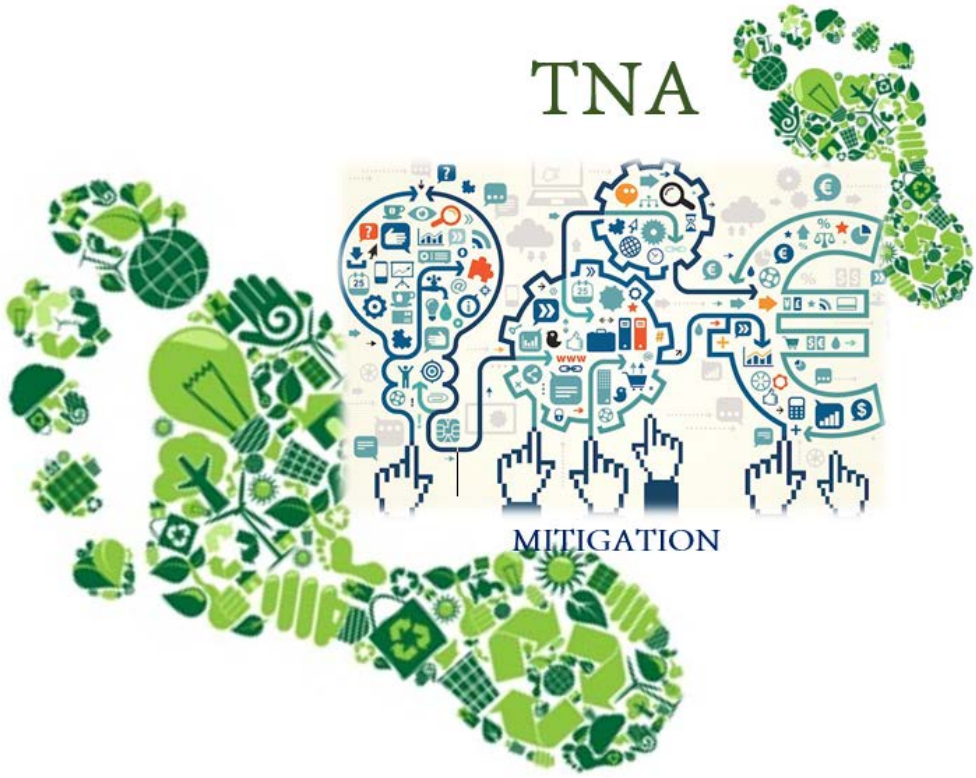
GOVERNMENT OF THE REPUBLIC OF ARMENIA

MINISTRY OF NATURE PROTECTION



TECHNOLOGY ACTION PLAN FOR MITIGATION TECHNOLOGIES

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TECHNOLOGY NEEDS ASSESSMENT REPORT

MITIGATION TECHNOLOGY
TECHNOLOGY ACTION PLAN

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Foreword

The impact of Armenia on global climate system is not significant, our share in global emissions is only 0.014%. Highlighting the need of countries to combine their efforts in combating climate change, Armenia as a developing country shares the commitment to limiting greenhouse gas emissions. The quantitative indicators of these contributions are summarized in the Intended Nationally Determined Contributions (INDC) of Armenia, which, in the result of extensive consultations, have been approved by both the Government of the Republic of Armenia and the civil society and have been presented to the attention of Parties of the UN Framework Convention on Climate Change (UNFCCC). This document actually represents the official long-term concept of our country aimed at the implementation of our commitments under UNFCCC, and where along with the mentioned climate change mitigation measures those of adaptation with the component on the transfer and development of the technologies are included.

We consider the on-going UNEP/DTU TNA as priority project to launch the mentioned technology mechanism, which will outline the path that will promote continuous selection and implementation of modern and accessible technologies in Armenia, on the examples of several selected mitigation and adaptation projects. In this sense, TNA project is aimed at strengthening the capacities on the development and transfer of technologies with positive and promising results for this phase.

First Deputy Minister of
Nature Protection of RA  **Simon PAPYAN**

Preface

The impact of/share of emissions of the Republic of Armenia (RA) to global climate system emissions is small, and is currently estimated to be around 0.014% of the global level. In January 2010, the country expressed its intention to be listed to agreeing to the Copenhagen Accord. Armenia accepted "Doha Amendment to the Kyoto Protocol" which was approved by the Government of the RA.

Armenia's stance on Convention is worded in the document "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 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.

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 Third National Communication (TNC) on Climate Change of the RA (Ref-2)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 RABi annual Update Report (BUR) (Ref-3)is submitted. The National Inventory of the RABUR is updated as of 2012. According to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines, the RA Biannual Update National Inventory Report (NIR)(Ref-4)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 Development Strategy for 2014-2025 (ADS) (Annex To RA Government Decree # 442 - N 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 (Ref-5).

Armenia is actively involved in Technology Need Assessment (TNA) that should ensure adequate technological support and create a favorable environment for technology development and transfer.

The process of TNA is the continuation of systematic research on climate change in the RA. The TNA Project provided a great opportunity for RA to perform country-driven technology assessment to identify environmentally sound technologies that might be implemented with a substantial contribution in addressing climate change mitigation needs of the country.

The first step was technology prioritization, which includes technological information, enabling environment, capacity building and understanding the mechanisms for technology transfer.

The first report provided the existing national policies on climate change mitigation and development priorities of the country, inventory of GHG emissions, stakeholder engagement and institutional arrangements of TNA, sector prioritization process, identification of criteria, assessment of the technologies on the selected sectors by using the multi-criteria approach and technology prioritization. The first report contained detailed description of prioritized technologies and Technological fact sheets (TFS) on all proposed technologies.

The second TNA Report for Mitigation aims to outline the analysis of existing barriers and enabling environment for prioritized technologies in Armenia. It has two objectives: to identify barriers to the transfer and diffusion of each selected technology, and based on these findings to establish an enabling environment for technologies of the same sector.

The present Report includes Technology Action Plans (TAP) and Project Ideas for prioritized technologies in Armenia.

Contents

Abbreviations

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
EE	Energy Efficiency
EU	European Union
EST	Environmentally Sound Technology
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
MEINR	Ministry of Energy Infrastructures 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
PSRC	Public Services Regulatory Commission of Armenia
RA	Republic of Armenia
RE	Renewable energy
R2E2	Renewable Resources and Energy Efficiency Fund of Armenia
SREP	Scaling-up Renewable Energy Program
SDP	Sustainable Development Program
SEUA	State Engineering University of Armenia
SNCO	State non-commercial organization
TAP	Technology Action Plan
TFS	Technological fact sheets
TFEC	Total Final Energy Consumption
TNA	Technology Need Assessment
TNC	Third National Communication
TPP	Thermal power plant
TPES	Total Primary Energy Supply
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

Units of Measurement

m^3	cubic meter
ha	hectare
Gg	gigagram (10^9 g)
t	tone
toe	tones oil equivalent
kW	kilowatt (10^3 W)
kWh	kilowatt hour (10^3Wh)
MW	megawatt (10^6 W)
GWh	gigawatt hour (10^6 kWh)
$^{\circ}C$	degree Celsius

Chemical Combinations

CO_2	Carbon dioxide
$CO_{2eq.}$	Carbon dioxide equivalent
CH_4	Methane
HFC	Hydrofluorocarbons
PFC	Perfluorocarbons
SF_6	Sulfur hexafluoride
N_2O	Nitrous oxide

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Executive Summary

This Report is the third one among the series of reports envisaged under the Technology Needs Assessment and Technology Action Plan (TNA/TAP) for Mitigation project in Armenia. The report aims to outline technological actions and responsible bodies for application and diffusion of technology. Its purpose is to present the action plan for prioritized technologies in Armenia, which is the outcome of the TNA/TAP process.

TAP is a summarized plan for the acceptance, diffusion and transfer of prioritized technologies that will contribute to the country's social, environmental and economic development and to climate changemitigation.TAP is composed of numerous specific Actions. Those are the central components of TAP with a view to implement the measures identified in the analysis of barriers and enabling frameworks.

The document was elaborated based on "Enhancing Implementation of Technology Needs Assessments Guidance for Preparing a Technology Action Plan" (Ref-6) developed by UNEP DTU Partnership.

Four sectors/groups (see, below) of technologies were selected for mitigation component. Selection of sectors was implemented based on the results of the inventory of GHG emissions by sectors and calculated forecasts (mitigation scenarios) till the year 2030, time series for years 2000-2012, trends and their potential mitigating effects on climate change. Economic, social and environmental development urgencies are identified as well, based on compliance with country development priorities.
Based on proposed TNA methodology, national experts have prepared a long list of possible technologies for each sector and technological fact sheets (TFS) for each listed technology. Criteria for prioritization of technologies have been clustered under Social, Social Economic, Economic, Environmental, Ecology, Technology groups. Based on current national strategy documents and expert judgments, appropriate criteria were selected for prioritization of mitigation technologies.
"Technology Needs Assessment" (Report I) was accomplished based on provided Multi-criteria analysis (MCA) approach (Ref-7). The proposed long list of technologies (seven technologies were assessed for each selected sector) has been scored. Each criterion has been analysed according to its qualitative and quantitative importance based on information provided in the TFSs. Calculation of swing value and provided weights, the latter have been normalized and appropriate values calculated. As a result, 14 technologies (comprising consumer and capital goods, public provided and other market goods) (see, below) received the highest values and were prioritized for the mentioned sectors.

"Barrier Analysis and Enabling Framework" report (Report II) outlines the analysis of existing barriers and enabling framework for prioritized technologies in RA. 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-8). 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 create an enabling environment for technologies of the same sector.
In order to organize 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.
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.

In order to understand the fundamental problems in technology transfer, the working group of each sector has applied Logical Problem Analysis (LPA)(Ref-8). The cause effect relations were prepared in Problem tree, with the main problem placed as a starter one, 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.

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), Industry (3 technologies), Land use (3 technologies) and Waste management (3 technologies) (see, below) 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.

Energy sector (including transport):

- **Combined production of useful thermal energy and electricity (Cogeneration, Small Scale Combined Heat and Power Production (CHP).**
- **Improving energy efficiency in multi-apartment buildings of RA. Registry creation, development.**
- **Mandatory Industrial Energy Audit as a mitigation technology.**
- **Reactive 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 (including chemical industry):

- **Synthetic rubber production from butadiene instead of using natural gas (Chemical industry).**
- **Production and usage of photoluminescent materials with prolonged afterglow.**
- **Production of new type (Entirely Plastic) of solar water heater.**

Land use sector (including forestry):

- **Radical improvement of degraded grasslands.**
- **Sustainable Forest management.**
- **New technology for the cultivation of perennial plants.**

Waste management sector (including agriculture):

- **Methane emanation from Yerevan city landfill for electricity and heat production.**
- **Operation and reissuance organizational technology for the existing Lusakert biogas plant.**
- **Cleaning of agricultural lands and prevention of their further degradation bycomplex processing of Artik tufa mine wastes.**

The implementation of the Project has been supervised by the working group of Interagency Council for coordination of requirements and provisions of UN Framework Convention on Climate Change established by Decree N 955-A of Prime Minister of RA of October 2, 2012. Representatives of respective ministries and public administration agencies, appointed by the order of Minister of Nature Protection of RA are involved in the working group. This provides a good opportunity for multi-stakeholder decision-making process, as well as awareness raising on technology needs assessment at different levels. The Project implementation has been administered by “Environmental Project Implementation Unit” State Agency of the Ministry of Nature Protection of RA, and UNFCCC National Focal Point, Mr. Aram Gabrielyan, has been acting as National Coordinator.

Sectoral technology working groups, representing relevant stakeholders, were formed for the organization of the TAP process. National consultants used participatory/combined approach during the stakeholder

consultation process. The stakeholders were part of the national teams, which were divided into four working groups according to selected areas- Energy, Industry, Land use and Waste management.

The TAP process started with the analysis of the specific technological objectives targeted to national needs, followed by desk study of relevant policy, regulatory and technical documents and relevant calculations and analysis. Further, the process of consultation took place through direct meetings, interviews and surveys with stakeholders.

Afterwards, meetings with stakeholders were organized to present the draft TAPs, discuss and familiarize them with the actions (should aim to implement the measures) and activities (specific tasks needed to realize an Action) pre-selected and pre-analyzed by working group, sector experts, expert team leaders and project coordinator.

Measures for overcoming barriers have been identified for each technology and respective action plans have been drafted by the project team. The action plans have then been discussed with stakeholders, particularly during the meeting held on December 19, 2016.
Over 35 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 December 19, 2016, (**Annex I**). Fourteen TAPs, those objectives and benefits, responsible bodies and budget per activity for each technology have been discussed in the four prioritized sectors.

Based on the recommendations of meeting participants, relevant amendments were made to the technology action plans, after which the final versions have been approved by the working group of Interagency Council for coordination of requirements and provisions of UN Framework Convention on Climate Change, during its regular meeting held on January 31, 2017.Based on presented TNA reports UNFCCC National Focal Point, Mr. Aram Gabrielyan received designation and instructions for establishment of Arm CTCN.
Stakeholders confirmed their interest to establish a national inventory system (National CTCN) for technologies in all spheres for climate change mitigation based on TNA and linked to the Climate Technology Centre and Network (CTCN).

The action plans for each technology include the descriptions of respective sector and sub-sector, the ambition related to implementation of the technology, the list of actions, as well as the activities to be implemented under each action. For each activity, there are presented details on the sources of funding of its implementation, responsible bodies, the implementation timeframe, relevant risks, success criteria, indicators for monitoring of implementation and the budgets.

All the above-mentioned prioritized technologies are described in detail in the First Report “Technology Needs Assessment”. Enabling framework and market mapping for those technologies are comprehensively analyzed in the Second Report “Barrier Analysis and Enabling Framework”. Moreover, all the discussed technologies are available for possible financing.

Chapter 1.Technology action plan for Energy sector

1.1 Actions at Energy Sector level

Necessary actions for the introduction and diffusion of technologies in the energy sector have been selected based on working discussions and barriers identified in the previous phases of the project, the implementation of the proposed measures for overcoming the barriers and interconnectedness of creation of enabling framework. The purpose of the actions is to eliminate barriers and implement the proposed measures for the creation of enabling environment in the energy sector and for transfer and diffusion of the mentioned technologies.

Activities are specific tasks or sub-actions for which detailed timeframes for implementation, resources, responsible parties, reporting plans, were provided. Several activities are typically combined into a single Action.

Below presented Energy Sector Actions have been determined based on the results of discussions with stakeholders/by the concerned parties in different formats and guidedby Armenian Second National Energy Efficiency Action Plan (NEEAP), which offers additional EE improvement measures for the period covering 2015–2020 (Ref-9).

The key pillars of the second NEEAP are:

- Reducing energy demand by improving energy end-use efficiency;
- Improving national energy security by reducing the need from imported(external) energy sources;
- Reducing the energy intensity of the key economic outputs to decreaseproduction costs and increase product competitiveness;
- Addressing growing energy access concerns through EE solutions (instead of relying on social aid), and
- Providing incentives to reduce the growth of energy consumption through behavioral changes, and thus encouraging the quality and sustainable development through the introduction of knowledge and effective use for resource efficiency and smart growth.

1.1.1 Energy Sector Overview

Armenia has no domestic fossil fuel resources and is almost completely dependent on imported energy. Domestically produced primary energy resources (hydro, nuclear, wind, and biomass) provide 35% of the country's 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 (PEC) per capita was 1.052 toe; the energy intensity of GDP was 0.320 toe/thousand USD (Ref-3).

The Energy sector is the largest producer of GHG emissions (CO2eq); its share of the total emissions is 70.3%. In 2012 the prevailing part: 95%of all carbon dioxide (CO2) emissions is generated by the energy sector driven by high emissions caused by thermal power plants (TTP), residential sectors and road transport.(Ref-4).

The second largest contribution of emissions (CO2eq) in the Energy sector is formed from Fugitive emissions (CH4) of natural gas sub-category that was conditioned by sharp increase of natural gas import due to increased power generation by thermal power plants (Ref-4).

Consequently, the major Mitigation potential is in the Energy sector.

1.1.2 General barriers and proposed measures

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 and 7) Human Skills.
Though, all the barriers identified in Energy Sector are profound, difficult to identify and difficult to understand, however respective measures were recommended to overcome those barriers for the creation of enabling framework.
In order to understand the fundamental problems in technology transfer Problem trees, objective trees and market mapping, each of prioritized technologies of Energy sector was analyzed with a view to overcome the barriers to transfer and diffusion identified during the Barrier Analysis and Enabling Framework phase of the Project.
The nature of the barriers in the sector is mainly considered to be institutional and regulatory while economic and financial measures have reasonable operational costs, low investment costs for the import of technologies, new equipment and techniques.
Measures for overcoming of barriers have been identified for each technology and respective action plans have been drafted by the project team. 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.

1.2 Action Plan for Combined production of useful thermal energy and electricity Cogeneration, Small Scale Combined Heat and Power production technology

1.2.1 General description of the technology

Cogeneration, also known as combined heat and power (CHP), is the use of a heat engine or power station to generate electricity and useful heat at the same time, technology with large economical energy saving potential. The generation of electricity based on useful thermal energy demand is known as Cogeneration or Combined Heat and Power production, which is an energy saving technology with a big potential.

According to the RA Government Decree on “Energy sector development strategy in the context of economic development in Armenia”, (N 24 protocol from 23.07.2005) energy efficiency is rightfully considered as one of Armenia’s own energy resources. At the same time, the strategy emphasizes the use of new technologies in the energy sector, including the need for introduction of promoting policies in the field of small-scale energy production.

Cogeneration stations may generate electric and thermal energy using modern gas turbines and gas piston aggregates with the cumulative Efficiency Coefficient of 90-92 %: 42-44 % for electric energy, and 48-50% for thermal, accordingly.

The RA energy system rated capacities/installed capacity exceeds the maximum demand for the electrical load, it is self – sufficient, besides, according to the annual energy balance, the thermal power stations in average generated about 30%-40% of electric energy in 2012-2016. All the thermal power plants work on a condensation mode and have the following Efficiency Coefficients: Yerevan (CCGT 242 MW) Combined-Cycle Gas Turbine (gas and steam power plant) 47%, Hrazdan 5 unit (CCGT 445 MW) Thermal Power Plant 45-44%, Hrazdan TPP 33% (the 4x200 MW aggregates of the latter have been operated for over than 40 years). It is obvious that capacities of the latter should be modernized.

Thus, 1kW power of a cogeneration station may annually generate at least 7,500 kWh electric energy and accordingly 8,200 kWh thermal energy. Annual fuel saving will be about 1,100-1,300 m3 of Natural Gas. Yet, stations with renewable energy resources have less working hours annually, small HPPs – 3,000 hours, solar stations – 1,800 hours. Estimates show that 1 kW power of a small Hydro Power Plant will save about 1,000 m3 of natural gas annually, whereas in case of Solar and Wind power stations the saving does not exceed 700 and 800 m3 of Natural Gas, respectively.

1.2.2 Objectives for technology transfer and diffusion

The European Parliament and the Council of Europe 2004/8/EC and EC-28 2014 directives require all EU states to develop and introduce useful heat demand-based incentive mechanisms for the construction of cogeneration units based on a useful heat demand. Moreover, each EU member state is entitled to develop a policy for promoting the development of combined heat and power production, which takes into account the situation of the respective country.

There is a faulty perception among the society and some experts, that the replacement of the exhausted power is more efficient to be done only with the help of stations working on the renewable energy resources. However, from the perspective of organic fuel saving, it appears that the cogeneration stations do not lag behind but in this case, exceed the known technologies for renewable energy resources.

There is a considerable potential of heat demand in densely built-up urban areas and the task of the Government is to ensure the legal framework for the introduction of safe, energy-saving and economically feasible heating technologies.

1.2.3 Barriers to technology diffusion

In contrast to renewable energy generating plants, in Armenia not a single legal act guarantees obligatory purchase of the energy generated by the CHP units as well as there are no certain principles for tariff formation. The only document, which sets out the RA Government's recommendations on those issues, is the Government Decree 509-N from 2005, according to which demonstration projects for rehabilitation of heating in Avan and Davitashen districts were approved, based on the use of electrical and thermal energy cogeneration units. At the same time, the Public Services Regulatory Commission (PSRC) was recommended to develop a tariff methodology promoting the implementation of that decision.

However, those recommendations may be legally binding only through the adoption of appropriate regulatory documents by the Commission, since according to the RA law on Energy the solution of those issues is in the scope of the competencies of the Commission.

The main barrier to the restoration of the district heating supply using cogeneration stations is the absence of the legal framework in the corresponding field.

According to the RA law on "Energy", electricity and thermal energy generation fields (except for small heat supply systems up to the power of 5.8 MW) are under Government regulation and are guided by the Public Services Regulatory Commission (PSRC) directives. In case of the absence of legal act ensuring obligatory purchase of the energy generated by the CHP and legal framework, the private investments in CHP are impossible. The mentioned exceptions should be revised so that the tariffs are defined in this domain and are competitive with respect to individual heating systems. In the absence of this approach, it is impossible to attract private investment.

