory staff, reduction of diseases, etc. The technology belongs to "capital goods" category where technologies are intended for a restricted national market with only a few buyers. In this case machinery and equipment are used in the production of electricity and produced electricity is to be purchased by "Electric Networks of Armenia" CJSC. "Capital goods" are also described by a limited number of potential consumers, relatively large capital investments and simpler market chain, i.e. few or no existing technology providers.

Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology (Consumer goods)

Positive impact on natural ecosystems and biodiversity of the surrounding area, protection of plants, reduction of pollution, land protection. The positive economic impact of technology: surrounding land use, positive impacts on other economic branches and activities, development of infrastructure. EST will contribute to: the increase in employment, the improving the atmosphere, the reducing diseases, etc. Proposed new material will be used in building construction as insulation material and will contribute to energy savings and GHG emissions reduction as well.

The technology belongs to "consumer goods" category where technologies are diffused in a mass market with large supply chains and a high number of customers, including households, businesses and institutions. The technology is described by a high number of potential consumers (produced foam-blocks, thermal and sound insulation plates may be used in construction of buildings and roads), interaction with existing markets and distribution demands and complicated supply chains with many actors, including producers, farmers, importers, wholesalers, retailers and end consumers. Besides, demand for products depends on consumer awareness and preferences and on commercial marketing and promotional efforts.

Main stakeholders related to waste management sector in Armenia are Public Administration Bodies like MNP, Ministry of Agriculture, MENR, PSRC, Armenian Settlement Center CJSC, Electro power system operator CJSC, Environmental Project Implementation Unit State Institution, Bioresources Management Agency, Scientific Center of Agriculture SNCO, Local Administration Bodies, Academic/Research Institutions like Armenian National Agrarian University, Research Center for Soil Science, Agrochemistry, and Land Reclamation, Armenian National Agrarian University, AUA, Scientific Research Institute of Energy, International Organizations like UNDP, UNIDO, REC Caucasus, R2E2 Fund, NGOs like Technology Transfer Association, Union of Public Advocates, Green Lane, Biosophia Healthcare, Environment, and Agriculture Development Center, Private Enterprises like, Nubarashen Station for Biogas Recovery and Burning, Eco technology LLC, Vink LTD, etc. (**see Annex IV**).

Main stakeholders were invited to workshop on identification of barriers against priority technologies, market description and analysis of a favorable environment for climate change mitigation in waste management sector. Wide range of stakeholders represented government agencies, academic institutions, private sector and

NGOs. During the workshop the stakeholders were acknowledge with the materials to be discussed (agenda and relevant materials were provided beforehand). The results of technology needs assessment for climate change mitigation in waste management sector (TNA first report) were presented by Tigran Sekoyan, TNA Mitigation Component Team Leader, which was followed by brief description of priority technologies in waste management sector by Davit Shindyan, Waste Management Sector Expert. Afterwards, preliminary description of the sector technology market was presented by Tigran Sekoyan (results elaborated by the professional working groups). Later on discussion on preliminary description of the sector technology market with stakeholders took place by the format proposed by the UDP. Preliminary description of the sector technology barriers was presented by Davit Shindyan, which was followed by the discussion on preliminary description of the sector technology barriers with stakeholders, by the format proposed by the UDP. Then Davit Shindyan presented preliminary description of the measures to overcome sector technology barriers. The proposed measures were discussed with stakeholders. Summary of technologies, recommendations, measures to overcome barriers and analysis of a favorable environment in waste management sector were introduced by Tigran Sekoyan. National TNA coordinator, UNFCCC focal point in RA Mr. Aram Gabrielyan introduced very unique and interesting facts about Utilization of methane form Yerevan city landfill for electricity and heat production and Existing Lusakert biogas plant operation and reissuance organizational technologies. All members of working groups participate in the discussions (excluding Liparit Hovhannisyan the author of the Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology but was communicated by email). All the comments and opinions, expressed during the meeting were taken into account and included in the current report.

4.2 Barrier analysis and possible enabling measures for Utilization of methane form Yerevan city landfill for electricity and heat production technology

In order to mitigate the effect of GHG generating from MSW and affecting the climate change, a technology of reprocessed gas recovery and its further burning in MSW landfills or electric energy production in gas engine power stations is being successfully applied in developed countries. This technology comprises of vertical wells, horizontal gas channels and a gas-gathering pipeline that are isolated by an airproof insulating film. Gas Golders, a compressor system and corresponding measuring equipment (gas meters, gas analysers) are also installed. In the soil, in wet medium, the gas reprocessing is done by means of vacuum. This EST makes possible to reprocess 60% and more of biogas.

Gas engine generator is a gas piston-like engine that can operate at low-density biogas (less than 27% of methane content), an electric generator, remote controls, equipment connected to an electric system and transmission lines. The efficiency coefficient of these engines is about 39-42%. This technology is widely used in Japan and other developed countries. Market mapping of Utilization of methane form Yerevan city landfill for electricity and heat production technology is presented in **Figure AI-12**. In the market mapping enabling environment is presented by laws, government resolutions, technical regulations and standards, financial and economic policy and strategy, energy tariff policy, PSRC decisions, Energy Efficiency project, tax policy and subsidies. Market actors are residential buildings, public buildings, industrial manufacturing facilities on one hand, and landfill CHP, thermal and boiler houses on the other hand. Important market players are Yerevan Municipality, private investors and international consulting companies. Among other market actors “Gazprom Armenia”, Electricity Network, organizations providing heating services, ESCOs and heating boiler importers and “AEG Service” are mentioned as well. In the figure insufficient awareness, high introduction costs are presented as issues. Service providers are government agencies, PSRC, Ministry of Energy and Natural Resources, Ministry of Nature Protection, foundations and municipality agencies from one side, and media, commercial banks, private companies and international organizations from the other

side. The figure illustrates the interactions between enabling environment, market actors and service providers.

The project will contribute to sustainable development of the Republic of Armenia in several ways: first of all, landfill site odor will be prevented (environmental improvement effect) and landfill site fire prevention will be another environmental improvement effect. The project implementation will positively impact on natural ecosystems and biodiversity of the landfill area. The introduction of technology will create employment opportunities through project realization. Technical skills of human resources, involved in the project, will be enhanced. The technology may become best practice of renewable energy project implementation in Armenia and lessons learnt may be useful for future waste-to-energy projects. Besides, a new culture of landfill management will be formed.

4.2.1 General description of the technology

In the last few years, this EST has been successfully applied also in Belarus in four different MSW landfills by means of gas engine stations processing power of 0.6 – 3.0 MW. The projects are developed by Shimizu Corporation (Japan) based on instruction form NEDO. 102-110 thousand tonnes of MSW is accumulated annually in Nubarashen landfill, near Yerevan city, and disposed there without preliminary processing and sorting. Nubarashen landfill site is the solid waste disposal site of Yerevan City since 1960. The landfill site is divided into three sections, A, B and C, each covering an area of 20 ha. Site A started service in 1960 and became full in 1985; Site B has been in service from 1986 until the present day; and Site C has been set aside for future use. The landfill is a source of methane emissions and environmental pollution.
The project proposes to use the waste and accompanying methane as fuel for combined electricity and heat generation and envisages equipment for waste collection, separation and preparation for burning, a system for methane collection, incinerators, boiler, energy block (steam turbine, generator), boiler-utilizer for obtaining hot water, cleaning system for discharged gases. The annual electricity production will be 89.3 GWh, heat energy 59.5 GWh. The annual saving of fossil fuel is 15.4 thousand tonnes of equivalent fuel (reference fuel, standard fuel).
In 2009 the first stage of the project was launched on the 7 ha of Nubarashen landfill. As a result of its implementation, the biogas (methane content 41%) generated from MSW was burnt: transformed into CO_2. The project was carried out jointly by Japanese company “Shimizu” and Yerevan Municipality. The second stage of the project intended installation of a gas engine system, which was to be done after obtaining more accurate information about the real expense of biogas. However, the gas engine system has not been yet installed because of the digression from the initial scope of the project (for the implementation of the project only 7 ha of landfill area was provided by Yerevan municipality instead of the foreseen 20 ha).
Currently, a new sanitary landfill is being designed [**Ref 13**]. The new landfill will be situated next to the extant landfill site, to the west. The overall area size amounts to about 30 ha. The project is implemented with financial support from the European Bank for Reconstruction and Development (EBRD) that provides a €8 million loan to Armenia. The loan is co-financed by a €8 million credit line from the European Investment Bank (EIB) and a capital grant of €8 million from the European Union (EU) Neighborhood Investment Facility (NIF).

4.2.2 Identification of barriers

There are several barriers limiting the development of the project discussed. In order to identify the existing barriers, consultations with key stakeholders in the working groups were conducted and the results are presented in the current chapter. Those barriers were divided into economic/financial and non-financial

blocks. Problem Tree based on LPA for Utilization of methane form Yerevan city landfill for electricity and heat production technology is presented in **Figure AII-12.**

4.2.2.1 Economic and financial barriers

The economic, in particular financial barriers pose a serious challenge for the implementation of the project. Those barriers refer mainly to the absence of economic mechanisms for introducing waste management technologies. In particular, there are next to no economic incentives for the introduction of modern waste management technologies. Moreover, difficulties arise with investment acquisitions due to underdevelopment and technical capability of local financial markets.

Installation of innovative technologies also introduces a threat for the market players. Electricity producers and importers may use their lobbing opportunities to hamper the project. One example is impeding the adoption of the relevant legislative act the National Assembly, the pressure on the Government for not providing tax incentives, or the creation of artificial barriers to the implementation of the technology by the Yerevan Municipality. Therefore, unfair competition is another barrier.

4.2.2.2 Non-financial barriers

The first group of non-financial barriers refer to market failure and imperfection. Weak capital market in Armenia represents a crucial factor and should be taken into consideration. Other imperfections include ill-protection of business interests, double standards and shadow economy. Poor protection of the business interests supposes absence or non-target activity of structures representing business interests, such as chambers of commerce, unions and business associations. The problems associated with the shadow economy are related to the sector of informal recycling: persons, involved in informal recycling activities in Nubarashen landfill, will be set against the implementation of technology. One of participants of the discussion, Hunan Ghazaryan, had a special position: he is against of “shadow economy” formulation and did not support including shadow economy as a barrier in the current document.

Among non-financial barriers, policy and legal barriers should be mentioned. Those barriers are caused by absence of policy vision and clear strategy. Practice of developed countries shows that effective waste management should be guided by an integrated policy, coherent to national and sectoral development goals. No prioritization of the sector has been implemented. Since the project discussed is unique and has no precedent in Armenia, relevant legislative acts and policies have not been developed. There are general policies related to waste management but they miss the legal ground and necessary mechanisms, which limit local authorities and other stakeholders to implement them properly. State authorities also do not have the awareness on the current situation and limited knowledge on the latest developments and trends in the waste management technologies does not allow transferring them into policies and legislation.

Institutional barriers include insufficient institutional regulations, uneven distribution of regulation activities among different public bodies and corruption risks. There are issues related to some confusion over the distribution of functions among public authorities, which is reflected in fragmentation of functions. Those include overlapping functions, lack of adherence to the principles of unity command and direction among different public authorities and the lack of coordination. Fragmentations of functions result in loss of synergy and expensive stand-alone scattered projects without follow up. Weak cooperation among state authorities is also a barrier, which obstructs the transformation of the relevant practical knowledge into legislation and policies. The conflict of interests among different ministries and agencies is quite typical. The situation when agencies do not share the information to other stakeholders is not an exception.

Corruption constitutes a serious challenge for the development of Armenia. In particular, the waste management business is very vulnerable to corruption. More transparency will be needed to ensure proper development of the waste sector in Armenia.

Information and awareness issues are caused by media inactivity and lack of awareness from one side and low level of interest among citizens. Mass media representatives show low level of interest in waste management issues. There are articles, covering waste management issues, but generally they miss professional ground. Besides, public also is not interested in waste management issues, since the latter might be associated to low status and considered as non -desirable topic.

Technological barriers are related to the selection of appropriate country-specific waste management technologies and their adaptation to Armenian realities. The selection of the coherent technologies requires certain technical awareness suitable for the local operational conditions such as waste characteristics, waste volume, types, etc. For this purpose, reliable sufficient data is required. Moreover, the information -sharing between different stakeholders regarding technical issues is not a common practice.

The state bodies do not utilize the opportunities of international cooperation and adoption of best practices. For instance, in the project discussed it was proposed to install a gas engine generator. Installation of 1.7 MW gas engine generator has not yet implemented since the actual amount of methane recovered made 17% to 48% of the required amount for the gas engine generator operation.

Human / Social and behavioral barriers mainly are related to the limited knowledge and skills at different levels of state bodies and companies' staff. Particularly, the personnel usually lacks the necessary technical expertise on waste management. Besides, there is no special education program on waste management in the country.

4.2.3 Identified measures

During the consultations and discussions with key stakeholders, solutions for overcoming the existent barriers were developed. A holistic approach was introduced trying to integrate all the key actors and address their concerns. The suggested measures were divided into economic/financial and non-financial groups. The measures were classified in accordance with identified barriers. Objective Tree based on LPA for Utilization of methane form Yerevan city landfill for electricity and heat production technology is presented in **Figure AIII-12.**

4.2.3.1 Economic and financial measures

Economic and financial measures include establishment of economic boosters to promote the introduction of modern waste management technologies. Besides, appropriate technical capacity of local financial actors should be built as services provided by them lack the necessary specification and orientation.

Furthermore, cost reimbursement mechanisms development plays an important role to mitigate the possible issues that arise during the implementation process. Another important factor is the introduction of risk assessment mechanisms.

Establishment of a favorable environment for technologies investment should be another priority for the state authorities. In that sense economic instruments should be introduced (or more broadly used), such as subsidies, tax reduction and exemption, grants and loans.

4.2.3.2 Non-financial measures

First group of non-financial measures include market failure and imperfection related solutions. For involving investments in modern technologies, the relevant market should be established and developed. Moreover, all

the important stakeholders should acquire each other. Cooperation between them should be established. In addition, business interests' protection mechanisms should be introduced. Equal competition conditions for all should be put in place as well.

Among non-financial measures, the following policy and legal measures were identified. To fill the lack of political will and clear strategy, relevant strategy and favorable national policies should be developed. The sector should enjoy political support from the Government. In the policy papers, sector priorities should be highlighted. Besides, legal regulations for the sector should be developed. Secondary legislation should be established as well (such as guidance and manuals describing how to interpret and implement legislative requirements properly).

Next group of non-financial measures is institutional measures. These measures aimed at strengthening cooperation between different state authorities and clear division of roles and responsibilities between them. Clear organizational structures should be established, coordination and communication channels between public institutions of the waste sector should be clarified. Moreover, clear definition of tasks and responsibilities, and interaction across the waste public sector, in order to avoid confusion, should take place. Corruption risks should be assessed and procedures for their elimination should be developed.

Information and awareness is the next group of measures identified. The measures are to organize awareness raising campaigns for state authorities and involve mass media representatives. It should be made an attempt to distribute the information by all means and all levels. Public awareness should be raised through education campaigns for citizens.

Technological measures are use of appropriate waste management technologies in the local market. For selection of proper technologies, reliable data on waste should be provided and waste management related databases should be developed. Therefore, new data collection systems should be developed. Interviews with Yerevan Municipality representatives should be taken in order to understand why is was proposed 7 ha of landfill area instead of promised 20 ha which resulted to non-installation of a gas engine generator. During the next phase of the project interviews will be held and results will be set as measures.

Human / Social and behavioral measures are related to the assessment of training needs among actors, involved in waste management, development of trainings strategy and organization of trainings to strengthen skills and technical expertise on waste management at levels, identified during trainings' need assessment. There is a need for trainings for the regional and local authorities.

Enabling framework for the discussed technology includes establishment of economic mechanisms to promote the introduction of modern waste management technologies and cost reimbursement mechanisms by the Government, strengthening of appropriate technical capacities of local financial actors, creation of up-to-date and comprehensive waste management databases, as well as elimination of corruption risks.

4.3 Barrier analysis and possible enabling measures for Existing Lusakert biogas plant operation and reissuance organizational technology

The proposed project aims to reduce GHG emissions, generated from Lusakert poultry farm animal waste through improvement of animal waste management system and to produce electricity and organic fertilizer from poultry litter and animal waste.

Lusakert biogas plant was built at the Lusakert poultry farm in 2008 for methane capture and combustion from poultry manure treatment. The plant has installed electric capacity of 0.85 MW and it is able to generate 7 GWh of electricity annually. Lusakert biogas plant used to be Armenia's only operating industrial-scale biogas-to-energy plant. However, currently, the plant is not in operation due to lack of litter. Market mapping of Lusakert biogas plant operation and reissuance organizational technology is presented in **Figure AI-13**. In the market mapping enabling environment is presented by laws, government resolutions, technical

regulations and standards, financial and economic policy and strategy, market liberalization, Energy Efficiency project, PSRC decisions, tax policy and subsidies. Market actors are poultry farms, public facilities, small industrial enterprises, organic fertilizer consumers, Lusakert biogas plant, electricity generation stations and organic fertilizer producers on one hand, and private investors, energy auditors, technology importers, international consulting companies, servicing organizations, "Gazprom Armenia" and Electricity Network on the other hand. In the figure insufficient awareness, high introduction costs, organizational technology needs and VAT payment delay needs are presented as issues. Service providers are government agencies, PSRC, Ministry of Nature Protection, Ministry of Agriculture and foundations from one side, and media, commercial banks, private companies and international organizations from the other side. The figure illustrates the interactions between enabling environment, market actors and service providers.

The implementation of the project will have a number of environmental benefits: animal waste problems associated with manure disposal on farms will be reduced. The odor will be reduced as well. CO_2 emissions to atmosphere will be decreased. Besides, local pollution of groundwater will be reduced. In the result of the technology implementation 75,000 tonnes of organic fertilizers per year will be produced. Economic benefits include generation of 7 GWh of electricity annually. Besides, employment opportunities will be created and professional qualifications of persons, involved in the technology implementation, will be improved.

4.3.1 General description of the technology

The factory as a litter processing system used in traditional open stabilization ponds, which are necessary for the processing of liquid waste from poultry operations. Anaerobic ponds generate methane (CH_4) and nitrous oxide (N_2O) emissions on the environment as a direct result of fermentation basins in the anaerobes.
The project consists of an advanced improvement to the common practice of poultry waste treatment, reducing a significant volume of GHG, as well as improving the quality of the reject water. The technology implementation is based on the use of anaerobic digester treatment as first step before a lagoon system.
The improved management of the poultry manure as a result of the implementation of digesters does not require changes to the barns or their physical structure, i.e.; there will be no changes in the physical housing capacity or in the management of the barns. Therefore, the volume of effluents to be treated does not increase and only treatment parameters are improved.
The biogas recovered in the digester is immediately used in a gas engine generator to produce heat and electricity, and any excess gas is flared. The heat from the cogeneration plant is used for heating the digester, in order to optimize operation and to increase the speed of decomposition of the organic matter of effluents, thus replacing the use of fossil fuel that would otherwise contribute to emissions leakage.

4.3.2 Identification of barriers

There is a number of barriers hindering the project discussed. For the identification of the existing barriers, consultations with key stakeholders in the working groups were conducted and results are presented in the current chapter. Those barriers were divided into economic/financial and non-financial blocks. Problem Tree based on LPA for Lusakert biogas plant operation and reissuance organizational technology is presented in **Figure AII-13.**

4.3.2.1 Economic and financial barriers

The economic, in particular financial barriers present serious obstacles for the implementation of the proposed project. It should be noted that there is no economic support from the Government. Currently, no

economic promotion mechanisms for waste management technologies are anticipated from the State. On the contrary, there was a case in 2012 when the Government made a decision to refuse the postponement for three years period of the value added tax payment of the Lusakert biogas plant.
The only form of support is that the Government ensured that electricity produced at the plant would be bought at the fixed price [44.31 AMD (VAT included) per kilowatt hour (in 2011) up to 50.91 (VAT included) AMD/kWh (in 2015)]. It worth mentioning that the price per kilowatt hour is higher than from other electricity producers (VAT included, 2015), [NPP (12.76 AMD/kWh), TPP (42.13 AMD/kWh), Large HPP (10.88 AMD/kWh)] and Average residential electricity tariff (38.517 AMD/kWh).
The next economic barrier is higher investment costs, compared to electricity prices in Armenia. That means payback period is long, meaning more time will be required to recover the cost of the investment. On the other hand, although investments were made, there is a lack of financial means for the complex investment of the technology and ensure project's sustainability.
Another barrier that project faced in 2014 was insufficient amount of wastes due to economic difficulties of the Lusakert poultry plant.

4.3.2.2 Non-financial barriers

Non-financial barriers refer to market failure and imperfection issues. These issues include weak market and lack of competition. Waste is not considered as a primary or even secondary source of income. Another issue is lack of mutual understanding and weak cooperation among market key actors, such as animal waste producers/suppliers. Unfair competition may also be a case: fertilizer importers may hinder the project.
Second group of non-financial barriers include policy and legislation issues. The sector is not regulated by any policy or legislation. No legislative acts were developed for specific poultry manure treatment. Lack of political will among decision making authorities also is an obstacle. However, in general policy and legislation issues are not key factors, preventing the project.
The next group of non-financial barriers comprises of institutional issues. In these terms the project faces imperfect regulation procedures and weak cooperation between regulation authorities. In addition, there is a certain lack of organizational capacities and managerial skills. In some cases there are parallel structures and confusion with roles and responsibilities. For instance, the Ministry of Nature Protection is in charge of the formulation of general policy in waste sector. At the same time the Ministry of Urban Development is responsible for the designing the policy in Municipal sector. The municipal waste is considering as the part of it.
Another group of non-financial barriers is information and awareness related issues. The project faces lack of awareness at all levels, starting from ordinary citizens up to high officials. Government officials do not have enough knowledge about technologies and waste management best practices. Regarding that issue, media has a crucial role and media inactivity results low level of awareness.
Fifth group of non-financial barriers is technology issues. The project faces with lack of counselling for technologies investment and as a result of that wrong investment of technological procedures. Another technological barrier is difficulties with adaptation to the local conditions. For instance, the poultry adds sand in the feed, which causes technological difficulties during waste treatment and no technical solution has been found yet.
Human Skills/ Social and behavioral barriers related barriers are lack of knowledge and skills and appropriate specialists (both in state authorities and waste management sector positions).

4.3.3 Identified measures

While identification of measures an attempt was made to use inclusive strategy: to hold consultations with all the key stakeholders, involving them in the process and addressing their concerns. During the consultations and discussions with stakeholders, the solutions to overcome barriers were developed. Identified measures were grouped in economic/financial and non-financial measures. Objective Tree based on LPA for Lusakert biogas plant operation and reissuance organizational technology is presented in **Figure AIII-13**.

4.3.3.1 Economic and financial measures

Economic and financial measures include establishment of economic booster mechanisms and development of economic support initiatives from the Government. Tax holidays also may be provided, meaning tax temporary reduction or elimination. Another form of support from the Government is provision of risk guarantees or insurance scheme.

The next measure is establishment of mild conditions for acquiring finances for EST investment both from foreign economic assistance and local financial institutions. Project sustainability should be ensured by finding appropriate investors and making connections with other waste suppliers in Armenia.

4.3.3.2 Non-financial measures

Non-financial measures concern market failure and imperfection arrangements, such as establishment of business interests' protection mechanisms. Establishment of equal competition conditions for all will be another non-financial measure. Cooperation with other waste producers (such as "Araks" and "Arzni" poultry farms) should be instituted: unfair competition among them should outgrow to cooperation. In this sense regular meetings may be organized.

Second group of non-financial measures contain legal regulations in the sector, such as laws or secondary legislative acts, regulating poultry manure treatment. Besides, favorable national policy should be developed. In particular, political will among decision making authorities should be formed and general concept should be elaborated. On the other hand, law enforcement mechanisms should be in place.

Non-financial measures include institutional changes, such as clarification of regulatory authorities' actions, their roles and responsibilities. Besides, cooperation between state authorities should be strengthened and interaction across the public sector should take place. Communication channels also should be established among public institutions.

Next group of non-financial measures comprises of information and awareness related activities. Necessary steps to be taken are distribution of information by all means and at all levels and raising public awareness, involving of mass media (via special workshops and campaigns).

Fifth group of non-financial measures are technological measures. There is a need to foster establishment of technologies investment counselling organizations and address adaption of technologies to local conditions. Moreover, use of appropriate local technologies should be considered. It is also suggested to increase the volume of litter through the import from other poultry plants. Furthermore, solutions should be found for technological difficulties through consultation with the plant technology manufacturer and/or international organizations, involved in exploitation of such plants.

Human/ Social and behavioral measures include organization of trainings for specialists and provision of qualification classes to them. Besides, activities, aimed at increasing the professional interests should be organized.

Enabling framework for the discussed technology includes formulation of favorable national policies, establishment of economic booster mechanisms and development of economic support initiatives by the Government, establishment of mild conditions for acquiring finances and creation of technologies investment counselling organizations. Moreover, collaboration between waste producers should be strengthened. Another crucial element of the enabling framework is raising public awareness and provision of qualification to specialists.

