Ministry of Nature Protection of RA

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Green Urban Lighting
UNDP-GEF/00074869 Project

GREEN URBAN LIGHTING

PROGRESS REPORT
ON ACTIVITIES PERFORMED
FROM JANUARY 2014 TO MAY 2016

YEREVAN – 2016

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Executing agency		UN Development Programme
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ABBREVIATIONS

CJSC	Closed Joint-Stock Company
CNCO	Community Non-Commercial Organization
EE	Energy efficiency
GEF	Global Environmental Facility
GHG	Greenhouse gases
G2iA	Armenia-France Inter-Professional Network
HPSL	High-Pressure Sodium Lamps
KM	Knowledge management
LED	Light Emitting Diodes
LLC	Limited Liability Company
MEPS	Minimum Energy Performance Standards
MoNP	Ministry of Nature Protection of RA
MoUD	Ministry of Urban Development of RA
MoENR	Ministry of Energy and Natural Resources of RA
MV	Mercury vapor
NPUA	National Polytechnic University of Armenia
PR	Public relations
RA	Republic of Armenia
R2E2 Fund	Armenia Renewable Resources and Energy Efficiency Fund
RV	Revolving Fund
SARM	National Institute for Standards of Armenia
TA	Technical assistance
UNDP	United Nation Development Program
YIC	Yerevan Illumination Company CJSC
YM	Yerevan Municipality

UNITS OF MEASURE

W	Watt
kW	kilowatt
kWh	kilowatt per hour
MWh	megawatt per hour
m	meter
m^2	square meter
°C	degrees centigrade
Lx	lux

Contents

1. Introduction

Lighting sector accounts for around 19% of total energy consumption globally, according to the data of International Energy Agency. As a result, this sector is among major sources of greenhouse gas emissions.

Along with that, application of modern energy efficient technologies and control systems allows decreasing essentially the installed capacity and power consumption of lighting systems, thus, reducing operation, maintenance and energy costs, as well as contributing to greenhouse gas emissions reduction. Therefore, transition to energy efficient lighting is one of direct and economically feasible tools for combating the climate change both globally and locally.

It is worth mentioning that along with these benefits energy efficient modernization leads to improvement of indoor and outdoor illumination quality contributing to better living and working conditions, comfort and traffic safety.

Wide use of inefficient technologies and equipment in the lighting sector in Armenia, as well as insufficient awareness of key beneficiaries (e.g. general public and local authorities) on modern energy efficient technologies result in continuous growth of power consumption and associated greenhouse gas emissions in the sector. This is true both for indoor lighting (e.g. residential sector) where inefficient incandescent lamps are still widely used and for outdoor lighting (e.g. streets) where sodium and even mercury lamps of low quality and efficiency are predominantly used. The situation is particularly complicated in municipal lighting sector as due to use of low quality equipment the operation and maintenance costs of lighting systems increase notably while making a significant share in community budgets.

In order to facilitate improvement of energy performance of municipal illumination in Armenia as well as to reduce its carbon footprint, UNDP-GEF "Green Urban Lighting" full-sized project (hereafter: "the Project") was launched in January 2014. The overarching goal of the project is to save energy and to reduce emissions of greenhouse gases by increasing energy efficiency of municipal lighting in the cities of Armenia via implementation of municipal investment programs and national policies. This objective is to be achieved via a number of interrelated activities including energy audits of municipal lighting systems, development of modernization proposals, piloting of modern energy efficient lighting solutions, establishment of financial and institutional mechanisms for replication of new technologies, improvement of legislative and regulatory framework, awareness raising and capacity building.

The report covers the progress of project for 29 months period of implementation (from January 2014 to May 2016) achieved in line with overall and annual work plans. The current progress report provides overview of the following achievements:

- The team of local and international experts is mobilized;
- The inception seminar conducted for introduction and validation project objectives and strategic vision and consider any changes in project action plan if needed and documented that in the inception report;
- The project Technical Advisory Committee is established and two meetings conducted;
- The partnership and cooperation framework with municipalities, state organizations, partner projects, private sector, financial institutions and other stakeholders established;
- The energy audit of municipal lighting systems of 9 urban communities in close cooperation with technical staff of municipalities was conducted, including: baseline data collection and verification, on-site actual measurements, analysis of the system performance and identification of major problems;
- Study tour to EU on advanced lighting technologies organized for project partners and Yerevan municipality;
- Educational modules on energy efficient lighting for high school students developed and conducted lessons in 5 colleges and modules under development for the National Polytechnic University of Armenia;

- Capacity building materials for technical staff of municipalities, lighting and design companies developed and training sessions organized on modern lighting, lighting norms and standards, measuring equipment, proper installation and operation of modern street lighting, technical regulations,
- Technical equipment is procured for the first testing and educational laboratory for lighting equipment in Armenia in the premises of Yerevan Illumination company;
- Awareness raising materials on green urban lighting including factsheets, leaflets, news, a lighting market reference book and a movie on street lighting developed and distributed;
- Presentation of the project objectives and progress at international events in Russian Federation and Kazakhstan;
- 9 demonstration projects on energy efficient modernization of street and park lighting in 7 urban communities of Armenia done and 3 projects on indoor and tunnel will be initiated in 2016;
- The concept developed and municipal revolving funds establishment in 5 urban communities for replication of energy efficient lighting modernization projects;
- The gap analysis of current legal framework on EE lighting is conducted and a new standard (SNiP) on natural and artificial illumination development on the base of most recent Russian and EU standard is initiated.

2. Expert team mobilization

A team of national and international specialist has been established to ensure proper implementation of the project activities and timely delivery of the expected outputs. Below brief information on scope of responsibilities of the experts involved on the base on the Long term contract arrangements and working on part-time in the framework of specified ToRs.

National Experts:

Mr. Artem Kharazyan, Senior Local Expert on Energy Efficiency
Responsibilities: (i) support the Program Coordinator to lead, supervise, and monitor project expert's team contractor's work, and to ensure timely delivery of outputs and conduct their performance appraisal; (ii) support in identifying and recruiting the competent staff and subcontractors, formulate task's technical specifications and participate in selection process; (iii) support the Program Coordinator to monitor and analyze the adequacy and content of the technical reports and project deliverables to achieve the project outcomes/outputs; (iv) provide technical backstopping and guidance to the national team of experts and subcontractors and supervise the work of technical experts; (v) organize and participate in meetings with the project partners and stakeholders aimed to coordinate joint activities aimed the fulfillment of the project objectives; (vi) participate in preparation of quarterly, semi-annual and annual progress reports in line with the project requirements for UNDP, responsible national partner, advisory board.

Mr. Armen Gulkanyan, Local Expert on Energy Efficient Lighting Market and Technologies
Responsibilities: (i) establishment and maintain communication with local and international companies represented in the Armenian lighting market; (ii) baseline data collection and analysis, monitoring of lighting systems; (iii) development of specifications for new lighting equipment; (iv) evaluation of proposals received from bidders; (v) supervision of delivery, acceptance, storage and installation of the procured equipment; (vi) coordination of establishment of a modern testing photometric laboratory; (vii) provision of technical consultation to the project and stakeholders.

Mr. Karen Sargsyan, Local Expert on Lighting System Audit (technical and supervision)
Responsibilities: (i) audit of municipal lighting systems; (ii) verification and analysis of baseline data; (iii) development of assessment reports and technical recommendations on lighting system modernization; (iv) support with development of technical specifications, bid evaluation and supervision of installation process; (v) periodic post-installation monitoring of pilot sites; (vi) development of statistics on technical parameters and results of pilot projects; (vii) technical consultations.

Mr. Vladislav Harutyunyan, Local Expert on Municipal Energy Efficient Lighting Pilot Projects
Responsibilities: (i) support with collection and verification of technical data on lighting systems; (ii) recommendations on design and implementation of pilot projects in Yerevan and other municipalities; (iii) organization and supervision of pilot implementation in Yerevan; (iv) periodic monitoring, technical check and defect identification of pilot systems; (v) support with development and adoption of a program for upgrades of public lighting system in Yerevan; (vi) consultations to technical staff of partner municipalities and stakeholders; (vii) collection and analysis of technical and financial information on new energy efficient street lighting projects implemented in Yerevan by local and international organizations and reporting to the project.

Mr. Hovhannes Nunyan, Local Expert on Economic Assessment and Financial Mechanisms
Responsibilities: (i) evaluation of economic feasibility of proposed pilot projects; (ii) analysis of financial baseline data on municipal lighting systems; (iii) development of a concert of municipal revolving fund for replication of pilot projects; (iv) support to the partner municipalities in establishment and operation of the funds; (v) monitoring of and monthly reporting on actual costs savings achieved through each pilot project; (vi) development of statistics on actual cost saving of pilot projects;

Mr. Tigran Sekoyan, Local Expert on Lighting System Audit (methodology and assessment)
Responsibilities: (i) support in planning and implementation of the municipal lighting system audits; (ii) development of methodology (guide) for energy audit of the selected municipal lighting systems; (iii)

support with energy audit of municipal lighting system of Yerevan; (iv) support in development of capacity building materials.

Mr. Arsen Karapetyan, Local Expert on Building Codes and Standards
Responsibilities: (i) development of overview of acting local legislation and regulation on lighting; (ii) lead, coordination and participation in the elaboration/revision/adaptation works on the new energy efficient legal acts, lighting codes and standards; (iii) development of a proposal on gradual phase-out of inefficient incandescent lamps based on best international practice; (iv) development of recommendations on energy efficient procurement of lighting equipment and lamps.