1.2.4 Proposed action plan for Cogeneration, Combined production of useful thermal energy and electricity

The Ministry of Energy Infrastructures and Natural Resources (MEINR) will have to shape Armenia's energy policy. It is charged with primary responsibility for the energy sector. Regulatory implementation is the responsibility of the PSRC, which was established in 1997 by Decree of the President of Armenia. PSRC is an autonomous regulatory agency; government entities cannot interfere with its decisions. It is a multi-member body responsible for electricity, gas, water and telecommunications.
Therefore, the Department of MEINR should initiate the elaboration of the strategy on general supply of heating for the country, based on the practices of introduction of electricity and heat cogeneration units widely used in developed countries. That strategy should be secured by the relevant decree of the RA Government. Moreover, the policy of promoting the use of renewable energy resources should equally be applied on the future projects on the combined production of electrical and thermal energy.

According to RA law en "Energy", PSRC have the authority to set the regulated tariffs for electric and thermal energy and natural gas, transmission, distribution in the energy sector, to issue licenses for operations in the energy sector, to issue regulations for supply and use of electric and thermal energy and natural gas, to approve the energy market rules in cooperation with the RA Government authorized body; to establish model forms or mandatory provisions for energy and natural gas supply and service contracts; etc. Therefore, PSRC should establish a clear methodology for setting tariffs for combined heat and power production.

The power system operator shall carry out the analysis of the RA power modes for a long-term (minimum 20 years) based on the control limits of the RA energy system and recommend potential volumes (maximum installed capacity) of the usage of the CHP. According to our estimations, that makes 50-52 MW of electric power.

MEINR should coordinate the large-scale work to be carried out in Armenia for the assessment of useful heat demand and based on those results appropriate projects should be ordered and implemented.
A serious obstacle to the introduction of CHP based on the useful heat demand is the need to change the heat supply ideology in the country emerged after collapse of the Soviet Union (with high rate of centralized heating).It is preferable to eliminate the separate production of electricity in the fossil fuel based energy projects.

We believe that preparatory activities of tender packages for the projects and organization of tenders should be performed by the PIU of the MNP, as an interested party. The main objective of the PIU is the provision of efficient implementation of the RA environmental sector projects, state sector projects, state sector projects on management of natural recourses and environment conservation, as well as projects financed by various international environmental organizations.

The successful tenderer organizations recognized as such for the implementation of relevant projects should obtain appropriate licenses and act under the terms of those licenses and other regulations by the PSRC. A more detailed action plan is presented in Table 1 below.

Table 1. Technology action plan for Cogeneration, Combined production of useful thermal energy and electricity

Sector	**Energy; Stationary combustion**							
Technology	**Cogeneration units constructed by using modern gas turbines and gas reciprocating aggregates can generate with the cumulative efficiency coefficient of electric and heat energy of about 90-92 %, from which 42-44 % for electric and 48-50% for thermal energy. One of characteristics of those technologies (both gas turbines and gas reciprocating aggregates) is the fact that they are manufactured with the power of from 40 kW to several MW, are delivered in ready for service units and can be installed in the place of heat and electric energy demand, nearby to consumers, with all the ensuing advantages. This means that with 0.4, 6 (10) kV output voltage they can be switched to near power lines or electrical substations, eliminating the need for high voltage electricity transmission.**							
Objectives	**Decentralized electricity production, which will result in the reduction of the losses associated withelectricity transportation. Reduction of the volume of imported primary energy sources at the expense of the combined heat and power generation and reduction of greenhouse gas emissions. According to our estimations the construction of central boiler systems in Yerevan using cogeneration technology will allow to satisfy the 125 - 130 Gcal of heat demand, 40% (42-45 Gcal) of which will be covered by heat generated by the cogeneration plants (the other 60% is assumed to meet by the use of peak-load boilers). That corresponds to 50-52 MW of cumulative power of cogeneration plants in the densely built-up and populated suburbs, or in newly constructed residential areas.**							
Benefits	**The introduction of this technology allows to reduce the consumption of primary energy (fuel) 1.5 times, compared to the same amount of separate production of electricity and heat, and as a result there is: 1) a decrease in demand for imported fuel, which contributes to strengthening economic and energy independence, 2) reduction of greenhouse gas emissions, 3) reduction of losses associated with the distribution of decentralized energy production. If introduced in the predetermined volumes the annual reduction of greenhouse gas emissions is expected as 11.7 Gg CO_{2eq}.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
№ 1 Regulatory reforms	**№ 1.1** Develop a conceptual approach and include it in the strategic development plan of the sector, excluding separate production of electricity in the projects involving fossil fuel carriers in which there is demand for useful thermal energy.	State and/or international Civic Fund	MEINR and MNP Head of Energy Department	0-1 year	Accurate assessment of heat demand	70% of the assessed demand for thermal energy is met by the mentioned technology in 10 years	RA Government Decree	10,000 USD for the development of the concept
	№ 1.2 The policy promoting the use of renewable energy	State and/or international	MEINR and MNP Head of Energy	0-1 year	A significant increase in the efficiency	Highly efficient district heating supply	Making amendments in the RA law onEnergy	20,000 USD

	resources should be equally distributed in the future projects on the combined production of useful thermal energy and electricity	Civic Fund	Department		of use of RE technologies and sharp decrease in prices	development of strategy	Policy	
	№ 1.3 Establish a proper methodology for setting tariffs for the combined production of useful thermal energy and electricity	State and/or international Grant	RA PSRC, head of Tariff Policy Department	0-2 years	Dependence on grants	Preparation of the draft decree of the PSRC	Decree of the PSRC	20,000 USD
№ 2 **Based on the control limits of the RA power system define potential volumes (maximum installed capacity) of the usage of the cogeneration units**	**№ 2.1** Carry out analysis of power system modes	State and/or international Civic Fund	"Electric Power System Operator" CJSC Senior Engineer	0-1 year	Unexpected growth of electricity produced by renewable energy sources	Recording the possibilities of installing cogeneration units with 50 - 55 MW electric power in the context of planning and regulation of power system modes	Provision of relevant references by the Electric Power System Operator	20,000 USD
№ 3 **Assessment of a useful heat demand, selection of favorable settlements for district heating, design and implementation of the projects**	**№ 3.1** Assessment of a useful heat demand for Yerevan and other relevant settlements in the Republic, design of projects on district heating	Civic Fund Grant	MEINR and MNP Head of the Department of Energy	0-2 years	Decrease in demand	Preparation of projects using cogeneration technology based on a useful heat demand	Ready projects	500,000 USD
	№ 3.2 Preparation of tender packages and organization of tenders for the project implementation	Civic Fund State and/or international	EPIU of MNP	0-3 years	Lack of attractivenes s 2 years later	Tenders, identification of winners	Provision of appropriate construction permits by local authorities	10,000 USD
	№ 3.3 Implementation of the projects by the	Private	MEINR and MNP	3-8 years	Reduction of tariffs on	10 years later, 70% of the heat	Decrease in the volumes of	60,000,000 USD

	winning companies	Civic Fund			natural gas, projects with no further demand	demand is met	imported gas and GHG emissions to an anticipated degree	
№ 4Institutional reforms	**№ 4.1** Creation of condominiums, active participation of the population in the process of management of buildings	State and/or international Civic Fund	RA Ministry of Territorial Administration and Development Yerevan Municipality	0-5 years	Residents' indifferent attitude	Increasing the number of conscious condominiums by 5 annually	conscious condominiums	100,000 USD annually
№ 5Information on the efficiency of the technology and awareness	**№ 5.**Broadcasting programs through various media	State and/or international	MEINR and MNP	0-5 years	Non-attractiveness	Enhancing knowledge of condominium residents	Radio, television programs and articles	20,000 USD annually
	№ 5.2 Development and distribution of information leaflets and illustrated booklets	Civic Fund International	MEINR and MNP	0-5 years	Residents' indifferent attitude	Distribution of 10,000 pieces of booklets and leaflets annually	Information leaflets and booklets disseminated	20,000 USD annually

1.3 Technology Action Plan for Improving Energy Efficiency in Multi-Apartment Buildings. Registry Creation and Development

1.3.1 Overview of the technology

The effectiveness of the implementation of measures to reduce GHG emissions in the buildings are significantly linked to the availability of multi-structured and accurate data on the technical specifications of buildings through the creation of Housing Register (this may be the first step).
The requirement to create a register is defined by the RA Government Decree dated 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 meters, total area of 435 thousand apartments) in RA.

1.3.2 Objectives for technology transfer and diffusion

Due to efficient use of energy resources, environmental protection and the need to reduce GHG emissions energy saving and EE of the apartment buildings is considered a priority policy for the Government. 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 CO2 or 20.4% of CO2 emissions in "Energy" sector (Ref-4).
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 that have adequate organizational and technological capacity and the potential for reducing greenhouse gas emissions and energy efficiency measures.

1.3.3 Barriers to technology diffusion

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).They are financial, institutional, information/awareness, technology issues and human skills.
One of the main barriers is the lack methodology on the selection of indicators/ criteria including Registry Optimization Software, which are important elements for the introduction of the technology and are aimed at reducing GHG emissions. Lack of financial support is the main financial barrier to technology diffusion.

1.3.4 Technology Action Plan for Improving Energy Efficiency in Multi-apartment Buildings. Registry Creation and Development

As a first step for the introduction of the technology, RA State Urban Development Committee should develop a methodology to determine priority indicators for the selection of multi-apartment buildings to be included in the Registry. Those indicators should be highlighted for further optimization of the selection process of multi-apartment buildings, especially in terms of reduction of greenhouse gas emissions.

Based on the methodology developed and coordinated by the above mentioned government agency, four-tier software should be developed and piloted for 3 settlements located in different climatic zones of Armenia. Based on the successful experience of the pilot projects and established methodology an integrated Registry of multi-apartment buildings will be created. A more detailed action plan is presented in Table 2 below.

Table2. Technology Action Plan for Improving Energy Efficiency in Multi-apartment Buildings. Registry Creation and Development

Sector	**Energy; Households (population)**							
Technology	**It is proposed to develop and implement demonstration(pilot) version of computerized Registry model for 3 cities located in different climatic zones. The model will be a four-tier: 1) multi-apartment building and/or managing body of the multi-apartment building, 2) local authorities, 3) territorial administration, 4) RA State Urban Development Committee, authorized body of the sector. It is anticipated that indicators, data describing economic, technical and energy parameters of the buildings will be included in the Registry. The software should also have the ability to choose the "best available technology". The information in the Registry should be transparent, accessible and available for the population.**							
Objectives	**The purpose of the Registry is to create an integrated information system using new technologies that will serve as an effective tool for identifying and prioritizing buildings that have sufficient organizational and technological potential for the implementation of energy saving measures and reduction of GHG emissions.**							
Benefits	**The housing sector consumes more than 35% and 25% of electricity and heat energy in the country's economy, with more than 40% of greenhouse gas emissions. For that reason, the creation of the Registry is one of the most important tools for increasing energy efficiency in buildings.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
№ 1 Creating a demo computerized Registry model for multi-apartment buildings	**№ 1.1**Development of methodology for indicators that are important for optimization purposes, particularly for targeted selection of GHG reduction, which will be included in the software of the Registry	Civic Fund Grant	RA State Urban Development Committee	0-2 years	Absence of grants	Approval of the methodology	Presentation of the methodology	25,000 USD annually
	№ 1.2 Creation of four-tier computer model for 3 cities located in different climate zones	Civic Fund Grant	RA State Urban Development Committee	0-1years	Non-attractiveness 1 year later	Introduction of demo software for all four-tier beneficiaries	Implementation of 6 workshops on the use of the Registry	150,000 USD
№ 2Raising awareness on the	**№ 2.1** Organization and implementation of	State and/or international	RA State Urban	0-2 years	Improper coordination of	Involvement of 70% of the	Trainings Participants	20,000 USD annually

creation of the Registry of multi-apartment buildings	trainings for building residents by specialists	Civic Fund	Development Committee Yerevan Municipality		activities	residents of the buildings		
	№ 2.2 Distribution of information leaflets and booklets	State and/or international Civic Fund	RA State Urban Development Committee Yerevan Municipality	0-2 years	Lack of interest on the part of community members	Improved knowledge of community members	Information leaflets and booklets	20,000 USD annually
	№ 2.3 Broadcasting TV and radio programs on media, articles in newspapers	State and/or international Civic Fund	RA State Urban Development Committee	0-2 years	The population of the community does not see any interest in awareness raising activities	Awareness raising of community members	Radio and television programs and articles	20,000 USD annually
№3 Provision of financial flows needed for the use of the technology	**№3.1** Financing from international donor organization	International development banks	RA State Urban Development Committee Yerevan Municipality	0-2 years	Poor cooperation between local authorities and ministries	Targeted use of received grants and loans	Received grants and/or interest-free/soft loans	10,000 USD
	№3.2 Grant from charitable foundations and benefactors	Environmental funds	RA State Urban Development Committee	0-2 years	Poor organization of activities	Targeted use of received grants and loans	Received grants and/or interest-free/soft loans	10,000 USD

1.4 Technology Action Plan for Conducting Mandatory Industrial Energy Audit as a Mitigation Component

1.4.1 Overview of the technology

Energy audits in the RA are conducted in conformity with the RA law on Energy Saving and Renewable Energy (adopted as HO-122-N dated 9 November 2004 and amended as HO-130-N of 14 April 2011 and HO-67 of 3 June 2016). The general procedure for conducting energy audit is defined by "Energy Audit Implementation Procedure" approved by decision #1399-N of 31 August 2006 of the Government of the RA and edited by decisions #1105-N of 4 August 2011 and #1026-N of 10 September 2015. Conducting energy audit is voluntary in Armenia; however, there is a list of mandatory measures for EE and energy saving in the construction of facilities at the expense of public funds, approved by decision #1504-N of 25 December 2014. Energy audit in Armenia can be conducted by state accredited certification bodies (amended to RA law, HO-67 of 3 June 2016). More than hundreds of energy audits were conducted in Armenia in the last five years, mainly of residential and public buildings, heating systems, street lighting and industrial sectors. Energy audits are mainly performed in the frames of the following EE related projects financed/implemented by international organizations.

1.4.2 Targets for technology transfer and diffusion

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, construction and commercial/institutional subsector share 916.2 Gg CO2 or 17.3% of CO2 emissions in energy sector. Mandatory Energy Audit in the larger enterprises (classified by their energy intensity, thermal energy and power consumption) will highly contribute to EE and GHG reduction polices. The benefits are obvious: EE and energy saving culture formation, cost reduction, increase in the competitiveness of the production, as well as reduction of primary fuel expenses, consequently reduction of GHG emissions.

1.4.3 Main barriers to technology diffusion

Institutional reforms are needed in the field of industrial energy audit, particularly definition of new EE targeted set of indicators and minimum energy saving requirements. The absence of obligatory requirement on annual publication of results related to enterprise energy activities for large industrial enterprises, as well as the rate/extend should be defined for the mandatory realization of the Industrial Energy Audit as a Climate Change mitigation measure.

Among serious barriers is that in Armenia there are no certified and accredited energy audit conducting organizations, and the existing ones do not have enough experience.

1.4.4 Technology Action Plan for Conducting Mandatory Conduction of the Industrial Energy Audit as a Mitigation Component

MEINR, in cooperation with the National Statistical Service, will define the format for submitting quarterly reports on energy intensity of product units. The report should include information on the energy

consumed by enterprises, and specifically accurate information on a product unit. Based on the analysis of annual reports received in the approved format, classification of large industrial enterprises should be implemented according to indicators on energy intensity (total energy costs). Along with that process, a state program should be carried out aimed at establishing institute of experts in energy efficiency, which implies organization of trainings for professionals with basic knowledge on the base of "Scientific Research Institute of Energy" CJSC, as well as appropriate profiling of graduate students of Energy Department of the National Polytechnic University of Armenia.

Prior to making the demand for energy audit/expertise of industrial enterprises statutory, there is a need to provide financial support to the enterprises subject to audit/expertise with the involvement of international donor organizations and civic revolving funds. In future the provided financial support will be compensated through savings from increased efficiency of energy consumption.

Only after the implementation of these steps MEINR should initiate institutional reforms, defining by law the requirement for mandatory energy audit/expertise of industrial enterprises and its frequency. A more detailed action plan is presented in Table 3 below.

Table 3. Technology action plan for Conducting Mandatory Industrial Energy Audit as a mitigation technology

Sector	**Energy; Energy expertise/audit of industrial enterprises**							
Technology	**EU directive EC-28 from 2014 obliges to conduct energy expertise of large industrial enterprises, at least once every 4 years, starting from 5 December 2015, as well as to promote making energy expertise mandatory for small and medium enterprises. Within the framework of the implementation of that policy enterprises can be classified based on energy intensity (e.g. in Russia, enterprises having annual energy expenses of 10 million Russian rubles and more, or in Kazakhstan, having annual consumption of energy equal or more 1,500 tons of equivalent fuel). Enterprises classified as high-energy consumers are subject to energy expertise by accredited companies. Eventually, for the implementation of identified energy efficiency potential an action plan is drawn and is realized in reasonable time and in economically profitable way.**							
Objectives	**Legally defined requirement for the implementation of mandatory energy audit/expertise, promoting reduction of energy consumption on unit of production and as a result reduction of greenhouse gas emissions.** **Moderate estimates show that as a result of the introduction of this technology the potential of energy efficiency is about 20% of total energy consumption. Potential reduction of GHG emissions will amount to 3.83 Gg CO_{2eq} annually.**							
Benefits	**Competitive products, increase in exports, and prerequisites for sustainable economic growth.**							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
№ 1 Perform classification of large industrial enterprises according to indicators on energy intensity (total energy costs)	**№ 1.1** Define the format/template of quarterly reports on energy intensity of production unit	State and/or international Civic Fund	MEINR and MNP Department of Energy National	0-1 year	Lack of qualified specialists and organizations conducting energy expertise	Introduction of the templates via trainings	Adoption of an appropriate Government Decree	20,000 USD annually

			Statistical Service					
	№ 1.2 Make changes in the institutional framework, defining requirement to publish accurate information on the energy consumption of enterprises, including data on a unit production	State International Civic Fund	MEINR and MNP	0-3 years	Necessity to evaluate credibility and accuracy of information	Introduction of the template and publication of quarterly information	Publication of statistical data	20,000 USD annually
№ 2 Implementation of government programs aimed at establishing institute of experts	**№ 2.1** Organization of trainings for professionals with basic knowledge on the base of "Scientific Research Institute of Energy" CJSC	State RR and EE Fund	MEINR and MNP	0-3 years	Lack of qualified specialists	Provision of professional qualification certificates and the establishment of "Energy Efficiency Specialists Association"	Specialists and associations in the field of energy efficiency	50,000 USD annually
	№ 2.2 Profile graduate students of Energy Department of the National Polytechnic	State RR and EE Fund	MEINR	0-10 years	Lack of attractiveness	Provision of relevant certificates along with master's degree diplo ma	Specialists in the field of energy efficiency	30,000 USD annually

	University of Armenia							
	№ 2.3 Provision of financial support to companies subject to expertise	Grant Civic Fund	International donor organizations Civic revolving funds	0-3 years	Lack of financial support	Conducting energy expertise in the 10 largest companies of the country, publication of the results and implementation of measures	Publications of the actually recorded results on the increased energy efficiency	100,000 USD annually
№ 3 Revision of the RA Law on Energy Efficiency and Renewable Energy, defining mandatory energy expertise for large industrial enterprises	**№ 3.1** Drafting law on making amendments to the RA Law on Energy Efficiency and Renewable Energy	State and/or international Civic Fund	MEINR and MNP	0-1 year	Slowdown in the process of establishment of the institute of experts	Submission of the draft law by the Government to the National Assembly of the RA	Preparing the draft law	10,000 USD

1.5 Technology Action Plan for Reactive Power Compensation Capability in the RA Electric Energy System

1.5.1 Overview of the technology

Modern compensator (adjuster) represents the capacitor 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 high-voltage electricity transmission network in some regimes may exceed the inductive power/capacity. In this case, operation of the additional capacities by consumers may cause problems in energy system, leading to an unacceptable voltage rise.

It is noteworthy that in the case of low values of power factor (cos ϕ) active power losses in the transmission lines is caused in both cases, inductive and capacitive natures of reactive power.

The solution of this problem is to implement complex measures: capacitive reactive power is compensated by means of controlled reactors in the energy system, while inductive reactive power is compensated by installation of automatically controlled capacitor batteries.

1.5.2 Targets for technology transfer and diffusion

Using compensating reactive power technologies in the chain from producers to consumers will bring to reduction of active power losses, increased efficiency of producing generators and transmission lines usage, increased capacitance 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 considerable potential for increasing EE (reducing active power losses). Reactive power is not measured or registered by energy consumers.

1.5.3 Barriers to technology diffusion

The issue of reactive power compensation seems to be partly excluded from the energy regulatory area. Reactive energy flows available in the energy system are recorded when calculating the energy losses, but no measures are undertaken (technical, institutional, etc.) to minimize their negative consequences.

After the collapse of the Soviet Union energy system reactive power compensation by consumers is not regulated anyhow, whereas it contains significant potential for EE (reducing active power losses).

Reactive energy is not measured and recorded by consumers and therefore the accurate information on values of the power factors is absent. Among the impediments the lack of specialized human resources should be mentioned.

The main issue is that there is no provision or requirement in the existing Technical regulations on the registration and compensation of the reactive energy. As well as no provisions regarding reactive energy management (incentives, sanctions, etc.) or tariff-setting mechanisms are established.