4.4 Barrier analysis and possible enabling measures for Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology

The territory of Armenia is covered with volcanic, sedimentary, metamorphic stone layers. Stone is used as a construction material. Each type of stone material is also considered as complex raw material, which can be used for production of various products. Research shows that vast majority of extracted stones are thrown into the environment as waste. There are types of stones 65-70% of which turn into waste.
(http://www.armworld.am/detail.php?paperid= 4290&pageid=132334&lang=_arm)
Until now, it was explored more than 110 in tuff stone mines in Armenia. The geological reserves are estimated at 2.5 trillion cubic meters. Market mapping of Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology is presented in **Figure AI-14.** In the market mapping enabling environment is presented by laws, state regulations, technical regulations and standards, financial and economic policy and strategy, market creation and development, availability of scientific developments, energy efficiency projects, environmental projects and tax policy. Market actors are Artik tuff stone mine, mining companies and local producers of thermal insulation materials on one hand, and state and private firms, construction companies and public and residential buildings on the other hand. Among market actors designers, scientific research institutions, waste management companies, technology developers, thermal insulation material importers, service providers, energy auditors, consulting companies, Artik community and private investors are mentioned. In the figure insufficient awareness, land clean up and degradation are presented as issues. Service providers are government agencies, Ministry of Urban Development, Ministry of Territorial Development and Administration, Ministry of Agriculture, Ministry of Energy and Natural Resources and foundations from one side, and media, commercial banks, private companies and international organizations from the other side. The figure illustrates the interactions between enabling environment, market actors and service providers.

The technology will have positive impacts on natural ecosystems and biodiversity of the surrounding area. The economic effects of the technology include use of surrounding lands and creation of employment opportunities. Other economic impacts are development of other economy branches and activities, related to construction, and development of infrastructures. Besides, proposed new material will be used in building construction as insulation material and will contribute to energy savings and GHG emissions reduction as well.

4.4.1 General description of the technology

The tuff stone of Artik is the most widely used one in the country. In 1928 machine extraction from Artik mine started. Up to now more than 50 million cubic meters of tuff stone mass was manufactured, of which only 30-40% was used as a construction material, the rest was mainly thrown into the environment as a waste.

These wastes and abandoned quarries occupy more than a thousand hectares of the fertile black soils. Overall, the area of 7.0-7.5 thousand hectares is covered by stone waste. The waste being influenced by the winds constantly pollutes the air basin of the surrounding settlements.

If the mass of the extracted raw materials used in full, the cost of materials will be reduced at least 1.5-2.0 times, so extraction of the stone mass will be correspondingly reduced as well, and the air spaces will not be polluted.

As a solution of this issue, it is recommended to use complex, phased and diversified approach implying organization of innovative production.

Accumulations of such a tuff-stone waste are conditioned by its technical characteristics. Because of the relatively low strength and high porosity rates the tuff stones waste is not attractive for construction and thus previously could not be used in construction like the other more solid stones waste, such as basalt, granite, marble and other mining wastes.

Possible areas of tuff waste utilization should be considered from their fractions aspect, considering minimal investment, operating costs and non-waste production conditions. This approach implies the following:

- In case of < 5 mm fraction foam-blocks, thermal and sound insulation plates, as well as production of foam-concrete products (Phase I);
- In case of 5 to 20 mm fractions gravel ground tuff blocks production (conventional and polymer) (Phase II);
- In case of 5 to 50 mm, fractions by combining with another problematic waste (plastic containers) and tuff-plastic crushed stone and on this basis organize a production of different products (Phase III) and so on.

Productions of the last two types conditioned by dramatically increase in utilization of waste volumes will allow parallel use of tuff waste big volumes (for instance, in road construction).

If the project's objectives for the implementation of phases I and II are known both the technologies and composition and value of the machinery, the same cannot be stated for the Phase III project objectives. In that case, it should start from zero level. No demand for gravel in the form of tuff waste, in addition to a relatively smooth (max. M 190) is due to its porosity high rate (40 to 70%), which strongly reduces its seasonal recurrence indicator (F50 - F600).

Vertical constructions, such as walls, the porosity is a positive indicator, in case of horizontal constructions (like in road construction) the constant presence of moisture/humidity due to seasonal freeze-thaw leads to its rapid depletion.

Plastic coverage of tuff remnants: 1. Gives them extra strength; 2. Excludes the moisture penetration into the gravel; 3. Ensures a minimum of 2 times increase in it’s seasonally recurrence indicator.

For the implementation of the EST can be useful the foreign experience and the scientific research results from the soviet period.

4.4.2 Identification of barriers

There is a number of barriers hindering the project discussed. For the identification of the existing barriers, consultations with key stakeholders in the working groups were conducted and results are presented in the current chapter. Those barriers were divided into economic/financial and non-financial blocks. Problem Tree based on LPA for Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology is presented in **Figure AII-14**.

4.4.2.1 Economic and financial barriers

No feasibility study was conducted to understand implementability of the project. In particular, economic benefits, resulted by land recovery, were not calculated and no assessment of the damages (economic, ecological, health etc.) was made.

Conducting feasibility study may require certain financial resources. Afterwards, if the proposed project seemed to be feasible, it will face high up-front costs. Moreover, during the implementation stage of the project barriers to the complete and effective realization of the technology could be insufficient financial resources.

4.4.2.2 Non-financial barriers

Non-financial barriers include market failure and imperfection issues, such as lack of scientific substantiation for solid waste use, market gaps in solid waste utilization sector and lack of information among market key actors.

Second group of barriers identified are related to policy and regulatory issues. No solid waste treatment policy has been developed and state authorities do not have strategy related to waste. On the other hand, agricultural lands rehabilitation strategy also has not been elaborated. Weak regulation of mining sector is another issue. It worth mentioning that legislation on mining is affected by mining business interests. Furthermore, technical norms are ignored, due to lack of punitive measures.

Institutional barriers are related to weak cooperation between decision making authorities and lack of coordination. Another issue is subordination of agricultural sector to the business sector.

Information and awareness related issues are related to lack of scientific substantiations for solid waste use. Besides, lack of awareness on the impacts (environmental, health and economic) is also a serious barrier.

Technological barriers include challenges, related to the selection of appropriate country-specific waste management technologies and their adaptation to Armenian realities. Moreover, the information -sharing between different stakeholders regarding technical issues is not a common practice. There is also limited understanding of technologies among companies or resource owners.

Human / Social and behavioral barriers mainly are related to the lack of corresponding skills at different levels and public knowledge.

4.4.3 Identified measures

While identification of measures an attempt was made to use inclusive strategy: to hold consultations with all the key stakeholders, involving them in the process and addressing their concerns. During the consultations and discussions with stakeholders, the solutions to overcome barriers were developed. Identified measures were grouped in economic/financial and non-financial measures. Objective Tree based on LPA for Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation technology is presented in **Figure AIII-14**.

4.4.3.1 Economic and financial measures

As an economic/financial measure it is proposed to conduct a feasibility study, calculating of economic benefits of lands recovery and the damage caused by solid waste. During studies both land recovery and getting rid of plastic and tufa wastes should be taken into account.

Another measure is development of strategies for raising funds from the citizens. In that way lack of financial resources may be addressed. Those kind of public funding is experienced in many developed countries.

4.4.3.2 Non-financial measures

Non-financial measures include market failure and imperfection related solutions, such as conducting complex scientific research for solid waste reuse. Besides, market development should be fostered. Information sharing and cooperation among market key actors should take place.
Policy and regulatory measures include establishment of a clear policy on solid waste treatment. There is also a need to define stricter mining regulation mechanisms. Besides, the Government should develop agricultural lands rehabilitation strategy.
As institutional measures it was suggested to clarify regulatory authorities' actions and strengthen cooperation between them. Moreover, the role of the agriculture sector should be highlighted.
As measures addressing information awareness related barriers development and distribution of scientific proposals was suggested. Raising awareness on the project's environmental, health and economic impacts will another measure.
As measures to technology issues selection of locally acceptable and feasible technologies was identified as a measure. In addition, use of appropriate local technologies for waste treatment will be another solution. On the other hand, information -sharing strengthened. In order to address lack of understanding of technologies among companies or resource owners outreach component should be implemented, such as seminars, conferences and roundtables.
Human / Social and behavioral measures include organization of trainings for specialists and provision of qualification classes to them. In particular, trainings should cover topics on land recovery and solid waste treatment modern technologies. Public awareness raising and education campaigns for citizens should be also organized.

Enabling framework for the discussed technology includes conducting a feasibility study that will assess economic benefits of lands recovery, development of strategies for raising funds from the citizens, as well as establishment of stricter mining regulation mechanisms and development of agricultural lands rehabilitation strategy by the state authorities.

4.5 Linkages of the barriers identified

Barriers related to technologies implementation in the Waste Management sector have been identified in seven categories: 1) Economic, Financial, 2) Market Failure and Imperfection, 3) Policy, Regulatory, 4) Institutional, 5) Information, Awareness, 6) Technology Issues, 6) Human Skills (**see Table1**).
Market mappings of Waste Management Sector technologies are presented in **Figures AI-12, AI-13, and AI-14.**
The process of barrier identification made clear that certain barriers in all three projects discussed are common. One of the most important barriers, hampering the waste sector development, is the fact that general public and business have low level of awareness and do not approach to waste as a business model. Lack of financial resources is also a serious obstacle.
Another shared barrier is lack of favourable national policies and economic promotion mechanisms from the Government, designed for the waste management sector. Furthermore, existent weak legislation misses law enforcement mechanisms, due to lack of punitive measures. Another barrier, related to the state authorities and common for all three projects discussed, is poor coordination between state bodies.
Problem Trees based on LPA for Energy Sector five technologies are presented in **Figures AII-12, AII-13, and AII-14.**

4.6 Enabling framework for overcoming the barriers in Waste management Sector

Identified barriers and proposed measures to overcome barriers to technology transfer in the Waste Management Sector are summarized and presented in **Table 5**.

Enabling framework for overcoming barriers in waste management sector may be established first of all, by arranging awareness raising activities and forming image of waste as a business model among general public and business. Another crucial factor is facilitating access to finance. Mechanisms of easy loans for waste management sector projects should be developed and incentives should be provided to the existing financing system.

Besides, relevant legal framework should be developed and law enforcement mechanisms should be in place. Effective economic promotion mechanisms should be elaborated. Furthermore, coordination between different ministries, departments and other governance entities should be improved.

Objective Trees based on LPA for Waste management Sector three prioritised technologies are presented in **Figures AIII-12, AIII-13, and AIII-14**.

Summary and Conclusions

In order to understand the core problems in technology transfer, the working group has performed LPA drawings that were elaborated by experts in consultation with stakeholders. The cause/effects relations were organized in Problem tree, having the main problem put as starter problem and causes and effects identified and analysed. Using LPA the working groups were able to bring together the key elements of problems, use logical analysis of inter-related elements, and identify casual relations of barriers, their linkages. The working group has used Market Mapping techniques as a tool for barrier identification and analysis of challenges the technologies have to ensure sustainable development.

The nature of the barriers in Energy sector, mainly is considered to be institutional and regulatory those are conditioned by change in management systems. All the technologies are successfully used in developed countries, contributing to the development of the national economy. This experience was reviewed and investigated by the country's government, research institutions, as well as by individual experts.

At the same time it is possible to achieve synergy between identified barriers of technologies under industrial sector, particularly with regard to financial barriers. Access to acceptable finance, as well as developing a mechanism for the provision of affordable financial loans.

Meanwhile, low income population prevails in the rural area, where land use is a dominant means of livelihood. Therefore, common barrier for all land use technologies are lack of infrastructures and insufficient finance resources. All land use improvement technologies require “up-front” investment.

The discussed projects in waste management sector are interesting experiences, lessons from which may useful for future projects. For instance, methane utilization technology can be successfully applied in landfills of Gyumri and Vanadzor (second and third largest towns in Armenia, respectively).

The working group has mentioned weak interaction between market actors, which creates logistic and institutional barriers. Poor communication and non-sharing the information between market players may lead to market failure. The lack of participatory arrangements that fully engage all the involved actors is a significant barrier.

Having established a comprehensive understanding of the barriers, the next step for the working group have been to identify of measures needed to overcome the barriers established and to improve each technology performances. LPA was used as a tool to identify the measures to overcome the barriers. The experts have prepared sector specific statistics, and other useful information for discussions during the meetings with stakeholders. The working group discussed the measures in the context the barriers were addressed, grouping by the same criteria as barriers. The problems were reformulating into positive statements of future situation, arranging measures and results into Objective tree. Enabling environment was analysed as part of Market mapping technique.
In parallel with traditional funding sources (state assistance, grants, loans, international support), new tools for fundraising should be used, such as Civic Climate Investment Fund where the decisive voice will belong to the civil society.

Through the innovative financial mechanism, civil society will be involved in climate change mitigation and adaptation processes. The fund shall be replenished on permanent base by allocations from environmental fees and ecosystem service fees. The emerging financial mechanism will to establish and develop reliable public-private partnership (PPP) and ensure the right of future generations to “use climate resources”.

In 2013, the Government of RA adopted a protocol resolution, which approved the concept paper on establishing such innovative financial mechanisms. With another resolution from 2013, the Government issued an assignment arising from this concept paper to make a relevant proposal to the Government to establish a civil investment revolving fund from the environmental fees by the example of green investment scheme.

However, implementation of stand-alone scattered projects is expensive and results in loss of synergy. Fragmentation of functions results in missed synergy opportunities. There is a need for a common strategy that will take into account cross-sectoral linkages and interactions between other projects.
The role of state authorities is to show political will, enable national favourable polices and legislation, and provide effective economic mechanisms. Moreover, better cooperation among state authorities may result in transformation of the relevant practical knowledge into legislation and policies.

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Ref-2	Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, Second Edition, UNEP DTU Partnership, Department of Management Engineering, Authors Ivan Nygaard, Ulrich Elmer Hansen http://www.tech-action.org
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Ref-8	Armenian National Statistical Service http://www.armstat.am/am/
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Ref-10	Third national communication on climate change (2015) Under the United Nations framework convention on climate change http://www.nature-ic.am/third-national-communication/
Ref-11	Assessment of Technical and Financial Viability of Nairit Chemical Plant Operation June 2015 Prepared by Jacobs Consultancy Ltd for World Bank http://www.minenergy.am/storage/files/Nairit_Final_Report_v.3_eng.pdf
Ref-12	Scaling-up Renewable Energy Program (SREP, 2014) Investment Plan for Armenia June 2014 http://r2e2.am/wp-content/uploads/2014/08/Armenia-SREP_2014.pdf
Ref-13	Armenia: Yerevan Solid Waste Project – Environmental and Social Due Diligence, Environmental and Social Impact Assessment, 2015 http://www.eib.org/infocentre/register/all/60142333.pdf

Annex I Market maps

Figure AI-1. Market Mapping of Cogeneration, Small Scale Combined Heat and Power production.

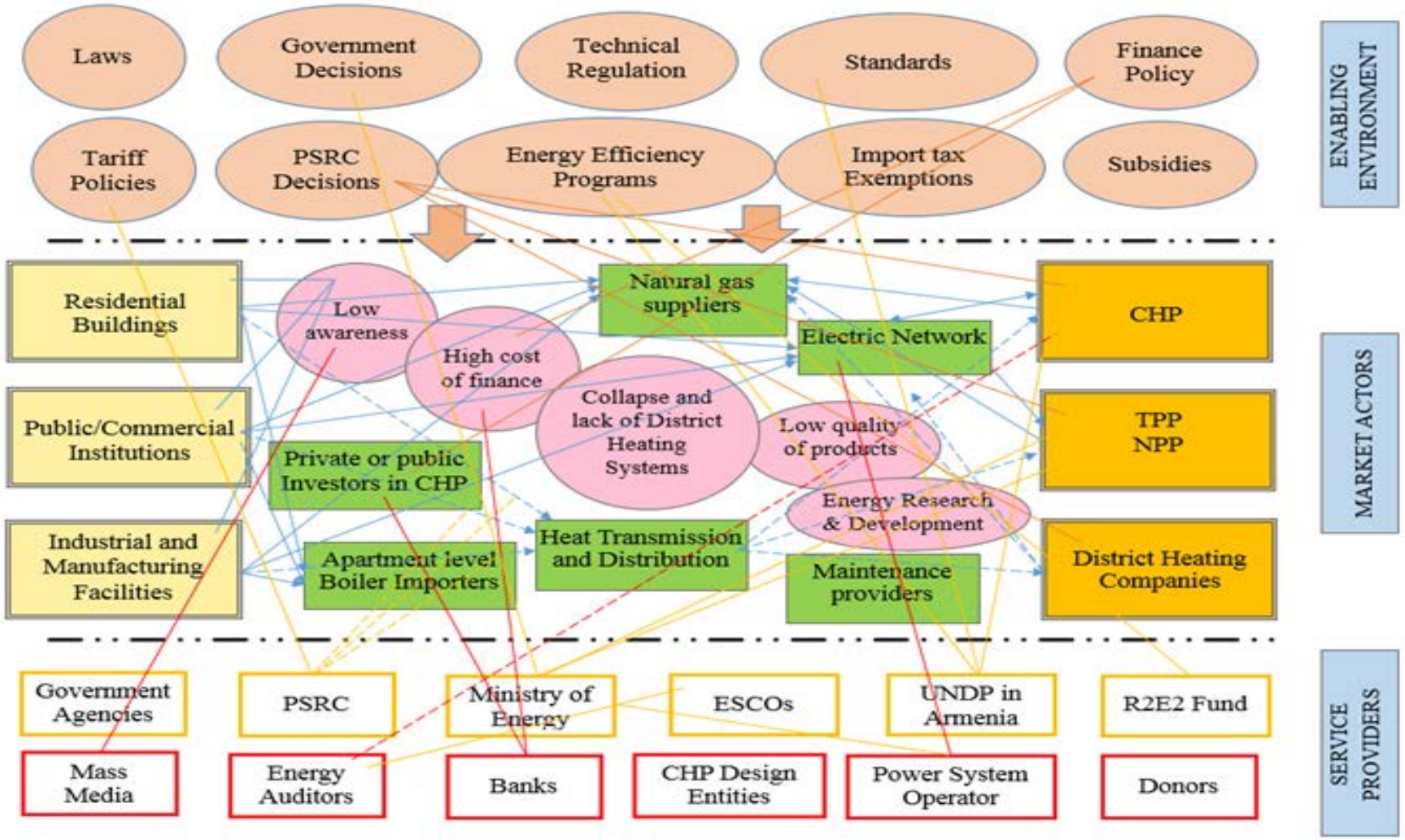


Figure AI-2. Market Mapping of Improving energy efficiency in multi-apartment buildings. Registry creation, development.

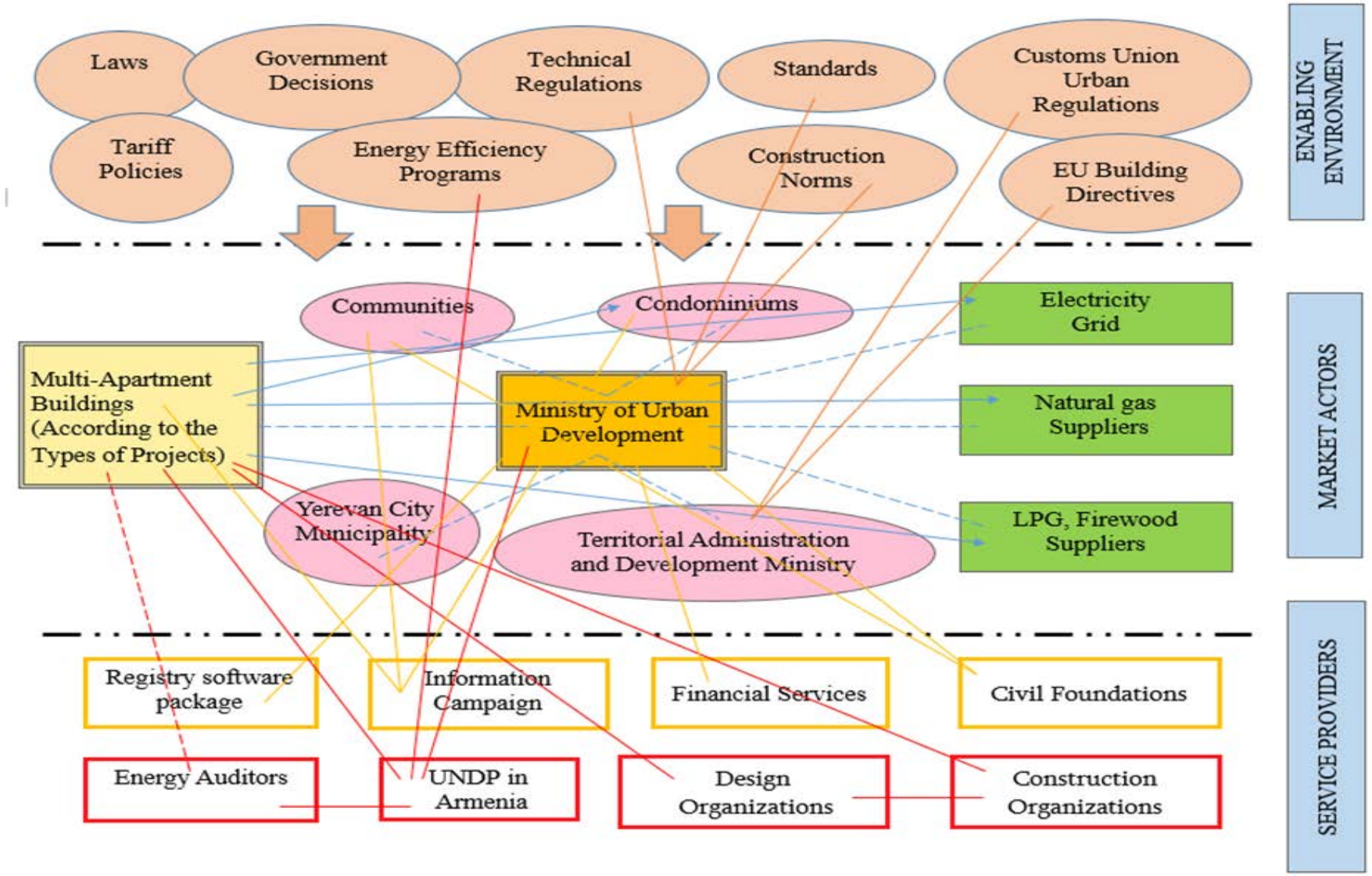


Figure AI-3. Market Mapping of Mandatory realization of the Industrial Energy Audit as a mitigation component.

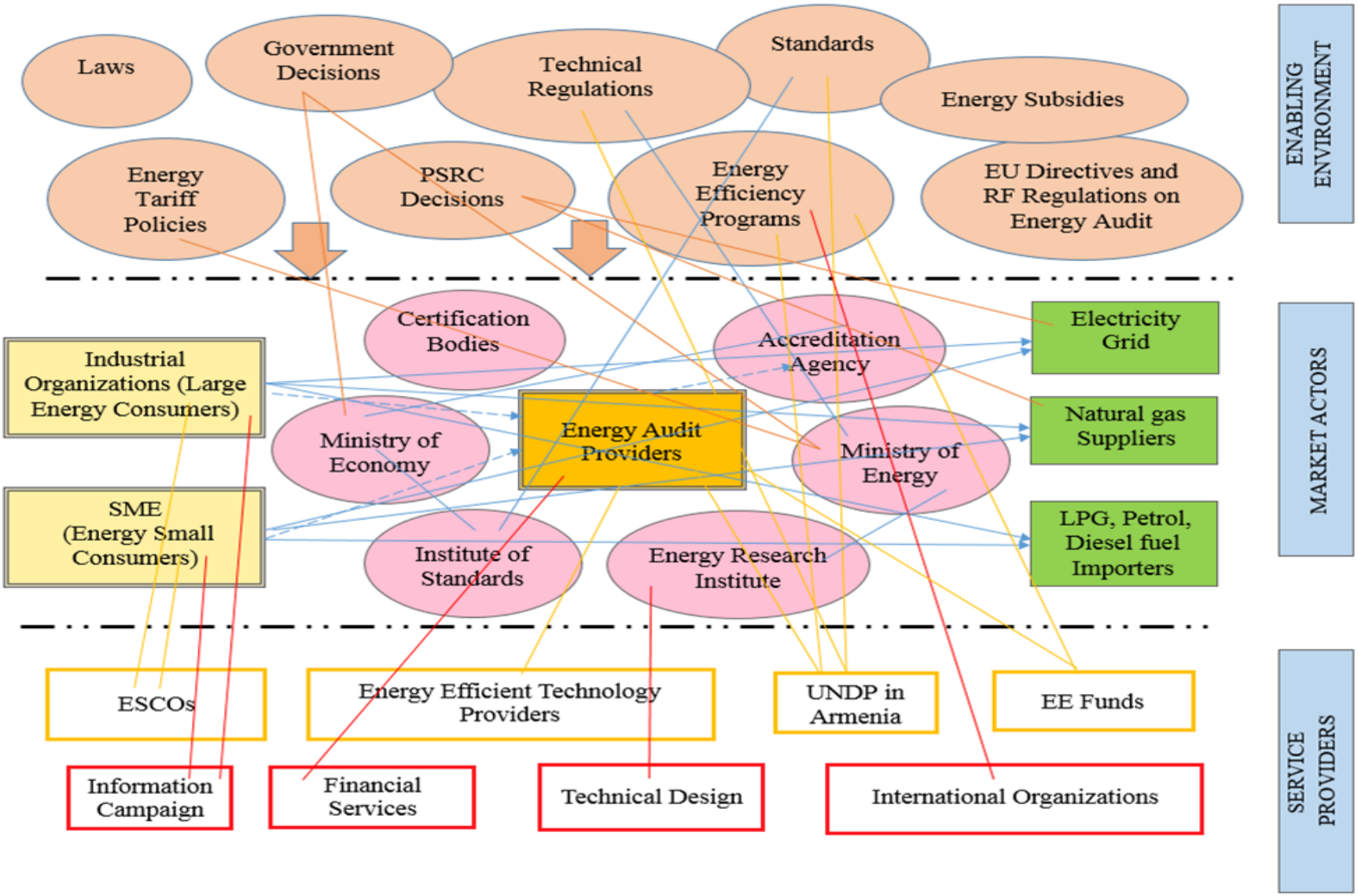


Figure AI-4. Market Mapping of Reactive capacity (power) compensation in the RA electric energy system.