Mr. Artur Tsughunyan, Expert on Energy Auditing and Evaluation of EE potential
Responsibilities: (i) support the project with carrying out energy audits of indoor and outdoor lighting systems; (ii) evaluation of energy saving potential of the proposed pilot projects; (iii) support the project with development of a methodological guide on energy audit of lighting systems; (iv) development of capacity building and information materials.

Mr. Artak Hambaryan, Expert on Development of Teaching Modules on Light and EE Lighting Technologies
Responsibilities: (i) development of draft teaching modules on lighting and energy efficient illumination for NPUA; (ii) finalization of the modules based on the comments and recommendations received from the project and the University; (iii) final editorial screening of the modules before publication of the modules by the project.

Ms. Marianna Arzangulyan, Expert Team Assistant
Responsibilities: (i) support the expert team in planning, implementation and monitoring of the related activities included in the annual work plan as well as in preparation of periodic progress reports; (iii) assistance in development, translation and submission of necessary technical and financial documentations and reports; (iv) research assistance in collection and systematization of the existing national and international documents and guidelines; (v) development of informational materials and news; (vi) logistical arrangements for the seminars, workshops and trainings; (vii) ensure communication within project team and maintain external correspondence.

Mr. Vahan Mardirosyan, Driver/Monitor
Responsibilities: (i) support the project team with monitoring of pilot projects; (ii) drive the office vehicle, deliver and collect mail, documents and other items.

International Experts:

Mr. Steve Coyne, International Expert on Energy Efficient Lighting for Inception Phase
Responsibilities: (i) development and delivery of presentation on international best practice and technologies in improving energy efficiency and achieving energy saving in urban lighting sector; (ii) analyse of existing project related documents as well as recommendations and opinions provided by stakeholders during and after the Inception Workshop in order to prepare recommendations on the full-sized project implementation strategy; (iii) assistance to the project in development of the Inception Report.

Mr. John Rands, International Consultant on Roadway Tunnel Illumination Systems
Responsibilities: (i) provision of general recommendations on modern solutions for road tunnel illumination and energy efficient upgrade of existing tunnel lighting systems to ensure proper illumination, traffic safety and energy saving; (ii) development of scope of works and technical specifications for energy efficient upgrade of the tunnel and illumination system of the tunnel on Mashtots avenue in Yerevan city.

Mr. Vesa Rutanen, International Expert on Energy Efficient Lighting
Responsibilities: (i) provision of assistance to the project team in summarizing and analysing the project current progress and lessons learned from implementation of the main project activities; (ii) development of the project performance report and lessons learned in the context of key targets of the project; development of strategic recommendations on improvement of the project performance with regard to all 4 key project components; (iv) consultancy to the project team on scaling the impact of the project

activities on energy efficiency measures implementation through legal, financial and institutional mechanisms for sustainable replication of municipal energy efficient lighting measures and programs; (v) support the project team in identification of relevant legislation, standards and regulations to promote energy efficiency in municipal lighting sector; (vi) analyse the potential for enhancing energy efficiency of Yerevan city street lighting system and prepare recommendations for the development of comprehensive upgrade programme for the city street lighting system; consultancy on overall implementation of project as per request of the project team.

The expert team is mobilized to implement project activities in line with the Project Logframe and Project Annual Work Plan. The Logframe and Project Performance Analysis summarizing achieved progress and pending tasks as of April 2016 is introduced in the Annex II, whereas the Work Plan for 2016 with allocation of expert tasks is available in the Annex III.

3. Inception workshop and report

The Inception Workshop took place on 15th January 2014 in Yerevan, Armenia. The event hosted 96 participants (representatives of UNDP Regional Centre and similar UNDP projects in other CIS countries, public, municipal and private sector, experts and project team members) and was co-chaired by Mr. A.Harutyunyan, Minister of Nature Protection of the RA, Mr. B.Busetto, UN RC, UNDP RR, , and Mr. K.Areyan First Deputy Mayor of Yerevan city. The workshop was led and moderated by Marina Olshanskaya, UNDP-GEF Regional Technical Adviser on Energy, Infrastructure, Technology and Transport of UNDP Regional Centre for Europe and the CIS.

During the workshop, the project objectives, management arrangements and implementation approaches were presented, discussed and approved of as based on the ProDoc. The International Expert on Energy Efficient Lighting for Inception Phase shared the main trends in lighting sector and presents the most applicable technologies considering the Armenian project objective and sector targeted.

Picture 1: Participants of the project inception workshop

The participants greeted inception of the project implementation and expressed their willingness to support the project activities. However, a number of comments and suggestions regarding scope of the project and its implementation approaches were made by the stakeholders and recorded in the Inception Report to be followed-up. The Report was discussed with and approved by the UNDP-GEF Regional Technical Advisor.

4. Technical Advisory Committee

In accordance with the ProDoc, Technical Advisory Committee was formed with the aim to ensure advisory and information support to implementation of project components, aimed at:

- Facilitation of communication between the project and respective sectors as well as contribute to efficiency of decision-making process;
- Supporting respective actions to overcome the identified barriers that may hamper timely implementation of the project
- Supporting in collection of necessary data and ensure information exchange between stakeholders.

The Committee consists of 11 members – representatives of Ministry of Nature Protection, Ministry of Territorial Administration and Development, Ministry of Urban Development, Ministry of Energy and Natural Resources, National Institute of Standards, Yerevan Municipality, Scientific Research Institute of Energy, National University of Architecture and Construction of Armenia and national Polytechnic University of Armenia.

The first meeting of the Committee was held on May 6, 2014 and the second meeting on February 19, 2016.

Picture 2: First meeting of the project Technical Advisory Committee

5. Activities aimed at building knowledge and capacities for urban green lighting

The project activities were aimed at building technical foundation for municipal investment programs for energy-efficient lighting. The strategy selected was teach while doing energy audits of public lighting systems (streets, parks, public buildings, etc.) and thus demonstrate energy savings potential and projected financial returns as well as demonstrate technology advantages through practical and theoretical examples.

5.1. Audits of public (municipal) lighting systems

The ProDoc states that he project team shall organize the design and execution of at least ten technical audits of public lighting, with the goal of defining the technical basis for municipal plans on comprehensive energy efficient upgrade of the systems and for development of financial proposals for specific sets of upgrades to be carried out.

The project has established formal communication and working relations with 13 municipalities: Yerevan, Alaverdi, Spitak, Abovian, Sevan, Tashir, Stepanavan, Goris, Echmiadzsin, Ararat, Kapan, Gavar and

Kajaran[1]. These particular municipalities were approached by the project within the reporting period due to the interest in cooperation with the project.

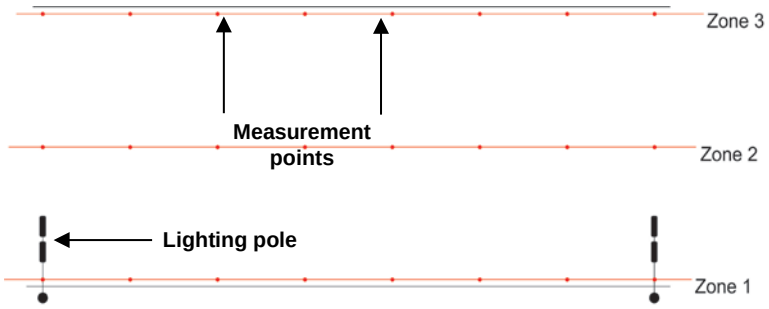
The standard Statements of Intent (SoI) were signed with the municipalities prior starting the audit of lighting systems and evaluation of EE measures in lighting systems. The SoIs defines the following three main cooperation areas: (i) organization of energy audit of the municipal lighting system, (ii) joint implementation and co-financing of demonstration project, (iii) establishment of a special revolving fund for financing energy efficient technologies' introduction in lighting system. Sample of SoI is introduced in the Annex VII.

Within the scope of the SoIs comprehensive energy audit of municipal lighting systems of Alaverdi, Spitak, Abovian, Sevan, Stepanavan, Goris, Ararat, Kapan, Kajaran and Gavar (ongoing) is conducted. The technical, financial and administrative baseline aspects of the systems are done and cost-effective energy efficient upgrade programs are proposed in line with acting norms. More detailed description of the proposed upgrade programs is presented in the Chapter 7 of this report.

The following data collection and analysis methodology (sequence of actions) has been applied for audit of the municipal lighting systems:

1. Collection of baseline information on municipal lighting system via a questionnaire provided to the municipal authorities. The questionnaire covers 25 parameters, including data on existing street lighting infrastructure - poles, luminaries, feeding and metering system, control equipment, annual O&M costs, service companies, procurement process, quality assurance, programs, etc.
2. Analysis of the received information, collection of missing data and information via email or phone communication with the municipal specialists and verification of information in course of site visits. During filed visits, the collection of additional data was done as well as joint on-site examination of street illumination systems and on-site measurement of illumination level and uniformity of a number of main and secondary streets was conducted with municipal technical staff. The measurements are made using mechanical pedometer, UA 1010BS type lux meter, GPS device and laser distance meter.

   Measurements of illumination level are performed in line with a standard methodology developed in line with recommended standards and applied to all municipalities. Particular, measurements were performed between lighting poles for the following three zones: (i) along the street side where lighting poles are installed; (ii) along the center of the street; (iii) along the street side opposite to the lighting poles. The measurement scheme with indication of above-described 3 zones and measurement points is introduced in the below drawing.