It will be required to acquire and install the appropriate equipment (compensators, reactors, etc.) for the technology introduction. Financial support will be needed for the study and localization of best practice.

1.5.4 Technology Action Plan for Reactive Power Compensation Capability in the RA Electric Energy System

The comprehensive introduction of the proposed technology is possible only by adopting appropriate regulations by the regulatory authority of the energy sector. For the preparation of the relevant draft decree of the PSRC, best experience on the use of the proposed technology should be studied and adapted to local conditions, which international consulting organizations are supposed to do.

Coordinated by the PSRC and MEINR, the draft decree on of the PSRC should be discussed with the entities of the electric energy system and biggest consumers in the context of distribution of responsibilities related to the implementation of the technology and realization of arising obligations, followed by the PSRC to approve the corresponding decree.

Landmark for the direct application of the technology is the definition of the maximum allowable values of power factor in the demarcation points of the electric energy system by the “Electric Power System Operator”, as well as development of mechanisms for regulation of reactive energy, including procedures for tariff definition and trade accounting, involving “Electric Network of Armenia” and “Settlement Center” CJSCs.

The process of the introduction of the technology will be completed by planning and implementation of investment projects aimed at compensation of reactive power (energy) by “Electric Network of Armenia” and "High Voltage Electric Networks" companies. A more detailed action plan is presented in Table 4.

Table 4. Technology Action Plan for Reactive Power Compensation Capability in the RA Electric Energy System

Sector	**Energy; Electric energy system**							
Technology	**The issue of reactive power compensation is partly left out of the regulation. The existent reactive flows in the energy system are considered when calculating losses, but no measures (technical, institutional) are undertaken to minimize their negative consequences. In case of small values of the power factor (cos ϕ) active power losses in power transmission lines are caused by both inductive and capacitive reactive power. The solution is to perform complex measures, on one hand compensation of capacitive reactive power by means of controlled reactors in the energy system, on the other hand compensation of inductive reactive power through the installation of automatic capacitor batteries.**							
Objectives	**Reactive energy is not recorded by consumers and therefore accurate data on the values of the power factor is missing. However, based on measurements carried out by "Scientific Research Institute of Energy" CJSC and based the accumulated experience of the USSR times, the discussed factor for some industrial consumers ranges from 0.7-0.75.** **If cos ϕ = 0.9 is considered as a target value for the energy system (including consumers), it is possible to roughly estimate the potential of the loss reduction. It is estimated to be around 80 million kWh per year.**							
Benefits	**The use of technologies for compensating reactive power in the chain from producers to consumers will result in** o **reduction of active energy losses,** o **increased efficiency of usage of generators and transmission lines,** o **increased conductivity of transmission lines and transformers,** o **reduction in voltage drops.** **Given that 30% of the electricity is produced in thermal power plants, the potential of reductions of GHG emissions will amount to 16.9 $GgCO_{2eq}$.**							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**
№ 1	№ 1.1 Adapting best	State	RA PSRC, Head of	0-1 year	Lack of financial	Preparing a draft	Presentation of	50,000 USD

Development of a draft decision on accounting and compensation of reactive power and adoption of the decision by the PSRC	international experience to local conditions with the assistance of international consulting organizations and drafting a respective decree of the PSRC	Grant	Tariff Policy Department		support by donor	decree	the draft decision	
	№ 1.2 Discussion of the draft decision with the stakeholders and approval of the decision by the PSRC	State and/or international Civic Fund	RA PSRC RA MEINR and MNP	0-1 year	Considering the introduction of the proposed technology outdated as a result of discussion	Adoption of the decision	Development of a strategy on the implementation of the decree	10,000 USD
№ 2 Implementation of reactive power (energy) compensation process	**№ 2.1** Definition of the maximum allowable values of power factor in the demarcation points of the electric energy system	State Donor organizations	"Electric Power System Operator" CJSC Senior Engineer	0-2 years	Lack of support from donors	Implementation of the relevant calculations	Definition of allowed range of changes in power factor	20,000 USD annually
	№ 2.2 Establishment of mechanisms for reactive energy regulation, including tariff definition and trade accounting	State Donor organizations Private	"Electric Network of Armenia" CJSC "Electric Power System Operator" CJSC Senior Engineer "Settlement	0-3 years	Lack of support from donors	Submission of jointly developed recommendations to the PSRC	Approval of the decision on reactive power (energy) compensation mechanisms and tariff setting by the PSRC	20,000 USD annually

			Center" CJSC					
	№ 2.3 Preparation and implementation of Action Plan on reactive power (energy) compensation by "Electric Network of Armenia" CJSC	Private International	"Electric Network of Armenia" CJSC	3-10 years	Investment restriction by the PSRC	Agreement of investment projects with the PSRC	Reduction of energy losses pre-planned by investment projects and hence reduction of respective of GHG emissions	100,000 USD annually

1.6 Technology Action Plan for the Correspondence of Natural Gas Tariff Structure to the Methodology Approved by Decision of Public Services Regulatory Commission (PSRC)

1.6.1 Overview of the technology

Natural gas is the main type of fuel used in the RA. The largest source of greenhouse gas emissions, more than 70% generates from burning fossil fuels. This is due to the fact that gasification rate is fairly high in the country about 95%. Natural gas is used across all end-use sectors and as feedstock for electricity generation, accounting for about 62% of Total Final Energy Consumption (TFEC) in 2014. About 22% of TFEC is electricity to supply households, businesses and industry, while oil, representing 16% of TFEC, is used in transport, industry and businesses. Natural gas is largely used in road transportation, as it is 2.5 times cheaper than gasoline and there is a developed compressed natural gas (CNG) fueling 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).

The second largest source of emissions in the Energy sector is fugitive emissions from natural gas operation subcategory conditioned by sharp increase of natural gas import due to increased power generation by thermal power plants.

Methodology established by the PSRC decision shall be applied to carry out a selection of the structure for natural gas distribution service tariffs (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.)..

1.6.2 Targets for technology transfer and diffusion

PSRC determined the natural gas tariffs with the following distribution: gas consumers up to 10,000 m3 per month and 10,000 m3 and more. Therefore, Natural Gas tariffs have a threshold of 10,000 m3 monthly consumption. Consumption less is paid by 139. 0 AMD / m3 (both revised since 01.01.2017), and more is paid less: 242. 1 USD/1,000 m3 [or 116.2 AMD / m3 (exchange rate 1 USD =480 AMD, January 2017)]. Studies show that in winter heating season a number of consumers (boiler houses, etc.) with average installed thermal capacity(200-450 kW) face a dilemma when it is possible to pay monthly the same amount of money increasing the consumption by 2,000-2,500 m3. Therefore, it is obvious that a grey zone is formed where the current tariff 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 decline the existing tariff structure and base on the methodology approved in 2004 (Decision #168A) by PSRC that will led to a more fair and reasonable tariffs for Natural Gas.

Large-scale information should be obtained and analyzed by the predetermined directions and distribution of expenditure per groups of consumers should be exercised.

Acceptable and fair tariffs for all consumer groups and suppliers should be defined.

1.6.3 Barriers to technology diffusion

The main difficulty is the limited resources of the PSRC staff working for the introduction of technology, which in its turn causes the need for financial support with a view obtain and develop information and study of best practices, as well as for the implementation of the core activities.

One of the financial barriers is the failure of PSRC budget to provide funding for such large-scale work, which is holding back the initiative.

In this regard, financial assistance from international donor organizations is a good incentive to start the process of revising the tariff structure.

In order to overcome barriers it is necessary to review current tariff system, adjusting it to the methodology approved by N168-A decision of the PSRC dated 21.12.2004. The mentioned methodology is based on the principle of fair tariff design so that equals are treated equally.

The most serious obstacle to achieve best results is the lack of experience in market-based rate establishment. In this regard, there is need for the involvement of international consultants.

1.6.4 Technology action plan for Correspondence of natural gas tariff structure to the methodology approved by the decision of Public Services Regulatory Commission (PSRC)

To review of natural gas tariff structure and tariff-setting process for consumer groups, it is necessary to include certain activities (mentioned in Table 5) in the annual work program of the PSRC and implement them according to the established timeframe defined in the annual work program. However, given the limited human and time resources of the Commission staff and their extreme daily workload the issue is postponed from year to year.

To solve the issue it is desirable to involve an international consulting organization with a view to present international experience on the extensive process of identification of expenses made by consumer groups for natural gas, localization of the international experience and organization of data collection.

In case the data is available, staff of Tariff Policy Department of the PSRC should define consumer groups, according to the principle of generated expenses. The identified expenses shall be assigned to the appropriate consumer groups and natural gas tariffs shall be calculated for all consumer groups. Technology introduction process will be completed by the adoption of corresponding decision by PSRC. A more detailed action plan is presented in Table 5 below.

Table 5. Technology action plan for Correspondence of natural gas tariff structure to the methodology approved by the decision of Public Services Regulatory Commission (PSRC)

Sector	**Energy industry; Gas supply system**							
Technology	**The standpoint of the Ministry of Energy Infrastructures and Natural Resources was expressed in the program on "Long-term developmental patterns of the energy system of the Republic of Armenia (up to 2036)" approved by N54 Protocol Decree of the Government of 10.12.2015, in which the list of medium-term measures envisages to carry out "Review of the methodology for definition of electricity tariffs and their structure, introducing an improved structure based on seasonal and hourly factors and review structure and gas tariff definition methodology, establishing new consumer groups and corresponding tariffs". Timeframe 2016-2018.**							
Objectives	**The current tariff structure does not promote the implementation of energy saving measures by gas consumers. Studies ("Practical guide for management of school boiler houses", Armenia Renewable Resources and Energy Efficiency) show that in the heating period a number of boiler houses with low and average power (installed thermal power 200-450 kW) find themselves in a dilemma when increasing consumption by 2,000-2,500 m^3 it is possible to pay the same amount of money.**							
Benefits	**The use of technology is aimed at improving the efficiency of natural gas use: during heating period up to 7-7.5 million m^3 of natural gas will be saved annually, which will lead to reductions of emissions by 3.5 $GgCO_{2eq}$.**							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
№ 1 Review of natural gas tariff structure and tariff-setting process implementati	**№ 1.1** Definition of consumer groups of natural gas in accordance with N168-A decision of the PSRC from 21.12.2004	State International	RA PSRC, head of Tariff Policy Department	0-2 years	Changing of the time period established by N54 Protocol Decree of the RA Government from 10.12.2015	Appropriate decision of PSRC	Definition of consumer groups of natural gas	10,000 USD annually

on for consumer groups	**№ 1.2** Identification of the expenses for natural gas consumer groups and tariff setting	State Donor organizations	RA PSRC, head of Tariff Policy Department	0-2 years	Lack of experience and skills	Appropriate decision of PSRC	Data collection defined by the tariff methodology	10,000 USD annually
№ 2 Raising awareness on the structure of natural gas tariff	**№ 2.1** Organization and implementation of trainings for target consumers by relevant specialists	State and/or international Civic Fund	RA PSRC "Gazprom Armenia" CJSC	0-2 years	Poor work organization	Involvement of 50% of the target consumers	Trainings Participants	20,000 USD annually
	№ 2.2 Distribution of information leaflets and illustrated booklets	State and/or international Civic Fund	RA PSRC "Gazprom Armenia" CJSC	0-2 years	Low interest by target consumers	Increased knowledge of consumers	Information leaflets and illustrated booklets	20,000 USD annually
	№ 2.3 Awareness raising through media	State and/or international Civic Fund	RA PSRC "Gazprom Armenia" CJSC	0-2 years	Consumers do not appreciate all the benefits of being informed	Ensuring consumer awareness	Radio and television programs and articles	20,000 USD annually
№3 **Provision of financial flows needed for the use of the**	**№3.1** Iinternational donor organizations	International development banks	RA PSRC "Gazprom Armenia" CJSC	0-2 years	Lack of funding	Targeted use of received grants and loans	Received financial flows	10,000 USD
	№3.2 Charitable foundations and	Environmental funds	RA PSRC	0-2 years	Poor organization	Targeted use of received grants	Received financial	10,000 USD

technology	benefactors		“Gazprom Armenia” CJSC		of activities	and loans	flows	

1.7 Crosscutting Issues in Energy Sector

The technologies of the energy sector mainly belong to “Other non-market goods” category. The introduction of technologies suggests both small and large scale projects: software and organizational components of the technologies are dominant. As a rule, transfer of such technologies is financed and carried out by parties involved in the development process, such as donors and NGOs. Meanwhile, main barriers to launching discussed projects are insufficient access to finance and lack of feasibility studies. On the other hand, barriers for long-term and successful implementation of the technologies are complex and multifaceted.

Barriers mainly have institutional and regulatory nature: they are caused by forms of ownership, change in management systems, lack of professionalism among the top management of those systems, etc.

Identified barriers in the Energy sector are interrelated to the extent that they are caused by the vagueness of the strategic plans adopted by the state, absence of appropriate regulations and their implementation not being fixed by law. Therefore, the actions are mostly intended to eliminate those obstacles and implement the proposed measures to establish enabling environment and allow technology transfer and diffusion in the energy sector.

As for the responsible organizations and coordinators for technology implementation, they are (which is typical to technologies in “Other non-market goods” category) mainly the authorities responsible for regulation of the system and development of state policy, such as PSRC,RA MEINR, RA MNP, RA Ministry of Territorial Administration and Development, RA State Urban Development Committee, Yerevan Municipality, the regions with their respective departments and specialists, who are in charge of transfer and diffusion of technologies in the energy sector and for targeted and efficient use of budgets**.**

Chapter 2. Technology Action Plan for Industry sector

2.1 Actions in Industry Sector

Necessary actions for the introduction and diffusion of technologies in the industry sector have been selected based on discussions and information obtained during the previous phases of the project. To analyze enabling environment for diffusion of climate change mitigation technologies, the elimination of identified barriers and implementation of actions, selected working groups studied in detail the nature of the addressed issues and existing situation in the industrial sectors (particularly, in chemical industry) in Armenia.

As a result of meetings and consultations factors hindering effectiveness in the sectors have been identified and actions have been developed, sectoral introduction of which will promote economic growth, have positive impact on society increasing the country's wealth, improving living conditions, leading to poverty reduction, solution of environmental problems, including aspects of climate change mitigation.

Actions in the industry sector presented below were identified based on the results of multiple discussion with stakeholders.

2.1.1 Industry Sector description

In 2012, industrial output in Armenia amounted to 102% of the 1990 level (calculation basis year for INDC).The average annual economic growth in 2007-2012 was 3.3% (Ref-2).

Before independence, Armenia's economy was based largely on industry: chemicals, electronic products, machinery, processed food, synthetic rubber and textiles highly dependent on outside resources.

After gaining independence, Armenia "inherited" unviable economy from the Soviet Union and found itself in the heaviest situation of all countries of the South Caucasus. From the agrarian-industrial country with developed metal working, mechanical engineering, chemical, light, the food-processing industry, Armenia turned into a small state which could not boast neither rich natural resources, nor favorable geographical position or fertile soils.

The collapse of the Soviet Union was followed by sharp economic downturn (53%) of 1991-1993. Armenia managed to overcome difficulties of transition period and to ensure economic growth. During 1995-2000, Armenia’s GDP increased annually by 5.4% and in the period of 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 (Ref-3).

The criterion on ‘promotion of economic development’ is considered the most important in the industry while estimating priorities in technologies and naturally it is connected with the refunctioning of chemical industry.

After the strong decrease of GHG emissions in 2009 from IPPU sector saw some increase in construction volumes and cement production and consequently GHG emissions in 2010. Meanwhile 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, SF6) emissions (Ref-2).

2.1.2 General barriers and proposed measures

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 and Awareness.

Barriers identified for each selected technology, market mapping analysis, addressing barriers, measures proposed and establishment of an enabling environment for technology transfer and diffusion of the sector are discussed in "Barrier Analysis and Enabling Framework" report.

Generally, the technologies analyzed in the Industry sector are unique or better to say not common, especially in the chemical industry technology rehabilitation. All technologies are interconnected to the extent that overcoming the identified obstacles should begin by clarifying the sales markets of the products. To overcome the identified barriers, active participation is expected from the state. Efforts are needed 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 Energy sector. However, in general policy and legislation issues are not the key factors blocking the projects.

2.2 Technology Action Plan for the Production of synthetic rubbers from butadiene instead of using natural gas (Chemical industry)

The chemical industry is of strategic importance for the country that is why resuscitation of the latter is highlighted. It will have a huge positive impact on the country's economy development, economic growth and on the creation of new jobs, comprising good prospects for small-scale chemistry development. The new technology will reduce CO2 and other GHG emissions.

2.2.1 Overview of the technology

The salt-water solution (NaCl) obtained at the salt mine near Abovyan (city in Armenia, near to Yerevan) is subject to electrolyse by direct current. Obtained chlorine gas will be liquefied and then evaporated for obtaining pure chlorine. The caustic soda and chlorine mixed with water will be sent to the special reactor where under the temperature 270˚C both compounds will react together with the butadiene vapor. The resulting vapor mixture called dichlorbutene (DCB) will be separated in order to extract the dichlorbutene to be passed through the isomerization reactor, where after using of catalyst and under the temperature 115˚C Copper naphthenate 1.4-DCB-2 will be transformed into 3.4-DCB-1 (Ref-10).

The reaction mixture is also separated by rectification and a product named 1.4-DCB-2 will be returned into the process, while other product named 3.4-DCB-1 into dehydrochlorination at the temperature of 90˚C, a process which is carried out under the influence of water and caustic soda.

The obtained product (mixture from reaction) will be subjected 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 is filtered, rectified and undergo polymerization.

Polymerization of chloroprene takes place in closed system consisting of emulsifiers, initiator, regulators, stabilizers, etc. A dispersion resulting from emulsion polymerization is often called latex which contains up to 40% of polymer to be extracted from latex by coagulation and cooling. End product in the form of granules is packed in multi-layer paper bags and labelled “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 colorless, noncorrosive liquefied gas that has a mild, aromatic or gasoline-like odor. 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-10).

2.2.2 Targets for technology transfer and diffusion

“Nairit” CJSC plans to start the production of monocarbonic acids, built new plant for diclorobutadien and expand the production of chloroprene rubbers. Following the goals, the following products are expected to be achieved (tons per year):

Chloroprene rubbers and latexes	25,000
Acetic acid	38,000
Propionic acid	6,600
Formic acid	9,000
Liquid chlorine	25,000
Caustic soda	32,500
Hydrochloride acid	12,500
Sodium chloride	4,000
Dimetilvyniletinylcarbinol	50

Functioning of technology i.e. operation of largest chemical plants (the most important among which is, certainly, “Nairit” CJSC), chemical complexes in Yerevan, Vanadzor and Kapan will have huge positive impact on Chemical Industry rehabilitation and Republic Economy Development on the whole, will contribute to creating new jobs, preventing environmental pollution etc.

2.2.3 Barriers to technology diffusion

The economic, in particular financial barriers are 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 eight other productions, 3) The need to overcome failures causes and the consequences of the reissue attempts in previous years.

Another group of economic and financial barriers is 1) unfavorable tariff policy in general and lack of natural gas and electricity favorable tariff policy for the sector in particular 2) unfavorable credit policy, 3) lack of financial resources for technology replacement and reissue.

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 of the chemical industry.

For the implementation of the technology the issues of property registration may be a barrier, as well as uncertainty related to the investments required for the project implementation.

2.2.4 Technology action plan for the Production of synthetic rubbers from butadiene instead of using natural gas (Chemical industry) technology

The technology belongs to the category of “Publicly provided goods”.

With a special significance in promoting the economic development, the introduction of technology for the development of chemical industry requires huge investments.

The introduction of technology is hindered by the fact that the form of ownership, as well as the owner of “Nairit” plant needs to be clarified.

It is recommended to register the plant as a civic property the shares of which will have inalienable status.

Tender for the investment projects of the proposed technologies will be announced. Moreover, both complete plans for the production of synthetic rubber introduction of technology and plans of technologies for adjacent production of separate materials, based on the production capacities of the plant, can be submitted. For the introduction of the technology logistics issue of optimization of butadiene import should be resolved by the owner as a separate question.

RA Government, MEINR, MNP and initiative group for reoperation of “Nairit” plant are identified as main responsible bodies for the implementation of the technology. The key role of the authorities responsible for regulation of the system and state policy is typical to the technology category.

As a rule, decisions on investments in the technologies of the discussed category are taken by governments.

A more detailed action plan is presented in Table 6.