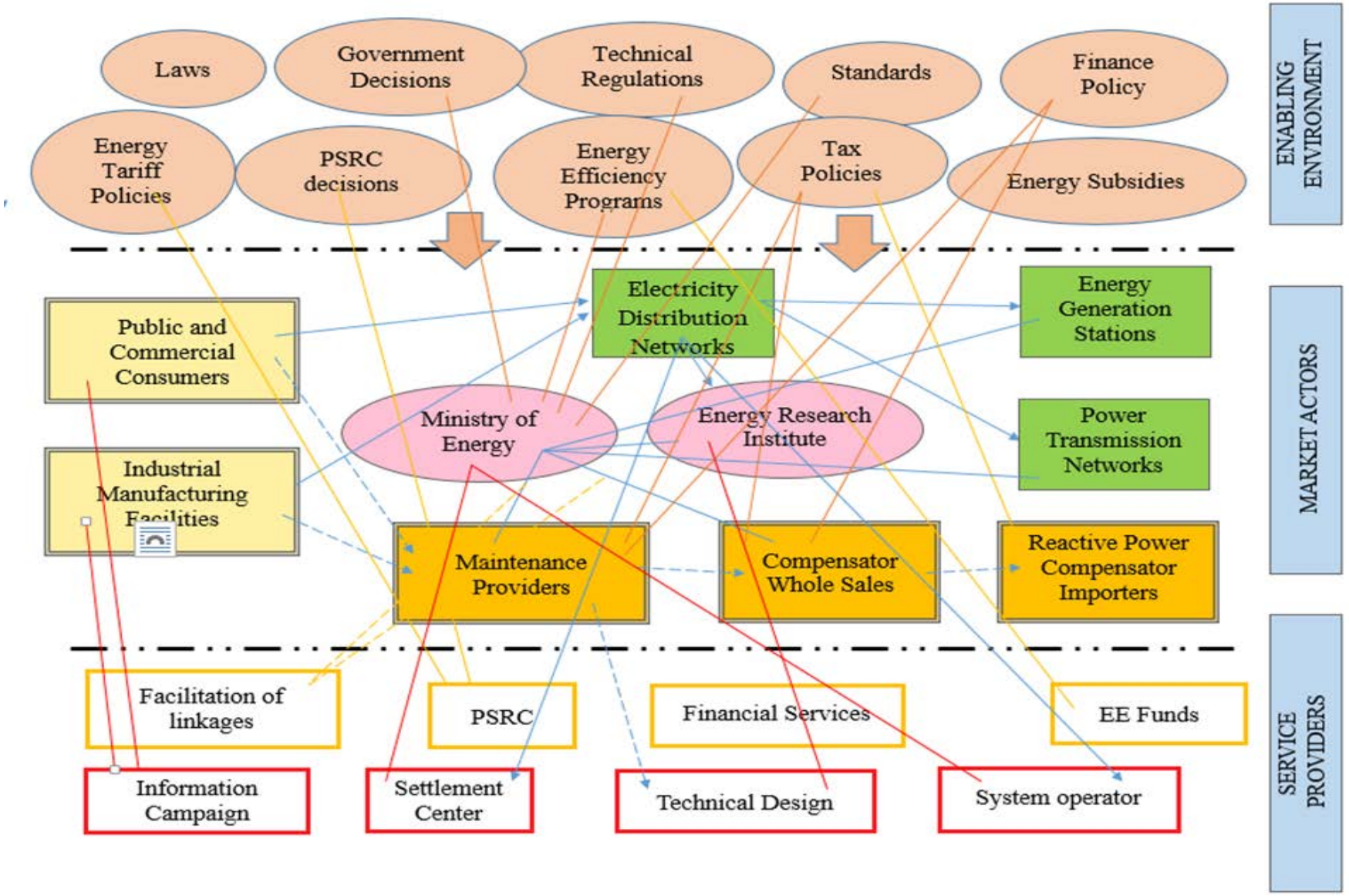


Figure AI-5. Market Mapping of Correspondence of natural gas tariff structure to the methodology approved by decision of Public Services Regulatory Commission (PSRC).

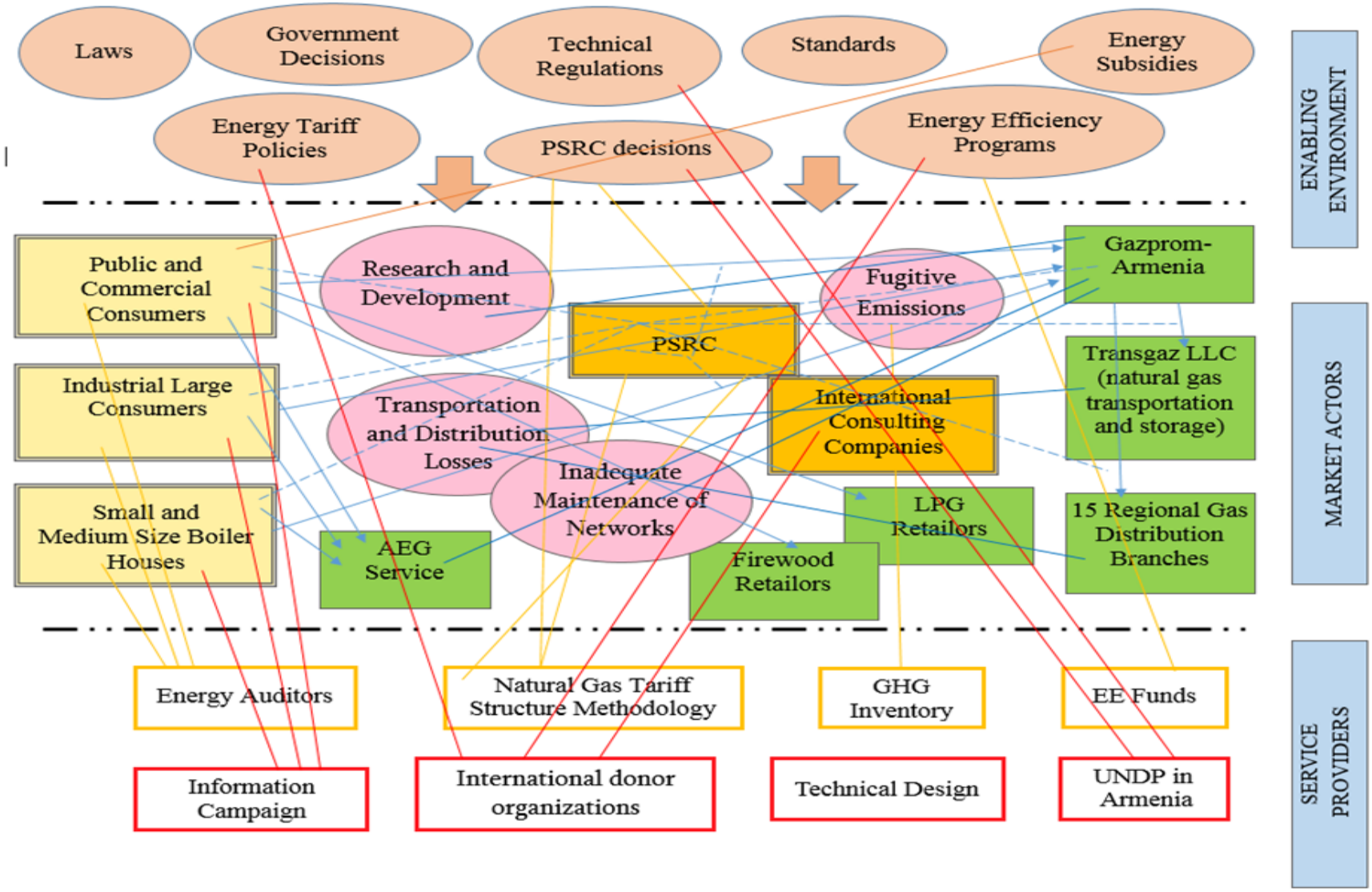


Figure AI-6. Market Mapping of Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry).

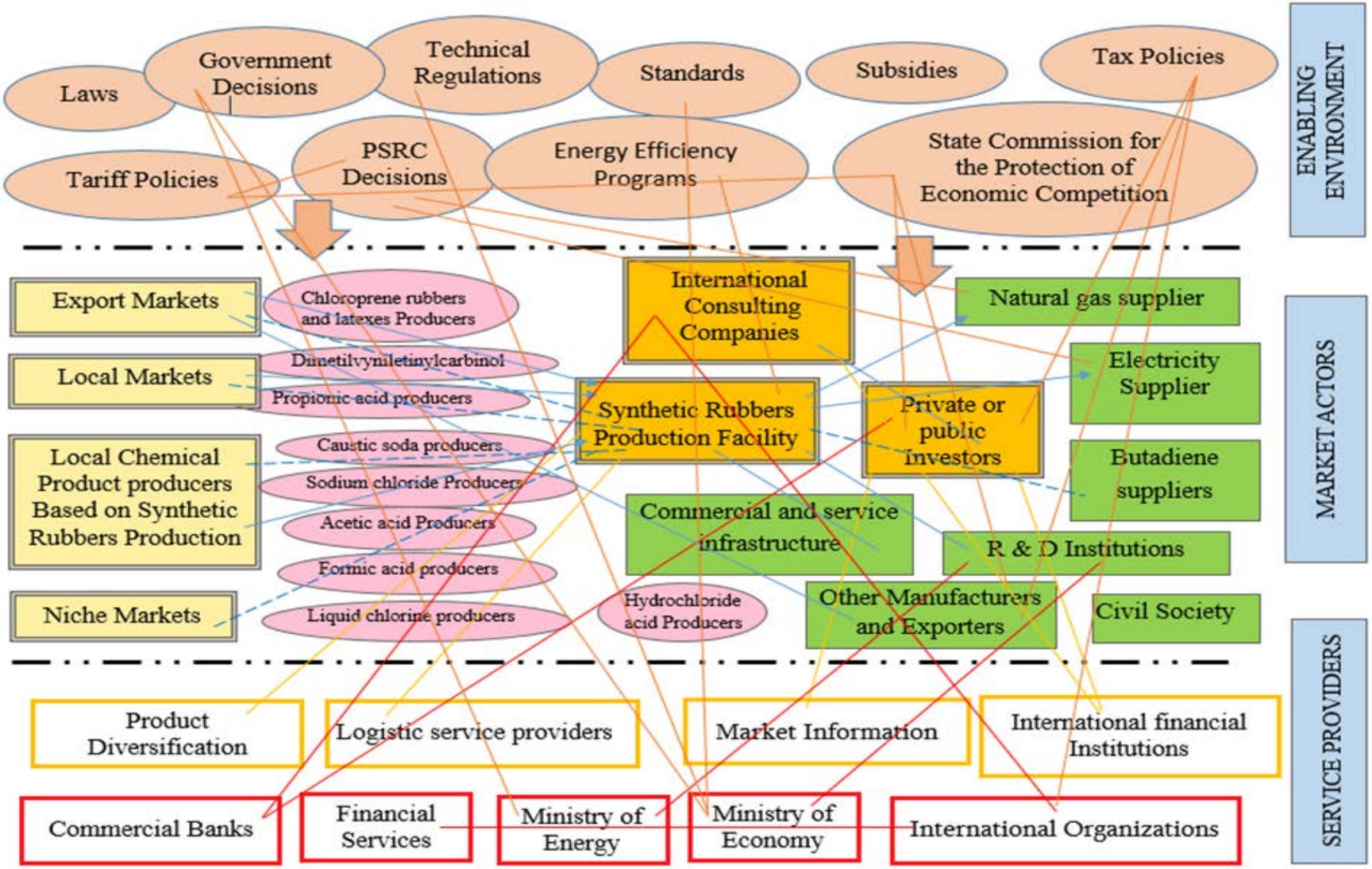


Figure AI-7. Market Mapping of Production and usage of photo luminescent materials with long-term lightening.

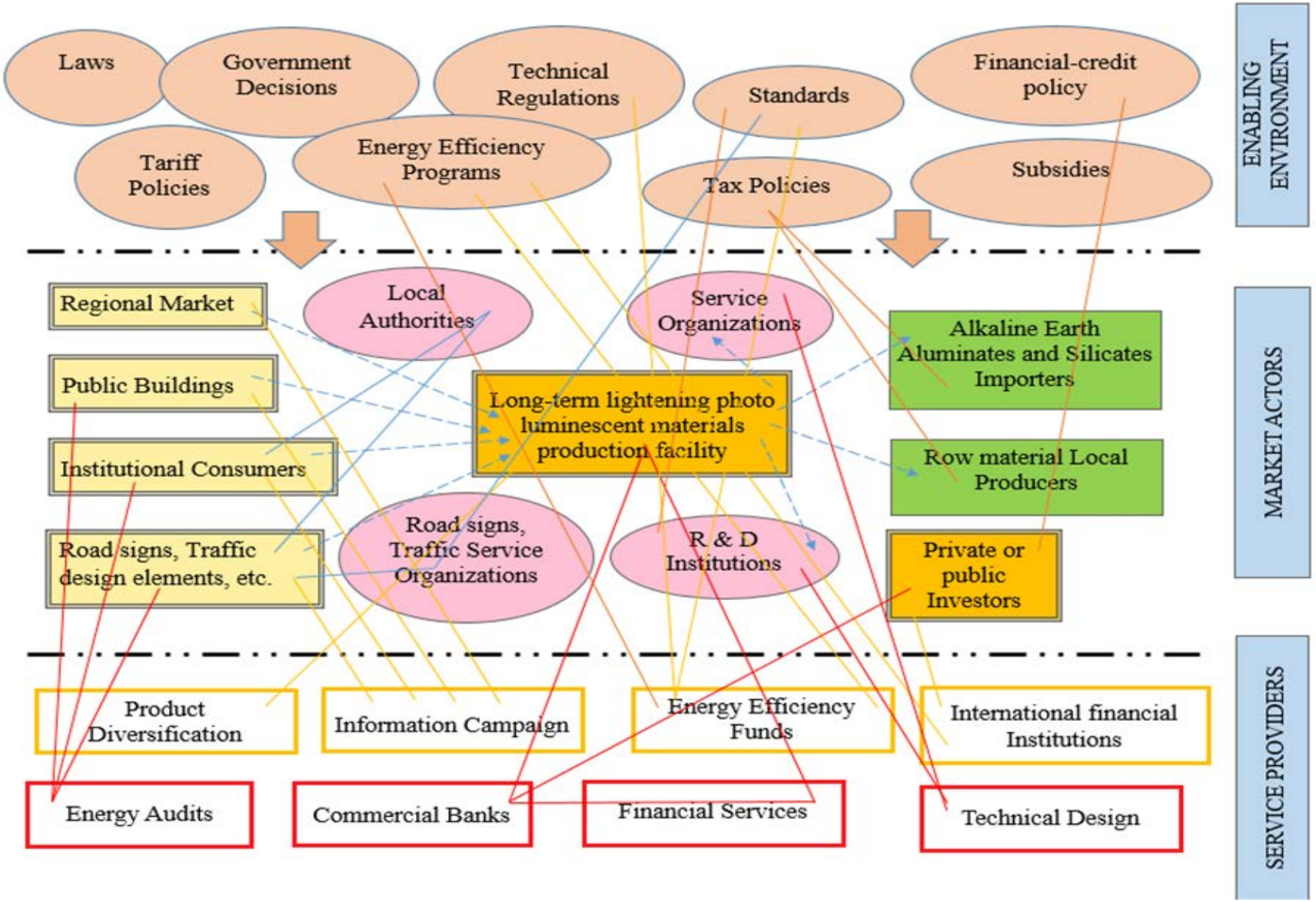


Figure AI-8. Market Mapping of New type of Entirely Plastic solar water heater.

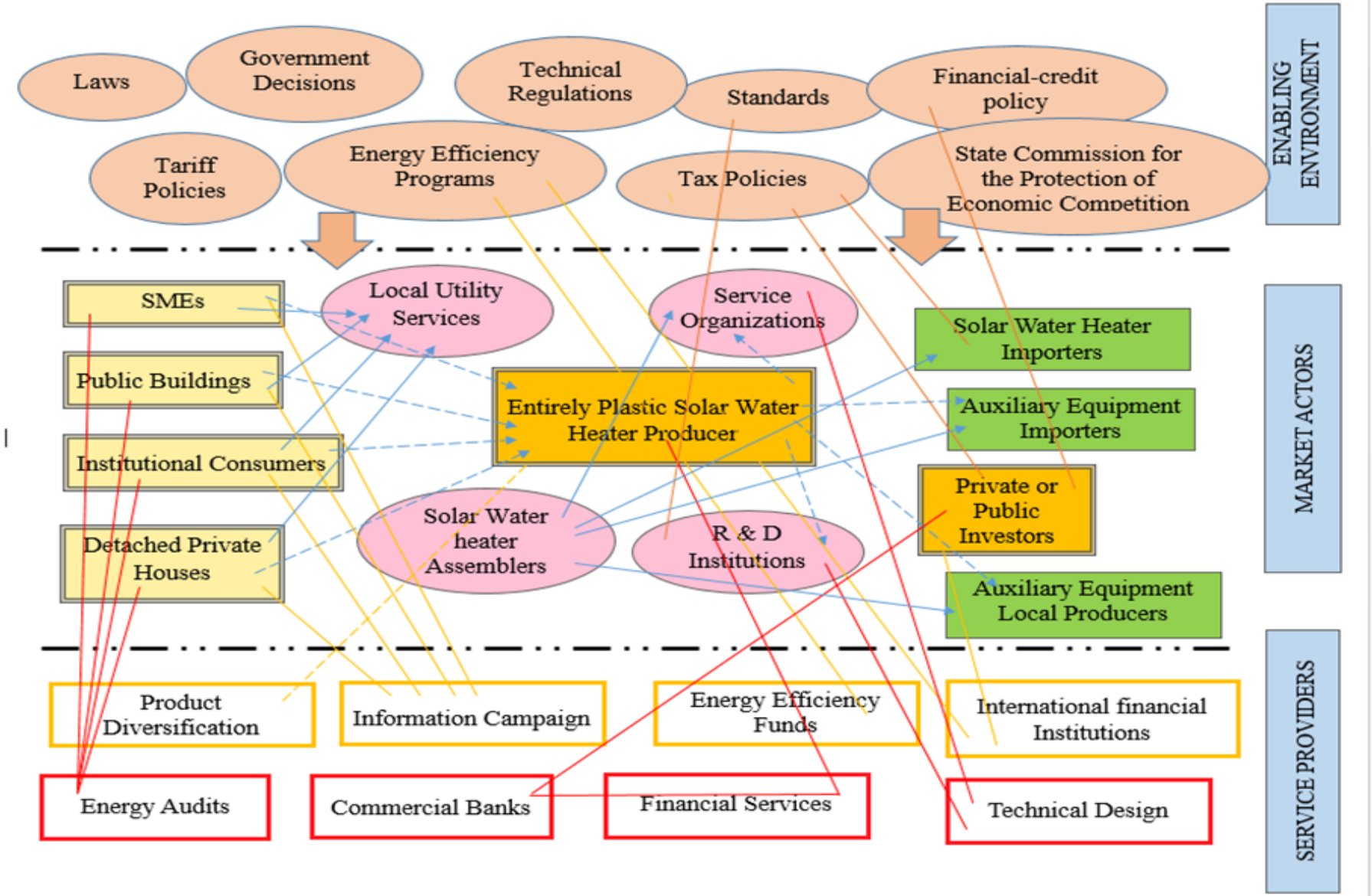


Figure AI-9. Market Mapping of Degraded Grassland radical improvement.

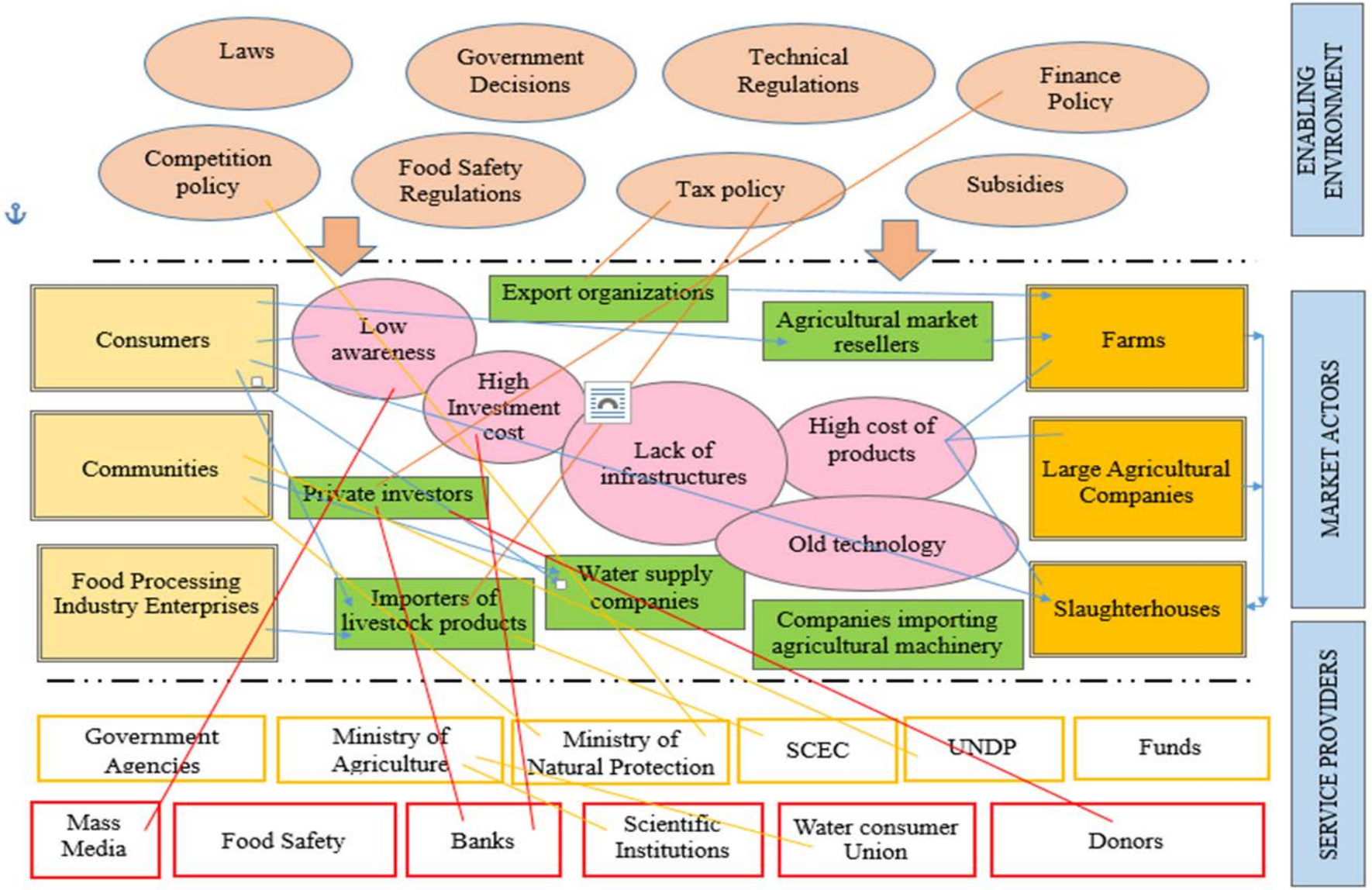


Figure AI-10. Market Mapping of Sustainable Forest management.