Picture 3: The street Illuminance level measurement scheme

3. Analysis of the obtained information and identification of the most suitable modernization option(s) done based on calculations performed by means of DIALux light emulation software.
4. Identification of basic parameters of the lighting equipment that may ensure necessary quality of illumination in line with the results obtained via DIALux software.

[1] Detailed list of communities, partner organizations and contractors that the project cooperated with within the reporting period is presented in the Annex III.

5. Development of a draft summary audit report with the overview and critical analysis of the existing system, identification of defects and proposed solutions, and description of technical advantages of the proposed modernization options as well as energy, costs and GHG emission reduction benefits, evaluation of approximate investment costs and calculation of simple payback period. For estimation of GHG emission reduction benefits respective standardized grid emission factor for Armenia is used[2].
6. Discussion of draft reports with the target municipalities and finalization of the reports based on received comments and remarks.
7. Publication of the reports on the project website.


Picture 4: Meeting with the technical staff of Kapan municipality and on-site measurements

Within the reporting period 8 audit reports were developed by the project team and provided to the partner municipalities.

The following general findings were made as the result of conducted audits:

- No detailed and reliable information on inventory and technical condition of existing street lighting infrastructure is collected in municipalities.
- Information on energy, operation and maintenance costs of street lighting systems is not collected and analyzed to identify potential for energy saving improvement.
- Power metering is usually executed via single-tariff meters.
- Commutation of the systems is performed either manually or via sensors and time relies.
- The vast majority of street lighting systems are based on plastic or aluminum fixtures without reflectors and optical parts equipped with sub-quality 250W and 150W HPS lamps.
- Wide application of 50-90W compact fluorescent lamps (CFL) that are usually considered inappropriate for street lighting because lamps of this type do not ensure proper luminance of the streets in compliance to the norms.
- Infrastructures are usually in poor condition (damaged poles and brackets, inappropriately installed or missing fixtures, old and not appropriate feeding systems, lack of grounding, high losses, etc.).
- Short daily duration of street lighting operation as a means to reduce energy costs.
- Indoor lighting of municipal structures such as city halls, kindergartens, libraries, etc. are predominantly based on CFLs or tube-type fluorescent lamps that ensure certain energy efficiency, however, do not meet specific illumination requirement because of shortages typical for fluorescent lamps (e.g. non-uniform lighting, blinking, low color rendering factor, etc.).
- Lack of awareness of the local technical personnel on modern, energy saving and cost-efficient lighting technologies.
- Procurement of inefficient and low-quality lighting equipment which is basically a consequence of state procurement system that is based on the cheapest offer and the main criteria of bid evaluation.

[2] https://cdm.unfccc.int/methodologies/standard_base/2015/sb36.html

All identified shortages were analyzed, duly reported to the municipal administrations via final discussion and submission of reporting as well as taken into consideration by the project team for development of modernization proposals and development strategies. At the same time, information on the current situation with poor and inappropriate illumination in the Armenian municipalities has been communicated to the project stakeholders in the Ministry of Territorial Administration and Development.

Detailed information on the results of municipal lighting system audits and proposed energy efficient modernization options is introduced in Annex IV.

5.2. Methodological guide for audit of municipal lighting systems

To support the municipalities in assessment of performance of municipal lighting systems the project has elaborated a draft methodology for energy audit of public lighting systems which is taking into consideration norm-setting and technical documentation currently in effect in Armenia as well as international best practice.

The draft methodology defined and details on procedure and scope of energy audit of lighting systems of Armenia for specialized entities to perform the audits. The document aims at revealing actual energy consumption in lighting systems, inefficient energy consumption points as well as explaining energy efficient and energy saving improvement measures.

It is envisaged to be submitted to specialized organizations for discussion and, upon confirmation by stakeholder parties, to approve as advisory handbook or a national standard. The draft methodology's development finalization and completion is foreseen during 2016.

5.3. Study tour on advanced technologies in urban lighting

Study tour for key sector actors on advanced technologies in urban lighting was organized from 27 till 30 October 2015. The tour was organized for the representatives of Yerevan Municipality, Yerevan Illumination Company and Institute of Standards of the Ministry of Economy of RA with the goal to build knowledge on state of art developments in planning and implementation of energy efficiency in municipal lighting sector in Europe. The study tour was co-financed by Schreder Company as main supplier of LED luminaries for retrofitting the first street lighting pilot project in Yerevan.

Armenian delegation met with CEN-CENELEC (17, Avenue Marnix, 1000 Brussels) to discuss cooperation with Institute of Standards of the Ministry of Economy of RA as affiliated member of CEN on norms and standards applied for promotion of the energy efficiency policy in lighting sector. Eric Marchand, Head of International Relations and Alexandro Beltrao, Program Manager of the Standards-Industry, Technology and Infrastructure Department provide inside on developments on norms and standards, and provided the list of standards on energy efficiency in lighting sector. Was agreed that Institute Standards will be provided access and right to translate and adopt the standards of CEN-CENELC, on condition of notification.

The visit to the Brussels main square, UNESCO heritage site, illuminated using SculpDot architectural floodlight concept by Schreder company was organized.

The delegation visited Liege - SKILL Schréder Light at Work in Liège to see and assess how the process of lighting product development, testing, and quality control is done. The mentioned processes are critical for ensuring the quality of the luminaries as well as lighting system selection by municipalities and decision makers, involved in infrastructural projects.

The agenda of meeting includes presentation of Companies general structure and history, quality control of luminaries produced; road and urban solutions, and visit to testing laboratory. For smart city solutions was presented the new product of Company named "Shuffle", which integrates, lighting column, Wi-Fi, surveillance cameras, dynamics. The presentations was followed by discussion on proper procurement planning for different solutions in cities and importance of proper technical specification development, to ensure appropriate energy efficiency solutions and selection of luminaries based on life cycle cost.

The next visit was to city Soto del Real Municipality, which implemented project on full replacement of the urban lighting systems in community, and scheme of ESCO contract. The project ensured 82% improvement of efficiency and the tour through the city proved the lighting quality in the evening hours. The important lesson learned from that example was ESCO contract modality.

The last visit was to Schreder factory in Guadalajara, were the Armenian delegation acquainted with the full cycle of the luminaries are production and quality testing.

Ideas and recommendations elaborated as a result of study tour:

- Request Mr. Petrenko to provide typical technical requirements developed of LED light manufactures association and used by urban municipalities in Ukraine to be used as procurement standard.
- Request from Soto Del Real municipality the ESCO contract;
- To establish communication with CEN-CENELEC on assessment and harmonisation of lighting system related standards;
- Update the software used by the UNDP-GEF project requesting the updated version of ULYSSE soft from Schreder;
- Provide all presentations, photos and printed materials to the project assistant for the web-site
- To elaborate opportunities for involving the private sector in street lighting upgrade based on the principle of ESCO service e.g.: (i) Dilijan town with Idea Foundation, ATDF management; (ii) Goris city with WB in the frames of tourism development project.

Picture 5: Participants of the study tour and the luminaries manufacturing shop

5.4. Technical training, capacity building and education for the respective stakeholders

The project has organized technical training and capacity building activities on energy-efficient lighting for specialists from municipal agencies, lighting companies, and building design institutes.

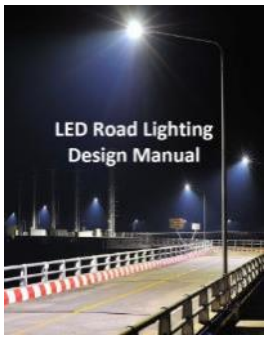
5.4.1. Development of training and capacity building materials

Translation and adaptation of LED Road Lighting Design Manual

The assessment of street lighting systems construction/reconstruction recent tenders organized for several communities in Armenia revealed the real gap in knowledge of specialists in design institutions and community administrations on modern technologies and proper development of technical specifications. Appropriate lighting services provided my municipalities are to ensure traffic safety and security of pedestrians and there is an increasing demand for such quality service specifically in urban areas.

At the same time, the increasing electricity tariffs trigger demand for efficiency of illumination. The rapidly evolving energy saving lighting technologies are making it an imperative for local authorities to reconsider traditional approaches of lighting provision taking into consideration the cost-effectiveness aspects.

To build the capacity of local municipalities and specialists of design institutions the project analyzed the available guidelines and manuals on modern lighting technologies and selected as most applicable the "LED Road Lighting Design Manual" commissioned by Philips Lighting (2015). The objective of this manual is to provide international funding organizations, client governments, and other stakeholders a useful tool to integrate LED road lighting solutions into relevant Energy, Transport, Urban and Rural Development projects. This manual suggests a practical project design and implementation roadmap that integrates industry best practices, internationally recognized standards, and cost effectiveness.



The permission for translation and publication of document was taken from the publisher. The manual was localized and published in Armenian language. Manual was presented to the broader audience during "Energy Efficient Lighting for Communities" workshop held on November 19, 2015, and distributed to key sector actors, specialized institutions, regional administrations and municipalities.

Translation and improvement of Street Lighting Evaluation Tool computer software

As proposed by UNDP Regional Technical Adviser the cooperation was established with the US based company to test and apply SEAD software (Street Lighting Evaluation Tool) aimed to evaluate the luminance and illuminance, energy consumption and life cycle cost for both LED and conventional fixtures on many common road layouts. The model allows assessing highest possible luminance of the selected pilot streets in combination with efficiency of the required investment.