Table 6. Technology action plan for Production of synthetic rubbers from butadiene instead of using natural gas (Chemical industry) technology

Sector	**Industry**							
Sub-sector	**Chemical industry**							
Technology	**Production of synthetic rubber from butadiene in "Nairit" does not imply a cancellation of existing (acetylene) technology, but will act as an alternative enabling a possibility of flexible response to market requirements. Modernizing the existing capacities, including construction of new buildings for the production of synthetic rubber and other chemicals and replacing natural gas by butadiene, it is expected to reduce technological consumption of natural gas by up to 8 m^3/h, respectively decreasing consumption of electricity and thermal energy. In addition, along with reduction of emissions of fugitive CO_2, CH_4 and other GH and harmful gases, dependence of the production cycle of the renovated plant on the gas supply also will decrease.**							
Objectives	**The chemical industry is of strategic importance for the country that is why it is important to revive it. It will have a palpable positive impact on the development of the economy of Armenia, ensuring economic growth and creation of new jobs, at the same time great perspectives will be created for the development of small-scale chemical industry. As a result of the introduction of the technology CO_2 and other GHG emissions will reduced by 225.0 $GgCO_{2eq}$.**							
Benefits	**The plant uses technology of production of synthetic rubber from natural gas. This technology is characterized by environmental harmfulness, high-energy consumption and low productivity. The introduction of the new technology, elimination of energy losses in the steam pipelines will significantly reduce the consumption of natural gas and other energy sources will reduce emissions of CO_2, CH_4 and fugitive GHG from stationary combustion sources, thus ensuring the sustainability of the project. The company intends to start production of monocarboxylic acids, build new facilities for the production of dichlorobutadiene and expand the production of chloroprene rubber.** **Following the identified goals, it is expected that chloroprene rubber and latex (25,000), acetic acid (38,000), propionic acid (6,600), formic acid (9,000), liquid chlorine (25,000), caustic soda (32,500), hydrochloric acid (12,500), sodium chloride (4,000), dimetilviniletinilkarbinol (50), etc will annually be produced (t / year).**							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**

№ 1 Definition of the type of ownership of the plant and legal arrangements	**№1.1** Definition of the type of ownership and its registration as civic property	Civic Fund International	MEINR and MNP Initiative group for reoperation of "Nairit" plant	0-1 year	Not smooth procedure of definition and establishment of civic property, new type of ownership.	Definition of civic property as a new type of ownership	Registration of shareholders	15,000 USD
	№ 1.2 Tender organization for the investment project	State	RA Government, Initiative group for"Nairit" plant reoperation	0-1 year	Reduction of interest	Tender	Recognition of tender winner, signing of investment agreement	20,000 USD
№ 2 Implementation of the investment project, reoperation of the plant, use of butadiene instead of natural gas in the production of synthetic rubber	**№2.1** Optimal or improved solutions to logistics problems on the import of butadiene	Private Donor organizations	RA Government, Initiative group for reoperation of "Nairit" plant	0-1 year	Substantial increase in transportation costs in transit countries	solutions to logistics problems on the import of butadiene	Import of the first batch of butadiene	50,000 USD
	№2.2 Production of synthetic rubber from butadiene	Private Donor organizations	Initiative group for reoperation of "Nairit" plant, private investor	0-2 years	Sharp decline in market prices of synthetic rubber	Production in the related technologies	Finished product storage	57,000,000 USD
№ 3 Policy, regulatory and institutional reforms	**№ 3.1** Recognition of chemical industry rehabilitation as a priority for economic	State and/or international Civic Fund	MEINR and MNP	0-2 years	Project boycotting by those having opposite opinion	Government Decree	Public discussions on the matter	20,000 USD annually

	development							
	№ 2.2 Establishment of favorable tariff policy for electricity and natural gas for the rehabilitation of chemical industry	State and/or international Civic Fund	MEINR and MNP	0-2 years	Failures in public discussions and in the activities of the PSRC	PSRC Decision	Public discussions on the matter	20,000 USD annually
	№ 2.3 Development of the concept for the development of chemical industry	State and/or international Civic Fund	MEINR and MNP	0-2 years	Project boycotting by the ones having opposite opinion	Concept	Public discussions on the matter	20,000 USD annually
№ 4 Information and Awareness	**№ 4.1** Raising awareness of civil society	Civic Fund	Initiative group for reoperation of "Nairit" plant	0-2 years	Improper coordination of activities	Establishment of Civic Fund	Trainings Participants	20,000 USD
	№ 4.2 Awareness on Civic Fund by the news media	Environmental funds	Initiative group for reoperation of "Nairit" plant	0-2 years	Low interest on part of the population	Establishment of Civic Fund	Radio and television programs and articles	30,000 USD

2.3 Technology Action Plan for the Production and Usage of Photoluminescent Materials with Prolonged Afterglow

2.3.1 Overview of the technology

The new extended content of the suggested photoluminescent materials (based on alkaline earth aluminates and silicates) and their production technologies are not poisonous or explosive. Those are fire-resistant, do not melt or decompose at the temperature up to 1,500 ˚C and do not contain radioactive elements, hard metals and other harmful components. They are eco-friendly and not harmful to the environment.

Photoluminescent materials produced through the mentioned technology due to the length of the afterglow (8-12 hours), as well as their relative low cost may contribute to its wide usage in various fields of economics.

In comparison to LED solutions to this issue: Dashboards and signs made from photoluminescent materials do not use electric energy at all. Yet, taking into account the absence of need to install energy transmission lines, the capital expenses are significantly reduced.

Limitations on the usage of photoluminescent materials are mainly conditioned by a short-term afterglow and harmful materials they contain.

2.3.2 Targets for technology transfer and diffusion

Marking the roads, boards, underground passageway and staircases in the common areas of buildings with photoluminescent materials will help increase traffic and pedestrian safety. Given the possible scope of application, especially for the urban economy, it will significantly reduce energy consumption and capital costs. As a result of EST introduction GHG emission will reduce.

Signs made of photoluminescent materials may be used for high-rise buildings, shops, hotels to mark the emergency exits of other facilities of social importance, road signs and markings, as well as for other design elements. They can be used in the sphere of extreme tourism by making landmarks on touristic routes, in emergencies, during wars and so on.

2.3.3 Barriers to technology diffusion

A number of barriers delay the production and usage of the material.

A serious financial barrier to technology industrial investment is the absence of orders/requests for the production of the material from the state or local (municipality, enterprise) levels. These orders may provide the required financial support necessary for the production of photoluminescent materials with prolonged afterglow.

The absence of technical regulations necessary for product certification, as well as the uncertainty of demand for photoluminescent materials in regional and domestic markets and the need for non-standard (unique) equipment preparation are also among the barriers to the technology application.

Discussions with stakeholders and NGOs in the framework of the TNA project revealed the public interest in using photoluminescent materials with prolonged afterglow, incomplete definition of safety requirements in public places, absence of requirements for usage of photoluminescent materials in the dark for road markings, signs and other warning notes.

2.3.4 Technology action plan for the Production and usage of photoluminescent materials with prolonged afterglow

Entitled state authorities (State Urban Development Committee, Ministry of Labor and Social Affairs) shall identify the scope for the use of photoluminescent materials, as well as define regulatory requirements on the orientation and warning signs and posts in normal and in the dark.

Photoluminescent materials classified by the length of lighting shall be certified in accordance with international standards (by private investor).

Raw materials needed for the production of photoluminescent materials are intended to import from China, which has a negative impact on costs and competitiveness. Thus, grants and “soft” loans should be involved for the production of materials on industrial scale, preparation of unique (special) equipment and for establishing the plant itself

Public awareness campaigns and workshops for the mass media should be organized. The Ministry of Nature Protection and authors of the technology are responsible for the activity. A more detailed action plan is presented in Table 7.

Table 7. Technology action plan for the Production and usage of photoluminescent materials with prolonged afterglow

Sector	**Industry; Processing industry**							
Technology	**The specialists at the National Institute for Materials Science have enahnced experience with the technology of production of glass ceramic and composite materials. They also have the necessary equipment for their industrial-scale production. The proposed photoluminescent materials (based on alkaline earth aluminates and silicates) and their production technology are not poisonous or explosive. They are fire-resistant, do not melt or disintegrate at the temperature up to 1,500˚C, and do not contain radioactive elements, hard metals and other harmful components. They are eco-friendly.** **Signsboards, decorations and markings made of photoluminescent materials do not use electric energy at all.**							
Objectives	**Photoluminescent materials due to the length of the afterglow (up to 8-12 hours) and their relatively low production cost may be used in various branches of economy. Signboards, decorations and markings made of photoluminescent materials may be used in the urban construction (high-rise buildings, shops, hotels, other buildings of social importance to mark the emergency exits), road construction (road signs and marking) and other design elements.** **If about 100,000 LED signboards in Yerevan city are replaced with that of the proposed technology, annual reduction of GHG emissions will amount nearly 3.2 Gg CO_{2eq}.**							
Benefits	**Taking into account potential scale of the application, particularly in urban economy, energy consumption and capital costs will be significantly reduced.** **Marking the roads, sidewalks, underground passageway and staircases in the common areas of buildings with photoluminescent materials will increase the safety of pedestrians and drivers.**							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**
№ 1Studies of	**№ 1.1** Definition of	Civic Fund	RA State Urban	0-2	High costs for the	Interest from civil	Establishment of	30,000 USD

markets on the application of photoluminescent materials with prolonged afterglow	norms on comfortable movement of citizens in public places (marking stairs, exits and entrances and other orientation information)	Grants	Development Committee, RA Ministry of Labor and Social Affairs	years	production of photoluminescent materials	society	qualitative and quantitative demand for photoluminescent materials in regional market	annually
	№ 1.2 Clarification of the issue and study of the demand by entitled state authorities	Civic Fund State	RA State Urban Development Committee, RA Ministry of Labor and Social Affairs, Municipalities	0-2 years	Indifferent attitude by entitled state authorities	Definition of safety norms by entitled state authorities	RA Government Decrees, decisions of public authorities and community councils	50,000 USD annually
№ 2 Organization of industrial-scale production of photo luminescent materials with prolonged afterglow	**№ 2.1** Certification of products (materials)	Private International	Authors of the technology	0-1 year	Noncompliance with environmental standards	Compliance with environmental standards	Certification of products (materials)	20,000 USD
	№ 2.2 Preparation of special equipment and shop furnishing	Donor organizations Private Civic Fund	RA MNP, RA Ministry of Labor and Social Affairs, Ministry of Healthcare	0-2 years	Lack of financial support by donors	Projects for the preparation of special equipment	Establishment of demand for photoluminescent materials	200,000 USD

№ 3 The use of photo luminescent materials with prolonged afterglow in advertising	**№ 3.1**Distribution of information leaflets and illustrated booklets	Private and/or international Civic Fund	RA MNP, Authors of the technology	0-2 years	Low interest on part of the population	Involvement of 40% of the population	Information leaflets and illustrated booklets	20,000 USD annually
	№ 3.2 Broadcasting of TV and radio programs on media, articles in newspapers	Private and/or international Civic Fund	Authors of the technology	0-2 years	Improper coordination of activities	Increased knowledge of population	Radio and television programs and articles	20,000 USD annually
№ 4Provision of financial flows needed for the application of the technology	**№ 4.1** Charity foundations and benefactors.	Environmental funds	Authors of the technology	0-2 years	Poor organization of activities	Targeted use of received grants and loans	Received financial flows	10,000 USD

2.4 Technology Action Plan for the Production of New Type of Solar Water Heater (Entirely Plastic)

2.4.1 Overview of the technology

The new technology of solar water heaters was developed by "Arevik" company which has many years of experience in the design, fabrication, testing and installation of solar systems.

Market studies show that lack of demand for the use of solar panels is only due to the relative high costs of traditional solar water heaters or because of low level population's solvency. The proposed technology is completely made of plastic solar water heaters and is about 3.5 times more affordable and easy to install. In contrast to available metallic (with glass pipes) solar water heaters, the price of which is about 500 USD for 1.5 m2, the price of proposed plastic collectors with the same surface area does not exceed 150 USD and the full weight of the collector is about 5 kg. All components of those collectors (pipes, transparent cover, frame, etc.) are made of plastic. Mentioned advantages and market studies gave rise to the establishment of industrial production volumes.

All components of theses collectors, pipes, the transparent covers, etc. are made of plastic.

These water heater samples have passed the appropriate tests. In climatic conditions of Armenia those water heaters are able to produce 70-80 l/m2 of hot water daily (temperature of hot water is up to 55-60˚C).

2.4.2 Targets for technology transfer and diffusion

Armenia is among countries with high solar resources. The average annual insolation 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 energy potential in Armenia is mainly done in two directions: the manufacture and installation of photovoltaic converters for electricity generation; and the manufacture and installation of flat-plate solar collectors for water heating. Financial analysis of solar thermal technology cost suggests that at present they are fully competitive with electric hat water supply and other heating options in Armenia, and can even compete with thermal energy from natural gas (Ref-11). Mentioned advantages and market studies gave rise to the establishment of industrial production volumes.

Proposed plastic solar water heaters will allow people with low-income to buy and use these systems and to obtain hot water in summer time for everyday use. The price of entirely plastic solar water collectors is much cheaper and will be more available to a wider population. Besides, the market analysis shows that there is a great demand for such systems for food processing facilities, restaurants, hotels, schools, chemical enterprises as well. Solar water heaters are considered as environmentally friendly because no fossil fuel is required for their operation.

2.4.3 Barriers to technology diffusion

The most significant barrier to large-scale introduction of the technology lies in small-scale production, which 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 there is a need to build a manufacturing facility, i.e. production line, which implies financial assistance, preferable in the form of interest-free loans or grants.

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. Therefore, the financial barrier 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.

The necessity for ongoing costs related to the need to ensure the regional market potential consumers' awareness of this technology is among financial and economic barriers.

Regional market restrictions, due to transportation costs and lack of flexible funding mechanism for the promotion of sales are also in line with the main economic and financial barriers.
There is also, 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.

2.4.4 Technology Action Plan for the Production of New Type of Solar Water Heaters (Entirely Plastic)

For the establishment of consumer market for the proposed technology extensive work is needed to raise awareness among potential consumers. This should be implemented by a private investor, with the support of donor organizations and coordination of RA MEINR and MNP. It is believed that demonstration projects should be carried out in different settlements of the region to promote the ease of installation (which does not require special training), extreme lightness, sufficient efficiency and much lower price of plastic water heaters, as well as the fact that no maintenance is required during the exploitation.

Along with the creation of consumer demand private investor should construct production line for manufacturing water heaters and furnishing them with appropriate equipment, in particular with conveyor for preparation of plastic elements. The success of the project depends on keeping production costs of water heaters low in the initial phase irrespective of small volume of sales. Therefore, support from RA PIU of MNP is expected for attracting grants or “soft” loans. A more detailed action plan is presented in Table 8.

Table 8. Technology Action Plan for the Production of New Type of Solar Water Heaters (Entirely Plastic)

Sector	**Industry; Processing industry**							
Technology	**In contrast to available metallic (with glass pipes) solar water heaters, the price for which is about 500 USD for 1.5 m^2, the price of proposed plastic collectors with the same surface area does not exceed 150 USD and the full weight of the collector is about 5 kg. All components of those collectors (pipes, transparent covers, frame, etc.) are made of plastic. Under the climatic conditions of Armenia those water heaters are able to produce 70-80 l/m^2 of hot water daily (temperature of hot water is up to 55-60˚C).**							
Objectives	**The project (construction of the factory) seems to be profitable (IRR=16-18%) if 100 thousand and more collectors are produced and sold on predetermined prices annually. However, it is considered realistic that in the initial period, demand will not exceed 25 thousand. Therefore, it is necessary to attract grants or low-interest loans, as well as undertake measures to raise awareness of stakeholders.**							
Benefits	**Opportunity of affordable, autonomous hot water supply.** **Annual reduction of GHG emissions will be 0.78-3.9 Gg CO_{2eq} (if 25,000-100,000 collectors are sold).**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
№ 1 Organization of industrial scale production of a new type of solar water heaters	**№ 1.1** Assessment of market demand and industrial-scale production	Environmental funds and other donor organizations Private	RA MEINR, RA MNP PIU of MNP	0-2 years	Sharp fall in prices of similar products	Promotion of water heaters at the regional level, presentation of implemented projects	Formation of pre-order packages	10,000 USD annually
	№ 1.2 Construction of production factory (facility), purchase of a conveyor for preparation of plastic components	Civic Fund Donor organizations Private	RA MNP PIU of MNP	0-2 years	Absence of low-interest loans or grants	Project design for the production factory (facility)	Financial resources for the implementation of the project	60,000 USD

№ 2 Implementation of measures to raise awareness among potential consumers of regional market	**№ 2.1** Distribution of information leaflets and illustrated booklets	State and/or international Civic Fund	RA MEINR, RA MNP PIU of MNP	0-2 years	Improper coordination of activities	Public and SME awareness	Trainings Participants	20,000 USD annually
	№ 2.2 Organization of TV and radio programs on media, articles in newspapers	State and/or international Civic Fund	RA MEINR, RA MNP PIU of MNP	0-2 years	Low interest among population	Increased knowledge of population and SMEs	Information leaflets and illustrated booklets	20,000 USD annually
№3 Provision of financial flows needed for the application of the technology	**№3.1** International donor organizations	International development banks	RA MNP PIU of MNP	0-2 years	Weak cooperation	Targeted use of received grants and loans	Received financial flows	10,000 USD
	№3.2 Charity foundations and sponsors	Environmental funds	RA MNP PIU of MNP	0-2 years	Poor organization of activities	Targeted use of received grants and loans	Received financial flows	10,000 USD

2.5 Crosscutting issues in Industry Sector

All the discussed technologies in the industry sector innovative, but the technology on the development of chemical industry (production of synthetic rubbers from butadiene instead of using natural gas)in terms of promoting economic development of Armenia has a crucial role. The technology belongs to the category of "Publicly provided goods".

The application of the technologies is characterized by the need for large investments and possible forms of general public ownership. As a rule, "equipment/goods" component is essential for this category. The technologies in the category are usually financed by donors and/or civic revolving funds. Decisions on investing in technologies of this category are usually taken by Governments. The latter limits the barriers to decision-making on the implementation of these technologies related to difficulty accessing finance and the low level of information available for establishing a decision base, such as feasibility studies, cost-benefit analyses and environmental impact assessments.

Implementation of the technologies in the Industry sector can be based only on their own knowledge and experience. In the case of implementation/accomplishment of each technology, the produced goods can be successfully exported to regional and international markets. It is worth noting that in Armenia the development of those technologies does not require preparation and training of new specialists, as well as scientific research imported from other countries.

Presented two technologies belong 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 on the transfer and diffusion of technologies in consumer goods, which are determined by market relations. The scope for government interventions to promote particular consumer goods technology is related to the provision of wide range of conditions for the creation of enabling environment.

Chapter 3. Technology Action Plans for Land Use Sector

3.1 Actions for Land Use Sector

In order to identify mitigation technologies against the effects of global climate change, analyze and conduct study on market barriers and create enabling environment for technology diffusion in land use sector working groups were selected, which studied the nature of the questions in recommended 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 the development of levelof agricultural projects, improvement of the socio-economic situation of workers involved in the sector and solution of environmental issues, as well as mitigation of negative effects caused by global climate change.

3.1.1 Overview of Land Use Sector

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 are irrigated. Main agricultural crops include: cereals, potato, fruits, grapes, and vegetables. Animal husbandry mainly includes cattle, as well as sheep and goat (Ref-2).

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 forestland 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 (Ref-3).

3.1.2 General barriers and proposed measures

Given the poor socio-economic condition of households, remote location of pastures, overgrazing and change in grassland vegetation cover, the technology offers to implement radical or surface improvement of degraded pastures and hayfields: vegetation destruction of more degraded grasslands located near the community; vegetation restoration through sowing of grass plants and further management; use of rotational or targeted grazing and provision of animals with water during pasture rotation.
The main measures promoting the introduction of radical improvement of degraded grasslands technology include:

- Strengthening of enforcement mechanisms of existing 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 taking into account 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 respective legislation,
- Development of tourist routes in the forestry area.
- Professional consultancy to raise awareness among the population:

3.2 Technology Action Plan for Degraded Grassland Radical Improvement

3.2.1 Overview of the technology

Sustainable management of natural pastures implies not only rehabilitation of natural ecosystems but also introduction of management and implementation measures that 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 type of degradation(erosion and desertification), degree and reasons/factors, 2) Select relevant improvement method for each particular area (deeper/in general), 3) Develop and implement complex sustainable management activities for each area.

Main activities are: 1) Radical improvement of degraded rangelands in nearby communities by the destruction of natural weed vegetation and creation of new vegetation cover by new grass seeding on it and effective management, 2) Targeted combination and application of animal grazing methods either free and irregular and “in turn” or “grazing distribution in spotty patterns”, 3) Introduction of grazing periodicity method in pasture utilization practice.

3.2.2 Targets for technology transfer and diffusion

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. To prevent soil erosion, planting of greenery and general phytoamelioration activities should be implemented, thereby promoting high crop yields from pastures and hayfields, and ensuring high quality forage and livestock products.

In order to prevent soil erosion, planting of greenery and general phytoamelioration activities should be implemented in this area of agriculture, 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 region) where breeding cooperation or its enlargement will be organized. This community is the target community in terms of degraded grasslands (pastures and hayfields).

The targets of the technology are: introduction of pasture rotation and pasture division into units 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 residents.

3.2.3 Barriers to technology diffusion

The main economic and financial barriers are market limits, low prices for agricultural products, high costs for the use of remote pastures, lack of soil conservation, care and improvement measures. Low sale prices are conditioned by the fact that farmers cannot purvey and sell their products. They are forced to sell their products to resellers at low prices.

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

Scarce community budgets are another barrier. Community budgets are barely enough to process the payments within the Community. Therefore, it is expected to raise funds for the implementation of the mentioned activities.