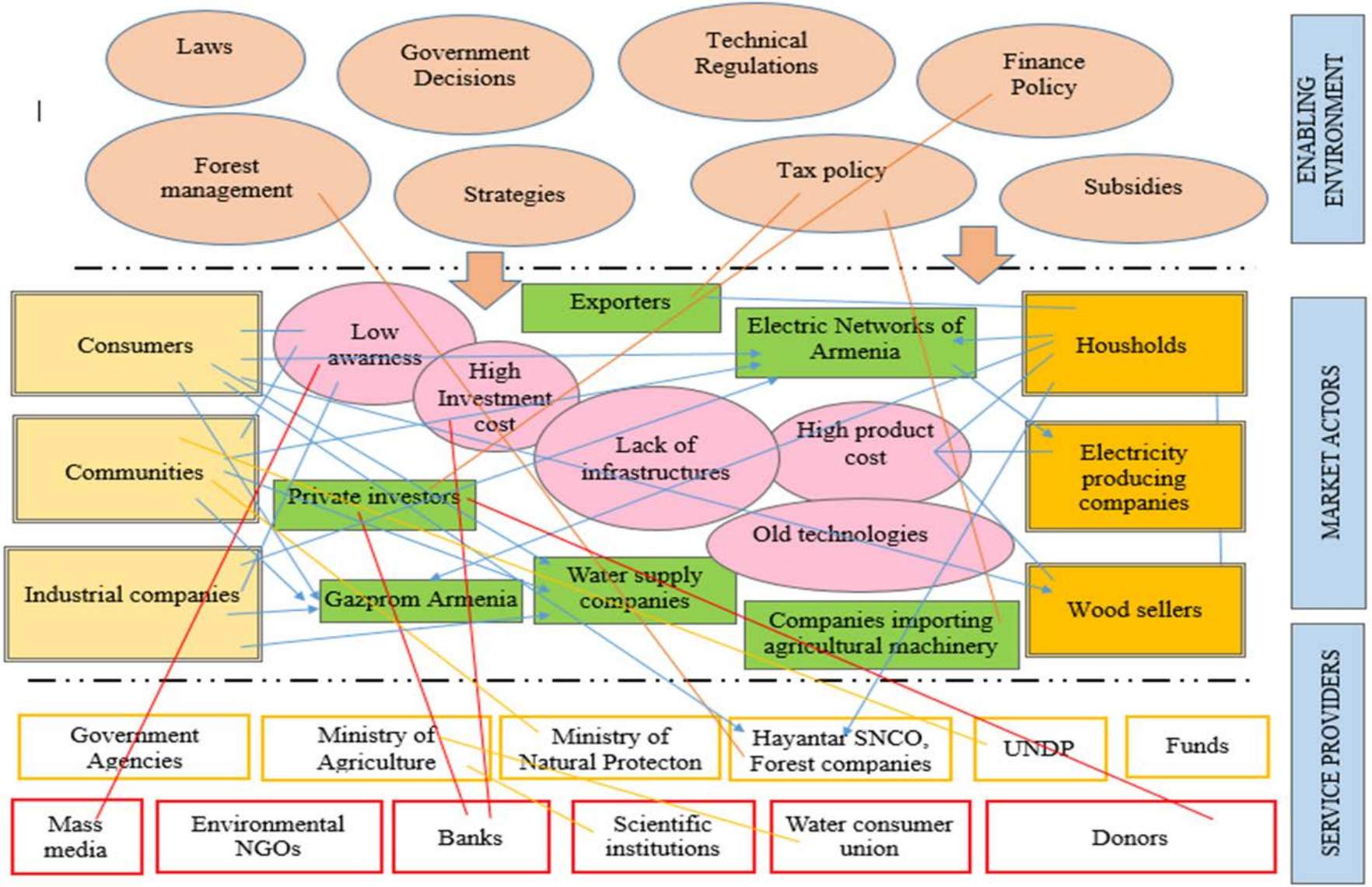


Figure AI-11. Market Mapping of New technology of cultivation of Perennial plants.

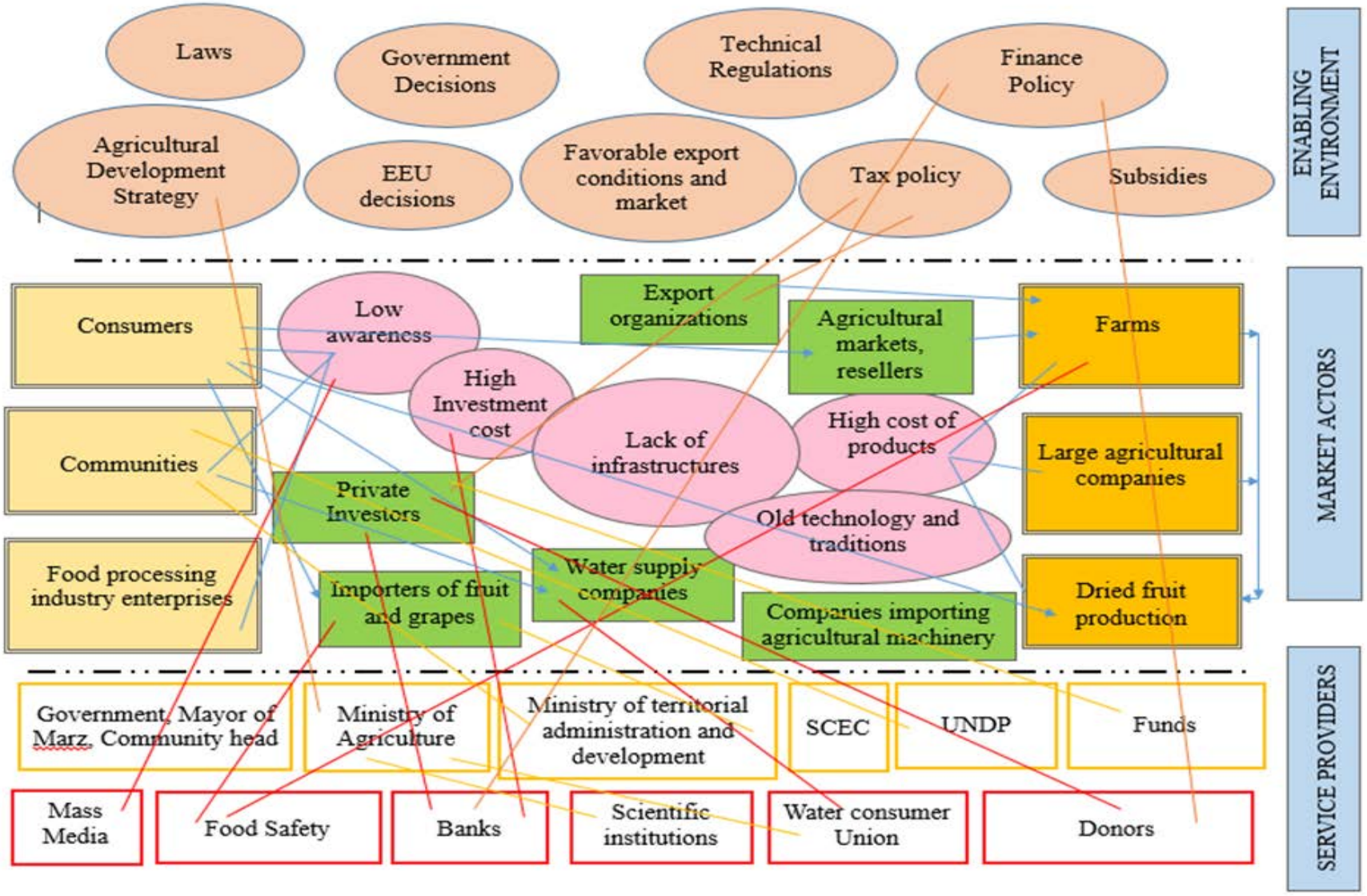


Figure AI-12. Market Mapping of Utilization of methane form Yerevan city landfill for electricity and heat production.

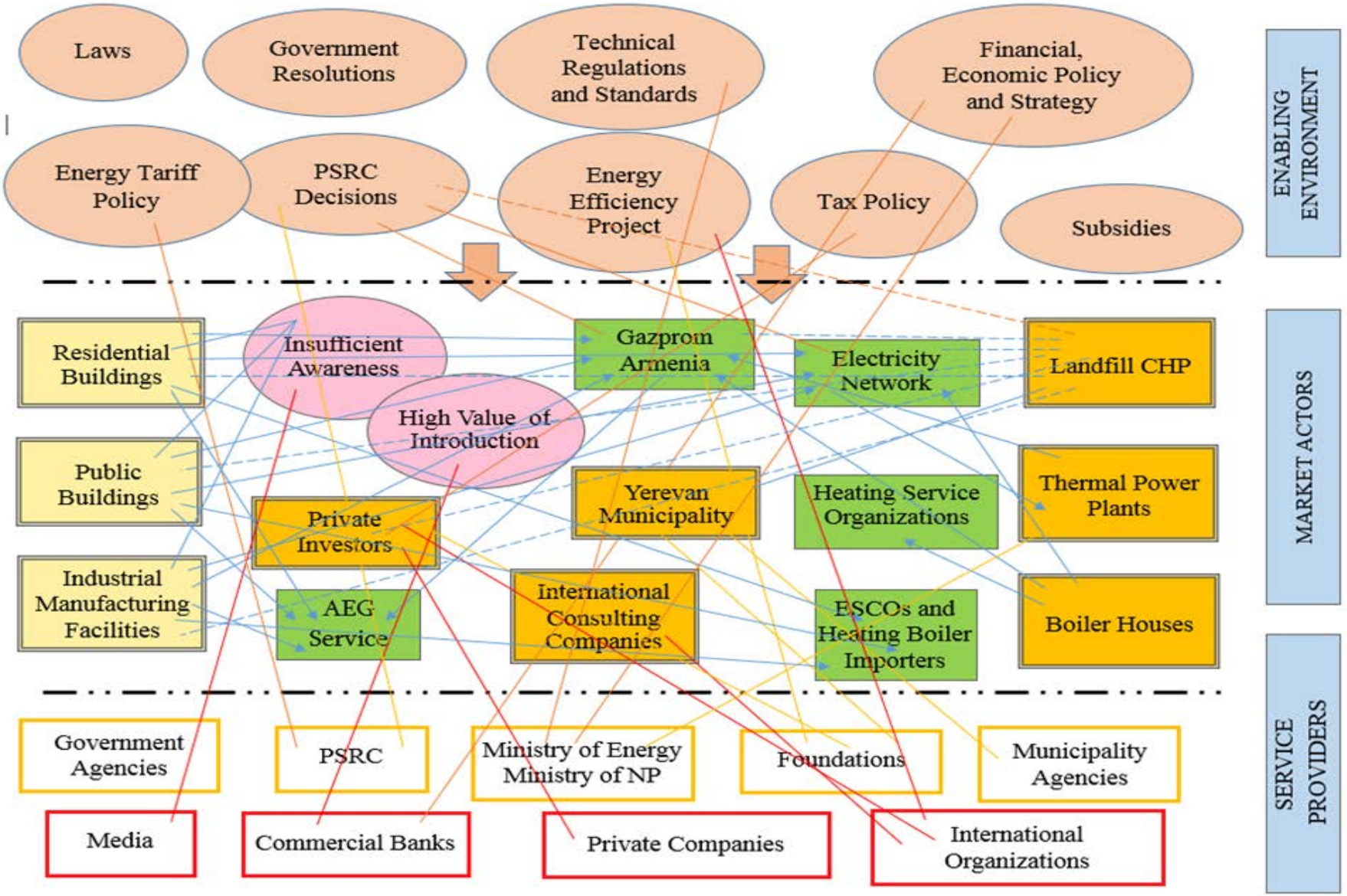


Figure AI-13. Market Mapping of Existing Lusakert biogas plant operation and reissuance organizational technology.

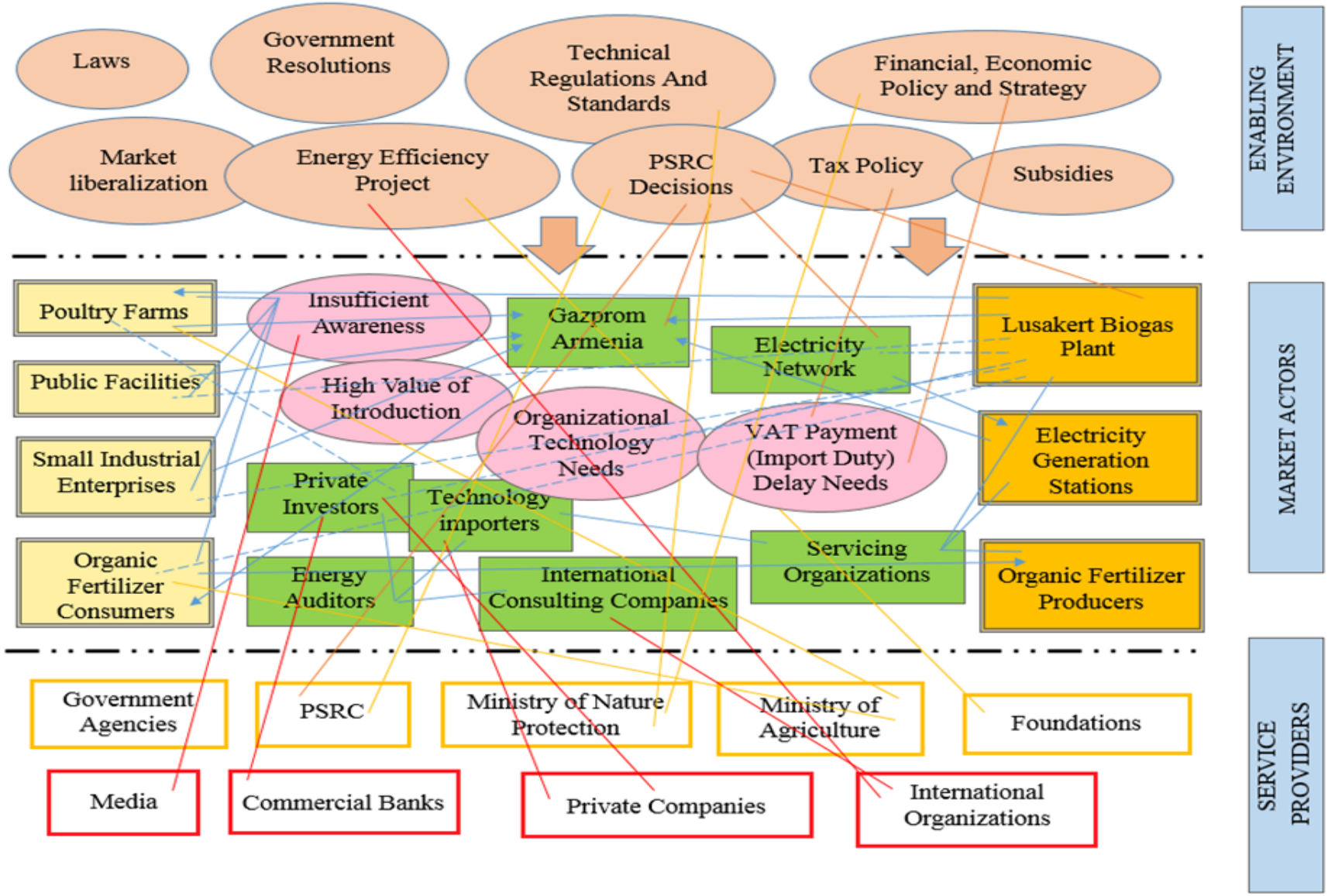
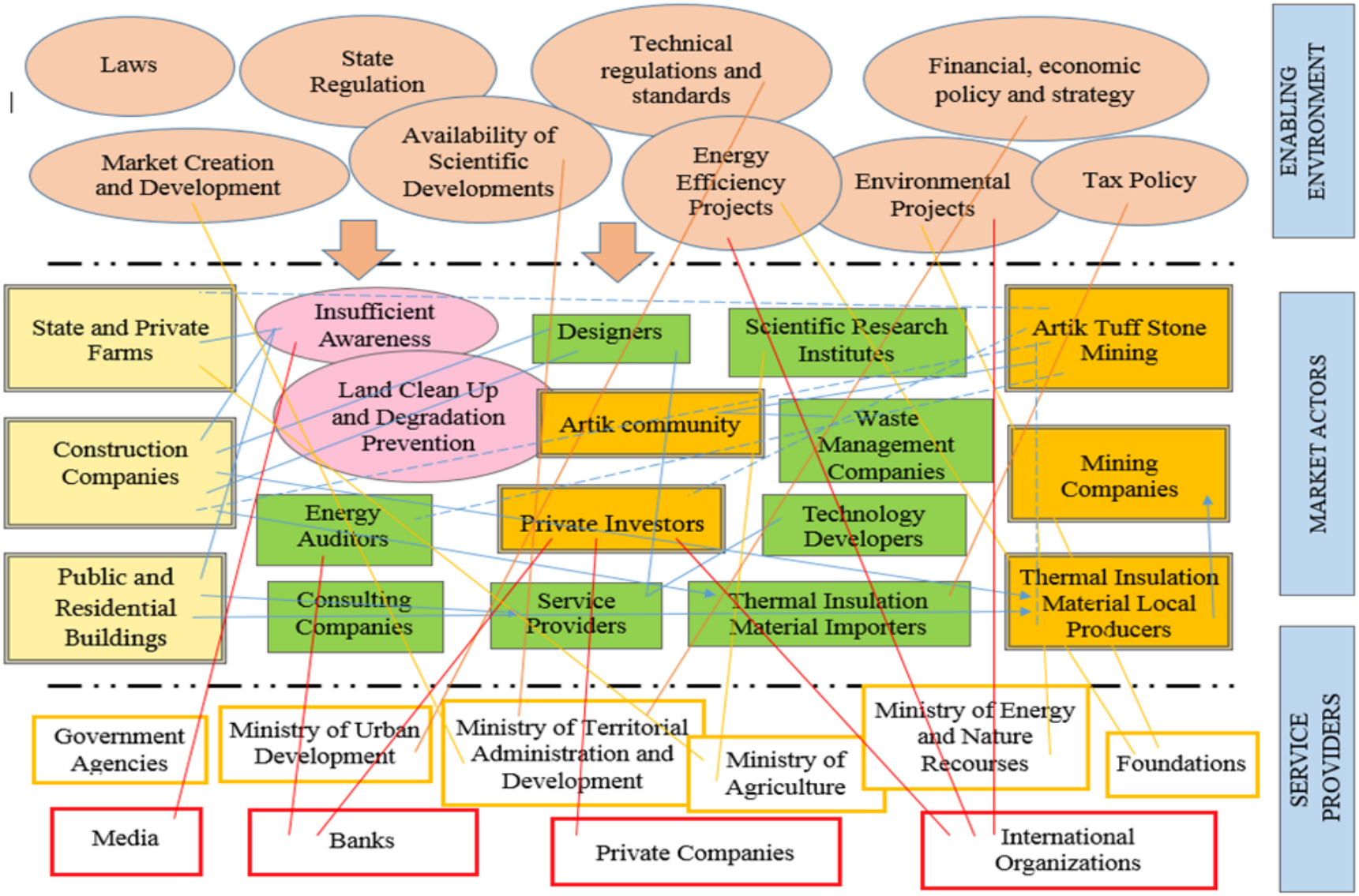


Figure AI-14. Market Mapping of Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation.



Annex II Problem trees

Figure AII-1. Logical Problem Analysis of Cogeneration, Small Scale Combined Heat and Power production. Problem Tree.

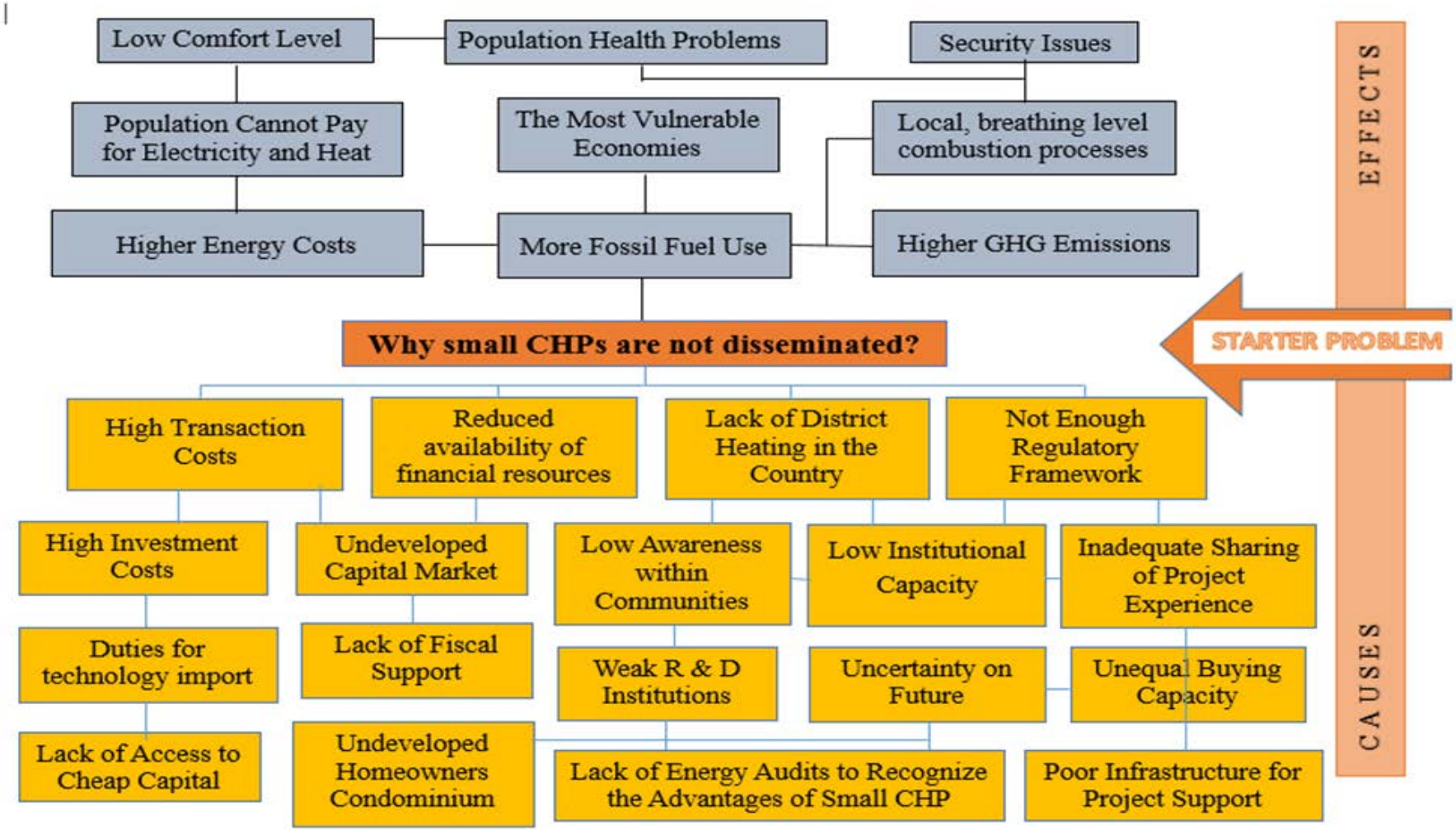


Figure AII-2. Logical Problem Analysis of Improving energy efficiency in multi-apartment buildings. Registry creation, development. Problem Tree.

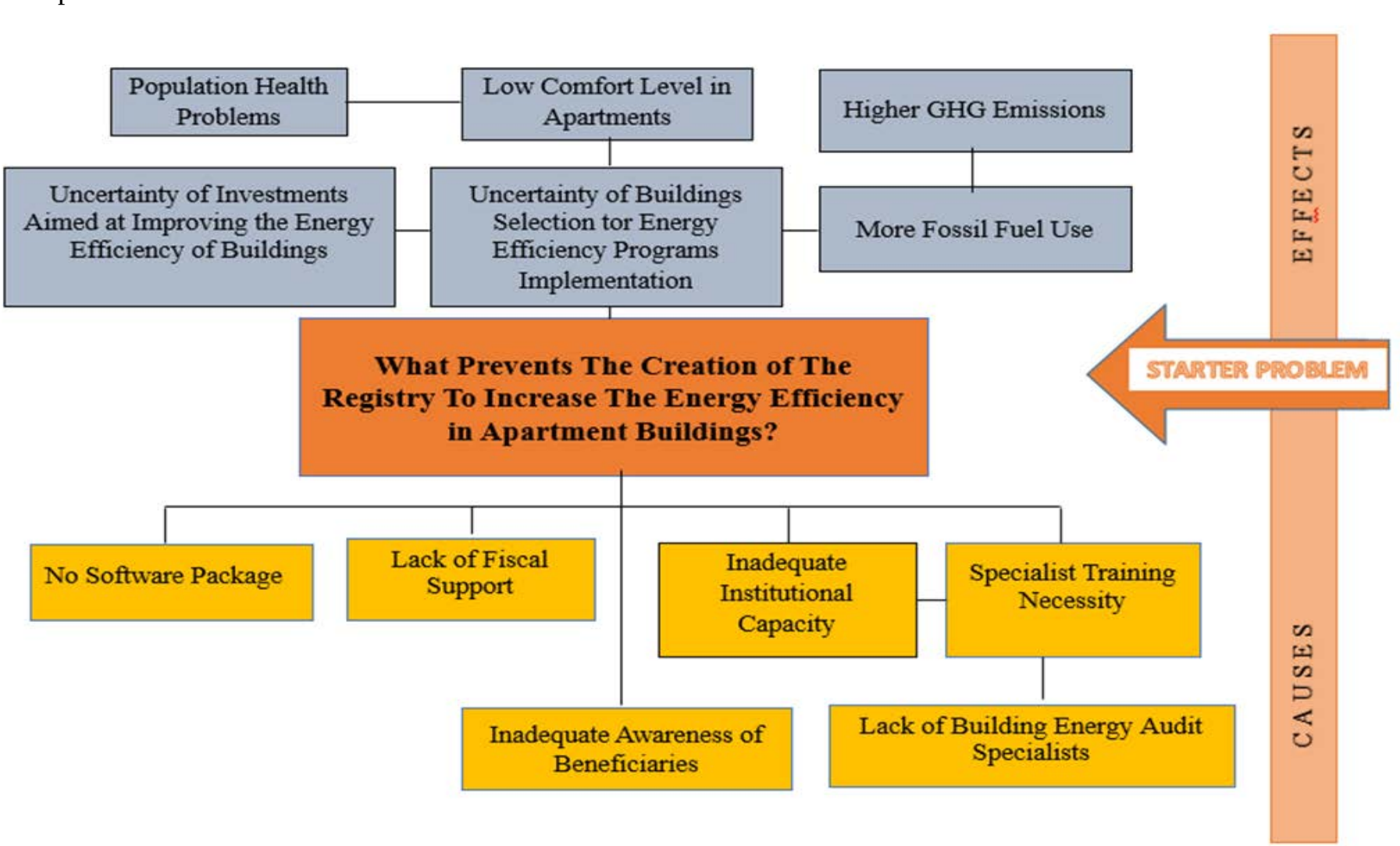


Figure AII-3. Logical Problem Analysis of Mandatory realization of the Industrial Energy Audit as a mitigation component. Problem Tree.