The comprehensive analysis of the proposed tool was conducted by the project technical expert team and the identified shortcomings and problems of the tool was identified and communicated to the tool developers. Besides, the tool operational and supporting materials were translated into Russian, embedded into the program and are in testing process. The work considerably increased the scope of application of the Tool not only in Armenia but also in other FSU countries.

Development and dissemination of Guide on Energy Efficient Lighting

Informational brochure "Guide on Energy Efficient Lighting" for high school students and specialized educational institutions students was drafted for be further disseminated to their target audiences within a series of respective events.

The document is aimed to increase awareness of students on indoor lighting technologies (incandescent, halogen, compact fluorescent and LED lamps) via comparison of their advantages and disadvantages as well as on key parameters that shall be note while buying indoor lighting equipment.

The main objective of the Guide is to facilitate well informed decision making for selection of lighting technologies and systems. Similar but more simplified guide will be developed for low grade students of secondary schools.

Development of educational module on light and EE technologies for school students

The lectures and practical training was organized in 5 educational institutions: schools after Anania Shirakaci; Mkhitar Sebastaci and Hunan Avetisyan; Quant lyceum; and Physics and Mathematics specialized school after A. Shahinyan. Lectures covered the following topics: (i) basic concepts of light and optics; (ii) basic principles of photometry and photometric measurements; (iii) light sources and (iv) assessment of energy and economic benefits of energy efficiency.

The materials of the lessons in the form of power point presentation, practical guide on evaluation of feasibility of retrofitting in-door lights and guide for teacher are developed to be shared with the National Institute of Education for dissemination among teachers.

Development and delivery of educational module on light and EE technologies for universities

Currently the process of transition to energy efficient lighting in Armenia is hampered, among other factors, by limited number of qualified specialists with proper background and practical experience in energy efficient lighting. The National Polytechnic University of Armenia (NPUA) used to train specialists in the field of lighting engineering in the past; however, because of closure of the only lamp manufacturing factory in the country the faculty terminated its activities about 10 years ago. As the result, currently, students have limited option to acquire appropriate skills in the field of lighting through professional training and practice. On the other hand, widespread interest towards modern and efficient lighting solutions triggered by constant rise of electricity tariffs requires professional support by skilled local specialists for indoor and outdoor lighting systems.

Cooperation with NPUA on the development and integration of teaching modules is organized within the scope of Statement of Intent signed between UNDP and the University. The document sets framework for cooperation on improvement of curricula for engineers with topics covering energy efficiency lighting as well as to consider feasibility of establishment of a laboratory.

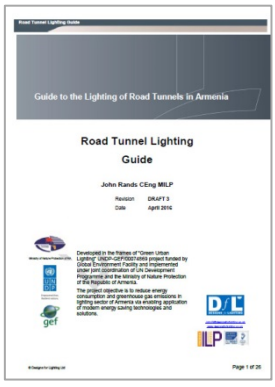
The mentioned activities will enhance student's understanding of the new developments in lighting sector and evaluation of economic and environmental benefits from proper design and operation of advanced energy efficient and environmentally safe technologies and practices.

To achieve this goal the project jointly with NPUA has initiated development of teaching modules on lighting and energy efficient illumination to be integrated into teaching curricula of the University. The task covers the following topics:

1. Lighting theory and principles for engineers and architects
2. Artificial light sources
3. Indoor lighting: health-related, efficient, and cost-effective solutions
4. Outdoor lighting: special deeds for street traffic, pedestrians, parks, landscaping and nature.
5. Software for simulation and design
6. Technical and economic principles of energy efficient lighting
7. Lighting and ecology.

Development of Guide to the Lighting of the Road Tunnels in Armenia

There are about 10 tunnels in Armenia (in Yerevan and regions) that are either under illuminated (illumination systems are of low quality and do not ensure proper light and traffic safety) or not illuminated at all. Ensuring safe illumination of existing and new road tunnels is a major issue to be addressed by the municipal and state authorities in the nearest future. In order to ensure both efficiency and quality of future technical solutions, relevant recommendations on international practice on tunnel lighting are needed to be communicated to the Armenian stakeholders.



For that reason the project contracted International Consultant on Roadway Tunnel Illumination Systems who was tasked to develop and present a Guide to the Lighting of Road Tunnels in Armenia, a document that provide key information on road tunnel lighting design and performance. The guide is to help Armenian designer, constructor as well designers makers to properly design and implement tunnel illumination projects.

The aim of this guide is to illustrate to the reader the processes involved in the development, design and analysis of road tunnel lighting together with, in the professional opinion and experience of the author, current best practice recommendations for the lighting scheme and potential equipment involved in achieving energy efficiency for the installation. From the guide the reader will be able to understand some of the complexities that can occur in producing a compliant road tunnel lighting scheme and any additional or specific considerations that may have to be made during scheme concept, specification, design, installation and operation & maintenance.

5.4.2. Organization of trainings and capacity building events

Training on proper installation and operation of modern street lights

Within the scope of the demonstration project on energy efficient modernization of Isakov Avenue and Tairov street, a two-day training session on proper installation and operation of Ampera LED luminaries was conducted by the project with specialist from Schréder Group member Comelec S.A.

The event took place on February 3-4, 2015 and hosted 47 participants from state and local government bodies, international organizations, design and other specialized organizations, management and technical staff of Yerevan Municipal Illumination CJSC, UNDP Armenia and Yerevan Municipality.

The event covered the following topics:

- Introduction to LED lighting solutions
- Overview of lighting sources
- Technical specificities and performance of Schréder Ampera Luminaires.

The presentation session was continued by practical on-site training on installation and adjustment of luminaries on the pilot street for technical staff of Yerevan Illumination Company.

Picture 6: Testing of new fixture, participants of the training session

Picture 7: Certificate granting ceremony at the Yerevan Illumination Company

Seminar on technical regulation and establishment of a national testing laboratory

The seminar on “Technical regulation of lighting devices’ application in the frames of Customs Union and issues of establishment of national testing laboratory” was held on March 24, 2015.

The specialists invited from the Center of LED and Optoelectronic Technologies of National Academy of Sciences of Belarus provided consultations on required equipment and setting operational procedures for a modern photometric testing laboratory to certify quality of locally produced and imported lighting equipment and devices. The event was attended by representatives of lighting companies, design institutions, partner municipalities, experts and other project stakeholders. At the same time, communication has been established with the Center to cooperate on identification of a list of required

equipment and setting operational procedures for a modern photometric testing laboratory to certify quality of locally produced and imported lighting equipment and devices.


Picture 8: Participants of the seminar


Picture 9: Participants of the event and demonstration of lighting equipment produced by the Center

Workshop on energy efficient lighting for communities

A workshop named “Energy Efficient Lighting for Communities” was organized on November 13, 2015 for project stakeholders to present project achievements, particularly, the experience in improving the lighting system in urban communities and to introduce perspectives of LED technology application expansion and lighting market development issues. Also the event was aimed at presentation and distribution of the recent project publications i.e. “Reference book on acting organizations and rendered services in the lighting sector of Armenia” and “LED Road Lighting Design Manual”.


Picture 10: Participants of the workshop on energy efficient lighting

Seminar on modern lighting, lighting norms and standards, measuring equipment

On February 19, 2016, the project organized a workshop on “Modern lighting, lighting norms and standards, measuring equipment” for about 40 stakeholders representing state authorities of the RA,

design institutions, private sector acting in lighting market as well as educational institutions and academia. The workshop was led by experts of Russian Lighting Research Institute after S.I.Vavilov (VNISI): Mr. Maxim Sachkov, Deputy General Director, Mr. Anatoli Chernyak, Head of Laboratory, and Mr. Roman Belyaev, Chief Metrologist.

VNISI is Russian Lighting Research Institute named after S.I. Vavilov is the leading Russian national research center for lighting engineering. The center specializes in knowledge-intensive problem solving in the fields of theory, methods, technology and standardization of lighting, developing high performance lighting fixtures and illumination devices, developing lighting systems for the national economy, military lighting equipment and space technology.

During the event the following topics were covered:

- Draft Technical Regulations "On requirements towards energy efficiency of energy-consuming electrical devices": main provisions and upgrade areas;
- Optometric norms of outdoor lighting devices;
- Control methods of standardized parameters of outdoor lighting;
- Legal basis: accreditation, licensing, compliance conformity, certification;
- Optometrics and electro-technical measurements of lighting devices: equipment and methods
- Operational features of lighting devices: equipment and methods;
- Instruments for quality control and compliance conformity of lighting devices: mobile optometric laboratory;
- Review of modern lighting devices and their application options: traditional lighting devices and light-emitting diodes.


Picture 11: Participants of the workshop on modern lighting, lighting norms and standards

<u>Presentation of educational module on light and energy efficient technologies for school students</u>

The project team organized a series of presentations on energy saving for students of 5 educational institutions (mentioned in above section). Lectures were followed by a contest aiming to strengthen the acquired knowledge through practice.

For the 15 best projects on energy efficient lighting prepared by students within the framework of the contests awards and certificates were prepared by Green Urban Lighting project.

Awards and certificates were granted at award ceremonies organized in each of the mentioned schools. All materials are available at the project website.


Picture 12: Participants of the training sessions on energy efficient lighting


Picture 13: Demonstration of work of the lamp testing stand and award granting ceremony

Presentation of a country-specific guide on EE modernization of tunnels

On April 20, 2016, a seminar aimed at presentation and discussion of the guide with country-specific recommendations and state-of-art solutions for energy efficient design and modernization of roadway and highway tunnels illumination systems was organized. The guide was developed and introduced by Mr. John Rands, International Consultant on Roadway Tunnel Illumination Systems. The seminar covered the following topics relevant to the discussed subject: (i) explanation of key terms and definitions; (ii) overview of road tunnels, the current practice of tunnel illumination and technical solutions; (iii) design and performance of tunnel lighting, materials and installation, summary of recommendation and risk assessment.