3.2.4 Technology action plan for degraded grassland improvement

The grassland, which is in Ararat Region (pastures and hayfields), belongs to Paruyr Sevak community. In order to improve the degraded pasture vegetation of the grassland (3,400 ha out of 4,200 ha territory, it is almost substantial portion of 80 % of the territory), the following activities should be carried out: water supply activities (plunger and jet irrigation should be placed), fertilization work should be done with the help of bio humus and organic-mix, and pasture rotation methods should be implemented. In that case, the composition of vegetation species will be improved up to 50-70% (remote pastures, 20-30%, and the community adjacent pastures, 75-80 %). Yield will be improved to the same extent and 400 head of cattle and 800 small ruminant productivity will be increased by 70-90% during the pasture period At the same time the content of organic carbon (which is 1.8%) in the degraded grasslands will rise up to 3.12%.The same percentage of organic carbon currently exists in the non degraded grasslands of the community. Due to rapid growth of biomass the GHG absorption will be increased.

To resolve the above mentioned issues, the envisaged actions and activities for the effective usage of the land sector are presented in Table 9, where three main actions with their three activities are introduced: information about raising necessary funds, information about the responsible bodies and coordinators (Ministry of Agriculture of RA, MNP of RA, Office of Agricultural and Nature Protection of Ararat Regional Government and Paruyr Sevak Community) as well as information about the deadlines of the activities and success criteria.

The Ministries of Agriculture and Nature Protection should mostly contribute to raising public awareness on the actual state of Paruyr Sevak Community grasslands, threatening hazards and their inefficient usage. It should be done through lectures organized by professionals, information leaflets and booklets, as well asthrough National Radio and Television programs and the popularization of the results.

The relevant Department of Ararat Region and the Land usage and Forestry Sector experts should systematically exercise control over the work done in the degraded grasslands of the community: removal of invasive plants, seeding of plant species, bio humus fertilization works and irrigation (plunger and jet irrigation etc.).

Paruyr Sevak Community (head E. Stepanyan) should be active all the time; public awareness in the community should be raised through publicas well as participation in the implementation activities to

improve the Community grasslands. There should be a relevant project for getting funds from Civil Fund and pasture rotation should be organized constantly.

Table 9.Technology Action Plan for the Improvement of Degraded Grasslands

Category	**Land use and forestry, grassland subsector**
Technology	**1. To manage the inventory of degraded grasslands of the Community, 2. To choose a relevant way of improvement (root, surface) for each region 3. fundamental improvement , destruction of natural vegetation and sowing of herbs, water supply 4.soil surface improvement , fertilization with bio humus or organic mix, then implementation of pasture rotation for both cases.**
Objectives	**The following activities should be carried out for the restoration of Paruyr Sevak Community degraded pasture vegetation (3,400 ha out of 4,200 ha territory, it is almost 80 % of the territory): water supply works should be done, which will contribute to the improvement of vegetation cover species up to 50-70%, yield will be increased up to 65-90%, and as a result of implemented activities the productivity of 400 head of cattle and 800 small ruminants of the 200 farms will be increased during the pasture period up to 70-90%. At the same time the content of organic carbon (which is 1.8%) in the degraded grasslands will rise up to 3.12%, the same percent of organic carbon currently exists in the non degraded grasslands of the community.**
Benefits	**As a result of introduction of the technologies the degraded pastures of the Community will completely be covered by legume crops (alfalfa, clover etc.), soil erosion will be prevented nearly 100%, as a result of organic fertilization yield will be increased up to 70-90%. The production of livestock products will be doubled in the pasture period, the social-economic status of the rural population will be improved, the food safety will be provided. Due to rapid growth of biomass the GHG absorption will be increased, the organic carbon reserves will be increased by 1.52% in the soil.**

Operation	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring and implementation	Budget per Activity (USD)
№1 Providing public awareness on the actual state of meadow soils, threatening hazards and inefficient use of the grasslands ofParuyrSevak Community	**№ 1.1** Organizing and conducting lectures by professionals for the Community population.	State and/or International Civil Foundation	MNP of the Republic of Armenia Paruyr Sevak Community, Ararat region	0-2years	Poor monitoring	Full involvement of adult populationof the Community	Workshops Participants	6,000 USD per year
	№1.2 Distribution of information leaflets and booklets	State and/or International Civil Foundation	Head of Paruyr Sevak Community –Eduard Stepanyan	0-2years	Lack of interest of Community's population	Increased knowledge ofCommunity's population	Information leaflets and booklets	10,000 USDper year
	№1.3 Radio and TV broadcasting	State and/or International Community's budget	Paruyr Sevak Community	0-2years	The Community's population is not interested in participation	ImprovedAwareness of the Community population	Radio and television programs and articles	8,000 USD per year
№ 2 Implementing inventory, classification and mapping of the areas for the improvement of grasslands. Natural vegetation	**№2.1** Establishing a working group with the involvement of soil specialists, agro chemists and GIS specialists	State and/or International Civil Foundation	Ministry of Agriculture of the Republic of Armenia Paruyr Sevak Community	0-1year	Lack of interest among specialists	Assessment and classification maps for pasture areas	Working group sessions	20,000 USD per year
	№2.2 Cost estimate based on the results of working groups	State and/or International	Technology needs assessment and mitigation technology	0-1year	Absence of the main risks	Full cost estimate	Working group visits	10,000 USD

recovery and fertilization of soil by bio humus or organic mix.	studies	Civil Foundation	(TNA) project's, land use and forestry sector's expert Merujan Galstyan					
	№2.3 Invasive vegetation removalfrom the pastures, organize fertilization with organic mix	State and/or International Civil Foundation	Ministry of Agriculture of the Republic of Armenia MNP of the Republic of Armenia	2-5years	Improper organization of works	Implementation of works in the Community's 70% of pasture area	Fertilized pastures	60,000 USD
№3 Irrigation of pastures	**№3.1** Making of trenches or furrows for the installation of sprinklers	Civil Foundation State and/or International	Head of the Paruyr Sevak Community – Eduard Stepanyan	0-2years	Improper organization of works	3-4 trenches or furrows made on each ha of soil	Trenches made	2,000 USD
	№3.2 Installation of monolithic foundation (of concrete)	Low interest loan State and/or International	Cultivation Department of the Ministry of Agriculture, Food Production Division	0-2 years	Improper organization of works	3-4 trenches installed monolithic foundations on each ha of soil	Number of installed monolithic foundation (of concrete)	3,000 USD
	№3.3 Installation of semi-circle steel tubes (d=240 mm, l=11.6 m), both sides should be painted	State and/or International Civil Foundation	Head of the Paruyr Sevak Community – Eduard Stepanyan	0-2 years	Improper organization of works	installation of 3-4 semi-circle steel tubes on each hectare of soil	Installed semi-circle steel tubes	6,000 USD

3.3 Technology Action Plan for Sustainable Forest Management

3.3.1 *Overview of the technology*

Sustainable management of forest ensures 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 afforestation, expansion of forested 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 managed forests, assistance to forest natural regeneration and rebuilding, tree planting activities, new forests planting and care, provision of water supply and landslide control, forest protection from illegal logging, grazing and farming activities etc.

3.3.2 *Targets for technology transfer and diffusion*

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 forestland management it is necessary to implement activities to improve tree care, expand conservation area, develop tourism and reforestation. In order to restrict loggings in the forest, expand reforestation areas and develop tourism, it is necessary to establish a nursery to produce quality and relatively cheap saplings, rehabilitate sparse forests and expand forest areas. At the same time, it is necessary to raise awareness among population on the dangers and risks from the forest degradation and elimination.

3.3.3 *Barriers to technology diffusion*

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

Next barrier is the lack of financial resources for reforestation. Given the lack of 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.

Barriers also include lack of other means for (coal, charcoal) heating of residential building or their high prices.

Forestlands are exploited in an unregulated way. There are areas in forest where the cultivation of crops or cultivation without alteration takes place.

For the implementation of mentioned works, funding is expected from the Ministries of Agriculture and Territorial Development and from donors which will contribute to the organization and expansion of ecotourism.

3.3.4 Technology Action Plan for Sustainable Forest Management

In Ijevan forestry it is planned to set up a nursery in the sustainable forest management subsector by the application of technology. Walnut, Hazel and Cornel tree species planting should be carried on15 hectare. 10 km fire prevention roads should be constructed and reconstruction of5 km roads, 10 km –long fence and

10 pavilions should be built, which will protect forest from fire and pests, as well as from illegal attacks. At the same time, additional 150 jobs should be created for the collection of fruit- berry species, fruit drying and the development of ecotourism. These factors will contribute to the rapid growth of the Forest Department's financial stability, as well as to quick absorption of the GHG emissions (due to rapid growth of the trees) and the improvement of environmental conditions in the region.

To solve the above mentioned issues the ways how the planned actions and activities should be implemented are listed in Table 10. Three main actions with their three activities are introduced here: information about raising necessary funds, (state or international, civic funds, banks providing agricultural loans etc.) and information about the responsible bodies and coordinators, as well as information about the deadlines of the activities and success criteria.

In this sub sector, Armenian Forests NGO (MA) and Bio Resources Management Agency (MNP) should raise Ijevan Forest Department employers' awareness through lectures organized by professionals, and booklets, as well as through National Radio and Television programs in order to prevent forest from degradation and destruction, and provide sustainable forest management. In the meantime, they should apply to international or national banks, as well as donor organizations in need of financing to ensure the implementation of technological processes.

"Hayantar" SNCO of the Ministry of Agriculture (MA) and Ijevan Forestry under the coordination of its head Suren Manukyan should organize and control the activities designed to establish nursery with tree species resistant to climate global change (walnut, hazel and blackberry). The trees should be planted on the 15 hectare of soil. At the same, time they should organize and construct 10 km long roads, reconstruct 5 km roads, 10 km long-fence and 10 pavilions for the protection of forests.

As presented in the table below the above mentioned organizations are responsible for the fruit-berry species collection in the Forest Department, organization of fruit drying and assistance ecotourism development. These activities will contribute to the creation of new vacancies and the maintenance of forests, as well as to the improvement of the financial situation of the Forest Department and to the regulation of ecological situation in the region.

Table 10.Technology Action Plan for Sustainable Forest Management

Category	**Land use and forestry, forestry subsector**
Technology	**Sustainable forest management implies complex implementation of technologies and measures: an inventory of tree species should be carried out in the forestry, a nursery farm should be organized, walnut, hazel and cornel trees resistant to global climate change should be recovered, activities should be carried out for the creation of buffer zones of protected areas, forest conservation, protection and ecotourism development.**
Objectives	**In order to apply the above-mentioned technology a nursery farm should be established in Ijevan. Walnut, hazel and cornel tree planting should be carried out on 15 ha of soil. 10 km fire prevention roads should be constructed and 5 km roads should be reconstructed, 10 km long fence and 10 pavillions should be builtthus contributing to the conservation of 2000 ha of forests and promoting ecotourism development.**
Benefits	**As a result of application of the technology the completeness of the forest nursery (2000 ha of forest areas) will be ensured, forests will be protected from illegal attacks, fires and pests, at the same time the creation of new 150 jobs will be provided (collection of fruit- berry species , fruit drying and ecotourism development).This will contribute to the improvement of the financial situation of the Forest Department and due to rapid growth of biomass of trees intense absorption of greenhouse gases will be provided and environmental conditions will be improved.**

Operation	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per Activity (USD)
№ 1 Raising public awareness on the actual stateof forest household, the prevention of forest from degradation	**№ 1.1** Presentation of reliable information to the Ministries of Agriculture and Nature Protection of the RA	State and /or International Civil Foundation	"Hayantar" SNCO of the Ministry of Agriculture of the RA	0-5years and always	Difficulties in presenting reliable information	Improved awareness of Community population	Workshops Participants	10,000USDper year
	№1.2.Broadcasting of TV Programs	State and /or International Civil Foundation	Ijevan Forest Department in Tavushmarz	0-5 years	Low interest among Community members	Improved awareness of Community population	Radio and television programs and articles	12,000 USD per year
	№1.3 Leaflets and illustrated booklets	State and /or International Civil Foundation Community's budget	Head of the Ijevan Forest Department in Tavush Region Manukyan Suren	0-5 years	Low interest of "Hayantar" staff	Community population involvement	Information leaflets and booklets	8,000USDper year
№ 2 Organizing tree planting, forest	**№2.1** Establishment of nurseries and	State and /or International	"Hayantar" SNCO of the Ministry of	0-3 years	Low quality of plantations	Implementation of planned	Tree planting area	15,000USDper year

establishment and restoration, forest conservation and protection activities	provision of planting materials	Civil Foundation	Agriculture of the RA			activities up to 50 % within 2 years		
	№2.2 Implementation of forest establishment	State and /or International Private	Head of Ijevan Forest Department Manukyan Suren	0-5 years	Improper organization of works	Establishment of nursery	Tree planting area	30,000USD per year
	№2.3 Forest protection and maintenance	State and /or International Private/Community's Budget	Ijevan Forest Department in Tavush marz	0-5 years	Lack of interest among Community members	Ecotourismdevelopment	Constructed and renovated roads, fences and pavilions	20,000USD per year
№3Financing needed for the application of technology	**№3.1** Applying to International donor organizations	International development bank Village cooperative bank	Armenian Forests NGO of the Ministry of Agriculture of RA	0-3 years	Weak cooperation between local authorities and ministries	Obtained and targeted grants and loans	Obtained grants/and or /Interest-free / soft loans quantity / amount	8,000USD
	№3.2 Applying to commercial banks	Civil Foundation /interest free loans Lowest interest rate loans	Ministry of Agriculture of RA/ MNP	0-5 years	Weak cooperation between government agencies and lending organizations	Creation of rotating funds	Obtained financial flows	8,000USD
	№3.3 Applying to charity foundations and sponsors	Fund for Armenian Relief (FAR) Private funding	Ijevan Forest Department in Tavush Region	0-5 years	Poor organization of activities	Received grants and loans	Received grants/and or /Interest-free / soft loans	8,000 USD

3.4 Technology Action Plan for Cultivation of Perennial Plants

3.4.1 *Overview of the technology*

As a result of various factors, 29% or 130 thousand hectares of arable land are not used for targeted purposes, so the implementation of land use effectiveness program is of strategic priority. Main activities of the suggested technology are:

1) To expand field collections of local and selective fruit and grape varieties through the expansion of collection orchards, by purchasing of samples of Armenian origin from other country genetic samples banks, and through orchard enrichment,

2) Focus of grape selection on frost-resistant, high quality, table, 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. For example, in case of Armenia in one ha of the old (public) orchards 156 trees (this management system is still preserved) were planted, 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 for 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) Restoration of forest shelter belts and planting of new ones.

3.4.2 *Targets for technology transfer and diffusion*

To use new technology for cultivation of perennial plantings and sustainable land management Rind village of Vayots Dzor marz was suggested as a target community. The main measures, designed by the technology are:(1) expand field collections of local and selective fruit and grape varieties through expansion of collector orchards,(2) focus the grape selection activities on the creation and introduction of frost-resistant, high quality, transportable, table and technical new varieties. A new EST for fruit (especially apricot) orchards establishment (3) by using smaller spaces between tree lines should be applied.
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 biomass growth. Stock of organic carbon in soil will increase and improve soil quality.

3.4.3 *Barriers to technology diffusion*

The economic and financial barriers are:

- Small arable lands, where the use of machines is impossible,
- Limited market,
- Low prices for agricultural products,
- Lack of professionals and appropriate consultancy,
- Lack of planting stock, fertilizers and equipment,
- Weak irrigation system.

3.4.4 Technology Action Plan for the Cultivation of Perennial Plants

It is planned to plant 5 ha apricot, 15 ha peach and 5 ha vineyards using technology in the VayotsDzormarz Rind Community. 300 households will carry out activities and the entire population of the village (1,300 people) will benefit. Due to installation of drip irrigation systems in the gardens the irrigation costs will be reduced by up to 30-40%. As a result of fertilizing fruit and grape gardens by bio humus and organic mix the yield will increase by up to 30-50%. Due to smaller spaces between the tree rows and rapid growth of the biomass of trees, soil erosion will be prevented, soil organic carbon accumulation will be increased around 3.8 %, GHG absorption by the plant mass will be increased significantly and the Community population socio-economic condition will be improved.

The envisaged actions with a view to solve the above mentioned issues are listed in Table 11, where 3 main operations with their 3 activities are introduced.

Action №1 refers to the establishment of agricultural cooperatives for the effective land usage of Community. It also refers to the enhancement of public awareness on investment and marketing. The Ministry of Agriculture and Vayots Dzor marz Department of Agriculture and Environment will bear responsibility for these activities. They should assist to enhance the Community's awareness through lectures, information leaflets and illustrated booklets, as well as through local and national media. Meanwhile, these organizations, as well as Rind Community (the head of the Community is Husik Sahakyan) should apply to the national and international banks and to the Community Civic fund to provide the necessary financingfor the implementation of the activities.

Vayots Dzor marz Department of Agriculture and Environment should assist to the implementation of the necessary activities with the assistance of Rind Community head Husik Sahakyan. The realization of the actions should be under the supervision of the Department of crop production and perennial plants. The following activities should be carried out by the application of technology: establishment of fruit and vineyards, decreasing spacing between rows of trees, installation of drip irrigation system, organization of bio-humus production and fertilization activities with bio-humus and organic mix.

As it is shown in the timetable of perennial plantations sub-sector the implementation of the activities under the control of the above mentioned organizations will contribute not only to the improvement of socio-economic situation of the population but also to the substantial increase of absorption of GHG by perennial biomass. Soil erosion will be prevented practically and organic carbon accumulation will be increased in the soil almost up to 3.8%.

Table 11.Technology Action Plan for the Cultivation of Perennial Plants

Category	**Land use and forestry, perennial planting subsector**							
Technology	**The technology aims to enhance the local fruit and grape varieties and expand orchards, to establish new orchardsby decreasing spacing between rows of trees, to drip irrigation and use fertilizers- bio humus and organic mix, obtained by Armenian –Norwegian joint venture.**							
Objectives	**Establishing 5 hectares of apricot and vineyards and 15 hectares of peach orchards in the Vayots Dzor marz Rind community by the application of the above mentioned technology.300 households will start to work, 1,300 people will benefit, they will get salaries during the first 3 years, and in 2 or 5 years their annual revenue will increase up to 15-25 %. Irrigation cost will be reduced around 30-40% and soil erosion will be prevented. Soil carbon accumulation will be increased up to 3.8%, greenhouse gas absorption will be significantly increased by biomass.**							
Benefits	**Technology benefits are: irrigation cost reduction by 30-40 %, yield increase of orchards and vineyards by 30-50%, revenue growth, improvement of social conditions of the community, prevention of soil erosion, provision of food safety of the population, employment increase, and improvement of environmental conditions.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for Monitoring and implementation**	**Budget per Activity (USD)**
№1Ensuring access to information on the creation of village cooperatives, investments and consumption markets for effective land use	**№ 1.1** Lectures for community population organized by the Ministry of Agriculture and Vayots Dzor regional administration	State and /or International Civil Foundation	Ministry of Agriculture, Department of Agriculture and Environment of Vayots Dzor regional administration	0-1year	Absence of financial means	Active participation of Community's population in every workshop	Workshops Participants	10,000USD
	№1.2 Organization of TV programs by local media	State and /orInternational Civil Foundation	Ministry of Agriculture of the RA, Governor's Media Department	0-1 year	Low interest of community members	Organization of 3 broadcasts by local and one by national news channels	Broadcast programs	12,000 USD
	№1.3 Provision of information leaflets and decorated booklets	Civil Foundation State and /or International	Media Department of Vayots Dzor regional administration, Rind Community	0-1 year	Community population has no interest in participation	Dessimination of 1000 information leaflets and booklets in the Community	Disseminated booklets and information leaflets	8,000 USD

№ 2Provision of necessary financing for the application of technology	**№2.1** Private (financing)	Civil Foundation Private	Rind Community of Vayots Dzor marz	1-2 years	Improper organization of activities by local authorities	Targeted use of received funds	Collected money	8,000USD per year
	№2.2 Commercial Banks	Civil foundation /interest free loans Lowest interest rate loans	Rind Community of Vayots Dzor marz	1-2 years	Weak cooperation between government agencies and loan companies	Creation of revolving funds	Received financing	8,000USD per year
	№2.3 Internation al organizations	International Development Bank Banks providing agricultural loans	Rind Community of Vayots Dzor marz	1-2 years	Poor organization of activities	Targeted use of received grants and loans	Obtained grants/and or /Interest-free / soft loans	8,000USDper year
№3Planting of fruit orchards and vineyardsby decreasing spacing between rows of trees, application of drip irrigation system and fertilization with bio humus or organic mix.	**№3.1** Establishme nt of plantation and provision of planting material	State and International Civil Foundation	Departmentof crop production and perennial plantsof the Ministry of Agriculture	0-2years	Low quality of planting material	Provision of 40% of planned activities in the first year	Tree planting area	20,000 USDper year
	№3.2 Creation of drip irrigation systems	Civil Foundation Village Cooperative Bank	Head of Vayots Dzor marz Rind Community Husik Sahakayan	2-3years	Lack of interest interest among Community's population	Transition 30 % of households to drip irrigation systems	Households using drip irrigation system	10,000 USD per year
	№3.3 Effective use of bio humus and organic mix (through the use of animal manure and feed residues), by participation of Californian hybrid earthworms	Civil Foundation Internatioanl , Agricultural and Environmental Organizations	Head of Vayots Dzor rmarz Rind Community Husik Sahakayan	2-3 years	Weak cooperation between local authorities and Ministries	Acquisition and widespread application of biohumus and organic mix	Households using bio humus and organic – mix	20,000USD per year

3.5 Crosscutting Issues in Land Use Sector

Analyzing the planned actions aimed at effective use of the land, it becomes obvious that the two main activities are similar for all three technologies: public awareness of the pilot communities and households should be increased in the same way (through lectures, information leaflets, illustrated booklets, radio and television broadcasting etc.), the necessary financing should be provided carrying out the same activities, by applying to National and International Banks, Community Civic fund and Charity organizations.