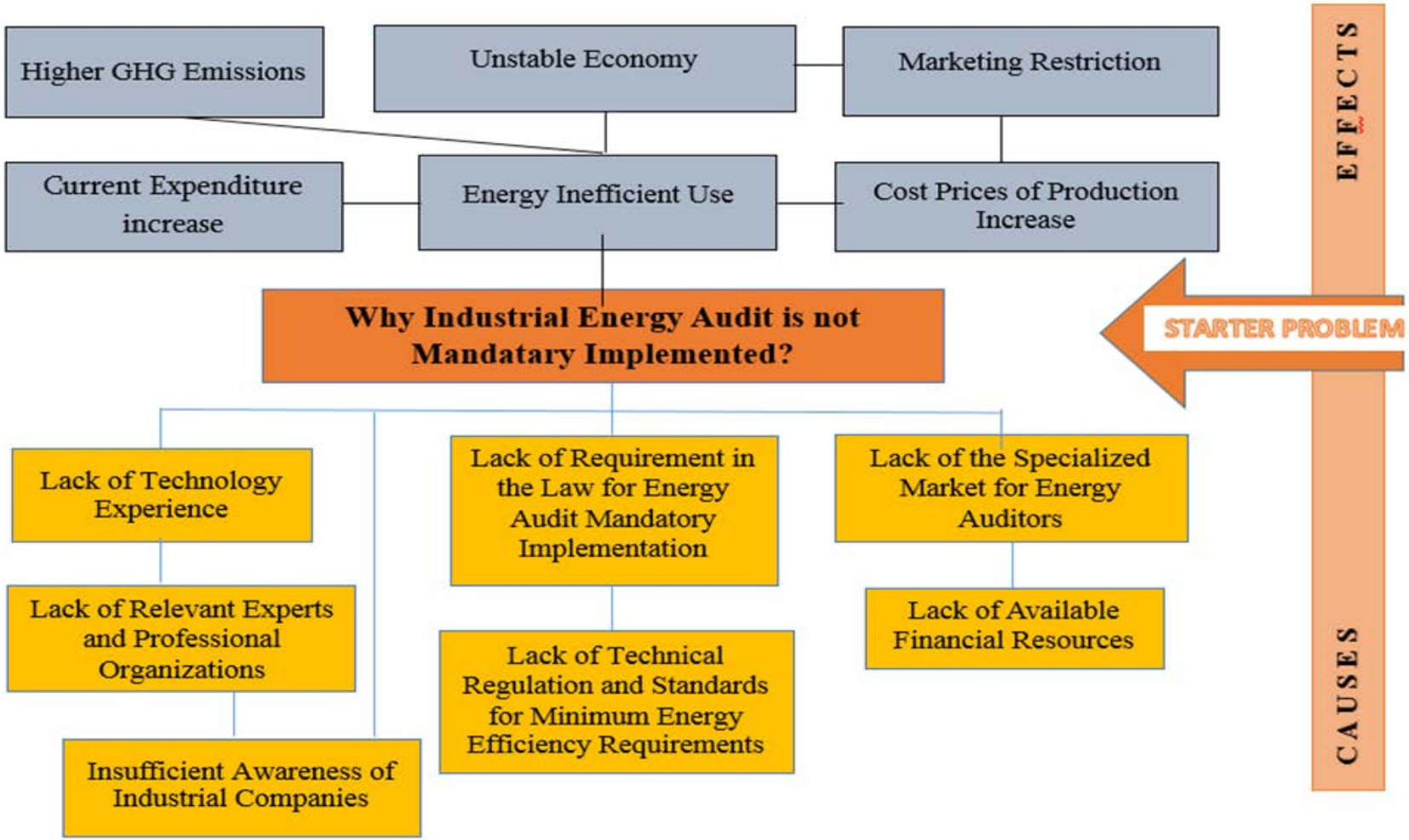
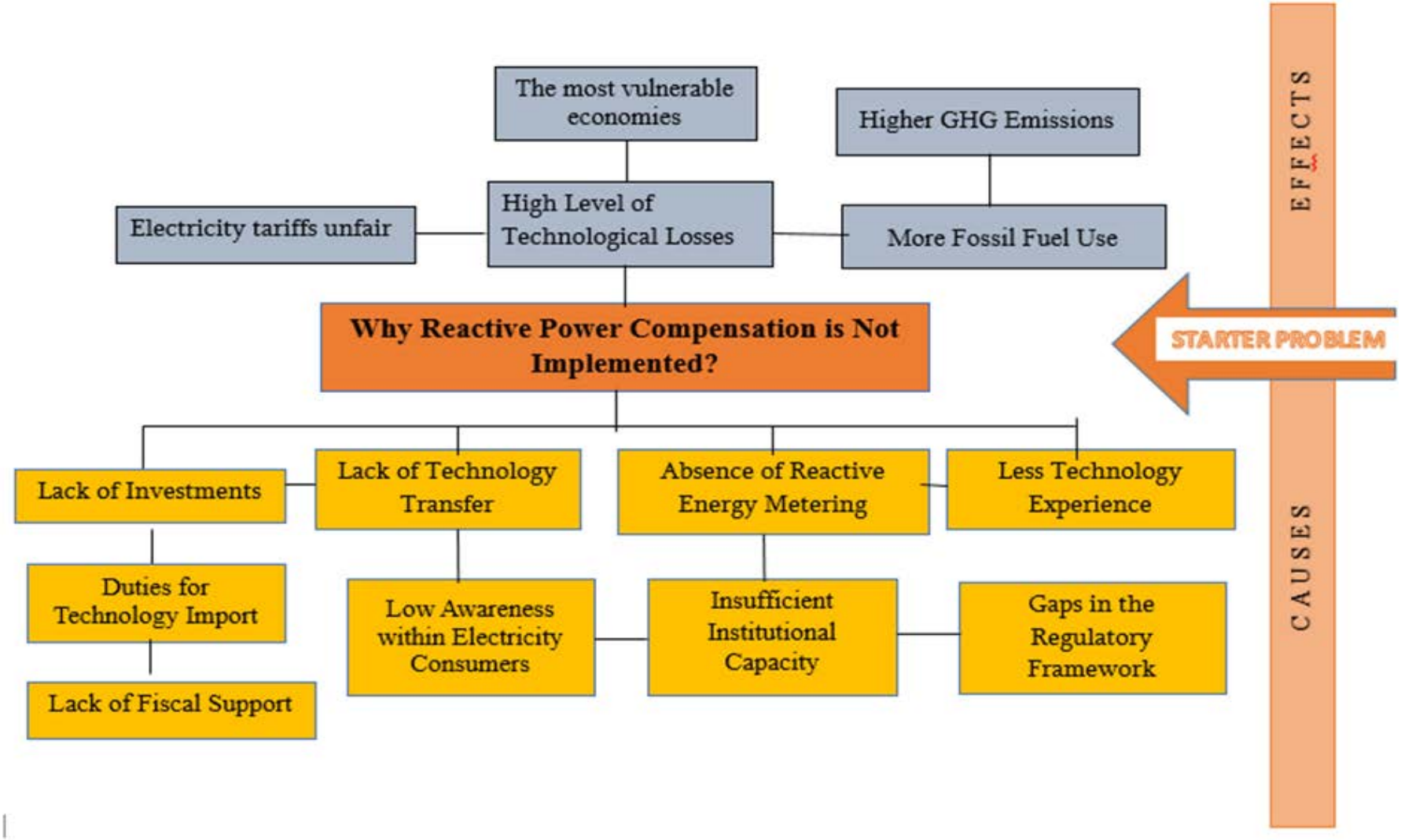


Figure AII-4. Logical Problem Analysis of Reactive capacity (power) compensation in the RA electric energy system. Problem Tree.



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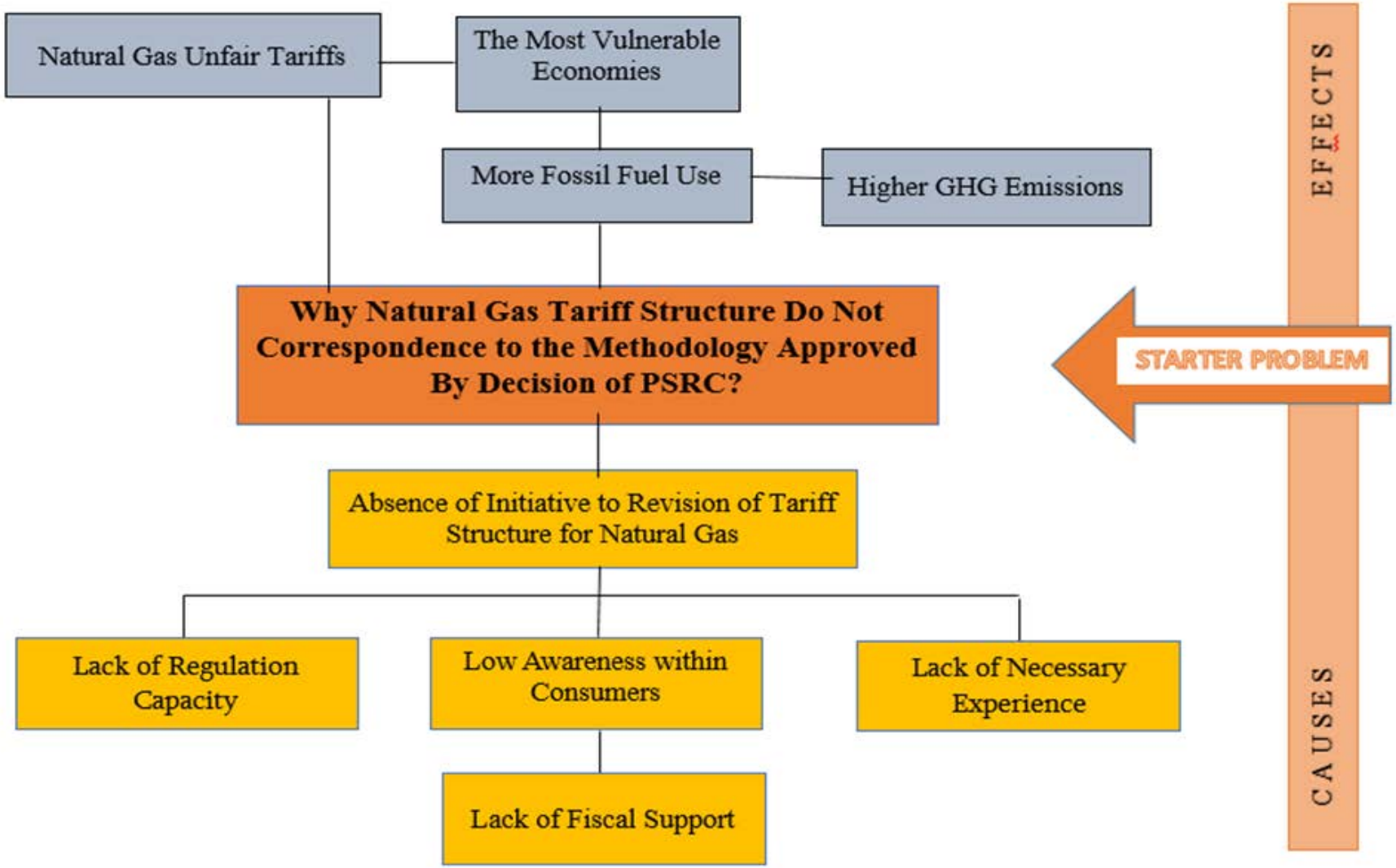

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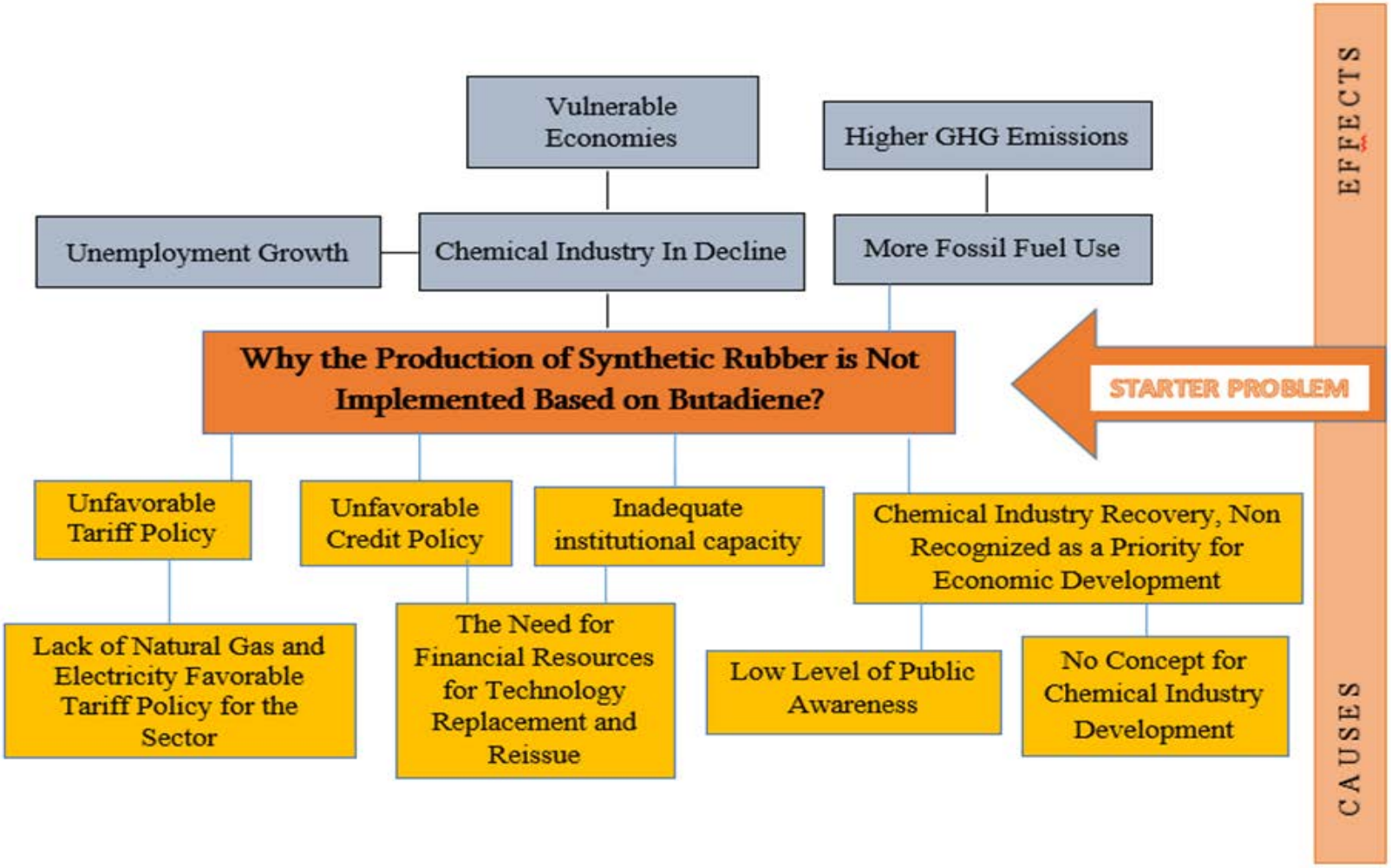


Figure AII-7. Logical Problem Analysis of Production and usage of photo luminescent materials with long-term lightening. Problem Tree.

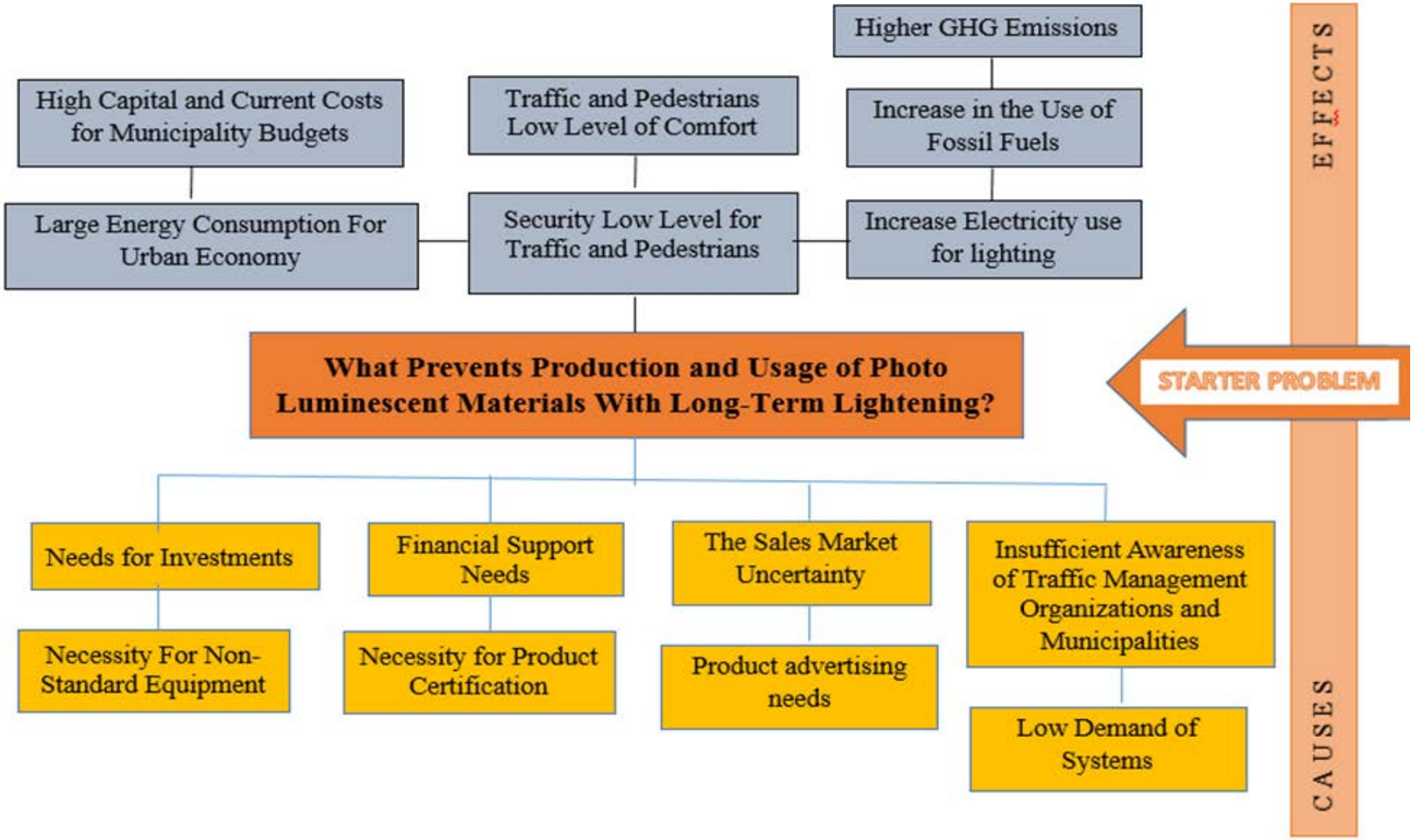


Figure AII-8. Logical Problem Analysis of New type of Entirely Plastic solar water heater. Problem Tree.

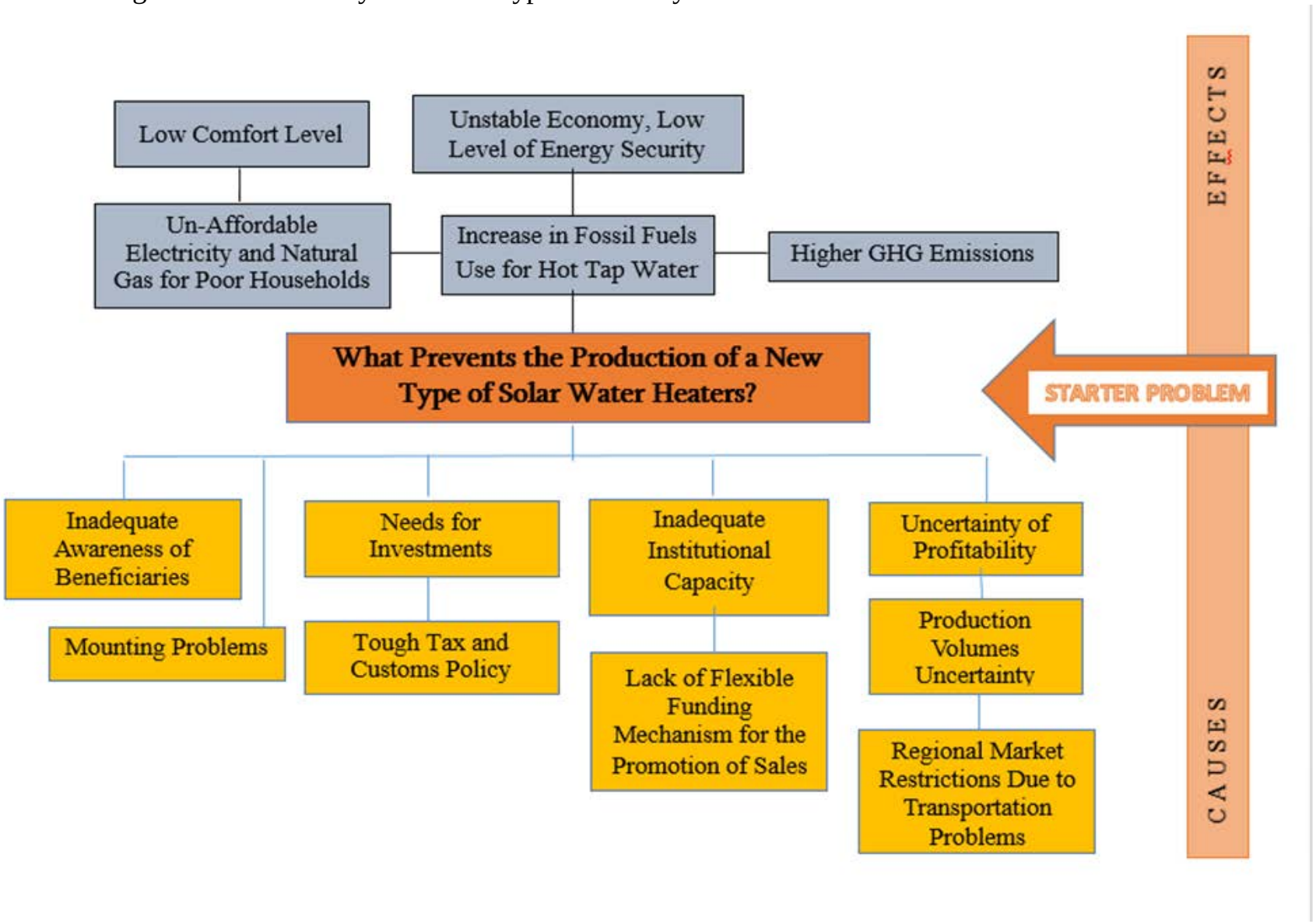


Figure AII-9. Logical Problem Analysis of Degraded Grassland radical improvement. Problem Tree.

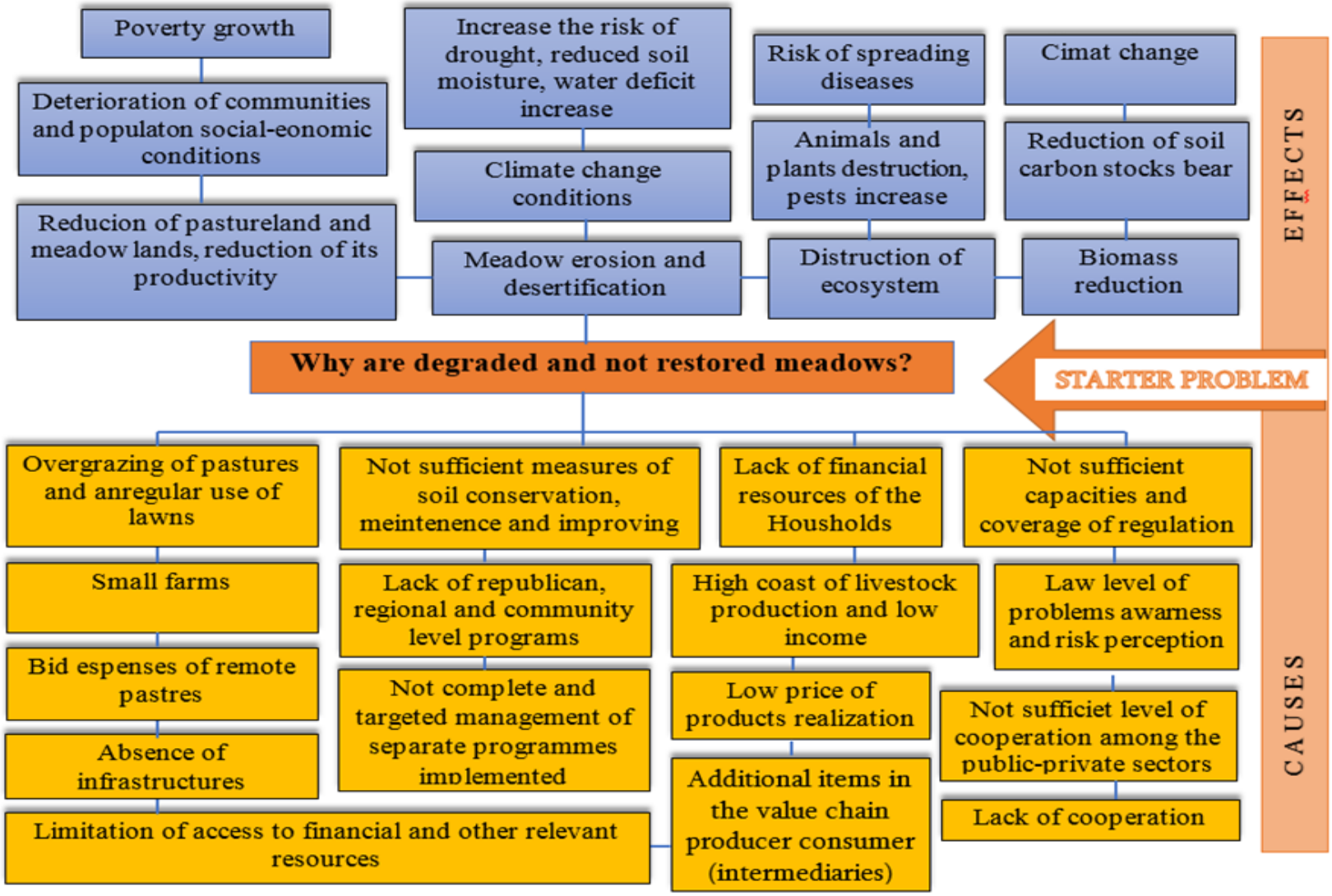


Figure AII-10. Logical Problem Analysis of Sustainable Forest management. Problem Tree.