The event hosted more than 15 representatives of national authorities, Yerevan Municipality, YIC, design and constriction organizations, individual experts.

Picture 14: Participants of the seminar on energy efficient tunnel illumination

5.5. Increased awareness and support among the general public for green urban lighting programs

Increased awareness of the project stakeholders and general public on cost saving and environmental benefits of modern energy efficient and energy saving lighting technologies is considered as the one of the main objectives of the project aimed at changing consumer behavior toward sustainable green urban lighting.

5.5.1. Awareness raising activities, material and publications

Project factsheet

An awareness raising leaflet to highlight the project's objectives, activities and expected outcomes as well as a booklet providing basic advices to consumers on energy performance and cost saving potential of 4 main types of indoor lighting products were developed and published. More than 150 copies of the leaflet and about 2000 copies of the booklet were distributed during different events organized by the project and in the course of social survey conducted by the project and described in next section.

Participation in the Energy Week 2014

Information and awareness raising materials developed by the project were presented and distributes during Energy Week organized by Armenia Renewable Energy and Energy Efficiency Fund in Yerevan Moscow House on July 2-3, 2014. The event aimed at demonstration of the latest developments in energy saving and renewable energy sector if the country including legislative reforms, technological innovations, funding opportunities, etc.

Development of factsheets on implemented pilots

Factsheets with information on completed pilot projects and highlights on improved parameters of modernized lighting systems were prepared for 7 pilot projects. The factsheets are available from the project website and are distributed at thematic events and relevant working meetings, such as Earth Hour, Yerevan Zoo opening and Yerevan city day.

Yerevan city energy efficient street lighting pilot project inauguration event

An event on inauguration of the Yerevan city energy efficient street lighting pilot project in the context of "Earth Hour" international environmental event was organized in the UN House Conference Hall on March 27, 2015. The event opened by Mr. Bradley Busetto, UN RC, UNDP RR in Armenia, Mr. Aramayis Grigoryan, Minister of Nature Protection of the RA, Mr. Kamo Areyan, First Deputy Mayor of Yerevan and

attended by more than 50 representatives of government agencies responsible for urban development, energy security sector, as well as international organizations, diplomatic corps, and the media.

“The environmental event launched today is a result of long-term successful cooperation with local self-government bodies, enabling to assess energy efficiency as an environmental issue. Yerevan city and, in particular, its municipal lighting system, accounts for a large share of energy consumption in the country, that is why Yerevan municipality was invited as a partner of the ‘Green Urban Lighting’ project, implemented under the coordination of the Ministry of Nature Protection. To demonstrate advantages of the energy efficient street lighting system, Isakov Avenue and Tairov Street that connect Yerevan city center to Zvartnots international airport were selected as a pilot area,” Minister of Nature Protection Aramayis Grigoryan said in his opening remarks.

“Yerevan is the largest energy consumer in the urban lighting sector in the country and admits its major responsibility for efficient resource management and emission reduction.

With the aim to facilitate the “green economy development” and improve the wellbeing of the city residents, Yerevan has joined the EU ‘Covenant of Mayors’ initiative. Covenant signatories aim to meet and exceed the 20 percent CO_2 reduction objective by 2020,” said the First Deputy Mayor.

Picture 15: Participants of the Yerevan pilot project inauguration event

Opening ceremony of Zoological Garden of Yerevan City

On June 1, 2015, on the International Day for Protection of Children, an opening ceremony of Zoological Garden of Yerevan city was held with participation of Mr. Taron Margaryan, Yerevan Mayor, Mr. Kamo Areyan, First Deputy Mayor of Yerevan city, and Mr. Bradley Busetto, UN Resident Coordinator and UNDP Resident Representative in Armenia.

In the frames of a comprehensive modernization program of the Garden implemented by the Yerevan city Municipality, the project successfully completed its another pilot – Improving energy performance of lighting system of Yerevan Zoological Garden.

The project banners were installed during the opening ceremony and informational materials and leaflets were distributes to the first visitors of the renovated Zoo.

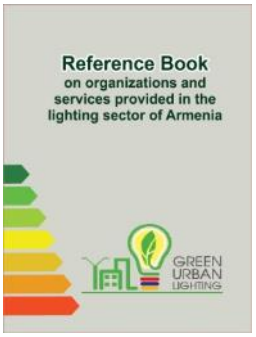
Picture 16: Project banners used for inauguration event and representatives of UNDP (Mr. Bradley Busseto, UNDP RR) and Yerevan Municipality (Mr. Taron Margaryan, Mayor) visiting newly reconstructed Zoo

Reference book on acting organizations and rendered services in the lighting sector of Armenia

A number of meetings were held by the project experts to establish and strengthen cooperation with key local and international players of the Armenian lighting market such as manufacturers and suppliers of modern energy efficient lighting equipment, distributions and designers, etc. This work resulted in development and periodic update of the comprehensive database of market players.

Constant communication with the players shows that the lighting equipment and services market in Armenia is dynamic and the interest for new technologies, including also energy efficiency solutions is evolving. The interest is triggered due to major projects on road construction, development of shopping centers, municipal programs, and development of hotel business as well as tourist attractive areas that also involve introduction of efficient (in last years, mainly LED based) lighting technologies.

Considering the importance of accessibility of information on international and local manufacturers and suppliers of modern energy efficient lighting equipment in Armenian market as well as on services provided in the sector, the "Reference book on acting organizations and rendered services in the lighting sector of Armenia" was developed and published in English and Armenian languages. The document presents specification of lighting equipment available in the local market, and provides information on companies that produce and import them.



The publication was distributed among municipalities, national and local stakeholders and financial organizations and placed on the project web-site. The project is planning to update the database on continuous base.

Using media channels

The media was invited to the major events of the project and the main news channels provided information on the demonstration project in Yerevan. The local TV channels transmitted information on the pilot projects, in Spitak and Alaverdi.

A twenty-minute movie on the main achievements of the project was produced for broadcasting by at least by 2 national TV channels and the Internet. Having mainly an awareness raising objective, the movie helps to build capacity of the general audience on the current energy efficient solutions of urban lighting in Armenia and to stress importance of the urban lighting as public service. It demonstrates long term advantages of timely consideration of energy saving technologies and solutions in urban lighting as well as stresses general energy and cost saving, quality improvement and climate change mitigation benefits that can be achieved within the context of country's limited energy resources, impact on community budgets and growing prices of electricity.

All these advantages are introduced on the example of successfully implemented energy efficient lighting pilot projects and energy efficiency revolving funds established with the direct support of the project and supported by interview with mayors and deputy mayors of the partner municipalities and project experts.

Technical and financial information and project statistics are introduced in the form of infographics.

Picture 17: Screenshots from the movie on the Green Urban Lighting project

The project web-site and Facebook page

Information on project objectives, activities and achieved results is being developed and published on the project webpage at the website of the Climate Change Information Center (www.nature-ic.am).

The page provides access to the following information in 2 languages:

- **Project Document:** includes brief project descriptions as well as full versions of the Project Document in English and Armenian.
- **Staff/Experts:** Project organigram as well as local and international experts.
- **Technical Advisory Committee:** Composition of the Technical Advisory Committee (TAC). Here the visitor can find also information on the meetings of the TAC.
- **Publications and Reports:** Inception Report, Reference Book and Manual produced by Project.
- **Pilot Projects:** this section is the most informative from the viewpoint of Project activities description, as it includes all fact sheets of pilot projects.
- **News and Events:** these are the most dynamic and frequently updated page, as information on workshops and different awareness raising events have been organized.

Another information dissemination channel is the Green Urban Lighting thematic group in the Facebook opened and regularly updated by the project team. The group is to serve as a platform for exchange of information, experience and views on energy efficient lighting in Armenia and throughout the world.

Currently the group joins 33 members from various sectors and is growing continuously.

Picture 16: Screenshots of the project webpage and Facebook page

5.5.2. Participation in international events

During the reporting period the project experts took part in a number of international workshops, seminars and exhibitions on energy efficient lighting organized by partner UNDP projects in Kazakhstan and Russian Federation. During these events experts made presentation on the project objectives and achievements as well as established working relation with partner organizations. The list of events is introduced below.

- International Conference on “Energy Efficient Lighting: Problems and Perspectives of Lighting Engineering Sector in Kazakhstan”, organized by UNDP/GEF Project “Promotion of Energy-Efficient Lighting in Kazakhstan” in Astana, Kazakhstan on 20-23.10.2014.
- Steering Committee meeting of UNDP “Transforming the Market for Efficient Lighting” project, organized in Moscow, Russian Federation on 3-5.03.2015.
- International Conference on “Promotion of Design and Construction of Energy Efficient Residential Buildings in Kazakhstan” organized by "Energy Efficient Design and Construction of Residential Buildings" project of UNDP-GEF in Astana, Kazakhstan on 4-5.11.2015.
- International Exhibition “Inter Light 2015”, Moscow, Russian Federation on 9-14.11.2015.
- International Conference on “Energy Efficient Lighting: Problems and Prospects of Development of Lighting Industry in Kazakhstan”, Astana, Kazakhstan on 18.11.2016.