The proper organization and implementation of these activities will assist not only to the improvement of pilot communities' welfare but also to the increase of public awareness of the similar communities and households in the same region. Moreover, it will become a good example for other communities for the implementation of similar operations.

The organizations and coordinators responsible for the implementation of the technologies are almost the same in all three sub-sectors: the Ministries of Agriculture and Environment Protection of the RA and the relevant departments and specialists of the relevant regions. They are all responsible for the implementation of certain activities, for the targeted use of budgets, reduction of risks and efficient operation.

Chapter 4. Technology Action Plan for Waste Management Sector

4.1 Actions at Waste Management Sector

The actions in the waste management sector were identified based on the barriers defined in the previous phase of the project. The actions are aimed at eliminating the barriers to create enabling environment in the waste management sector and attract investments for these technologies. The following actions are chosen as a result of discussions and interviews with interested parties.

4.1.1 Overview of Waste management sector

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 before disposal. In 2012 total waste amounted to 650.3 thousand tons, while the amount disposed in landfills was 461.3 thousand tons (70.9%). None of the landfills, except for the largest one in Yerevan, are managed. The decomposable organic carbon in MSW reaches 50-60%. Disposal of large quantities of MSW in landfills causes anaerobic decomposition of MSW combustible matters and methane emissions (Ref-3).

4.1.2 General barriers and proposed measures

It was revealed that certain barriers in all three projects discussed are common. One of the most important barriers to the waste sector development is the fact that general public and business have low level of awareness and do not see waste as a business opportunity. Lack of financial resources is also a serious obstacle.

Another common barrier is the lack of favorable national policies and economic incentives from the government, designed for the waste management sector. Furthermore, current legislation lackseffective law enforcement mechanisms. Another barrier, related to the state authorities and common for all three projects discussed is poor coordination between state bodies. A number of actions have been proposed to eliminate the mentioned obstacles (Table 12).

4.2 Technology Action Plan for Methane Emanation from Yerevan City Landfill for Electricity and Heat Production

4.2.1 Overview of the technology

In order to mitigate the effect of GHG emitted from MSW affecting climate change, technologies on biogas emanation and combustion used in MSW landfills or electric energy production in gas engine power stations is successfully applied in developed countries. This technology comprises of vertical wells, horizontal gas passageways and a gas-gathering pipeline that are isolated by an air-impermeable membrane. This technology makes it possible to reprocess 60% and more of biogas(Ref-12).

4.2.2 Targets for technology transfer and diffusion

The technology proposes to use the waste and accompanying methane as fuel for electricity and heat cogeneration. The program provides for waste collection, separation and burning equipment, a system for

methane emanation, incinerators, a boiler, a power unit (steam turbine, generator), a boiler house for obtaining hot water, exhaust gas cleaning system.

4.2.3 Barriers to technology diffusion

Economic barrier is a serious challenge for the implementation of the project. This ismainly related to the lack of economic mechanisms for the introduction of waste management technologies. Main barriers for technology diffusion are improper waste management, lack of reliable data on waste and insufficient awareness.

4.2.4 Technology Action Plan for Methane Emanation from Yerevan City Landfill for Electricity and Heat Production

Technological action plan is suggested for the implementation of the technology of methane emanation from Yerevan city landfill for electricity and heat production, which includes the following actions: improvement of landfill management practices, installation of a gas engine system for complete implementation of the technology, as well as elimination of economic and financial barriers and awareness raising.

To implement the technology, improvement of landfill management practices is required, in order to to capture the maximum amount of methane. To achieve this it is necessary to carry out the planning of waste placement in the landfill and waste disposal in the landfill properly in order to avoid fires. Furthermore, proper information on the quantity and the composition of the waste should be ensured to have reliable data on the disposed waste. Yerevan Municipality is responsible for the mentioned activities.

Given the fact that currently a new sanitary landfill is being designed in the vicinity of the existing one, after the closure of the old landfill, possibilities of installation of methane capture system in the new landfill should be discussed. Yerevan Municipality and Ministry of Territorial Administration and Development of the RA were identified as the responsible bodies.

Gas engine system installation activities should be organized in the scope of which more affordable and easy operated equipment should be looked for, as well as studies on the expediency of either electricity or thermal energy production or cogeneration should be conducted. Before the installation of a gas-engine system, negotiations should be initiated to identify potential consumers of produced energy. Yerevan Municipality and Ministry of Territorial Administration and Development of the RA were identified as the responsible bodies for the mentioned activities.

In order to eliminate economic and financial barriers, it is necessary to develop and implement recommendations on stimulating economic mechanisms for waste management technologies. The Ministry of Economic Development and Investments was designated as responsible body for the activity, which will cooperate with NGOs and international donor organizations. Technical capacities of local financial institutions should be strengthened in order to promote investments in waste management sector. As the responsible bodies for the activity, Chamber of Commerce and Industry and Union of Banks were identified.

Awareness-raising as well as educational campaigns for the public authorities, the media and for citizens should be organized. The Ministry of Nature Protection of the RA was designated as the responsible body for the activity.

In general, according to rough estimates, a lump sum of 230,000 USD and 60,000 USD per year is needed for the realization of the proposed technological action plan for methane emanation from Yerevan city landfill for electricity and heat production technology respectively. The more detailed action plan is presented in **Table 12** below.

It is suggested to implement the project in the newly built landfill designed in the vicinity of the existing landfill in Nubarashen since the old one will be closed after the construction of the new one. Moreover, installation of gas-engine system is not feasible due to the decreased amount of methane. It is suggested to carry out a study to understand feasibility of moving and installation of methane capture system from the old landfill to the new one. Besides, to install gas engine system in the new landfill more affordable and easy operated equipment should be found, as well as studies on expediency of either electricity or thermal energy production or cogeneration should be conducted. Before the installation of a gas-engine system negotiations should be initiated to identify potential consumers of produced energy.

Table 12.Technology Action Plan for Methane Emanation from Yerevan City Landfill for Electricity and Heat Production

Sector	**Waste**							
Sub-sector	**Electricity and heat production; Municipal solid waste**							
Technology	**In order to mitigate the effect of greenhouse gas emissions from municipal solid waste affecting climate change, technologies on biogas emanation and combustion used in MSW landfills or electric energy production in gas engine power stations is successfully applied in developed countries. The technology proposes to use the waste and accompanying methane as fuel for electricity and heat cogeneration. The program provides for waste collection, separation and burning equipment, a system for methane emanation, incinerators, a boiler, a power unit (steam turbine, generator), a boiler house for obtaining hot water, exhaust gas cleaning system.**							
Objectives	**Credit period of the project is 16 years and overall reduction of emissions during that period is estimated as $2.16*10^6$ tons CO_{2eq}. Production of 89.3 GWh electricity and 59.5 GWh heat energy annually is envisaged, annual saving of fossil fuel of 15.4 thousand tons of equivalent fuel (reference fuel, standard fuel).**							
Benefits	**Benefits of the technology include reduction of GHG emissions, creation of new employment opportunities, formation of a new culture of MSW landfill management, improved atmosphere in Yerevan, positive impact on the circulation of water resources, controllingf odour from landfills, increased fire safety etc.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**
№ 1 Improving landfill management practices	**№ 1.1** Planning of waste placement and proper disposal of the waste in the landfill	Government Civic Fund	Yerevan Municipality	0-3 years	Risk 1. Continuation of existing practices due to insufficient control Risk 2. Lack of interest from Yerevan Municipality	Presence of methane in the disposed waste	Indicator 1. Decreased number of fires Indicator 2. Properly disposed waste	20,000 USD annually
	№ 1.2 Provision of proper information on the quantity and composition of the	Government, International donor	Yerevan Municipality	0-3 years	Risk 1. Insufficient data Risk 2. Lack of	Reliable data on the quantity and composition of	Reports on the amount and composition of the disposed	30,000 USD annually

	waste	organizations			interest from Yerevan Municipality	the disposed waste	waste	
	№ 1.3 Study of the possibilities of installation of methane capture system in the new landfill after the closure of the old one	Government, Internation donor organizations	Yerevan Municipality, Ministry of Territorial Administration and Development	0-2 years	Bureaucracy in government agencies	Definition of the expediency of equipment installation in the new landfill	Developed study	10,000 USD
№ 2Installation of a gas-engine system	**№ 2.1** Searching more affordable and easy-operated equipment	Government Civic Fund	Yerevan Municipality, Ministry of Territorial Administration and Development	0-1 years	Absence of affordable equipment	More affordable equipment	Report on the implemented activities	10,000 USD
	№ 2.2 Conducting studies on expediency of either electricity or thermal energy production or cogeneration	Government Civic Fund	Yerevan Municipality, Ministry of Territorial Administration and Development	0-2 years	Insufficient amount of landfill methane	Definition of appropriate technology	Report on the implemented activities	20,000 USD
	№ 2.3 Initiation of negotiations to identify potential consumers of produced energy	Government	Yerevan Municipality, Ministry of Territorial Administration and Development	0-3 years	Bureaucracy in government agencies	Availability of stable (60% of the thermal power installed) demand for heat produced from landfill gas	Produced electricity based on useful heat demand	10,000 USD annually

№ 3Elimination of economicand financial barriers	**№ 3.1** Development and introduction of economic support initiatives, promoting the introduction of waste management technologies	Government, International donor organizations	Ministry of Economic Development and Investments NGOs, International donor organizations	0-2 years	Risk 1. Recommendations are not implemented or are implemented partially. Risk 2. Required financial resources for the introduction of economic mechanisms can be high, and the government may not approve them.	Criterion 1. Investment growth in the waste management sector Criterion 2. Enforced economic boosters.	Package of developed proposals	100,000 USD
	№ 3.2 Strengthening technical capacities of local financial actors	Commercial banks, interested in the introduction of the technology, International donor organizations	Chamber of Commerce and Industry, Union of Banks	0-1 years	Risk 1. Low interest among commercial banks. Risk 2. Insufficient funding.	Strengthened technical capacities of local financial actors	Indicator 1. Loans granted by commercial banks in the waste management sector Indicator 2. Trained persons Indicator 3. Trainings	50,000 USD
№ 4Awareness raising	**№ 4. 1** Organization of awareness raising campaigns for state authorities and mass media	International donor organizations Civic fund, NGOs	Ministry of Nature Protection	0-3years	Risk 1. Low level of interest among the publicagencies Risk 2. Personnel turnover in public agencies	Criterion 1. The knowledge of the employees of the state bodies was enriched Criterion 2. The knowledge of	Indicator 1. Trained persons Indicator 2. Trainings	20,000 USD

						representatives of mass media increased		
	№ 4. 2 Organization of education campaigns for citizens	International donor organizations, NGOs	Ministry of Nature Protection	0-3 years	Citizens are not interested	The knowledge of the citizens increased	Indicator 1. Number of trained persons Indicator 2. Number of trainings	20,000 USD

4.3 Technology Action Plan for Operation and Reissuance Organizational Technology for the Existing Lusakert Biogas Plant

4.3.1 Overview of the technology

The proposed project aims to reduce GHG emissions generated from Lusakert poultry farm animal waste through the improvement of animal waste management system and to produce electricity and organic fertilizer from poultry manure 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 nameplate capacity of the factory is 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.

4.3.2 Targets for technology transfer and diffusion

Traditional open waste stabilization ponds were used in the plant as litter processing system. They were necessary for the processing of the liquid waste from poultry operations. Methane (CH4) and nitrous oxide (N2O) can be emitted into the atmosphere as pollutants as a direct result of anaerobic fermentation in the ponds.

The biogas recovered in the digester was immediately used in a gas-engine generator to produce heat and electricity and any excess gas was flared.

4.3.3 Barriers to technology diffusion

The main barriers to technology transfer are lack of economic incentives from the government, lack of cooperation between market players and inappropriate use of the equipment. Technology implementation is hampered by the lack of counseling organizations, specialized in technologies investment and consequently, the introduction of technological procedures is insufficient. Difficulties related to the adaptation to local conditions are another technological barrier.

4.3.4 Technology Action Plan for Operation and Reissuance Organizational Technology for the Existing Lusakert Biogas Plant

For the implementation of the existing Lusakert biogas plant operation and reissuance of organizational technology, technological action plan is proposed which includes the following actions: elimination of economic and financial barriers, elimination of awareness related barriers, and elimination of technological barriers and implementation of social measures.

For the implementation of the technology the economic and financial barriers should be eliminated, for which a package of economic support initiatives should be developed, that will include provision of risk guarantees or insurance schemes. As responsible body for the activity, Ministry of Economic Development and Investments was identified.

It is also necessary to establish mild loan conditions by local financial institutions which will facilitate receiving loans for the organizations acting in waste management sector. Chamber of Commerce, Industry, and Union of Banks were identified as the responsible bodies for the activity.

The next measure to be taken to eliminate the economic and financial barriers is the establishment of cooperation with other animal waste producers (including region's farmers), as a result of which sufficient biomass materials will be available to operate the biogas plant. The Ministry of Economic Development and Investments was designated as the responsible body for the activity.

For the reissuance of the biogas plant, machinery and equipment should be prepared which was not exploited for two years. “Max Concern” LLC was chosen as the responsible body for the mentioned activity. The company is responsible for operation of the plant.

The following action to eliminate the economic and financial barriers is the reconsideration of tariffs of the electricity produced by the plant, which would make operation of the plant profitable. The tariff may be revised by the PSRC, based on the application from “Max Concern” LLC.

To eliminate awareness related barriers, awareness campaigns should be organized for the public, as well as workshops for media representatives. The Ministry of Nature Protection will be responsible for the activity.

To eliminate technological barriers, it is necessary to promote consulting organizations that provide advice on investment in technologies. As the responsible bodies for the activity, the Ministries of Nature Protection and Territorial Administration and Development were designated. It is also necessary to use equipment suitable to local conditions and to install devices that were designed to carry out proper monitoring. “Max Concern” LLC was designated as the responsible body for the activity.

Organizing qualification courses for the employees of the biogas plant was determined as a social measure. “Max Concern” LLC was designated as the responsible body for the activity.

In general, according to rough estimates the budget for the realization of the proposed technological action plan for the existing Lusakert biogas plant operation and reissuance organizational technology makes about 315,000 USD. The more detailed action plan is presented in the Table 13 below.

Table 13. Technology Action Plan for the Operation and Reissuance Organizational Technology for the Existing Lusakert Biogas Plant

Sector	**Waste**							
Sub-sector	**Electricity and heat production; Wastewater treatment**							
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 manure and animal waste.**							
Objectives	**In the result of the implementation of the technology, 75,000 tons of organic fertilizer and 7 GWh of electricity will be produced annually. CO_{2eq} emissions into the atmosphere will be reduced by 63,000 tons per year.**							
Benefits	**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 into the atmosphere will be decreased. Besides, local pollution of groundwater will be reduced. Furthermore, employment opportunities will be created and professional qualifications of persons involved in the technology implementation will be improved.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**
№ 1 Elimination of economicand financial barriers	**№ 1.1** Development of a package of economic support initiatives including provision of risk guarantees or insurance schemes	Government, International donor organizations Civic fund	Ministry of Economic Development and Investments	0-2 years	Risk 1. Recommendations are not implemented or are implemented partially Risk 2. Required financial resources for the introduction of economic mechanisms can be high and the government may not approve the	Successful implementation of the package of the developed proposals	Indicator 1. Package of the developed proposals Indicator 2. Investments in waste management sector	20,000 USD

					proposals.			
	№ 1.2 Improving credit conditions by local financial institutions	Commercial banks interested in the introduction of the technology, International donor organizations	Chamber of Commerce and Industry, Union of Banks	0-3 years	Risk 1. Low interest among commercial banks Risk 2. Insufficient funding	Reduction of loan interest rates	Loans granted by commercial banks in the waste management sector	20,000 USD
	№ 1. 3 Establishment and (or) strengthening cooperation among animal waste producers (including local farmers)	International donor organizations	Ministry of Economic Development and Investments	0-2 years	Lack of interest from the poultry producers	Animal waste producers effectively cooperate	Conducted meetings, discussions and round tables	20,000 USD
	№ 1. 4 Preparation of machinery and equipment for the reopening of the plant	International donor organizations Private investors	"Max Concern" LLC	0-1 year	Lack of funding	Machinery and equipment is successfully operated	Reports	20,000 USD
	№ 1. 5 Revision of tariffs of the produced electricity	International Civic Fund	Public services regulatory commission, "Max Concern" LLC	0-1 year	Public services regulatory commission establishes unacceptably low prices	The produced electricity is sold at a higher price	Application to Public services regulatory commission	5,000 USD

№ 2 Elimination of awareness related barriers	**№ 2.1**Organization of public awareness raising campaigns	International donor organizations, NGOs Civic Fund	Ministry of Nature Protection	0-3 years	Citizens are not interested	The knowledge of the citizens increased	Indicator 1. Trainings Indicator 2. Ttrained persons	30,000 USD
	№ 2.2 Organization of workshops for the mass media	International donor organizations, NGOs	Ministry of Nature Protection	0-3 years	Low interest among mass media	The knowledge of representatives of the mass media increased	Indicator 1. Trainings Indicator 2. Trained persons	20,000 USD
№ 3Elimination of technological barriers	**№ 3.1** Promotion of consulting firms with a view to give advice about investingin technologies	International donor organizations, NGOs	Ministry of Nature Protection, Ministry of Territorial Administration and Development	0-5 years	Risk 1. Small number of consulting firms Risk 2. Lack of interest from consulting organizations	Consulting firms have sufficient technical skills and knowledge	Indicator 1. Trainings Indicator 2. Trained persons Indicator 3. Study visits	40,000 USD
	№ 3.2 Use of the technologies adapted to localconditions	Private International	"Max Concern" LLC	0-2 years	Insufficient market study	Electricity and heat production	Installed equipment	10,000 USD
	№ 3.3 Installation of the monitoring devices defined in the project design	Private investors International	"Max Concern" LLC	0-2 years	Risk 1. Insufficient market study Risk 2. Lack of funding	Criterion 1. The operation of the plant is properly monitored Criterion 2. Financial resources are derived from CDM	Properly prepared monitoring reports	100,000 USD

№ 4 Implementation of social measures	**№ 4.1** Organizing qualification courses for the employees of the biogas plant	International donor organizations Private investors	"Max Concern" LLC	0-2 years	Risk 1. Personnel turnover Risk 2. Lack of funding	Successful operation of the plant equipment	Accidents	30,000 USD

4.4 Technology Action Plan for Cleaning of Agricultural Lands and Prevention of Their Further Degradation by Complex Processing of Artik Tuff Mine Wastes

4.4.1 Overview of the technology

The tuff of Artik is the most widely used stone in the country. In 1928 machine extraction of tuff 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 waste.

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

If the extracted raw materials are fully used, the cost price of materials will drop at least 1.5-2.0 times, so extraction of tuff stone will be correspondingly reduced, leading to less air pollution.

4.4.2 Targets for technology transfer and diffusion

Complex, phased and diversified approach is recommended to the solution of this issue which implies organization of innovative production.

Such accumulations of tuff stone waste are conditioned by its technical characteristics. Because of its soft structure and high porosity, the tuff stones waste is not attractive for construction and thus previously could not be used in construction like other more solid stones waste such as basalt, granite, marble and other mining wastes.

Possible areas of tuff waste use should be considered depending on their fractions given the minimal investment, operating costs and non-waste production conditions.

4.4.3 Barriers to technology diffusion

No technical and economic research was done to understand project feasibility. In particular, economic benefits of land recovery were not calculated and no assessment of the damages (economic, ecological, health etc.) was made. No policy on the treatment of mining wastes has been developed by the government.

4.1 4 Technology Action Plan for Cleaning of Agricultural Lands and Prevention of Their Further Degradation by Complex Processing of Artik Tuff Mine Wastes

Technology Action Plan for the cleaning of agricultural lands and prevention of their further degradation by complex processing of Artik tuff mine wastes is proposed, which includes the following actions: elimination of economic and financial barriers, implementation of regulatory measures and organizing awareness raising campaigns.

In order to eliminate the financial and economic barriers there is a need to carry out a detailed research on feasibility and submit recommendations to the relevant public agencies. Possibilities of cross-sectoral linkages

and synergies between different sectors and projects should be taken into account during the development of the feasibility study. The Ministry of Nature Protection and Artik Municipality were designated as the responsible bodies for the activity. It is also necessary to strengthen the cooperation and exchange of information between the stakeholders. The Ministry of Nature Protection was designated as the responsible body for the mentioned activity.

To implement regulatory measures proposals of stricter regulation of the mining industry should be developed with the inclusion of recommendations for mining wastes management. The Ministry of Energy Infrastructures and Natural Resources was designated as the responsible body for the activity.