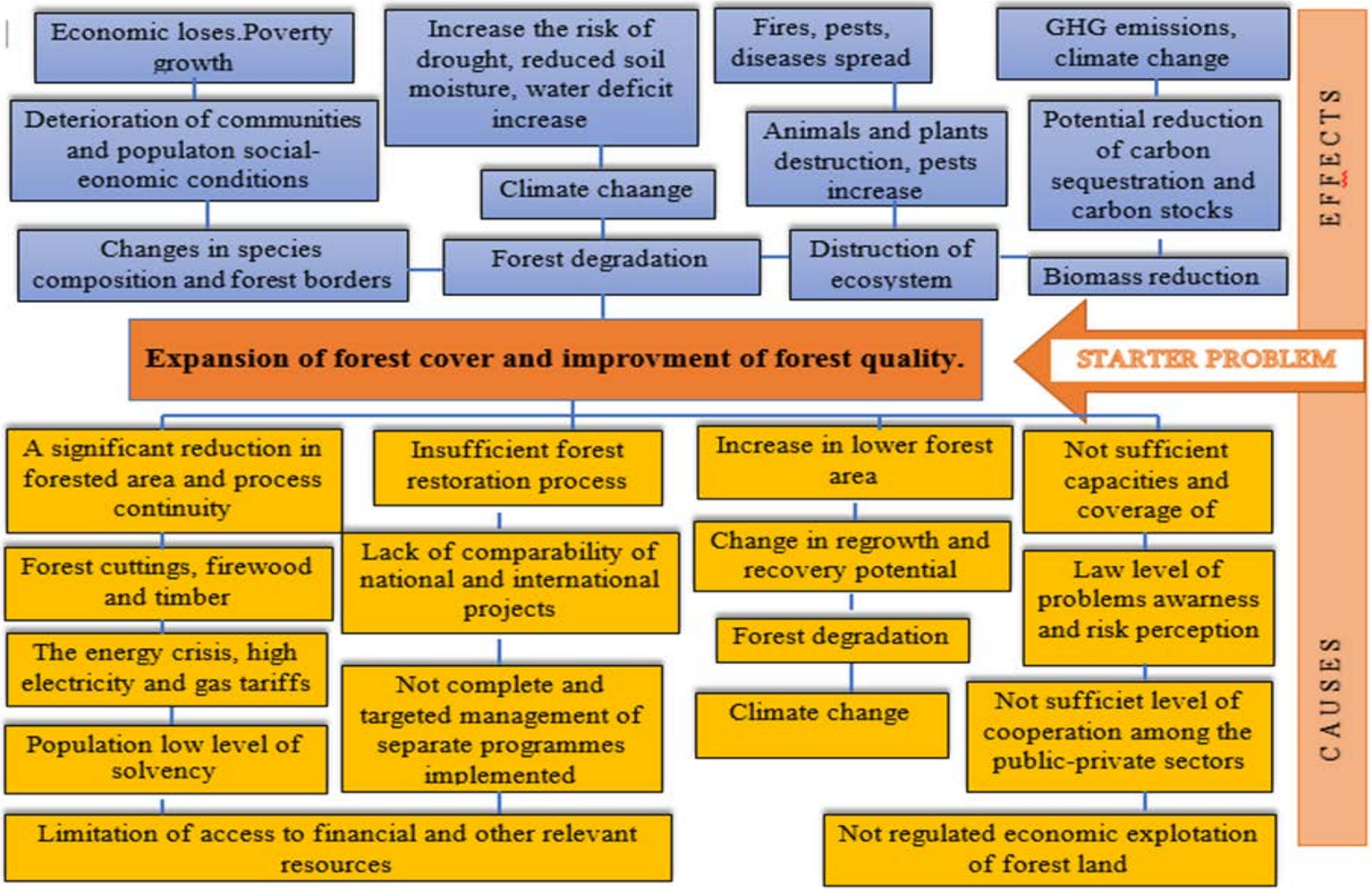


Figure AII-11. Logical Problem Analysis of New technology of cultivation of Perennial plants. Problem Tree.

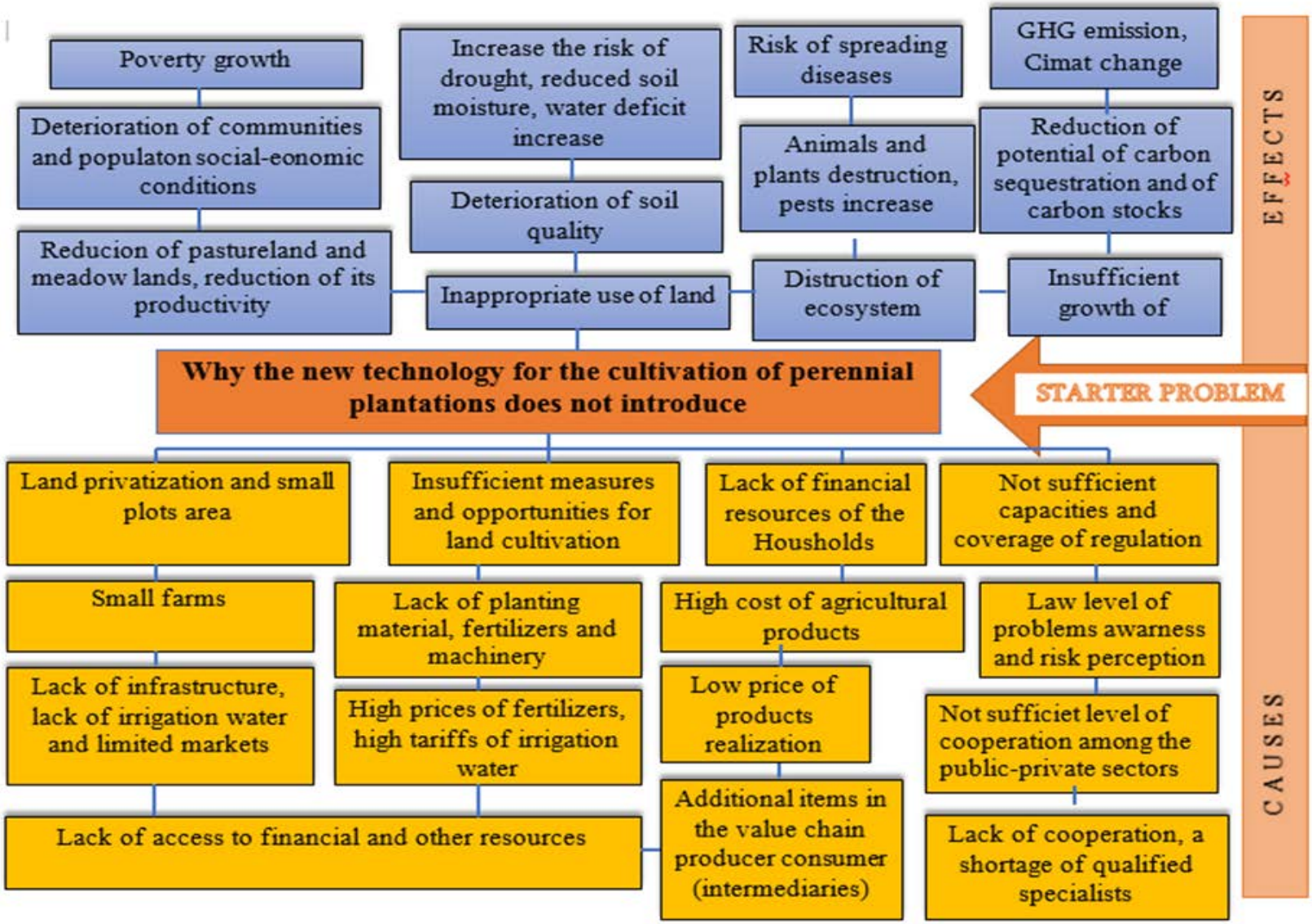


Figure AII-12 production. Problem Tree.. Logical Problem Analysis of Utilization of methane form Yerevan city landfill for electricity and heat

Figure AII-13. Logical Problem Analysis of Existing Lusakert biogas plant operation and reissuance organizational technology. Problem Tree.

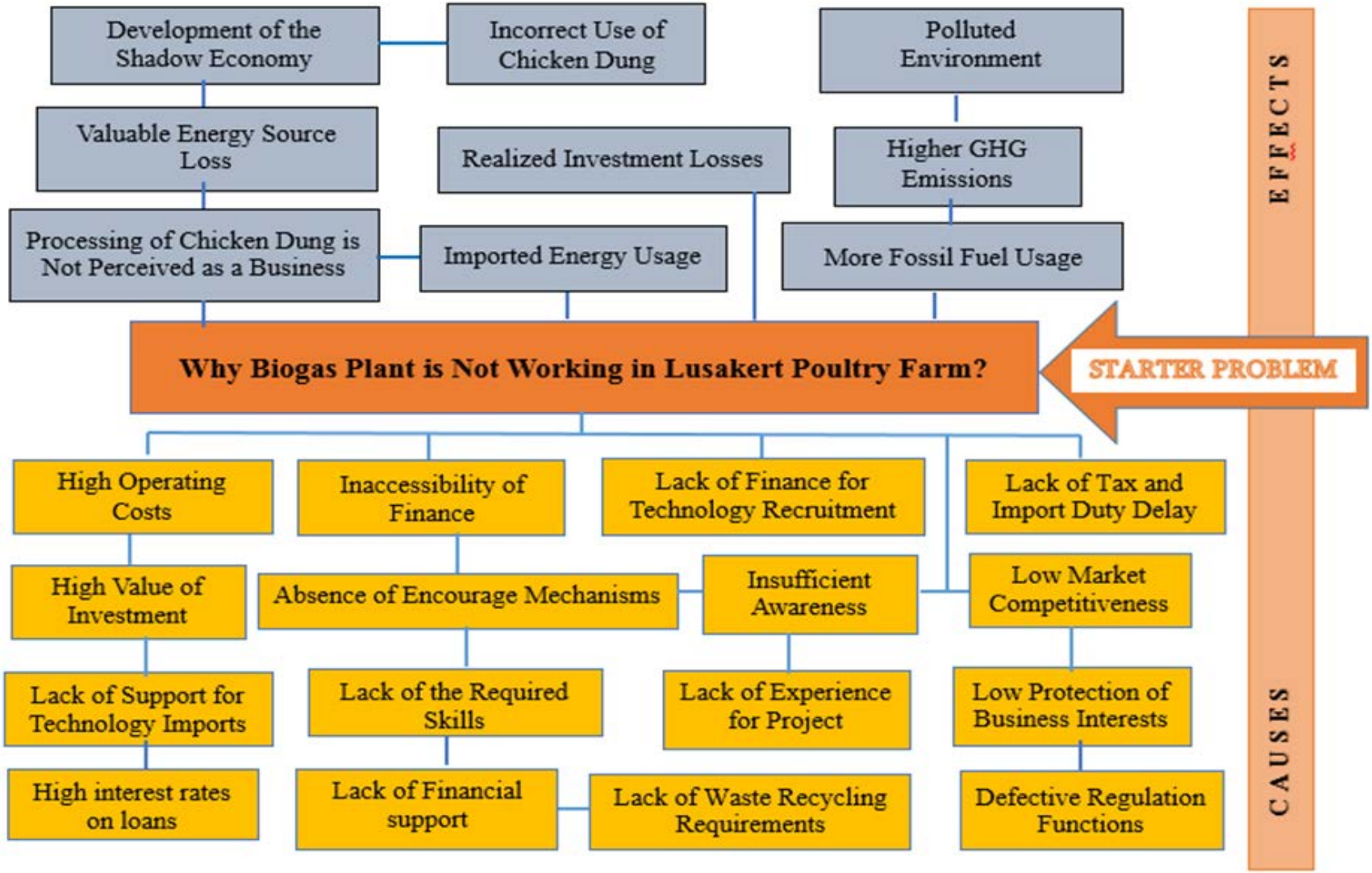
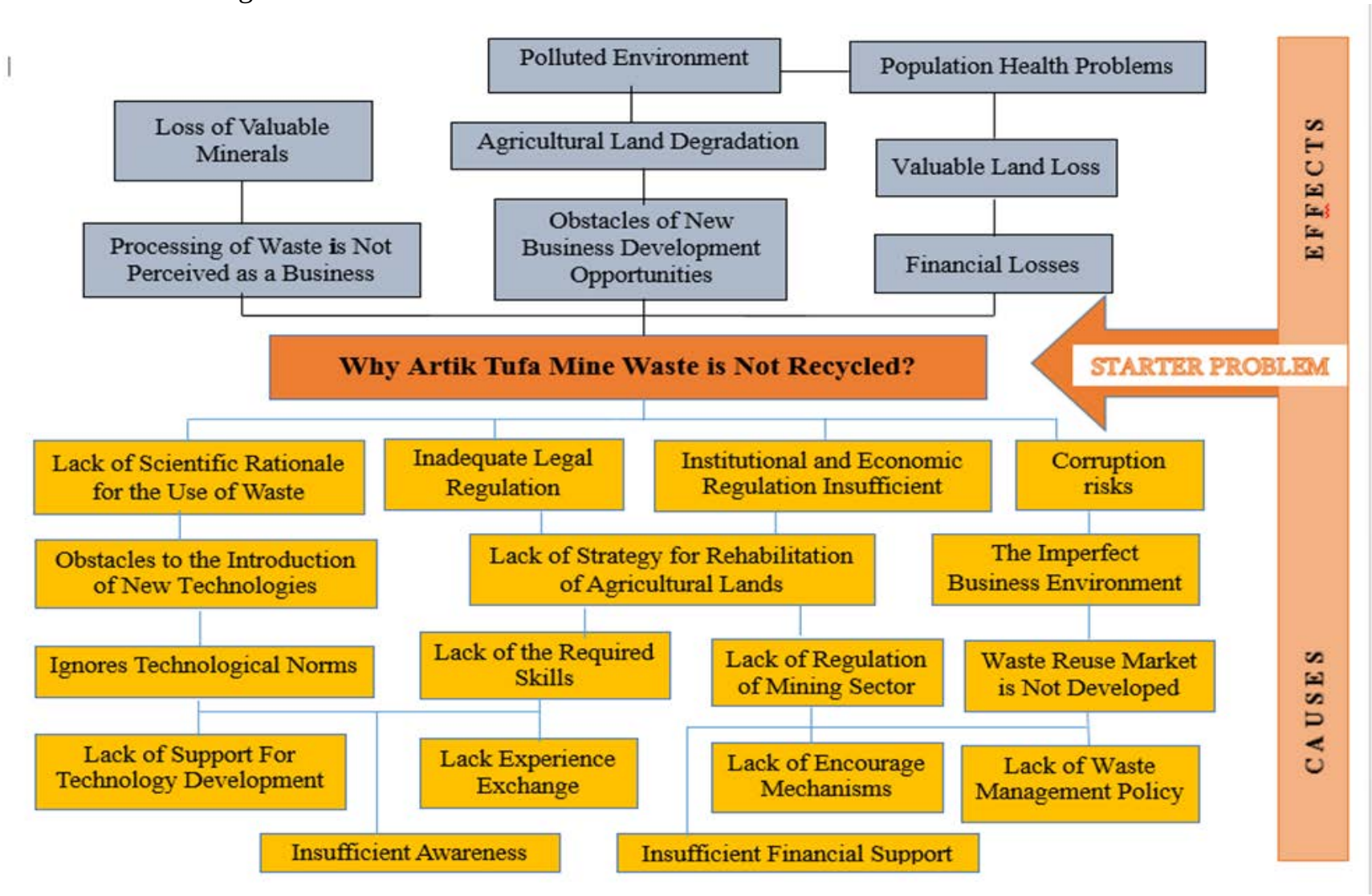


Figure AII-14. Logical Problem Analysis of Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation. Problem Tree.



Annex III Objective trees

Figure AIII-1. Logical Problem Analysis of Cogeneration, Small Scale Combined Heat and Power production. Objective Tree.

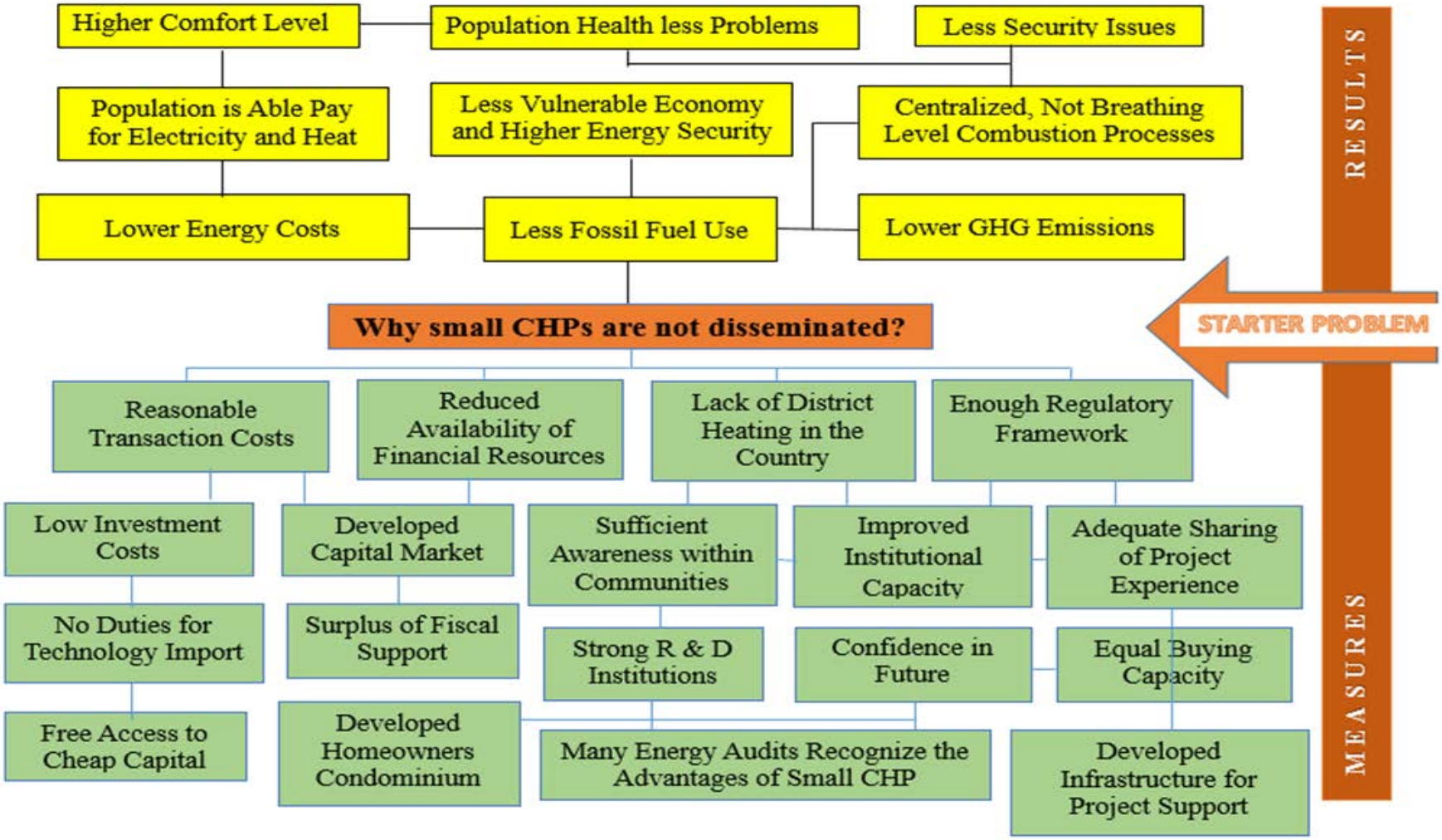


Figure AIII-2. Logical Problem Analysis of Improving energy efficiency in multi-apartment buildings. Registry creation, development. Objective Tree.

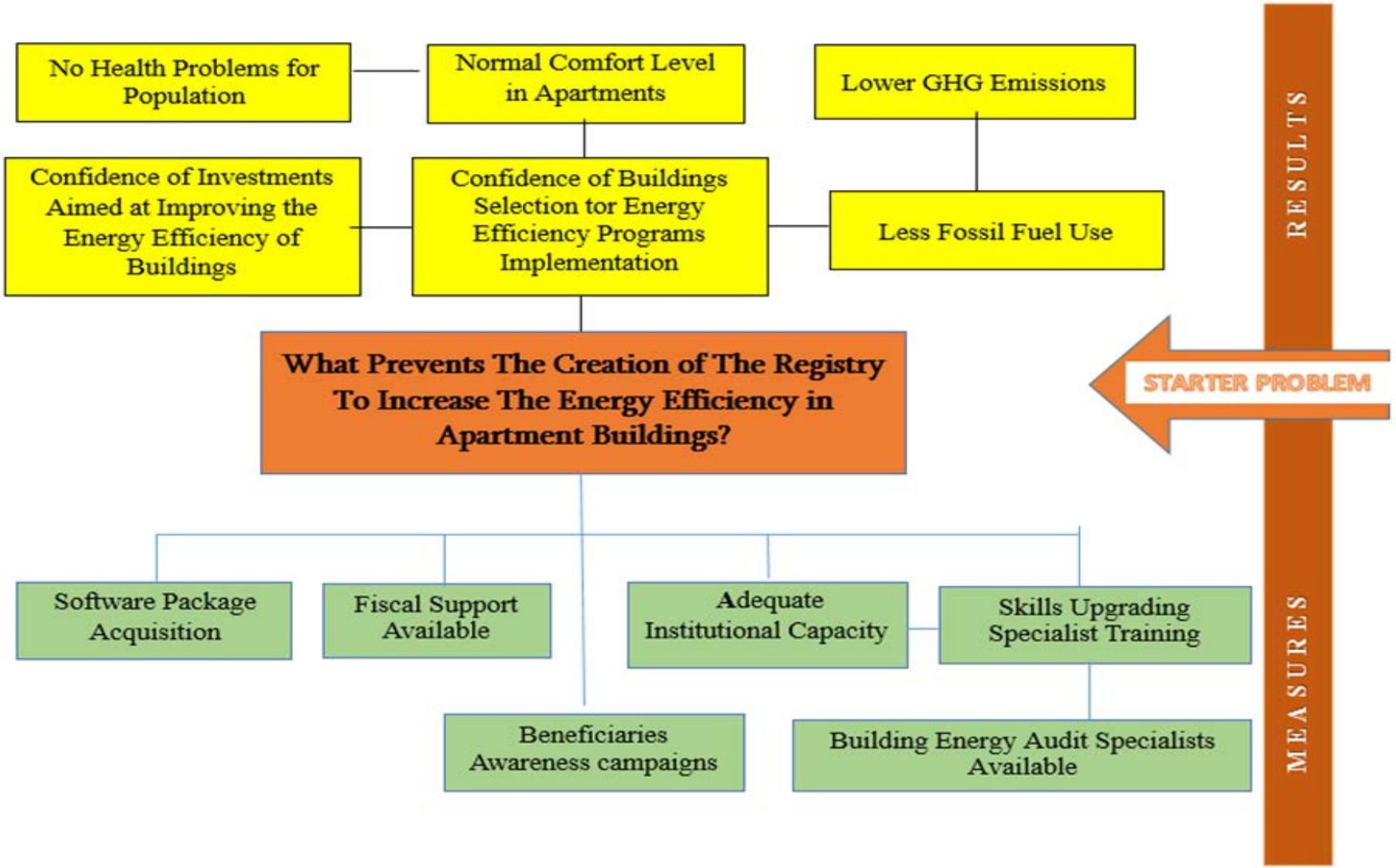


Figure AIII-3. Logical Problem Analysis of Mandatory realization of the Industrial Energy Audit as a mitigation component. Objective Tree.