5.6. Establishment of a testing laboratory for lighting equipment and educational laboratory in a university

5.6.1. Establishment of the first modern photometric laboratory in Armenia

Widespread presence of outdated, inefficient and poor quality lighting sources on the Armenian lighting market is considered as serious barrier for penetration of the EE lighting technologies. In order to address this issue, the project initiated establishment of a modern photometric lighting laboratory that will enable checking the technical parameters of light sources and confirm their conformity with the declared and/or required parameters.

The list of most essential equipment for the laboratory was proposed by consultants from Belarusian and consists of integrating sphere and spectroradiometer as well as necessary ancillary equipment on initial stage. Yerevan Illumination Company as beneficiary of this activity provided space - two renovated rooms located in the Komitas 28 premises of the Company. The installed equipment will allow checking and measuring technical parameters of light sources such as luminous flux, luminous efficacy, spectrum, color temperature and color rendering index. In 2016, the laboratory will be supplied with complementary equipment and the staff of the laboratory will be trained for provision of services to all interested parties from private and public sectors. At the same time the laboratory will serve as a training center for university students (particularly, NPUA), who are taking courses on energy efficient lighting.

Picture 17: Installation of the equipment at the new laboratory premises provided by Yerevan Municipality

5.6.2. Establishment of an educational laboratory

With the scope of the SoI signed between UNDP and NPUA it is planned to establish an educational laboratory at the premises of the University. The project will provide support for equipping the laboratory with a lamp testing stand (portable and stationary) that allows simultaneous operation of different types of lamps (incandescent, halogen, compact fluorescent, LED), visual testing of their brightness and color range and measurement of their parameters, namely, wattage, amperage, etc. The stand will help in visual demonstration of advantages of energy saving lamps. Along with the testing stand, the laboratory will be equipped with a computer with lighting design software (e.g. DIALux or ReLux) allowing emulation of various lighting options and generation of effective and professional lighting calculations in an easy way. Interested students may learn to operate the software by the help of a user guide to be provided by the project. In case of successful cooperation, it is planned to install similar lamp testing stand in the branch of the University in Gymri.

5.7. Evaluation of results of awareness raising and capacity building efforts

In the below table an overview of the results of the project awareness raising and capacity building activities implemented within the reporting period is provided. This information is developed to help the project to analyse achieved progress and identify needs for further awareness raising and capacity building activities to be organized by the end of the project.

Table 1: Overview of the results of the project awareness raising and capacity building activities

Awareness Raising			
N	**Activity**	**Provided Information**	**Dissemination and Audience**
1	Seminar on Energy Efficient Lighting	Types and parameters of energy efficient lighting equipment.	More than **15 representatives** of MoNP, YM, R2E2 Fund, individual experts.
2	Guide on Energy Efficient Lighting for Students	Existing lighting technologies, their application, pros and cons, modern energy efficient solutions.	Hard copies distribution is ongoing. **Posted on the website.**
3	Presentation of educational module for college students	Key information on light and issues and energy efficient technologies and solutions in the sector.	About 180 college students in 5 institutions. **Posted on the website.**
4	Workshop on Energy Efficient Lighting for Communities	Sharing experience in improving the lighting system in urban communities, perspectives of LED technology application expansion and lighting market development issues. "Reference book on acting organizations and rendered services in the lighting sector of Armenia" and "LED Road Lighting Design Manual" translated into Armenian and localized were presented and distributed to the participants.	More than **60 representatives** of urban communities of RA, experts of specialized organizations, Armenian lighting equipment market actors, representatives of financial sector, and education and science institutions. **Posted on the website.**
5	Development of the project factsheet	Key points on objective, components, measures, partners funding and timelines.	Distributed widely **Posted on the website.**
6	Development of factsheets on implemented pilots	Key points on the selected sites/streets features, co-financing arrangements, partners, before/after situation, energy performance gains, replicability potential.	Distributed widely **Posted on the website.**
7	Yerevan city energy efficient street lighting pilot project inauguration event	Present the pilot project as setting new standards for street lighting and expected to become scaled-up through upgraded energy efficiency standards for street lighting, public procurement, and through development of business plans for urban street lighting improvement. For awareness raising purposes, the ceremony is organized to coincide with Earth Hour, an internationally recognized "lights-off event" (last Saturday in March).	More than **50 participants** from various sectors including high-level decision makers. **Posted on the website.**
8	Opening ceremony of Zoological Garden of Yerevan City	Present the pilot project as a particular case of park illumination effort, as Yerevan Zoological Garden serves as a facility for natural sciences, environmental protection and educational purposes, especially for children and youth.	About **30 participants**, high-level presiding persons. **Posted on the website.**
9	Development of documentary on Green Urban Lighting Project	Ensure higher visibility of the projects' achievements and outputs of its pilots as providing modern energy efficient technical financial and institutional solutions for municipal lighting sector.	In production **Posted on the website.**
Capacity Building			
N	**Activity**	**Covered Topics**	**Recipient**
1	Reference book on acting organizations and rendered services in the lighting sector of Armenia	Information on products and services provided by local companies in Armenia.	Distributed to about **70 sector actors** including **41 municipalities**. **Posted on the website.**

2	Study tour on advanced technologies in urban lighting	The participants visited production facilities and testing laboratories of the Schreder company, Belgium, held talks on financial and institutional bases for ensuring higher energy performance in municipal lighting with the municipal authorities of Soto del Real town, Spain, discussed improvements to the relevant regulative base and the respective policy promotion options with specialists of European Committee for Standardization.	**6 participants** from Armenia, including representatives of Yerevan city municipality, Yerevan Municipal Illumination company, National Institute of Standards and the Project. **Posted on the website.**
3	LED Road Lighting Design Manual	The manual is a vendor-neutral knowledge management tool prepared by Development Finance International, Inc. and commissioned by Philips Lighting for professional reference by transport, urban, and energy sector professionals. Translated into Armenian and localized.	Distributed to about 70 sector actors, including 41 municipalities **Posted on the website.**
4	Training on proper installation and operation of modern street lights	Train the respective staff of "Yerevan Municipal Illumination" CJSC to properly handle the LED luminaires and contribute to implementation of the pilot projects; training certificated handed.	More than **20 technicians** of Yerevan Municipal Illumination company **Posted on the website.**
5	Seminar on technical regulation and establishment of a national testing laboratory	The event is contributed to identification of need for establishment of modern photometric laboratories in Armenia and to engaging Armenian companies in the network of national testing laboratories of lighting products.	About **30 sector actors** from state authorities, design institutions and production companies **Posted on the website.**
6	Seminar on modern lighting, lighting norms and standards, measuring equipment	Experience exchange on modern energy efficient lighting implementation, lighting norms and standards improvement, measuring equipment application.	About **50 representatives** of state authorities of the RA, design institutions, private sector, educational institutions and academia. **Posted on the website.**
7	Presentation of a country-specific guide on EE modernization of tunnels	Information on modern solutions for energy efficient lighting design and implementation for roadway tunnels.	About **15 specialist** and **experts** from state authorities, design institutions, construction companies, etc. **Posted on the website.**

6. Pilot urban green lighting projects

Drawing upon results of energy audits described in the Chapter 5.1., the project has provided both technical assistance and incremental direct investments to support the implementation of selected pilot projects for energy-efficient public lighting in Yerevan and other selected urban areas. This is one of the most important components of the project as it is to demonstrate not only energy, cost and emission reduction but also comfort and safety improvement benefits from introduction of new energy efficient lighting technologies and solutions, as well as to provide technical, procedural and financial insight for replication of the proposed approaches through municipal programs and associated financial support.

Along with these major objectives the pilots shall serve also the following purposes.

- Assessment of the current technical conditions and performance of municipal public lighting (further to the results of audits);
- Generation of technical and financial documentation to confirm or deny the projections and recommendations of the public lighting audits;

- Creation of informational and practical knowledge basis for comprehensive city-wide plans for public lighting upgrades;
- Building trust of key national and local stakeholders and decision makers towards new energy efficient lighting technologies tested within the scope of pilots;
- Enhancement of capacity of national and municipal officials, experts, and energy-service contractors to manage and implement lighting efficiency projects, in preparation for expanded implementation later;
- Identification of financial partners and testing of financing mechanisms (e.g. revolving funds);
- Creation of financial track records to help to identify and define partners, terms and conditions for future financing of expanded lighting efficiency programs (ideally reducing costs and increasing availability of financing by reducing investors' risk);
- Creation of a vehicle for public education and outreach about the environmental and financial benefits and visual appeal of energy efficient lighting;
- In certain cases, acceleration of medium- and long-term market penetration of LEDs via increased awareness, reduction of the perception of risk, and stimulus for expanded supply.

Pilots were identified in line with pilot site selection criteria and designed and implemented in line with the common methodological approach applied in all municipalities.

The key criteria for selection of pilot projects are as follows:

- Importance of the proposed objects (e.g. street, park, house) from social, safety, visibility and other standpoints;
- Current technical condition and performance of the illumination system (audit of pilots);
- Pilot energy saving, cost reduction and GHG emission reduction potential (data analysis);
- Willingness of a municipality to provide information, technical and financial support to project implementation (signing of SoI);
- Pilot replication potential.