It is also necessary to develop a strategy for the rehabilitation of agricultural lands for which the Ministry of Agriculture was designated as the responsible body.

In the context of the awareness raising measures the results of the complex scientific researches on waste re-use, environmental, health and economic impacts of technology introduction should be disseminated among the general public and, as well as seminars, conferences and roundtables should be organized for companies or those who have respective resources. It is necessary to organize trainings and qualification courses for professionals. The Ministry of Nature Protection was designated as the responsible body for the activity.

In general, according to rough estimates the budget for the realization of the proposed technological action plan for the complex processing of Artik tufa mining waste and technology to prevent agricultural lands from further degradation makes about 190,000 USD. A more detailed action plan is presented in Table 14 below.

Table 14. Technology Action Plan for Cleaning of Agricultural Lands and Prevention of Their Further Degradation by Complex Processing of Artik Tuff Mine Wastes

Sector	**Waste**							
Sub-sector	**Municipal solid waste**							
Technology	**The introduction of the technology supposes organization of innovative production using tuff mining wastes. From that foam-blocks, thermal and sound insulation plates, foam-concrete products can be made, as well as tuff blocks on tha basis of tuff gravels and different products may be produced by combining tuff waste with plastic waste.**							
Objectives	**Up to now more than 50 million cubic meters of tuff stone mass was manufactured from the Artik mine, of which only 30-40% was used as a construction material, the rest was mainly thrown into the environment as 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 influenced by the winds constantly pollutes the air of the surrounding settlements. The purpose of the introduction of the technology is the use of accumulated wastes, cleaning the land and making agricultural activities possible.**							
Benefits	**The technology will have positive impacts on natural ecosystems and biodiversity of the surrounding area. The economic effects of the technology include the use of surrounding lands and creation of job opportunities. Other economic impacts are development of other branches of the economy related to construction and development of infrastructures. Besides, the new material will be used in construction as insulation material and will contribute to energy savings and GHG emissions reduction as well.**							
Operation	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success Criteria**	**Indicators for monitoring and implementation**	**Budget per activity (USD)**
№ 1 Elimination of economicand financial barriers	**№ 1.1** Conducting a detailed feasibility study taking into account intersectoral linkages	Government, Civic Fund	Ministry of Nature Protection Artik Municipality	0-3 years	Lack of funding	The findings of the study are available for potential investors and general public	Developed study	30,000 USD

	№ 1.2 Strengthening of information sharing and cooperation among market key actors	Government, International donor organizations	Ministry of Nature Protection	0-3 years	Lack of interest from stakeholders	Interested parties cooperate successfully	Meetings (discussions)	20,000 USD
№2Implementation of regulatory measures	**№ 2.1** Development of a package of proposals for a stricter regulation of the mining industry	Government, International donor organizations	Ministry of Energy Infrastructures and Natural Resources	0-2 years	Developed recommendations are not implemented or are implemented partially	Developed proposals are successfully implemented	Package of developed proposals	30,000 USD
	№ 2.2 Development of a strategy for the rehabilitation of agricultural lands	Government, International donor organizations	Ministry of Agriculture	0-2 years	Lack of funding	The strategy is successfully implemented	Developed strategy	30,000 USD
№3Organizing awareness raising campaigns	**№ 3. 1** Dissemination of the results of complex scientific researches on waste re-use	Government, International donor organizations	Ministry of Nature Protection	0-3 years	Risk 1. Lack of funding Risk 2. Lack of interest from stakeholders	Interested parties are aware of the results of the complex scientific researches on waste re-use	Indicator 1. Organized campaigns Indicator 2. Participants	20,000 USD
	№ 3. 2 Organization campaigns for raising awareness on the environmental, health and economic impacts of the technology	Government, International donor organizations	Ministry of Nature Protection	0-3 years	Risk 1. Lack of funding Risk 2. Lack of interest from stakeholders	Interested parties are aware of the impacts of the introduction of the technology	Indicator 1. Organized campaigns Indicator 2. Participants	20,000 USD

	№ 3.3 Organization of seminars, conferences and roundtables among companies or those who have respective resources	Government, International donor organizations	Ministry of Nature Protection	0-2 years	Risk 1. fLack of funding Risk 2. Lack of interest from stakeholders	Interested parties are aware of the possibilities of waste re-use	Indicator 1. Organized campaigns Indicator 2. Participants	20,000 USD
	№ 3.4 Organization trainings and qualification courses for specialists	Government, International donor organizations	Ministry of Nature Protection	0-2 years	Lack of funding	The technical capacities of the specialists increased	Indicator 1. Trained specialists Indicator 2. Trainings	20,000 USD

4.5 Crosscutting Issues in Waste Management Sector

Certain barriers are common in all three projects discussed. One of the most important barriers hampering the development of waste sector is the low level of public and business awareness, as well as the fact that they do not consider waste as a business.

Lack of financial resources is another serious barrier that can be overcome through facilitated access to finance. Schemes for affordable loans for the projects in waste management sector should be developed, and incentives should be provided to the existing financing system.

Another common barrier is the lack of favorable national policies and economic incentives from the government, designed for the waste management sector. This issue can be solved through the development of appropriate policies and the introduction of economic instruments, such as subsidies, tax breaks and exemptions, provision of grants and loans.

Another common issue is the non-systematic relationship between the government agencies, the private sector and the donor organizations. As a result of the exchange of information and joined efforts, the effectiveness of the implementation of the projects may increase.

It should also be noted that the implementation of individual projects is expensive which results in the loss of synergy. There is a need for a common strategy for the use of synergy potential, taking into account cross-sectoral linkages and interactions with other projects and technologies.

One of the critical issues is the identification of the body (organization) responsible for each technology which may be involved in the introduction of the technology on a long-term basis and can regularly deal with issues related to it. As to the existing Lusakert biogas plant operation and reissuance organizational technology, the person concerned and the focal point are also identified.

Crosscutting Issues for Mitigation Component

14 technologies in the 4 sectors recommended as mitigation technologies for TNA are interconnected not only for the mitigation of climate change, reduction of GHG emissions and positive impact on natural ecosystems, but also for the crosscutting nature of the activities, actions, steps and functions presented in TAPs.

There are certain cross-sectoral and crosscutting issues, common barriers and joint measures to overcome them, as well as actions aimed to achieve cross-sectoral synergy.

For instance, the implementation of all five TAPs in the energy sector will have a positive impact both on the introduction and diffusion of the three technologies presented in the industry sector in terms of facilitation and promotion of implementation of three technologies in land use sector.

Furthermore, in waste management technology sector, in particular the two technologies (Utilization of methane from Yerevan city landfill for electricity and heat production technology, Existing Lusakert biogas

plant operation and reissuance organizational technology) are directly related to the technology of combined heat and power production in the energy sector.

Crosscutting issues are evident in terms of manifestation of political will by state authorities, creation of a national enabling environment and legislation, effective economic mechanisms and provision of up-front investments, social security of poor population with low-income, introduction of non-traditional sources of funding and other aspects.

Intersectoral ties are also available for the provision of affordable funding, development of effective mechanisms for soft loans, as well as in changes in the management systems, strengthening research and development capacities and to ensure that actions have clearly defined targets, consistency and synergy.

In parallel with traditional funding sources (state assistance, grants, loans, international support), new tools for fundraising should be used, such as Civil Climate Investment Fund where the decisive voice will belong to the civil society.

The discussed projects in all sectors are interesting experiences, the lessons learnt from which might be useful for future projects.

TNA ensure adequate technological assistance and creation of an enabling environment for the development and diffusion of the technology; establish institutional mechanisms to overcome barriers to the introduction of innovative technologies and creation of TAPs for climate change mitigation. TNA ensure transparent system of technology introduction and transfer as a contribution to the INDC, such as through the cooperation and exchange of experience with "Climate Technology Centre and Network" (CTCN).

Stakeholders also expressed their interest in ensuring the continuation of the TNA process based on TNA/TAP and in establishing a national inventory system for technologies in all spheres for climate change mitigation. It can be a system for technology introduction and transfer, such as National Network or Centre for Climate Technologies or in other words National Directory, Technology database and which surely has to be linked with the international "Climate Technology Center and Network's" (CTCN).

In the frame of the TNA the Project team and especially National TNA coordinator, UNFCCC focal point in RA Mr. Aram Gabrielyan has special meetings with Government Officials, “Nairit” Chemical Plant management, famous specialists and professionals in all prioritized sectors. Many essential issues for the establishment of “Arm CTCN” aimed to industry rehabilitation, social, economic and environmental growth development perspectives, as well as creation of inter sectoral issues. All these subjects are also a matter for discussion within “Arm CTCN”.

Chapter5.Project ideas

5.1 Project Ideas for Energy and Industry Sectors

5.1.1 Summary of Project Ideas for Energy and Industry Sectors

The following project ideas are concrete actions supporting the implementation of the overall target indicated in the Technology Action Plans (TAP) for Energy and Industry sectors and refer to the following technologies:

- Improving energy efficiency in multi-apartment buildings of the RA. Registry creation and development technology;
- Mandatory implementation of the Industrial Energy Audit/Expertise as a component of mitigation technology;
- Reactive (power) compensation capability in the electric energy system of the Republic of Armenia (RA);

The technologies were selected and further observed in consultation with stakeholders, the representatives from the Ministries of Energy Infrastructures and Natural Resources (MEINR), Nature Protection (MNP), Agriculture, Public Services Regulatory Commission (PSRC), Private Sector, International Organizations, Academic/Research Institutions and Non-governmental organization (NGO). The stakeholders were part of the National Working Group assigned to Energy and Industry sectors.

The project ideas for the technologies have been developed based on UNEP DTU Partnership and AIT "Enhancing Implementation of Technology Needs Assessments-Guidance for Preparing a Technology Action Plan" (Ref-6), as well as the appropriate chapter in the e-learning tool: https://www.youtube.com/watch?v=y6AEICkQTiU.

All project ideas in Energy and Industry sectors are based on ecosystem approach, giving priority to balanced and joint actions. The approach is approved by RA Government Intended Nationally Determined Contributions of Armenia (INDC) (Ref-1).

Note: Armenia has no domestic fossil fuel resources and is almost completely dependent on imported energy. 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 (Ref-2).

After the independence, Armenia "inherited" unviable economy from the Soviet system and found itself in the heaviest situation of all countries of the South Caucasus. From the agrarian-industrial country with developed metal working, mechanical engineering, chemical, light, the food-processing industry Armenia turned into a small state which could not boast neither rich natural resources nor favorable geographical position or fertile soils(Ref-3).

The Energy sector is the largest producer of GHG emissions, its share of the total emissions is 70.3%. Methane emissions (in 2012) 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-4).

5.1.2 Improving energy efficiency in multi-apartment buildings. Registry creation and development technology (Other non-market good)

Introduction and Background

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 (the first step).

As of 2012 Housing Stock of Armenia 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 in the republic accounted for Yerevan city (Ref 1).

Register creation requirement is a prerequisite to increase EE in residential buildings.

Objectives

The Registry is designed to use new technologies to create an integrated information system that will serve as an effective tool for identifying and selecting the priority buildings that have adequate organizational and technological capacity and the potential for reducing greenhouse gas emissions and energy efficiency measures.

Due to efficient use of energy resources, environmental protection and the need to reduce GHG emissions energy saving and EE of the apartment buildings is considered a priority policy for the Government. 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 CO2 or 20.4% of CO2 emissions in “Energy” sector (Ref-4).

Project outputs

The purpose of the Registry is to create an integrated information system using new technologies that will serve as an effective tool for identifying and prioritizing buildings that have sufficient organizational and technological potential for the implementation of energy saving measures and reduction of GHG emissions.

Relationship to the country`s development priorities

The necessity to create a Registry is defined in five-year strategic improvement plan on housing management, maintenance and operation approved by the Government multi-protocol Decree N 38 dated 29 September 2011.

Project deliverables (Value/ Benefits/Massages)

It is recommended to develop and implement a computerized registry model demonstration project with pilot version for 3 cities with different climatic zones. It is going to be four-layer model: 1) Apartment building, or Apartment Building Management body, 2) Local administration, 3) Territorial administrative body, 4) and the authority body: the Ministry of Urban Development.

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

Project scope and possible implementation (How broad is the project? How feasible is the project? Is it linked to current or past projects?)

Based on the methodology developed and coordinated by the same government agency, four-layered software should be developed and piloted for 3 settlements located in different climatic zones of Armenia. Based on the successful experience of the pilot projects and established methodology integrated Registry of multi-apartment buildings will be created.

Project activities

As a first step of the introduction of the technology, RA State Urban Development Committee should develop a methodology for determination of indicators for prioritization of selection of multi-apartment buildings included in the Registry of multi-apartment buildings. Those indicators should be highlighted for further optimization of the process of selection of multi-apartment buildings, especially in terms of reduction of greenhouse gas emissions.

Project Timeline

Action/Activity	Timeframe
Development of methodology for indicators that are important for optimization purposes, particularly for targeted selection of GHG reduction, which will be included in the software of the Registry	up to 2 year
Creation of four-tier computer model for 3 cities located in different climatic zones	up to 1 year
Organization and implementation of trainings for residents of buildings by specialists	up to 2 year
Distribution of information leaflets and illustrated booklets	up to 2 year
Organization of TV and radio programs on media, articles in newspapers	up to 2 year
Sourcing grant from international donor organization	up to 2 year
Sourcing grant from charitable foundations and benefactors	up to 2 year

Budget and Resource requirements

The total cost of the project considered to be 340 k$ i.e. first year 255 k$; second years 85 k$.

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.

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.

Measurement and Evaluation

The factors to measure, evaluate and monitor are:

- Organization of the presentation of methodology;
- Implementation of workshops on the application of the Registry;
- Number of trainings and number of participants;
- Quantity and types of informative leaflets and illustrated booklets;
- Number of radio and television programs and articles;
- Amount of the received grants and/or interest-free/soft loans;

Possible complications challenges and Risks

- Absence of grants;
- Lack of attractiveness 1 year later;
- Improper coordination of activities;
- Low interest among community members;
- The population of the community is not interested in taking part in raising awareness activities;
- Weak cooperation between local authorities and ministries;
- Poor knowledge of organization of working phases for grant sourcing;

Responsibilities and coordination

Action/Activity	Responsible	When	How
Creation of a demonstration (pilot) version of computerized Registry model of multi-apartment buildings	RA State Urban Development Committee	2017-2019	Approval of the methodology; Introduction of pilot software for beneficiaries of all 4 layers;
Ensuring awareness on the creation of the Registry of multi-apartment buildings	RA State Urban Development Committee; Yerevan Municipality	2017-2019	Involvement of 70% of the residents of the buildings; Improved knowledge and awareness raising of

			community members;
Provision of funds required for the application of the technology	RA State Urban Development Committee; Yerevan Municipality	2017-2019	Received and purposefully realized grants and loans
Measurement, reporting and verification	RA State Urban Development Committee	2017-2022	Procedure and methodology approved

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

Introduction and Background

Conducting energy audit in the RA is not obligatory; 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 25December 2014. Energy audit in Armenia can be implemented by certification bodies accredited by the state (amendment to RA law "On Energy Saving and Renewable Energy" HO-67 of June 3, 2016). 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 EE related projects financed/implemented by international organizations.

Objectives

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 Industrial process and product use (IPPU) sector. Manufacturing Industries and Construction and Commercial/Institutional subsector generates 916.2 Gg CO2 or 17.3% of CO2 emissions in Energy sector (Ref-4). 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 objectives of technology diffusion seems to be formation of EE and energy saving culture in the sector, decrease of expenses, and increase of the production competitiveness. Reduction of primary fuel expenses, consequently reduction of GHG emissions are goals of the project as well.

Project outputs

Legally defined requirement of implementation of mandatory energy audit, promoting reduction of energy consumption on unit of product and as a result reduction of GHG emissions.

Modest estimates show that as a result of the introduction of this technology the potential of EE is about 20% of total energy consumption. Potential reduction of GHG emissions will amount to 3.83 Gg CO2eq annually.

Relationship to the country`s development priorities

Energy audits in the RA are implemented in accordance with the RA law on Energy Saving and Renewable Energy adopted as HO-122-N on 9November, 2004 and amended as HO-130-N of 14April 2011 and HO-67 of 3June 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.

Project deliverables (Value/ Benefits/Massages)

Technology diffusion will insure significant benefits to Manufacturing Industries and Construction and Commercial/Institutional subsector. Development of competitive products creation, increase in exports, and provision of preconditions for sustainable economic growth are the core benefits, promoting EE and GHG emission reduction as well.

Project scope and possible implementation (How broad is the project? How feasible is the project? Is it linked to current or past projects?)

The project comprises the total industry sector of the republic. MEINR, in cooperation with the National Statistical Service, will define the format of quarterly reports to be submitted on energy intensity of a product unit. The report should include information on the energy consumed by enterprises, and specifically accurate information on a unit of a product. Based on the analysis of annual reports received in the approved format, classification of large industrial enterprises should be performed according to indicators on energy intensity (and/or total annual energy costs).

Project activities

Project activities comprise a state program implementation aiming at establishment of institute of experts in EE, which implies organization of training courses for professionals with basic knowledge on the base of "Scientific Research Institute of Energy" (SRIE) CJSC, as well as appropriate profiling of graduate students of Energy Department of the State Engineering University of Armenia (SEUA).

Only after these steps are implemented MEINR should initiate institutional changes, establishing legal requirement for mandatory energy audit of industrial enterprises and its frequency.

Project Timeline

Action/Activity	Timeframe
Define format of quarterly reports to be submitted on energy intensity of a product unit.	up to 1 year
Implement changes in the institutional framework, defining requirement to publish accurate information on the energy consumption of enterprises, including data on a product unit.	up to 3 year
Organization of training courses for professionals with basic knowledge on the base of SRIE CJSC.	up to 3 year
Profiling of graduate students of Energy Department of the SEUA.	up to 10 year
Provision of financial support to companies subject to the energy audit.	up to 3 year
Drafting a law on amending the RA Law on Energy Efficiency and Renewable Energy	up to 1 year

Budget and Resource requirements

The total cost of the project considered to be 840 k$ i.e. first year 230 k$; second and third years 200 k$, and from forth to tenth year 30 k$ each year.

Before making the demand for energy audit of industrial enterprises obligatory, at the initial stage, there is a need to provide financial support to the enterprises subject to audit with the involvement of international

donor organizations and civic revolving funds. In future provided financial support will be compensated through savings from increased efficiency of energy consumption.

Measurement and Evaluation

The factors to measure, evaluate and monitor are:

- Adoption of an appropriate Government Decree;
- Publication of statistical data of enterprises;
- Number of specialists and associations in the field of EE;
- Number of specialists in the field of EE;
- Publications of the actually recorded results on the increased EE;
- Preparation of the draft law on amendments to "RA Law on EE and RE";
- Adherence to time schedule;
- Effective spending of financial resources;
- The quantity of GHG emission reduction;

Possible complications challenges and risks

- Lack of relevant specialists and organizations conducting energy audit;
- Need for evaluation of the credibility of the information;
- Lack of attractiveness;
- Slowdown of the process of establishment of the institute of experts;

Responsibilities and coordination

Action/Activity	Responsible	When	How
Classifying large industrial enterprises according to indicators on energy intensity (total energy costs).	MEINR and MNP National Statistical Service	2017-2018	Preparation of the draft Government Decision
Implementation of government programs aimed at establishment of the institute of experts.	MEINR and MNP	2017-2020	Study Road map
Amending the RA Law on Energy Efficiency and Renewable Energy, envisaging mandatory energy audit for large industrial enterprises.	MEINR and MNP	2017-2018	Drafting the RA Law on EE and RE
Measurement, reporting and verification	MEINR and MNP	2017-2022	Procedure and methodology approved

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

Introduction and Background

While active power is the energy supplied to run a motor, heat a house, or light an electric bulb, reactive power provides the important function of regulating voltage. If voltage on the system is not high enough, active power cannot be supplied. Reactive power is used to provide the voltage levels necessary for active power to do useful work. Reactive power is essential to move active power through the transmission and distribution system to the customer. Reactive Power is a by-product of Alternating Current (AC) System. Reactive power is chiefly produced from the windings of the electrical generators in the power grid. Reactive power is also be produced as a side effect of unbalanced loads.

The problem of compensating reactive power (inductive and capacitive) has arisen since the creation of energy systems. The consumers' inductive load causes the demand of inductive reactive power, and overall it is generated in the system generators, moves and distributes in respective networks and causes extra losses. 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.

Objectives

After the collapse of the USSR, the issue of compensating reactive power for energy consumers in the Armenian energy system is not regulated, meanwhile it has a significant potential for increasing energy efficiency (reducing active power losses).

Reactive energy is not recorded on the side of consumers and therefore accurate data on the values of the power factor is missing. However, based on measurements carried out by SRIE CJSC and based the accumulated experience of the Soviet times, the power factor for some industrial consumers is in the range of 0.7-0.75. If cosϕ = 0.9 is considered as a target value for the energy system (including consumers) it is possible to roughly estimate the potential of the loss reduction. It is estimated to be around 80 million kWh per year.

Project outputs

Given that around 30% of the electricity is produced in thermal power plants, the potential of reductions of GHG emissions will amount to 16.9 Gg CO2eq. Considering the tariffs calculation on equitable basis, each consumer should reimburse his expenses. This principle is distracted as some consumers cause/create reactive energy losses and all consumers pay for it.