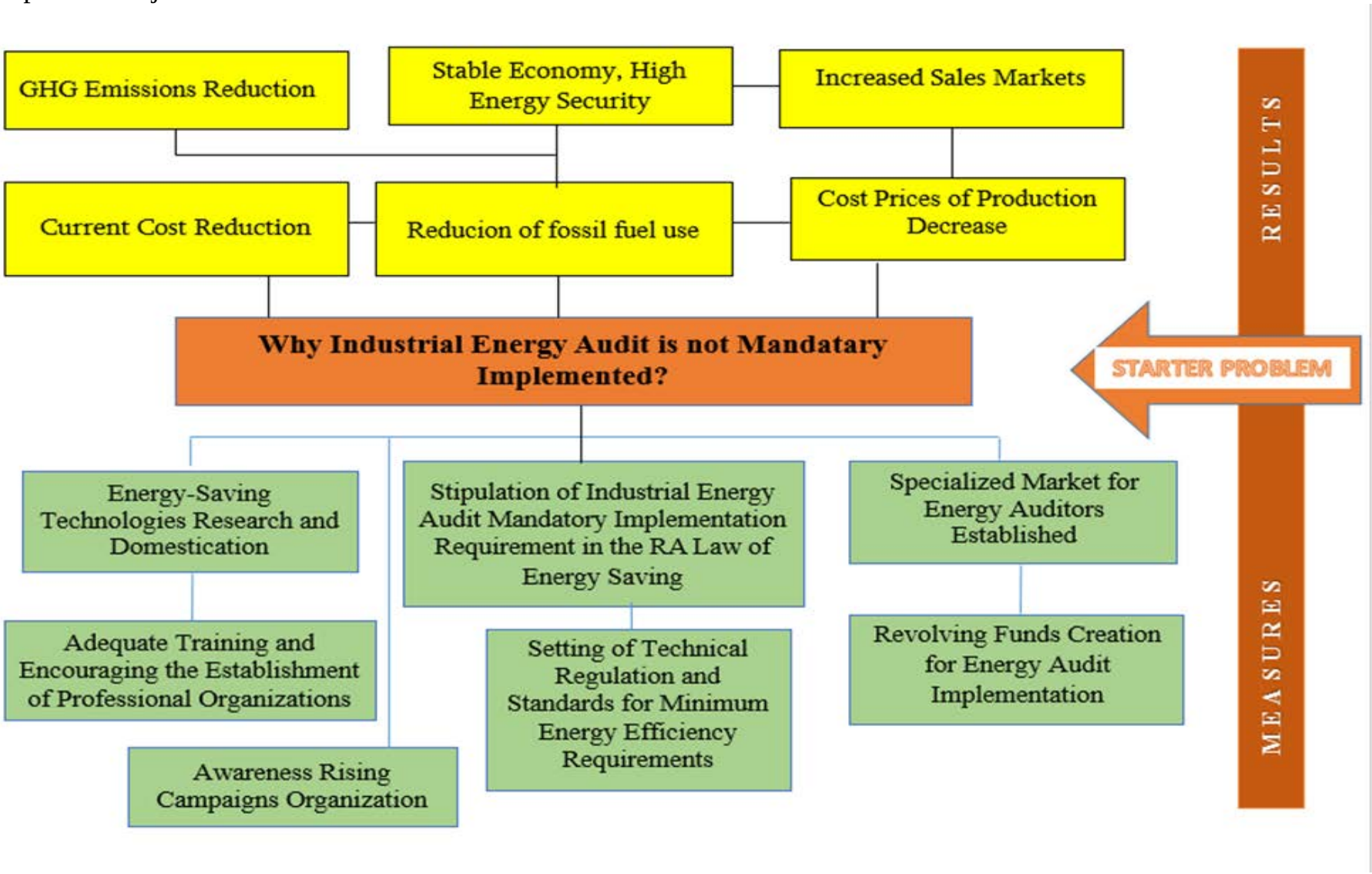


Figure AIII-4. Logical Problem Analysis of Reactive capacity (power) compensation in the RA electric energy system. Objective Tree.

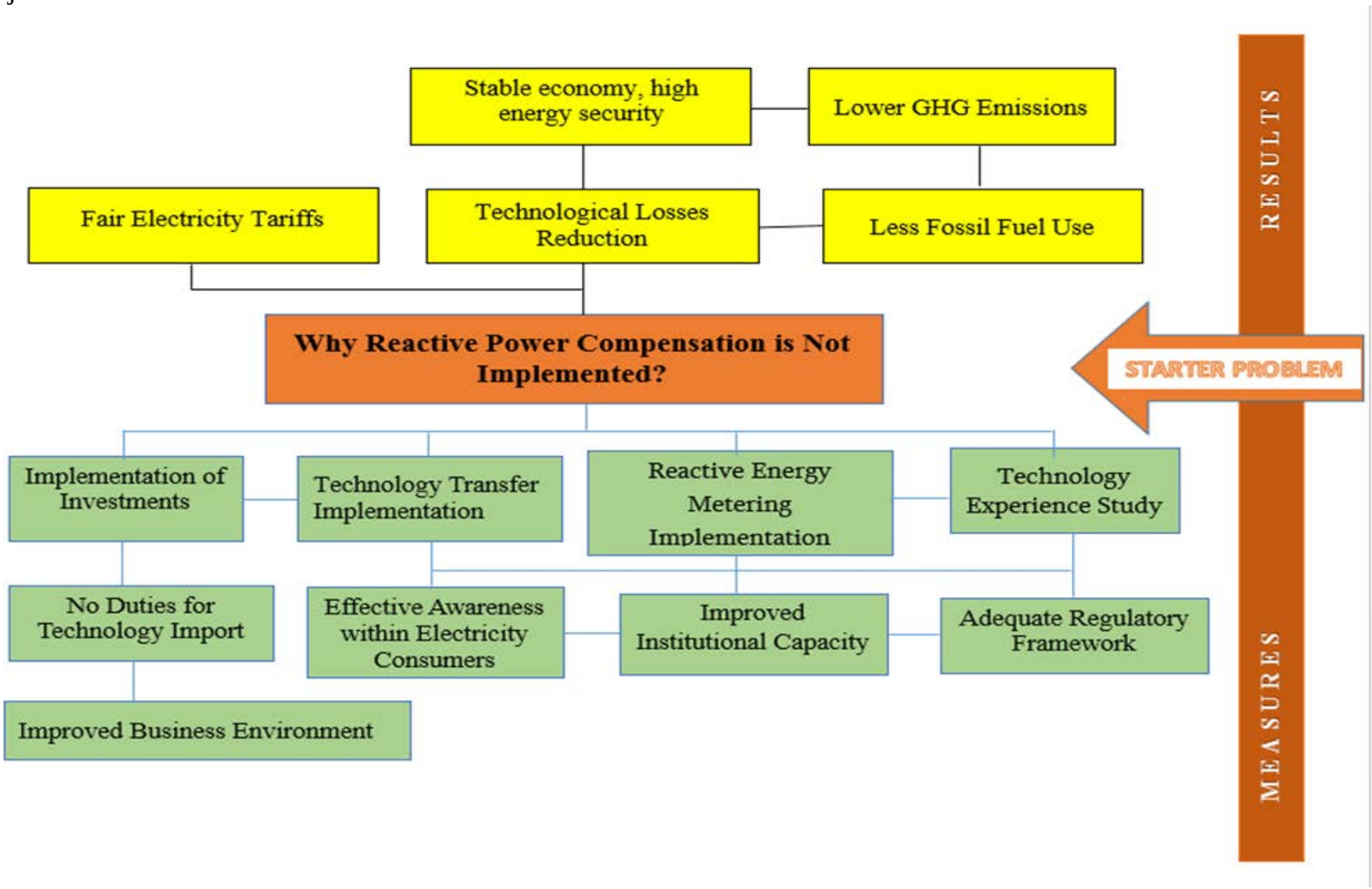


Figure AIII-5. Logical Problem Analysis of Correspondence of natural gas tariff structure to the methodology approved by decision of Public Services Regulatory Commission (PSRC). Objective Tree.

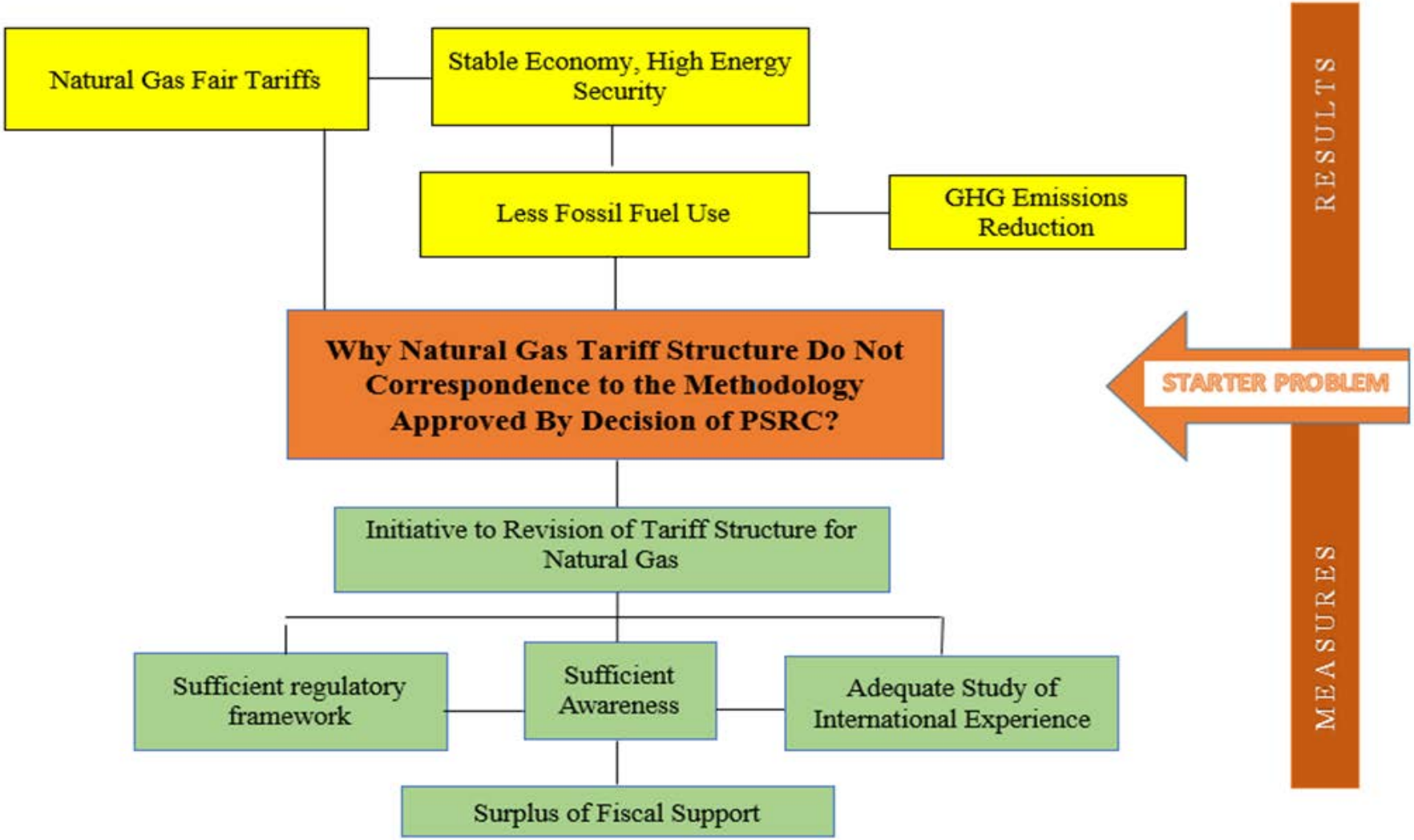


Figure AIII-6. Logical Problem Analysis of Production of synthetic rubbers from butadiene instead using natural gas (Chemical industry). Objective Tree.

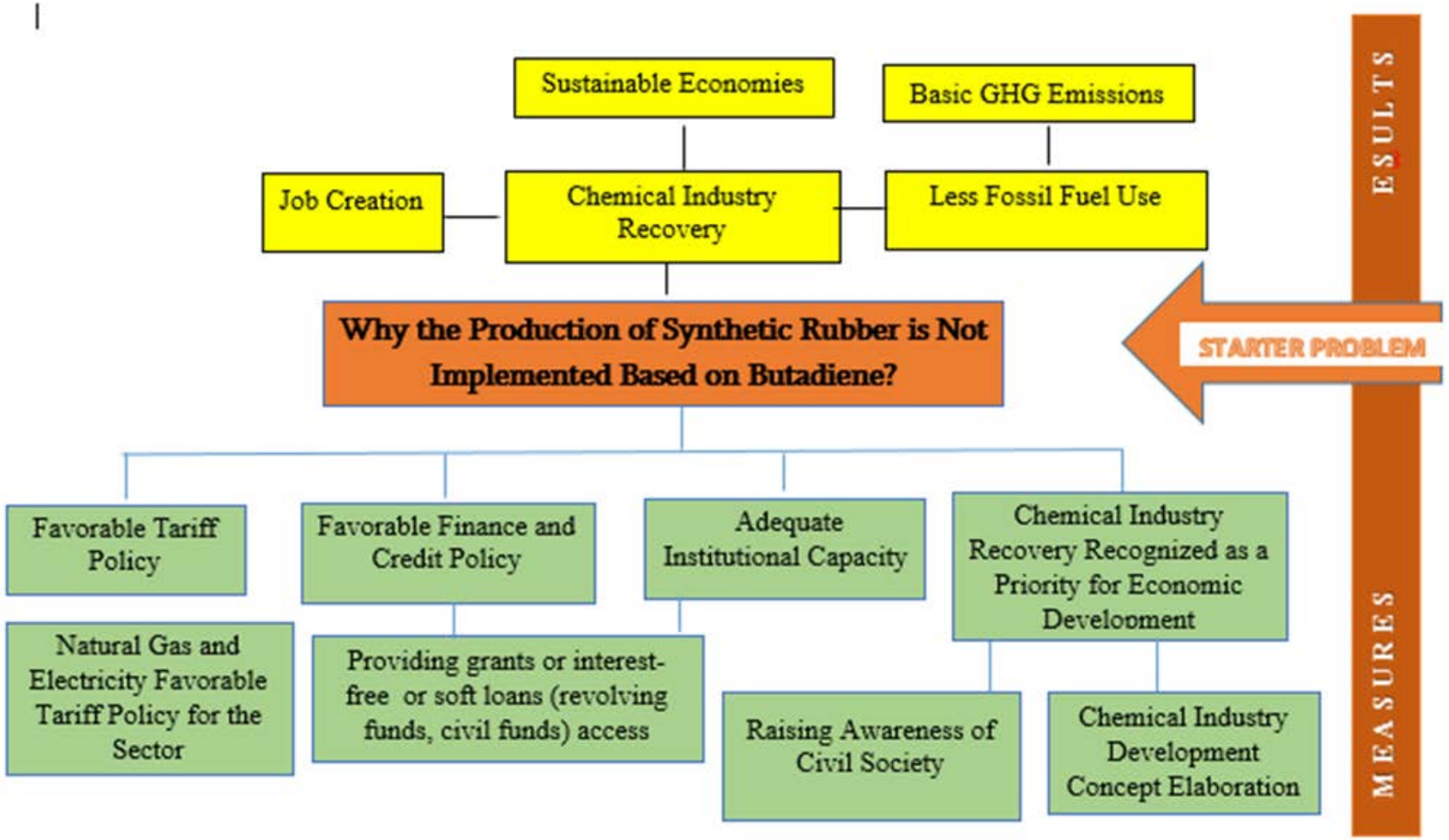


Figure AIII-7. Logical Problem Analysis of Production and usage of photo luminescent materials with long-term lightening. Objective Tree.

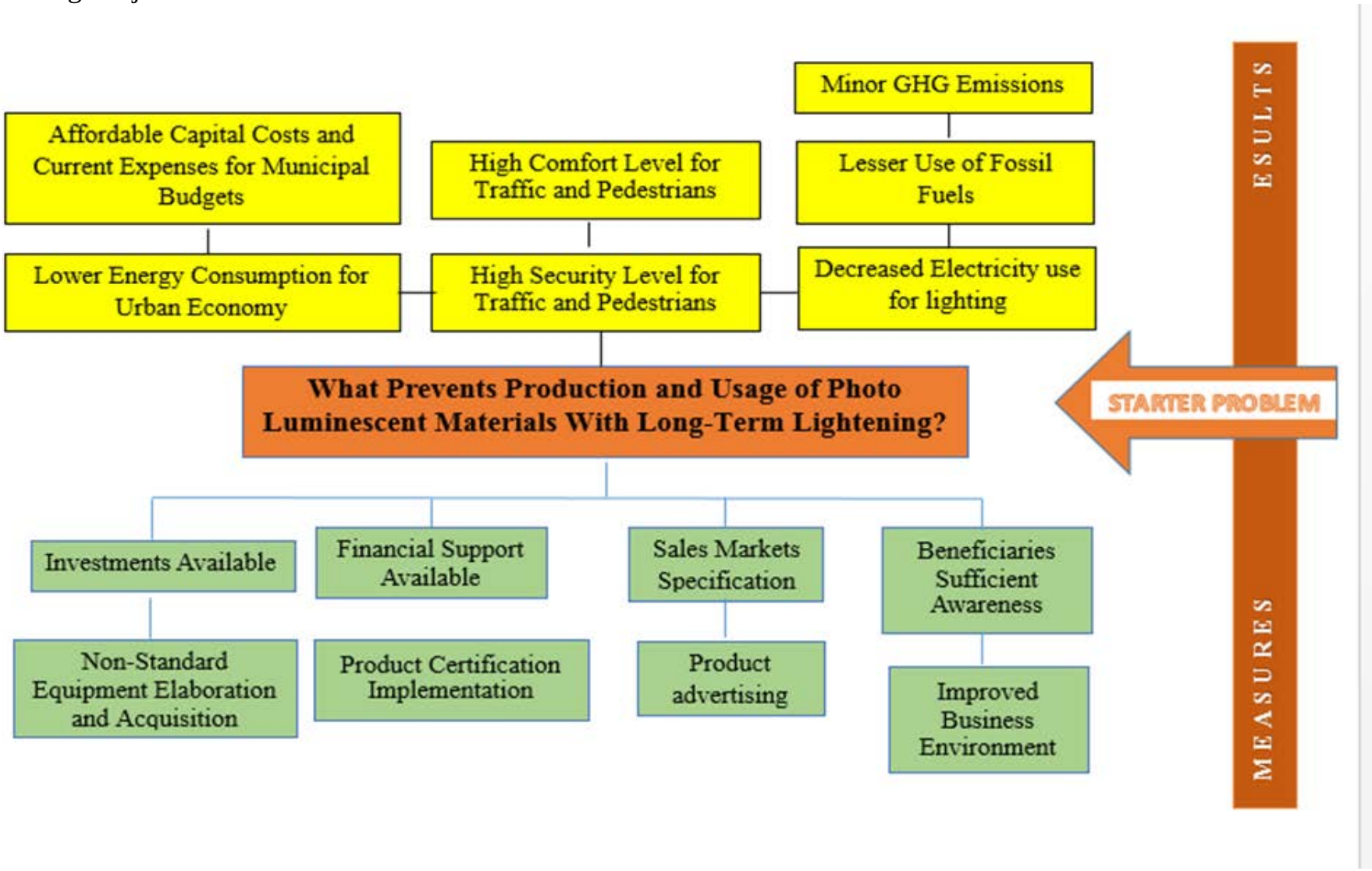


Figure AIII-8. Logical Problem Analysis of New type of Entirely Plastic solar water heater. Objective Tree.

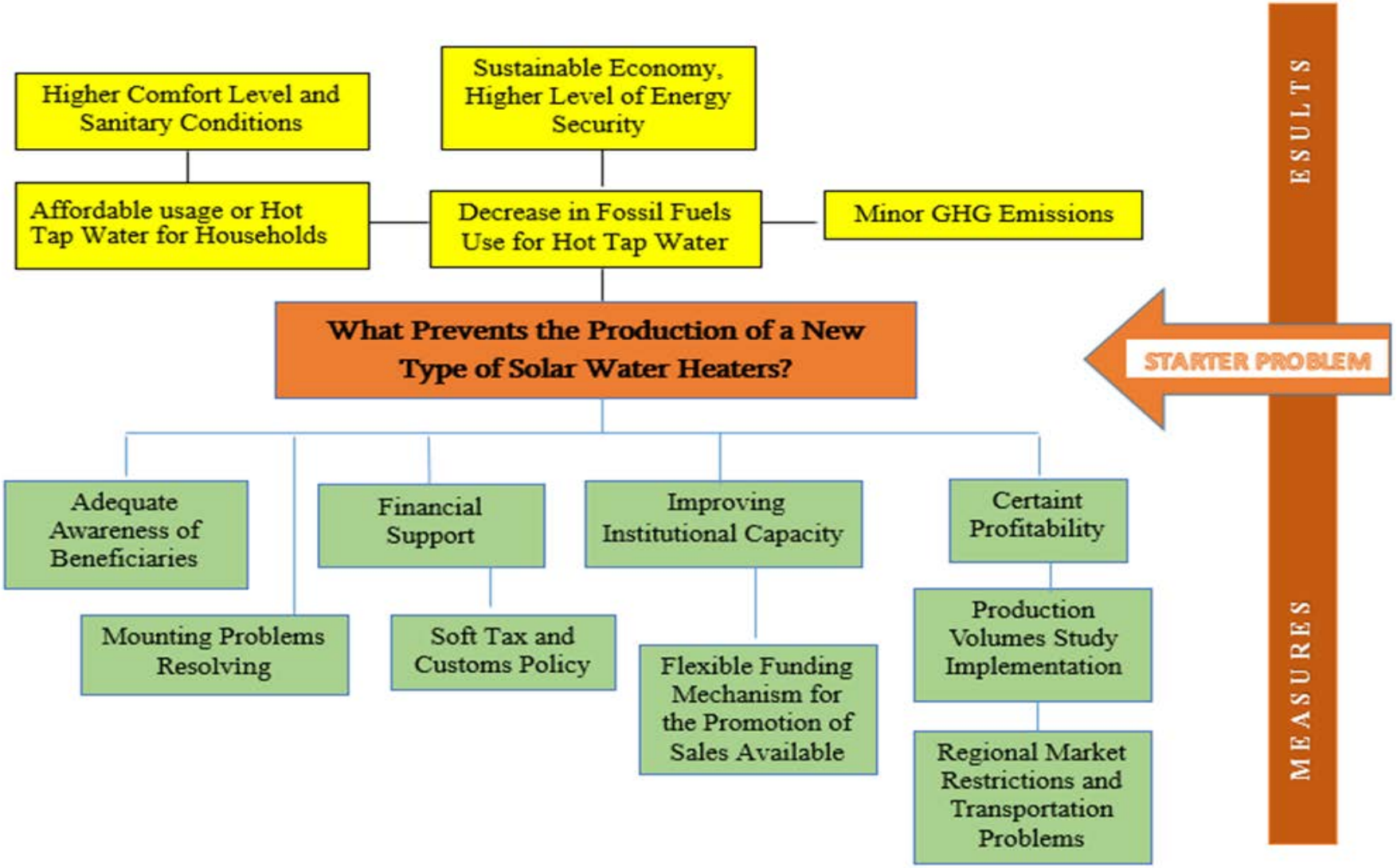


Figure AIII-9. Logical Problem Analysis of Degraded Grassland radical improvement. Objective Tree.

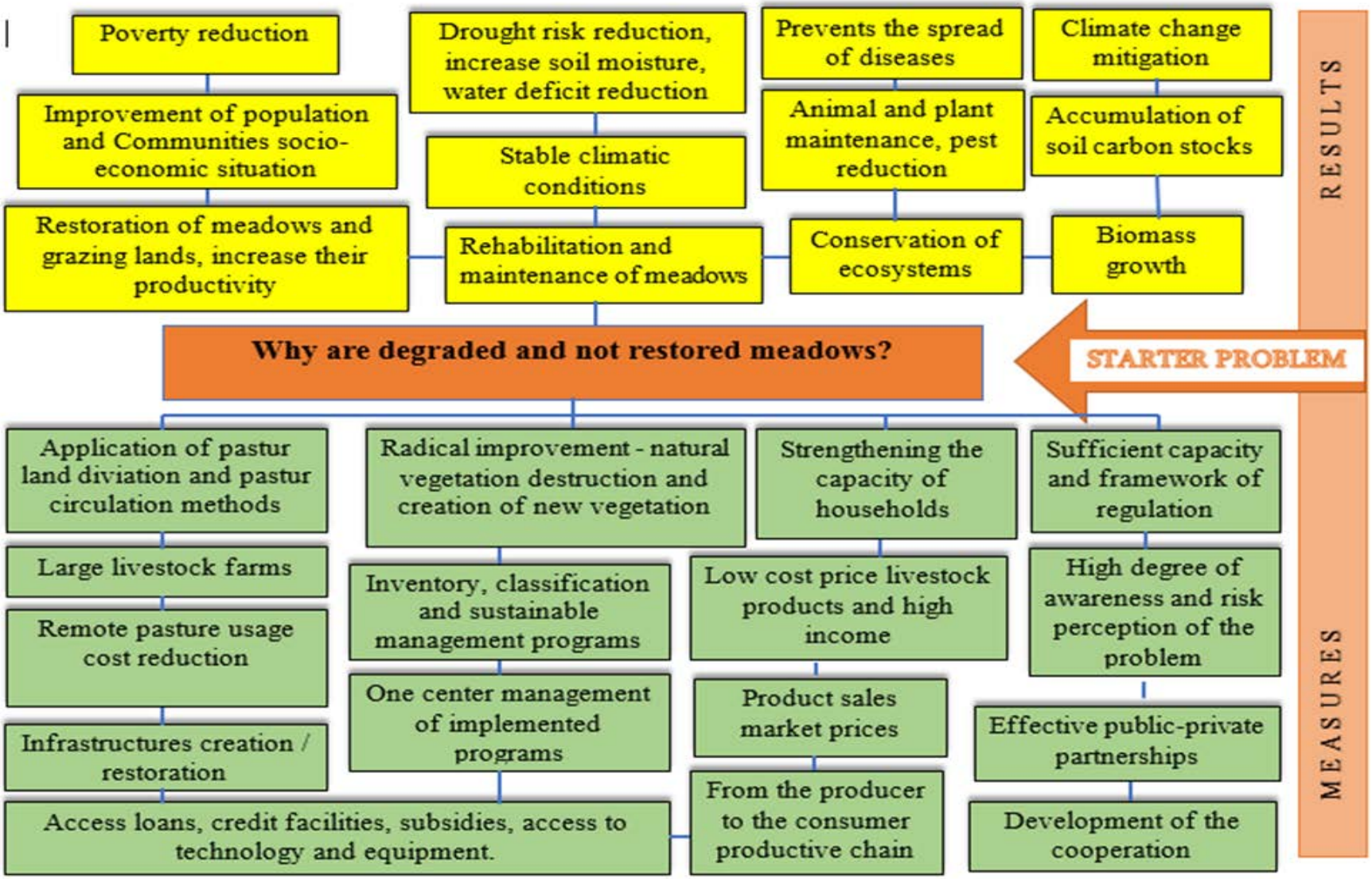


Figure AIII-10. Logical Problem Analysis of Sustainable Forest management. Objective Tree.