The methodology applied by the project for data collection and analysis, pilot design implementation and monitoring is quite similar to the one used for municipal lighting system audit described in Chapter 5.1 and involves the following stages:

1. Collection of baseline information on proposed pilot objects via a questionnaire provided to the municipal authorities. The questionnaire consists of 20 questions on technical parameter of objects (e.g. streets) and illumination systems;
2. Analysis, verification and analysis of the received information;
3. On-site examination of the proposed objects and measurement of illumination level and uniformity of illumination systems (performed as per standard methodology applied for audit);
4. Analysis of the obtained information and identification of the most suitable modernization option(s) via calculations performed by means of DIALux light emulation software.
5. Identification of basic parameters of the lighting equipment that may ensure necessary quality of illumination in line with the results obtained via DIALux software;
6. Incorporation of information on the pilot proposals and expected benefits as well as on identified defects of infrastructures (e.g. damaged or missing poles and brackets) and defect elimination actions into summary reports to be agreed with the partner municipalities;
7. Development of technical specifications for and procurement of new luminaries and other equipment;
8. Organization and supervision of delivery and safe storage of new equipment;

9. Transfer of new equipment to the partner municipality (only upon confirmed completion of the propose defect illumination activities);
10. Guidance to municipality on proper installation of new equipment and on-site supervision of installation process;
11. Post-installation monitoring of actual performance of the new system and analysis of projected and actual outcomes;
12. Agreeing the methodology for assessment of monthly energy and cost savings achieved through the pilots (under municipal revolving fund);
13. Development and publication of factsheets on each pilot.

Within the reporting period the project designed and implemented 7 pilot projects on street and park illumination. By the end of 2016, it is planned to implement 6 more pilots on street, tunnel and indoor lighting. In this chapter information on the implemented and planned pilots is provided.

6.1. Completed pilot projects on energy efficient street lighting

In this chapter information on completed pilot projects is provided. All pilots were designed and implemented within the framework of SoIs signed between UNDP Armenia and partner municipalities.

1. Modernization of lighting system of Isakov Avenue and Paraqar Street in Yerevan

The very first pilot project implemented in early 2015 envisaged complete replacement of existing street lighting system of one of main thruways, a nine-kilometer roadway from the Victory Bridge to the intersection of Zvartnots International Airport (Isakove Avenu, Tairoav and Paraqar streets), that connects the Yerevan city center with the airport. The pilot was selected after a series of consultations with Yerevan Municipality (YM) and taking into consideration the pilot selection criteria, particular, maximal duration of operation, out-of-date illumination system, strategic importance of the roadway, etc.

As a result of competitive bidding, 482 modern LED based luminaries were procured to replace existing 756 luminaries equipped with 250W HPS lamps (on Isakov Avenue 274 new 213W luminaries were installed to replace 548 old ones, whereas on Tairov and Paraqar streets 208 new 99W luminaries replaced old equipment). As per SoI signed between YM and the project all pre-installation (fixing of damaged infrastructure) and installation works including dismantling of old luminaries and second brackets and installation and adjustment of new luminaries were performed by YM. Pilot implementation costs of 362.000 USD were covered by the project (80%) and YM (20%).

Completion of installation process in March 2015 was followed by post-installation monitoring of the system performance.

The key results of the pilot are as follows:

- Reduction of system capacity (kW): 136,5 kW
- Reduction of annual power consumption: 503 MWh (63%)
- Reduction of GHG emission: 223,5 tCO_2/year
- Expected annual O&M costs saving: 47.800 USD
- Improvement of illumination quality
- Simple pay-back: 5,9 years[3]
- Number of beneficiaries: 1,2 mln (Yerevan population)

Also the project has been collecting monthly statistics on number of car accidents on the pilot street before and after installation of the new lighting system to assess actual impact of the improved lighting on traffic safety. The data will be analyzed once statistics for 2016 and 2017 is available.

[3] Hereafter simple pay-back is calculated for cost of luminaries only.

Picture 18: Old luminaries with 250W HPS lamps and new 213W LED luminary installed on Isakov Avenue

Picture 19: Installation and adjustment of new luminaries organized by YIC

Picture 20: Comparison of old and new luminaries and their performance on the pilot street

2. Modernization of lighting system of Yerevan Zoological Garden

The second demonstration project in Yerevan city was performed for Zoological Garden in the frames of a larger-scale reconstruction and expansion program implemented by the Yerevan city Municipality. The garden's old lighting system was based on inappropriate 50W CFLs. The project team executed audit of the system and developed technical specifications for its modernization that was included in the reconstruction works. According to the agreed technical features and designs, UNDP organized procurement and installation of 112 new 39W LED luminaries specifically designed for parks and public areas lighting. These luminaries replaced traditional 150W HPS lamp based luminaries that would have been installed otherwise (in business as usual scenario).

The Municipality was responsible for installation of new poles and fixtures, as well as wiring. The demonstration project was implemented on co-financing basis with 35% provided by YM and 65% - by the project. Total project cost was 83.000 USD. Completion of installation process in June 2015 was followed by post-installation monitoring of the system performance.

The key results of the pilot are as follows:

- Reduction of system capacity (kW): 14,8 kW
- Reduction of annual power consumption: 21,4 MWh (77%)
- Reduction of GHG emission: 9,5 tCO_2/year
- Expected annual O&M costs saving: 1870 USD
- Improvement of illumination quality
- Number of beneficiaries: 300.000 (number of visitor of the ZOO)

Along with the above positive achievements the project contributed to the following changes and benefits:

- Longer operation of the illumination system and, as a result, longer operation of the Garden;
- Introduction of environmentally sound and resource saving technologies for park illumination;
- Elimination of mercury leakage hazard;
- Improvement of aesthetic appearance of the system and the garden;
- Improvement of safety and comfort of visitors.

Picture 21: Old luminaries with 50W CFLs

Picture 22: Monitoring of the lighting system of the Zoo

Picture 23: Installation of new feeding system and LED luminaries

Picture 24: Installation of new feeding system and LED luminaries

3. Modernization of lighting system of Zoravar Andranik, Sayat-Nova and Shahumyan streets in Alaverdi Municipality in Lori Region

The pilot project is implemented in the frames of SoI signed between UNDP Armenia, Alaverdi Municipality and "French-Armenian Inter-professional Network" NGO. The pilot covered three main streets in Alaverdi (Zoravar Andranik, Sayat-Nova and Shahumyan) with the total length of 1840 m. The project and NGO organized procurement of 67 new 50W LED street luminaries (project - 52 and NGO - 15) to replace old 250W HPS lamps based system, whereas, the municipality of Alaverdi ensured renovation, painting of lighting poles and installation of new luminaries.

Pilot implementation costs of 16.240 USD were covered by the project (70%), NGO (20%) and the municipality (10%). Opening ceremony of the pilot project was held on 14 September 2015 and followed by a monitoring mission.

The key results of the pilot are as follows:

- Reduction of system capacity (kW): 15,8 kW
- Reduction of annual power consumption: 24,1 MWh (82%)
- Reduction of GHG emission: 10,84 tCO_2/year
- Expected annual O&M costs saving: 3054 USD
- Improvement of illumination quality
- Simple pay-back: 4,1 years
- Number of beneficiaries: 13.000 (Alaverdi population)

Picture 25: Old luminaries with 250W HPS lamps

Picture 26: New 50W LED street luminaries installed under the pilot project

4. Modernization of lighting system of A.Manukyan and S.Avetisyn streets in Spitak town in Lori Region

The pilot covered A.Manukyan and S.Avetisyn streets in Spitak town with total length of 1350 m. This is the first pilot on energy efficient modernization of the street lighting involving complete replacement of infrastructure (dismantling of old poles and feeding system and installation of new ones) in accordance with recommendations developed by the project experts. The project procured 50 new 120W LED street

luminaries that replaced traditional 250W HPS lamp based luminaries that would have been installed otherwise (in business as usual scenario). The Municipality of Spitak financed design and installation of new street lighting infrastructure as well as installation and adjustment of new LED luminaries.

Pilot implementation costs of 50.025 USD were covered by the project (27%) and the municipality (73%). Opening ceremony of the pilot project was held on 11 November 2015 and followed by a monitoring mission. The key benefits results of the pilot are as follows:

- Reduction of system capacity (kW): 8,25 kW
- Reduction of annual power consumption: 14,5 MWh (58%)
- Reduction of GHG emission: 6,38 tCO_2/year
- Expected annual O&M costs saving: 1917 USD
- Improvement of illumination quality
- Simple pay-back: 7,1 years
- Number of beneficiaries: 13.000 (Spitak population)

Picture 27: Old luminaries with 250W HPS lamps

Picture 28: Night time view of the pilot street

Picture 29: Delivery and installation of new lighting poles

Picture 30: New 120W LED street luminary and night time view on the pilot street with the new lighting system

5. Modernization of lighting system of Shahumyan street in Sevan municipality in Gegharquniq Region

Shahumayna Street with the length of 1080 m was selected as a pilot site in Sevan town. Within the scope of the pilot 62 new 75W LED street luminaries were procured by the project to replace the same number of old 250W HPS and MV lamp based luminaries. The Municipality of Sevan organized installation and adjustment of the lights.