Relationship to the country`s development priorities

The comprehensive introduction of the proposed technology is possible only by adopting appropriate regulations by the regulatory authority of the energy sector. For the preparation of the relevant draft decision of the PSRC, best experience of the application of the proposed technology should be studied and adapted to local conditions, which is expected to be done by the consulting organizations.

Project deliverables (Value/ Benefits/Massages)

The use of technologies of compensating reactive power in the chain from producers to consumers will result in

- Reduction of active energy losses;
- Increased efficiency of usage of generators and transmission lines;
- Increased conductivity of transmission lines and transformers;
- Reduction of drops in voltage;

Project scope and possible implementation

Coordinated by the PSRC and MEINR, the draft decision of the PSRC should be discussed with the entities of the electric energy system and biggest consumers in the context of distribution of responsibilities related to the implementation of the technology and realization of arising obligations, followed by the PSRC to approve the corresponding decision.

Milestone for the immediate application of the technology is the definition of the maximum permissible values of power factor in the demarcation points of the electric energy system by the "Power System Operator" CJSC, as well as development of mechanisms for regulation of reactive energy, including mechanisms for tariff definition and trade accounting, involving "High Voltage Grids" CJSC, "Electric Network of Armenia" CJSC, "Settlement Center" CJSC and SRIE CJSC.

Project activities

Currently the issue of the compensation of reactive power is partly left out of the regulation. The existent reactive flows in the energy system are considered when calculating losses, but no measures (technical, institutional) are taken to minimize their negative consequences. In case of small values of the power factor (cosϕ) active power losses in power transmission lines are caused by both inductive and capacitive reactive power. The solution to that issue is to perform complex measures, meaning on one hand compensation of capacitive reactive power by means of controlled reactors in the energy system, and compensation of inductive reactive power through installation of automatic condenser batteries at consumer's side on the other.

Project timeline

Action/Activity	Timeframe
Adapting best international experience to local conditions with the assistance of international consulting organizations and development of the corresponding draft decision of the PSRC	up to 1 year
Discussion of the draft decision with the stakeholders and adoption of the decision by the PSRC	up to 1 year
Definition of the maximum permissible values of power factor in the demarcation points of the electric energy system	up to 2 years
Establishment of mechanisms for regulation of reactive energy, including mechanisms for tariff definition and trade accounting	up to 3 years
Preparation and implementation of Action Plan on the compensation of reactive power (energy) by "Electric Network of Armenia" CJSC	from 3up to 10 years

Budget and Resource requirements

The total cost of the project is anticipated to be 960 k$ i.e. first year 100 k$; second year 40 k$, third year 120k$ and from forth to tenth year 100 k$ each year.

For the technology introduction it will be required to obtain and install the appropriate equipment (compensators, reactors, etc.). Financial support can be needed for best practice research and adoption, localization and adaptation. Involving financial resources and civil funds is considered a reasonable option.

Measurement and Evaluation

The factors to measure, evaluate and monitor are:

- Presentation of the draft decision by PSRC;
- Development of a strategy on the implementation of the decision by MEINR and MNP;
- Definition of permissible range of the changes in power factor;
- Approval of the decision on the compensation mechanisms for reactive power (energy) and setting tariffs by the PSRC;
- Reduction of energy losses pre-planned by investment projects;
- Reduction of the volumes of GHG emissions;
- Adherence to time schedule;
- Effective spending of financial resources;

Possible complications challenges and Risks

- Lack of financial support by donors;
- Introduction of the suggested technology is considered premature as a result of discussion;
- Lack of support from donors;
- Restriction of investment volumes by the PSRC;

Responsibilities and coordination

Action/Activity	Responsible	When	How
Drafting a decision on accounting and reactive power compensation and adoption of the decision by the PSRC	RA PSRC, Head of Tariff Policy Department	2017-2018	Drafted decision
Implementation of reactive power (energy) compensation process	RA MEINR "Electric Network of Armenia" CJSC "Electric Power System Operator" CJSC "Computing Center"	2017-2027	Relevant calculations, submission of jointly drafted recommendations to the PSRC, Coordination of investment projects with the PSRC

	CJSC		
Measurement, reporting and verification	RA MEINR,PSRC	2017-2027	Procedure and methodology approved

Note: The Project Ideas are developed for 5 TAPs out of 14 covered for mitigation sector. Stakeholders confirmed their concern for including all 14 TAPs in the established national inventory system (Arm CTCN).

5.2 Project Ideas for Land use and Waste management Sectors

5.2.1 Brief summary of project ideas for Land use and Waste management Sectors

Currently initiatives are being taken in the Land use and Waste management Sectors by different stakeholders, during the preparation of project proposals related to prioritized technologies. After the consultation with representatives from Ministry of Agriculture, MEINR, MNP, PSRC, Private Sector, International Organizations, Academic/Research Institutions, NGO and Local Administration Bodies two project ideas under the Land use and Waste management Sectors were proposed:

- New technology of cultivation of Perennial plants technology;
- Existing Lusakert biogas plant operation and reissuance organizational technology;

The project ideas for the technologies have been developed based on UNEP DTU Partnership and AIT Enhancing Implementation of Technology Needs Assessments Guidance for Preparing a Technology Action Plan (Ref-6), and the appropriate chapter in the e-learning tool as well: https://www.youtube.com/watch?v=y6AEICkQTiU.

All project ideas in Land use and Waste management sector have been based on ecosystem approach, requiring prioritization of balanced actions. The approach is promoted by RA Government, particularly in INDC(Ref-1).

Note: 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 are irrigated. Main agricultural crops include: cereals, potato, fruits, grapes, and vegetables. Animal husbandry mainly includes cattle, as well as sheep and goat (Ref-2).

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-3).

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 was mainly because of the increase of the number of cattle (Ref-4).

5.2.2 New technology for the cultivation of perennial plants (Other non-market goods)

Introduction and Background

Since the beginning of 90s as a result of privatization, transformations in land and agricultural production means, service infrastructures along with the positive effect also had negative impact on the future development this sector. Particularly:

- Agricultural lands desecrated (over 1.2 million plots), which resulted in a rapid decrease in the cultivation efficiency;
- Most areas of perennial plants turned into grain crop areas. Only recent years have seen a growth area of orchards;
- Consumption volumes of inorganic and organic fertilizers notably reduced. In comparison with the preceding years economic reforms reduced the use of mineral fertilizers almost 7-8 times, while the use organic fertilizers and means of plant protection was reduced 18 times.
- Land use advanced technologies remained out of practice.
- Irrigation system became deteriorating, costs and volume of uncultivated land increased, etc.

On the other hand, economic recession, higher level of poverty and decrease of population incomes were the reasons leading to the engagement of rural population in crop cultivation having higher potential consumer "liquidity" in the market. That is why perennial, technical and other liquid crop fields were gradually expanded.

Objectives

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

Project outputs

It is planned to plant 5 ha of apricot, 15 ha of peach and 5 ha vineyards using technology in the Vayots Dzor marz Rind Community. Three hundred households will carry out activities and the entire population of the community (1,300 people) will benefit. Due to setting up a drip irrigation in garden areas the irrigation costs will be reduced up to 30-40%. By fertilizing orchards and vineyards by bio humus and organic mix, the yield will increase up to 30-50%. Due to the application of smaller planting spaces and rapid growth of biomass, soil erosion will be prevented, soil organic carbon accumulation will increase around 3.8 %, GHG absorption by the plant mass will increase significantly as well and the socio-economic status of community population will be improved.

Relationship to the country`s development priorities

There is an enabling environment for the implementation of the technology. In particular the Government of the RA has developed and adopted several strategies related to the balanced regional development, rural and agricultural development etc., where the proposed political objectives create basis for the introduction of these technologies. The introduction of this technology will lead to development of multiple forms of agricultural cooperatives on a voluntary basis and multifunctional approaches due to which land plots will be expanded per household which will increase labor and capital productivity.

Because of various reasons, 29% or 130 thousand hectares of arable land are not used for intended purposes, so the implementation of land use effectiveness program is a strategic priority.

Project deliverables (Value/ Benefits/Massages)

Effective introduction of the technology will notably increase the volume of agricultural production. The introduction of new technology for vineyards and fruit cultivation, carbon absorption will significantly increase in this category of land use due to the rapid growth of biomass. Soil organic carbon stocks will increase and soil quality will improve.

Implementation of the project activities under the supervision of relevant organizations will contribute not only to the regulation of socio-economic status of the population but also to the substantial increase of absorption of greenhouse gases by perennial biomass. At the same time soil erosion will be prevented and organic carbon accumulation will increase in the soil almost up to 3.8%.

Project scope and possible implementation (How broad is the project? How feasible is the project? Is it linked to current or past projects?)

The use of new technology for the cultivation of perennial plantings and sustainable land management are suggested to be implemented in Rind community of Vayots Dzor marz. The main measures of the technology are:

- expand field collections of local and selective fruit and grape varieties through the expansion of collection 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 spaces between tree lines, should be applied;

Project activities

Main activities of the suggested technology are:

- To expand field collections of local and selective varieties of fruit and grape by the expansion of collector orchards, by purchasing of samples of Armenian origin from other countries genetic samples banks, and through the enrichment of orchards;
- Focus of grape selection to frost-resistant, high-quality, transportable, universal directions and creation of new varieties;
- Establish new EST for fruit (especially apricot) orchards by using smaller spaces between the tree lines, with thickness of 5 m x 5 m or plantations.
- Restoration of forest shelter belts and planting of new ones;

Project Timeline

Action/Activity	Timeframe
Organization of lectures by the Ministry of Agriculture and VayotsDzorregional administration for the community population	up to 1 year
Project coverage by local media	up to 1 year
Information leaflets and illustration booklets	up to 1 year
Fundraising with Private Sector	up to 2 year
Fundraising with Commercial Banks	up to 2 year
Fundraising with International organizations	up to 2 year
Plantation and provision of planting material	up to 2 year
Creation of irrigation systems by drip method	up to 3 year
Acquisition and use of bio humus and organic mix (through the use of animal waste and feed residues), by participation of Californian hybrid Earthworms	up to 3 year

Budget and Resource requirements

The total cost of the project amounts to 208 k$ i.e. first year 104 k$; second year 74 k$, and third year 30 k$. Responsible organizations for the implementation of the activities, as well as Rind Community (the head of the Community Mr. Husik Sahakyan) should apply to the national and international banks and to the Community Civic fund to receive the necessary financial flows.

Measurement and Evaluation

The factors to measure, evaluate and monitor are:

- Number of workshops and number of participants;
- Number of displayed programs and number of distributed booklets and information leaflets;
- The obtained financial flows;
- Obtained grants and/or Interest-free/soft loans quantity/amount;
- Tree planting area;
- Number of drip irrigation providers;
- Number of households using bio humus and organic–mix;
- Adherence to time schedule ;
- Effective spending of financial resources;
- The quantity of GHG emission reduction;

Possible complications challenges and Risks

- Absence of financial means;

- Low interest of Community members;
- Unscrupulous organization of work by local authorities;
- Weak cooperation between government agencies and lending organizations.
- Poor knowledge of the work steps;
- Low quality of planting material;
- Uncertainties in Carbon content calculations;

Responsibilities and coordination

Action/Activity	Responsible	When	How
Creation of village cooperatives for the effective usage of soils, provision of information on investment and sales markets	Ministry of Agriculture, Department of Agriculture and Environment of VayotsDzor Regional Admisnitsration,	2017-2018	Organizing lectures, coverage by local media; provision of information leaflets and community's population active participation in workshops.
Provision of necessary financial flows for the application of technology.	Rind Community of VayoctsDzor Region	2017-2019	Applying to private fundraising, Commercial Banks and International organizations
Establishment of fruit and vineyards, decrease of spaces between plantations, application of drip irrigation system and fertilization with bio humus or organic mix.	Division of perennial plantation cultivation of the Ministry of Agriculture, Mr. Husik Sahakayan, Head of Rind Community of Vayots Dzor marz	2017-2020	Establishment of plantation; Creation of irrigation systems by drip method; Widespread use of bio humus and organic mix;
Measurement, reporting and verification	Ministry of Agriculture, Rind Community of Vayots Dzor marrz	2017-2020	Procedure and methodology approved

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

Introduction and Background

Traditional open stabilization ponds are used as a litter processing system in the factory which are necessary for the processing of liquid waste from poultry production operations. Methane (CH4) and nitrous oxide (N2O) can be emitted into the atmosphere as pollutants as a direct result of anaerobic fermentation in the ponds.

The project consists of an advanced improvement in the common practice of poultry waste treatment, reducing a significant volume of GHG emissions, as well as improving the quality of the reject water. The implementation of technology is based on the use of anaerobic wastewater treatment systems as first step before a lagoon system.

Lusakert biogas plant was built at the Lusakert poultry farm in 2008 for methane capture and combustion from poultry manure treatment. The nameplate capacity of the factory is 0.85 MW. Lusakert biogas plant used to be Armenia's only operating industrial-scale biogas-to-energy plant. However, currently, the plant does not operate due to lack of poultry manure, the uniqueness of the CDM (electricity prices, SER price drop) etc.

Objectives

The implementation of the project will have a number of benefits for the environment: poultry waste problems in farms will be reduced. Composting can also reduce nuisance odor emissions from poultry waste storage and treatment areas. CO2 emissions to atmosphere will be decreased as well. Besides, local groundwater contamination will be reduced. In Addition, employment opportunities will be created and professional qualifications of persons involved in the technology implementation will be improved. Interesting perspectives can open up by overcoming barriers. In particular, a unique tariff policy, project withdrawal from "CDM isolation" and the involvement of other poultry factories can have a positive effect.

Project outputs

The proposed project aims to reduce GHG emissions, emitted from Lusakert pedigree poultry farm animal manure through the improvement of animal waste management system and to generate electricity and organic fertilizer from poultry litter and animal waste. As a result of the implementation of the technology 75,000 tons of organic fertilizer and 7 GWh of electricity will be produced annually. CO2eq emissions to the atmosphere will be reduced by 63 Gg per year.

Relationship to the country's development priorities

The only form of support from the Government consists in ensuringthat electricity generation by the plant is bought at a fixed price [from 44.31 AMD (VAT included) per kilowatt-hour (in 2011) up to 50.91 (VAT included) AMD/kWh (in 2015)]. It should be noted that the price per kilowatt-hour is higher than from other energy 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).

Besides the above mentioned there is no other economic support from the Government. Currently, no economic incentives for waste management technologies are expected from the State. On the contrary, in

2012 the Government decided to reject to postpone the value added tax payment by the Lusakert biogas plant for three years.

Project deliverables (Value/ Benefits/Massages)

EST will contribute to the prevention of environmental pollution, as well as that of water and land resources and elimination of stench. Economic benefits of technology implementation will be: organic fertilizer production, other economic activities, additional sources of fuel and energy. The project aims to create new jobs requiring professional qualifications, improvement of the working conditions of factory staff, reduction of diseases, etc.

Project scope and possible implementation (How broad is the project? How feasible is the project? Is it linked to current or past projects?)

The implementation of the project will have a number of environmental benefits: animal waste problems related to manure disposal on farms will be reduced; the odor will be reduced as well; CO2 emissions into the atmosphere will be decreased. Besides, local groundwater contamination will be reduced. Furthermore, employment opportunities will be created and professional qualifications of persons involved in the technology implementation will be improved. Project possible implementation highly depends on the availability of sufficient raw material i.e. manure, animal waste provided from other poultry farms operating in the country.

Project activities

The proposed project aims to reduce GHG emissions generated from Lusakert poultry farm animal waste by improving animal waste management system and to produce electricity and organic fertilizers from poultry litter and animal waste.

Project Timeline

Action/Activity	Timeframe
Development of a package of economic support initiatives including provision of risk guarantees or insurance schemes	up to 2 years
Credit conditions improved by local financial institutions	up to 3 years
Establishment and (or) strengthening of the cooperation between poultry manure producers (including local farmers)	up to 2 years
Preparation of machinery and equipment for the reopening of the plant	up to 1 years
Electricity tariff review	up to 1 years
Organization of public awareness raising campaigns	up to 3 years
Organization of workshops for mass media	up to 3 years
Promotion of organizations providing counseling on investment in technologies	up to 5 years

Use of the technologies adopted to local conditions	up to 2 years
Installation of devices mentioned in the project design to carry out proper monitoring	up to 2 years
Provision of training courses and qualifications for the employees of the biogas plant	up to 2 years

Budget and Resource requirements

The total cost of the project is estimated 315 k$ for three years including installation of devices defined in the project design phase in the amount of 110 k$. Most possible and reasonable financing sources are private, international investments as well as revolving financial resources of civil funds.

Measurement and Evaluation

The factors to measure, evaluate and monitor are:

- Package of the developed proposals;
- Amount of investments in waste management sector;
- Amount of loans granted by commercial banks in the waste management sector;
- Number of the meetings, discussions and round tables held;
- Application to PSRC for revision of electricity tariffs;
- Number of trainings, trained persons, study visits;
- Number of installed equipment; Properly filled in monitoring reports;
- The quantity and uncertainties of GHG emission reduction;
- Schedule adherence;
- Effective spending of financial resources;

Possible complications, challenges and risks

- Recommendations are not implemented or are implemented partially;
- Required financial resources for the introduction of economic mechanisms can be high and the government may not approve the proposals;
- Low interest among commercial banks and insufficient funding;
- Lack of interest among the poultry producers;
- PSRC establishes unacceptably low tariffs for electricity;
- Small number of consulting organizations; Lack of interest among consulting organizations;
- Insufficient market study; Personnel turnover;
- Lack of funding;

Responsibilities and coordination

Action/Activity	Responsible	When	How
Elimination of economic and	Ministry of Economic Development and	2017-	Successful implementation of the package of the developed proposals; Reduction of

financial barriers	Investments	2018	loan interest rates; Effective cooperation among animal waste producers; Successful operation of machinery and equipment; The produced electricity is sold at a higher price.
Removal of awareness related barriers	MNP	2017-2019	The knowledge of the citizens and representatives of the mass media increased.
Elimination of technological barriers	MNP, Ministry of Territorial Administration and Development, "Max Concern" LLC	2017-2022	Consulting organizations have sufficient technical skills and knowledge; Electricity and heat production; The operation of the plant is monitored properly.
Implementation of social measures	"Max Concern" LLC	2017-2019	Organizing training courses and qualifications for the employees of the biogas plant. Successful operation of the plant equipment.
Measurement, reporting and verification	MNP, "Max Concern" LLC	2017-2020	Approval of procedure and methodology

List of References

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Ref-2	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-3	Armenia's First Biennial Update Report 2014 to the UNFCCC (under development) http://www.nature-ic.am/bur-project_document/
Ref-4	National Greenhouse Gas Inventory Report of the Republic of Armenia (2012) under the United Nations Framework Convention on Climate Change. Yerevan 2015 http://www.nature-ic.am/wp-content/uploads/2013/10/Inventory_final_eng.pdf
Ref-5	Armenia Development Strategy for 2014-2025 (ADS) (Annex To RA Government Decree # 442 - N on March 27, 2014) www.minfin.am/index.php?fl=78&lang=3
Ref-6	Enhancing Implementation of Technology Needs Assessments Guidance for Preparing a Technology Action Plan http://www.tech-action.org/-/media/Sites/TNA_project/TNA%20Guidebooks/Guidance-for-Preparing-a-Technology-Action-Plan_Upload.ashx?la=da
Ref-7	Multi-criteria analysis: a manual January 2009 Department for Communities and Local Government: London http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf
Ref-8	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
Ref-9	Draft 2nd National Energy Efficiency Action Plan for The Republic Of Armenia https://www.energy-community.org/portal/page/portal/ENC_HOME/DOCS/4062399/2DC80ACE5DDE36BFE053C92FA8C0D222.pdf
Ref-10	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-11	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-12	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 List of stakeholders involved and their contacts

Institutions involved in stakeholder consultation process

Institution	Representative	Contacts
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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

Discussion of Technology Action Plans for priority technologies, presentation of barriers, market description and analysis of favorable environment for Climate Change adaptation and mitigation technologies transfer and diffusion, 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 Buzand st., Yerevan, 0010, Armenia,
December 19, 2016

10:00 – 10.05	**Opening of the meeting** *Aram Gabrielyan, TNA National Project Coordinator*
10:05 – 10:30	**Presentation of the measures to overcome barriers forClimate Change Adaptation technologies transfer and diffusion** *Vardan Melikyan, TNA Adaptation Component Team Leader*
10:30 – 11:15	**Presentation of the measures to overcome barriers for Climate Change Mitigation technologies transfer and diffusion** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
11:15 – 11:30	**Discussions**
11:30 – 12:00	**Coffee brake**
12:00 – 13:00	**Technology Action Plan template presentation** *Tigran Sekoyan, TNA Mitigation Component Team Leader*
13:00 – 14:00	**Lunch**
14:00 – 15:30	**Discussions of Technology Action Plans preliminary versions in sectoral working groups** *Samvel Avetisyan, Agriculture Expert* *Arevik Hovsepyan, Water Expert* *Mkrtich Jalalyan, Energy and Industry Expert* *Meruzhan Galstyan, Land Use and Forestry Expert* *Davit Shindyan, Waste Management Expert*
15:30 – 16:00	**Summary**