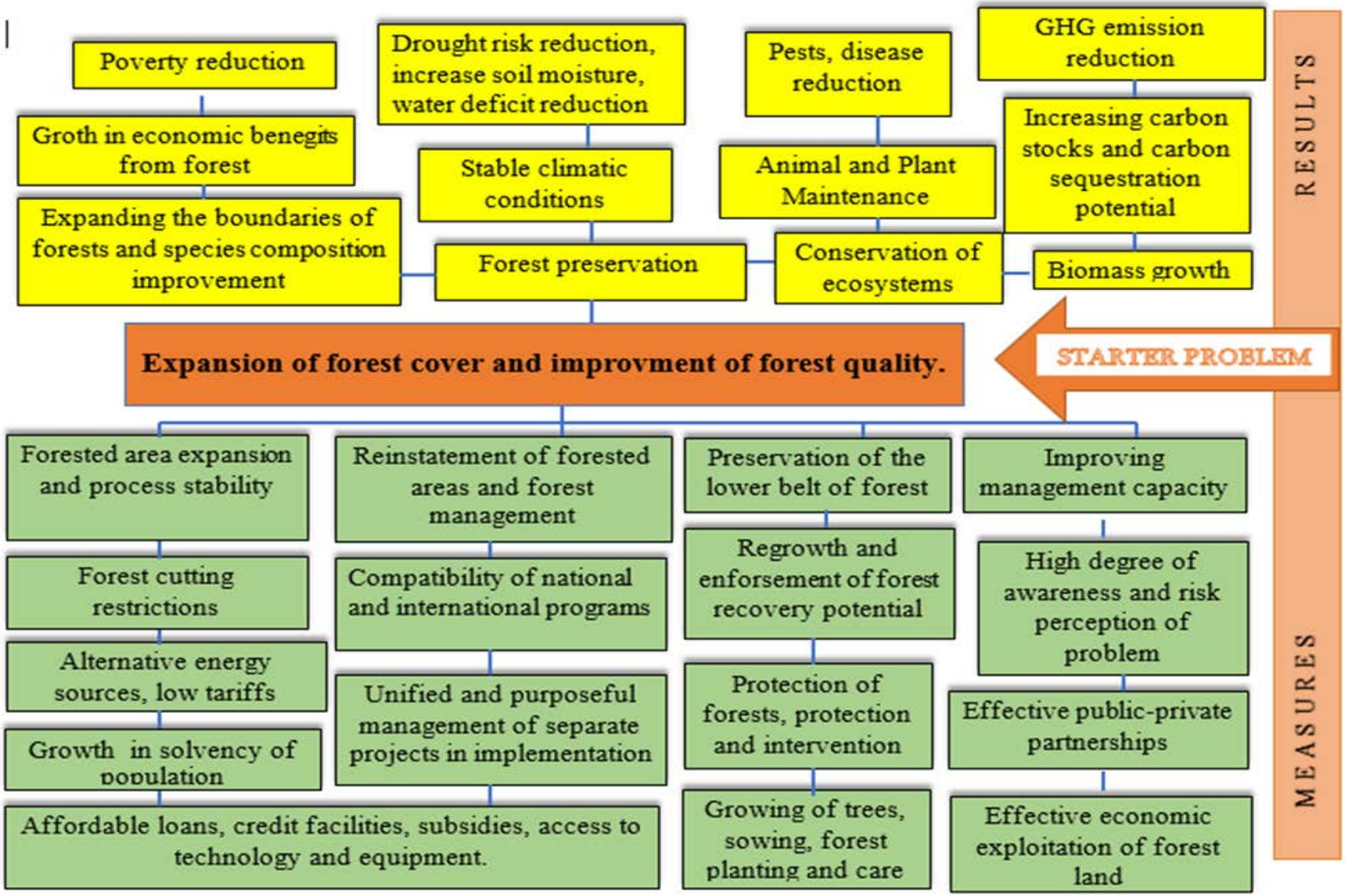


Figure AIII-11. Logical Problem Analysis of New technology of cultivation of Perennial plants. Objective Tree.

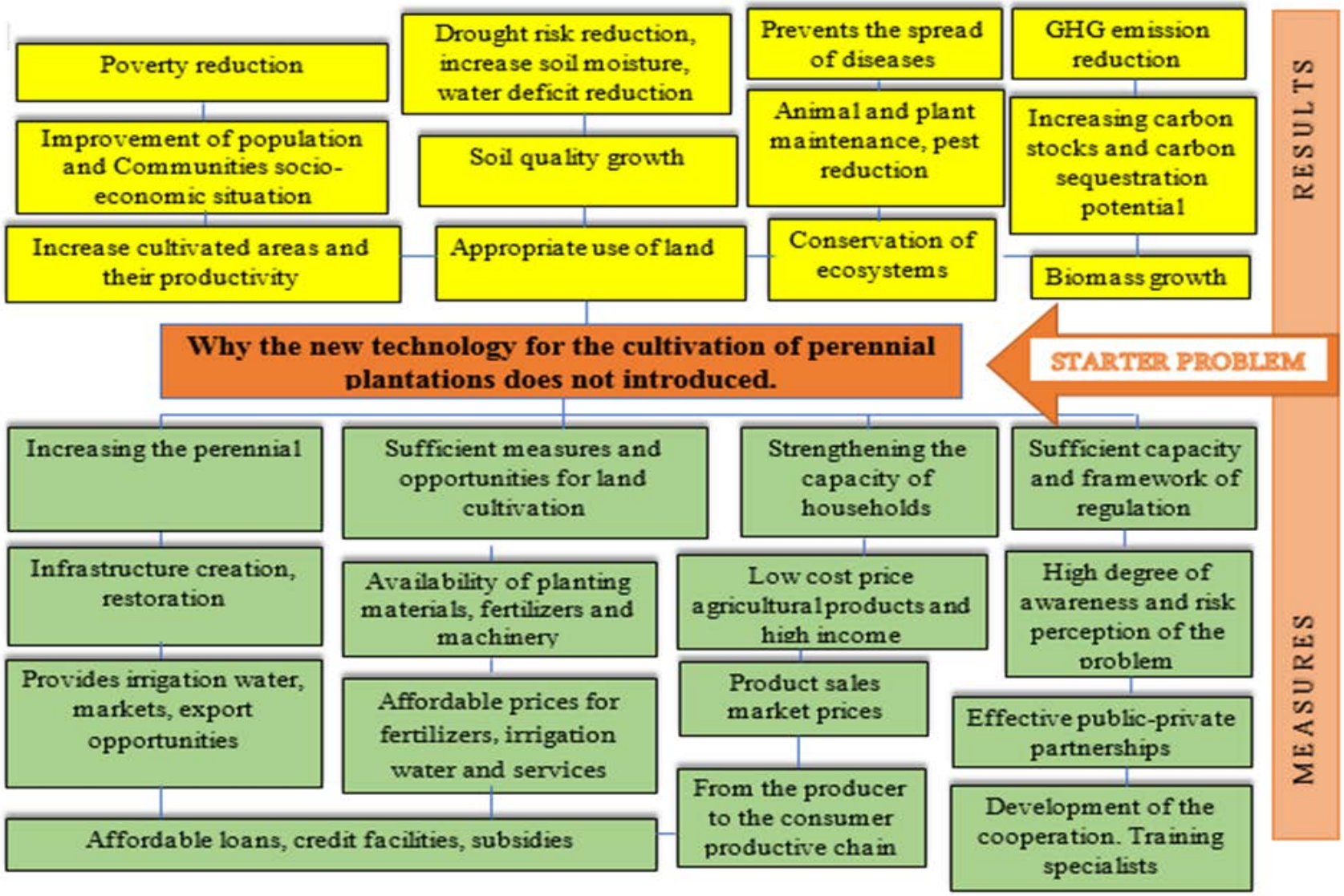


Figure AIII-12. Logical Problem Analysis of Utilization of methane form Yerevan city landfill for electricity and heat production. Objective Tree.

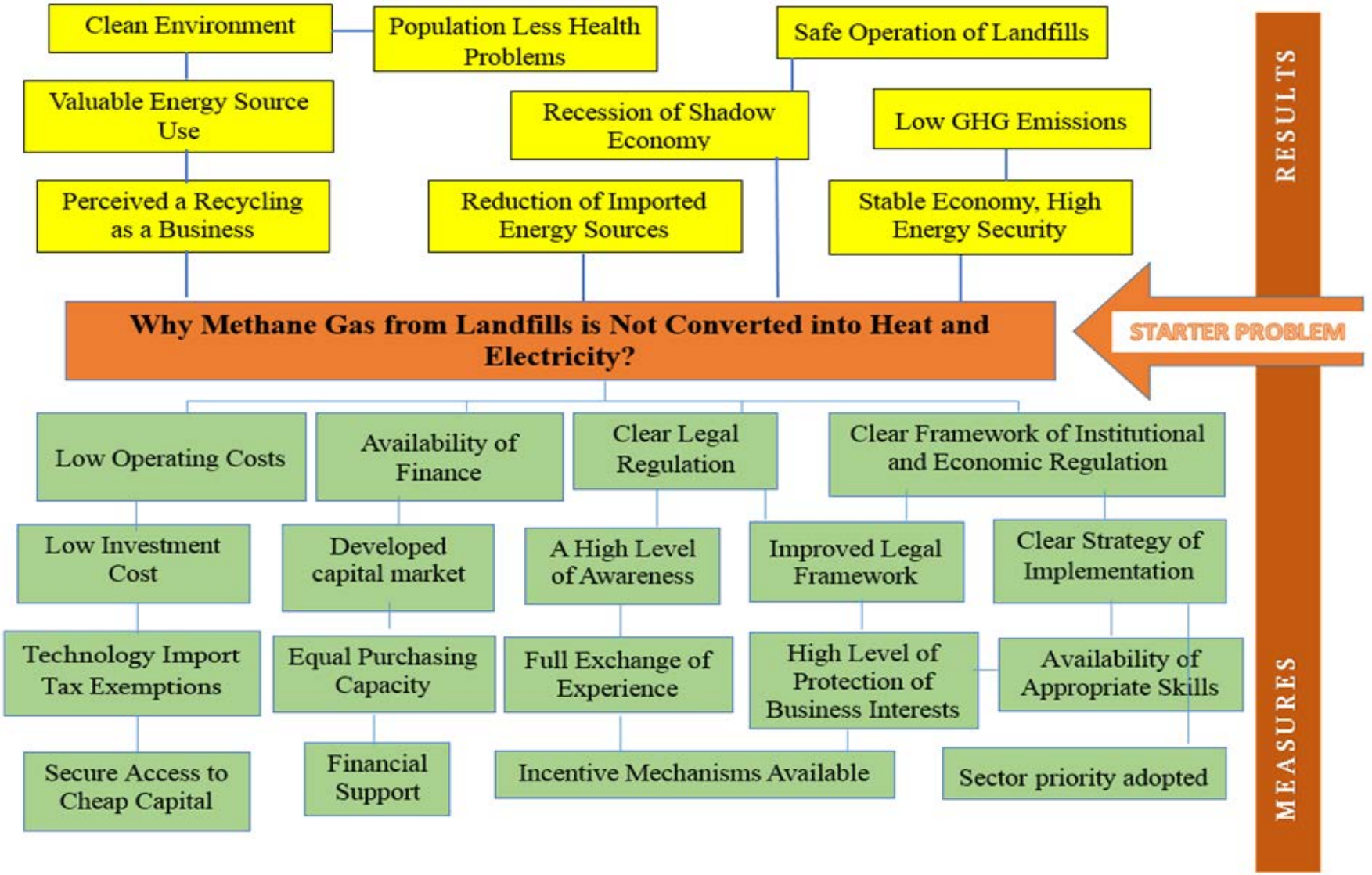


Figure AIII-13. Logical Problem Analysis of Existing Lusakert biogas plant operation and reissuance organizational technology. Objective Tree.

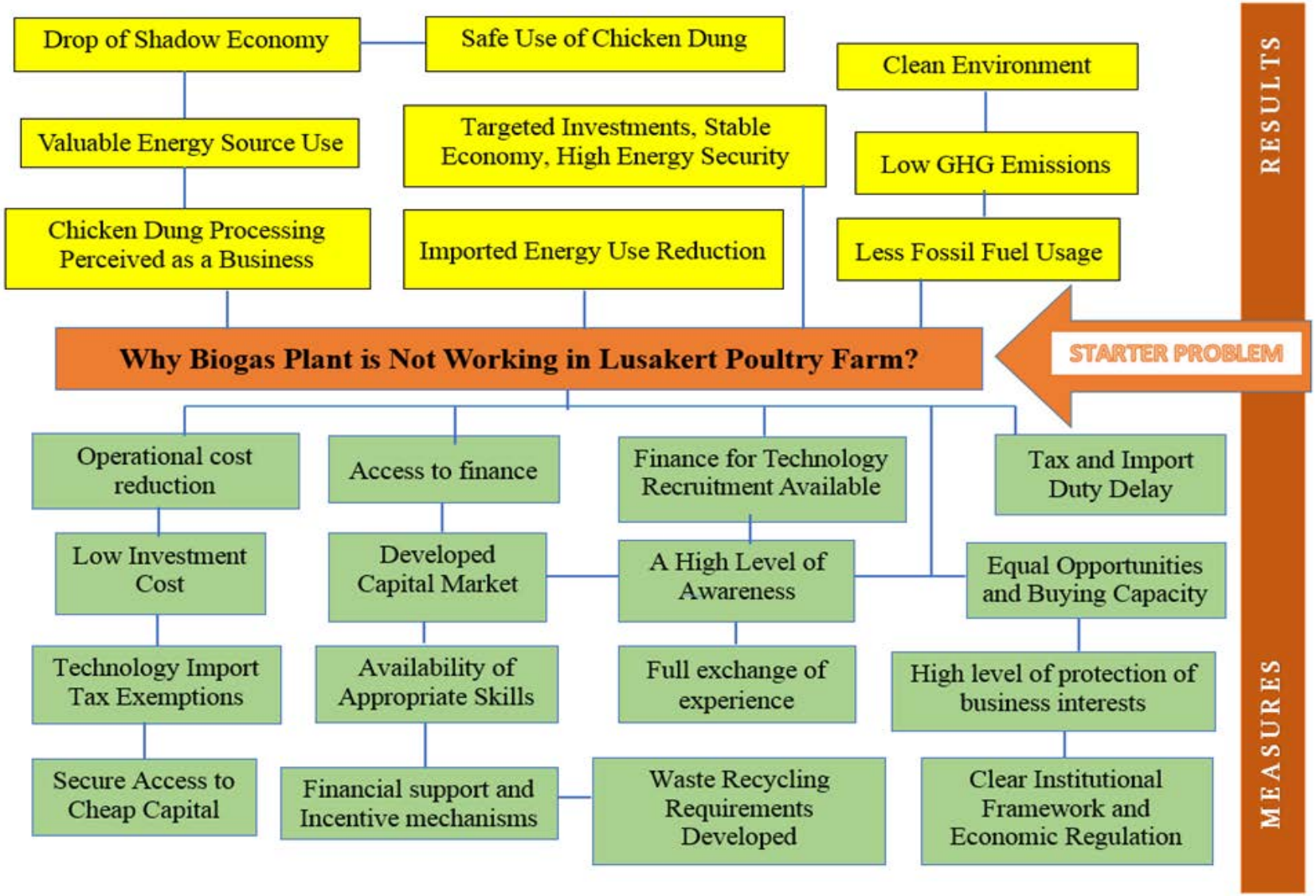
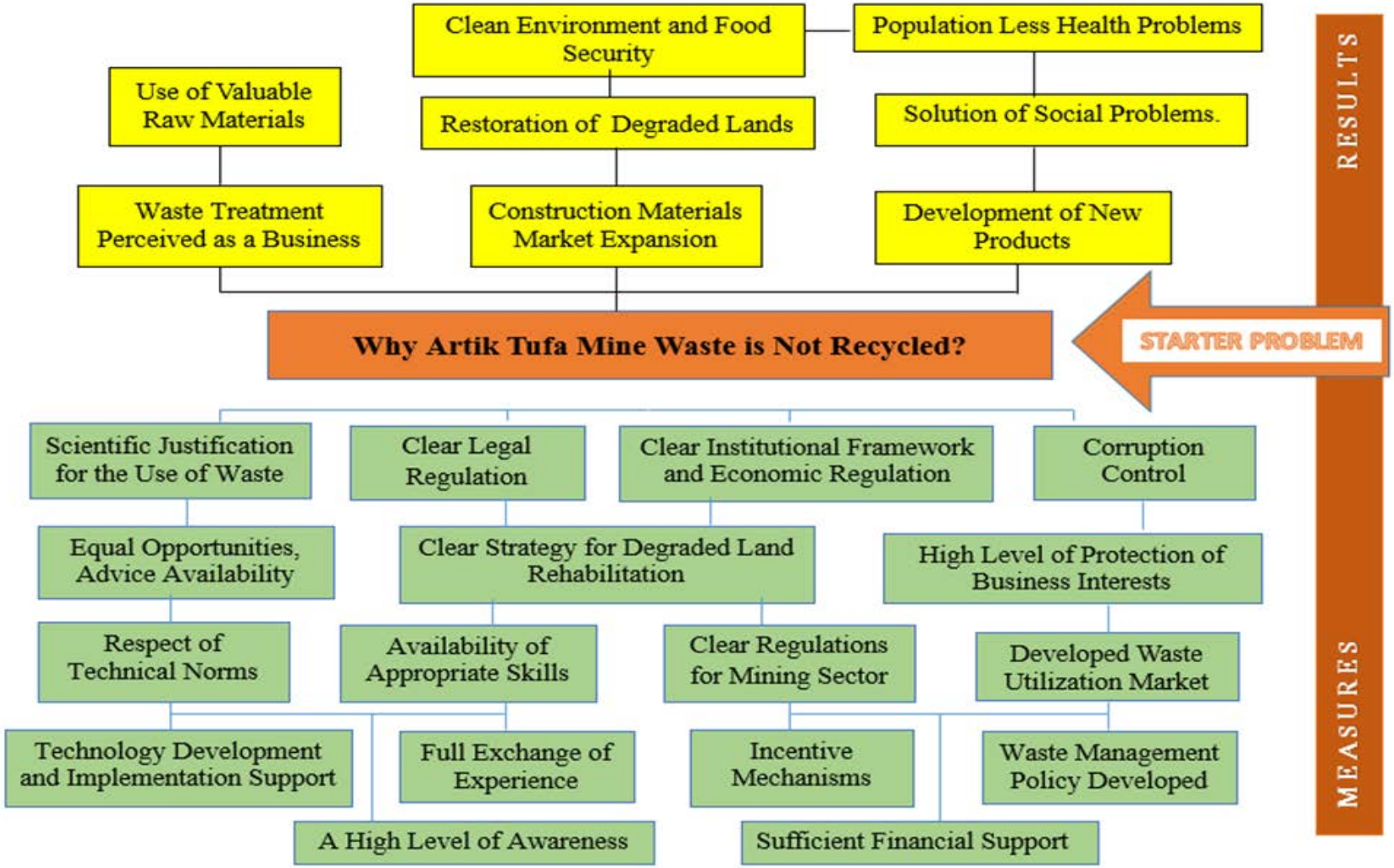


Figure AIII-14. Logical Problem Analysis of Complex processing of Artik tufa mining waste and agricultural lands to prevent their further degradation. Objective Tree.



Annex IV List of stakeholders involved and their contacts

Institutions involved in stakeholder consultation process

Institution	Representative	Contacts
Public Administration Bodies		
Environmental Project Implementation Unit State Institution www.mnp.am/?p=291; www.epiu.am/	Rubik Shahazizyan	+374 94 251709 rshahazizyan@yahoo.com
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	Vardan Arustamyan	+374 77 528989
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United National Industrial Development Organization http://www.unido.org/office/armenia.html	Anahit Simoayan	a.simonyan@unido.org
Renewable Resources and Energy Efficiency Fund of Armenia	Hrant Ter-Gabrielyan	+374 94 224290 hrantt@rambler.ru terhrant@yahoo.com

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Technology Needs Assessment (TNA) Project implemented by
"Environmental Project Implementation Unit" State Institution,
RA Ministry of Nature Protection, and UN Environment Programme

Identification of barriers against priority technologies, market description and analysis of a favorable environment for climate change mitigation in Energy and Industry sectors of technology needs assessment, with the participation of stakeholders

A G E N D A

Venue: Bioresources Management Agency, Ministry of Nature Protection

Address: 3rd Floor, 1/3 Building,
Pavstos Buzandi St., Yerevan, 0010, Armenia,
September 1, 2016

13:30 – 14:00	*Registration of Participants*
14:00 – 14.05	**Opening of the meeting** *Aram Gabrielyan, TNA National Project Coordinator*
14:05 – 14:15	**Results of technology needs assessment for climate change mitigation, including Energy and Industry sectors** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
14:15 – 14:30	**Brief description of priority technologies Energy and Industry sectors of technology needs assessment for climate change mitigation** *Mkrtich Jalalyan, Sectors Expert*
14:30 – 14:50	**Preliminary description of the sectors technology markets** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
14:50 – 15:30	**Discussion with stakeholders, by the format proposed by the UDP, on preliminary description of the sector technology market**
15:30 – 15:50	**Preliminary description of the sector technology barriers** *Mkrtich Jalalyan, Sectors Expert*
15:50 – 16:10	**Discussion with stakeholders, by the format proposed by the UDP, on preliminary description of the sector technology barriers**
16:10 – 16:35	**Preliminary description of the measures to overcome sector technology barriers** *Mkrtich Jalalyan, Sectors Expert*
16:35 – 17:10	**Discussion with stakeholders, by the format proposed by the UDP, on the measures to overcome sector technology barriers**
17:10– 17:30	**Summary of technologies, recommendations, measures to overcome barriers and analysis of a favorable environment in Energy and Industry sectors, the format proposed by the UDP** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
17:30– 17:40	**Summary**
17:50 – 18:00	**Refreshments**

Technology Needs Assessment (TNA) Project implemented by
"Environmental Project Implementation Unit" State Institution,
RA Ministry of Nature Protection, and UN Environment Programme

Identification of barriers against priority technologies, market description and analysis of a favorable environment for climate change mitigation in land use and waste management sectors of technology needs assessment, with the participation of stakeholders

A G E N D A

Venue: Bioresources Management Agency, Ministry of Nature Protection

Address: 3rd Floor, 1/3 Building,
Pavstos Buzandi St., Yerevan, 0010, Armenia,
September 2, 2016

14:30 – 15:00	*Registration of Participants*
15:00 – 15.05	**Opening of the meeting** *Aram Gabrielyan, TNA National Project Coordinator*
15:05 – 15:15	**Results of technology needs assessment for climate change mitigation, including land use and waste management sectors** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
15:15 – 15:30	**Brief description of priority technologies in land use and waste management sectors of technology needs assessment for climate change mitigation** *Meruzhan Galstyan, Davit Shindyan, Sector Experts*
15:30 – 15:50	**Preliminary description of the sector technology market** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
15:50 – 16:10	**Discussion with stakeholders, by the format proposed by the UDP, on preliminary description of the sector technology market**
16:10 – 16:30	**Preliminary description of the sector technology barriers** *Meruzhan Galstyan, Davit Shindyan, Sector Experts*
16:30 – 16:50	**Discussion with stakeholders, by the format proposed by the UDP, on preliminary description of the sector technology barriers**
16:50 – 17:10	**Preliminary description of the measures to overcome sector technology barriers** *Meruzhan Galstyan, Davit Shindyan, Sector Experts*
17:10 – 17:30	**Discussion with stakeholders, by the format proposed by the UDP, on the measures to overcome sector technology barriers**
17:30– 17:40	**Summary of technologies, recommendations, measures to overcome barriers and analysis of a favorable environment in land use and waste management sectors, the format proposed by the UDP** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
17:40– 17:50	**Summary**
17:50 – 18:00	**Refreshments**