Pilot implementation costs of 14.100 USD were covered by the project (93%) and the municipality (7%). The new system was launched in December 2015. Post installation monitoring organized by the project proved the following results achieved though the pilot:

- Reduction of system capacity (kW): 13 kW
- Reduction of annual power consumption: 27,3 MWh (74%)
- Reduction of GHG emission: 12,1 tCO_2/year
- Expected annual O&M costs saving: 2804 USD
- Improvement of illumination quality
- Simple pay-back: 4,7 years
- Number of beneficiaries: 19.200 (Spitak population)

Picture 31: Old luminaries with 250W HPS and MV lamps

Picture 32: New 75W LED street lights

Picture 33: Nigh time view on the pilot street in Sevan before and after installation of the new lighting system

6. Modernization of lighting system of Yerevanyan street in Abovyan municipality in Kotayk region

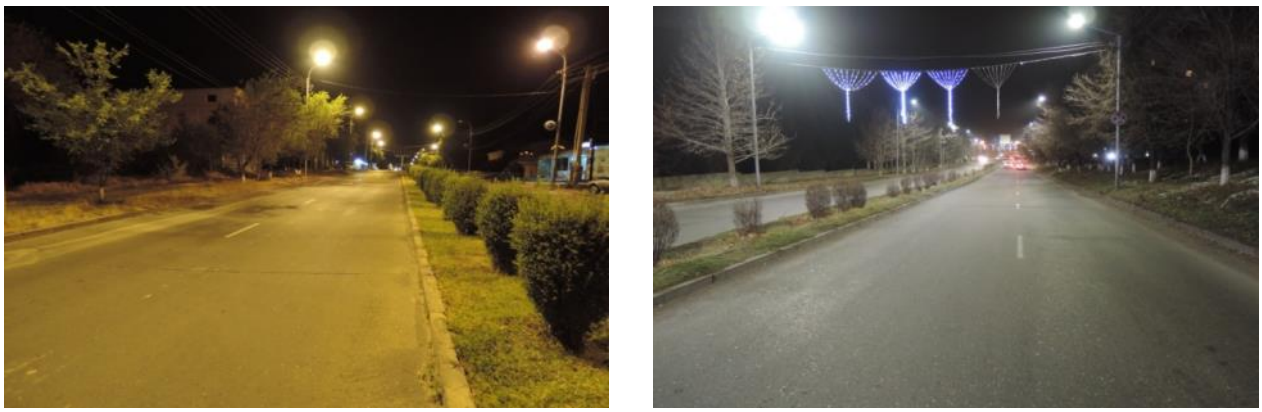
Pilot demonstration project in Abovian municipality covered Yerevanyan street with length of 1350 m connecting the town with Yerevan city. The project experts performed a comprehensive audit of the proposed pilot street, developed technical specifications and procured new street lights. Abovyan Municipality implemented necessary construction and adjustment works including installation of a missing pole and replacement of the existing double-brackets system with single brackets system as well as organized installation of new LED luminaires in line with the technical requirements and instructions of the project experts. Within the framework of the demonstration project 128 old 250W HPS lamps were replaced with 87 new 75W LED street lights.

Pilot implementation costs of 24.558 USD were covered by the project (75%) and the municipality (25%). The new system was launched on 18 January 2016. Post installation monitoring organized by the project proved the following results achieved though the pilot:

- Reduction of system capacity (kW): 30 kW
- Reduction of annual power consumption: 54,8 MWh (82%)
- Reduction of GHG emission: 24,3 tCO_2/year
- Expected annual O&M costs saving: 5518 USD
- Improvement of illumination quality
- Simple pay-back: 3,3 years
- Number of beneficiaries: 44.400 (Abovyan population)

Picture 34: Old luminaries with 250W HPS lamps

Picture 35: New 75W LED street lights



Picture 36: Nigh time view on the pilot street in Abovyan before and after installation of the new lighting system

7. Modernization of lighting system of Victory Bridge and Mashtots avenue in Yerevan

The first pilot project aimed at replication of the energy efficient technologies and co-financed from the municipal revolving fund[4] was implemented in Yerevan and covered Victory Bridge and Mashtots Avenue (till the France Square) with the total length of 2110 m. Along with street illumination lighting system for sidewalks.

The project procured 244 new LED street luminaries with capacity of 139W, 106W and 36W that replaced 397 old 250W and 70W HPS lamp based luminaries. YM provided co-financing of the pilot from the revolving fund as well as organized dismantling of old luminaries and brackets, installation and adjustment of new LED lights.

Pilot implementation costs of 74.855 USD were covered by the project (30%) and the municipality (70%).

The key results of the pilot are as follows:

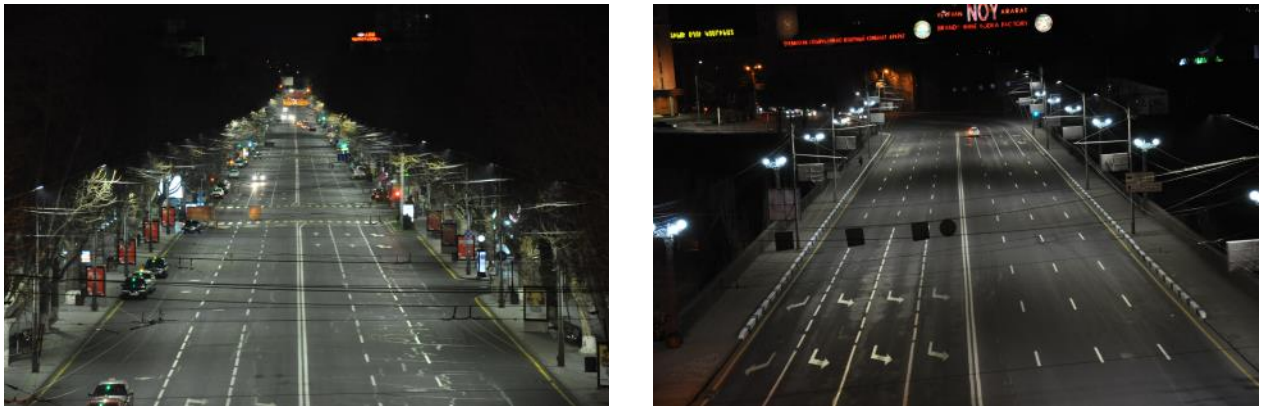
- Reduction of system capacity (kW): 65,35 kW

[4] See information on the municipal funds in Chapter 7.1.

- Reduction of annual power consumption: 240,8 MWh (75%)
- Reduction of GHG emission: 107 tCO_2/year
- Expected annual O&M costs saving: 22.653 USD
- Improvement of illumination quality
- Simple pay-back: 2,5 years
- Number of beneficiaries: 1,2 mln (Yerevan population)

Picture 37: Old luminaries with 250W and 70W HPS lamps for street and sidewalk (Mashtots Avenue)

Picture 38: New 139W and 36W LED luminaries installed for street and sidewalk (Mashtots Avenue)



Picture 39: Nigh time view on Mashtots Avenue and Victory Bridge after pilot realization

Savings achieved through the replication project will be accumulated in the municipal revolving fund of Yerevan.

Summary of the key benefit of the implemented pilots is introduced in the below table.

Table 2: Summary of the results of the implemented pilot projects[5]

N	Municipality	Reduction capacity	Annual energy saving	Annual cost saving	Annual GHG emission reduction	Illuminance improvement	Simple payback
		kW	MWh	USD	tCO_2	lx	years
1	Yerevan (Isakov)	136.51	503.2 (63%)	45 381	223.4	from 16 to 26	6.9
2	Yerevan ZOO	15.18	22.2 (77%)	1 932	9.8	from 4 to 10	N/A
3	Alaverdi	16.45	24.0 (82%)	2 094	10.7	from 4 to 13	6.3
4	Spitak	8.25	14.5 (58%)	1 263	6.4	from 16 to 26	10.8
5	Sevan	13.02	27.3 (74%)	2 758	12.1	from 17 to 20	4.6
6	Abovyan	28.25	51.7 (81%)	5 217	23.0	from 17 to 20	3.4
7	Yerevan (Mashtots)	86.4	293.0 (74%)	27 611	130.1	from 12.7 to 24	2.7
8	Goris	18.48	32.4 (53%)	3 051	14.4	from 4.9 to 29	9.0
	TOTAL	**322.53**	**968.3**	**89 307**	**429.9**	**-**	**-**

Monitoring of performance of new illumination systems proved compliance of the designed parameters and actual outcomes of the pilot projects.

Analysis of measurements and evaluation of results confirmed that the following benefits were achieved by the pilot projects implemented so far by modernization of EE street lighting systems:

7. Reduction of total installed capacity of the pilot systems: 322,53 kW
8. Annual energy saving: 968,3 MWh (up to 82%);
9. Considerable improvement of uniformity and illuminance (compliance with norms);
10. Annual electricity costs saving: 89.307 USD;
11. Annual greenhouse gas emissions reduction: 429,9 tCO_2:
12. Improved city infrastructure and attractiveness for tourists;
13. Improved visibility and security level on the road in dark time and reduction of traffic accidents;
14. Improved comfort level and traffic safety for drivers and pedestrians;
15. Total co-financing from the partner municipalities: 201.251 USD (35,5% of total costs);
16. Total number of beneficiaries: 1,2 mln in Yerevan and 110.000 in regions.

16.1. On-going pilot projects on energy efficient street lighting

1. Modernization of lighting system of Syuniq and Qristophor streets in Goris municipality, Syuniq Region

After a series of consultation with the municipality of Goris and analysis of measurement data Syunik and Qristaphor streets were selected as pilot sites for realization of demonstration projects. Both streets with the total length of 3750 m are interstate roads that are mainly passed by cars and trucks travelling from Iran to Armenia and back (part of M2 interstate highway). Qristaphor street is continuation of Syunik street. The streets were illuminated only recently, in 2014, using 250W mercury-vapour lamps.

The project developed technical specifications and organized procurement of new 145W LED street lights to replace the existing luminaries. Goris municipality will install 13 new poles, repair and pain damaged poles and brackets, install and adjust new luminaries. Completion of all works under the pilot is planned in May 2016. Municipal fund for accumulating cost savings will be established immediately after completion of the pilot.

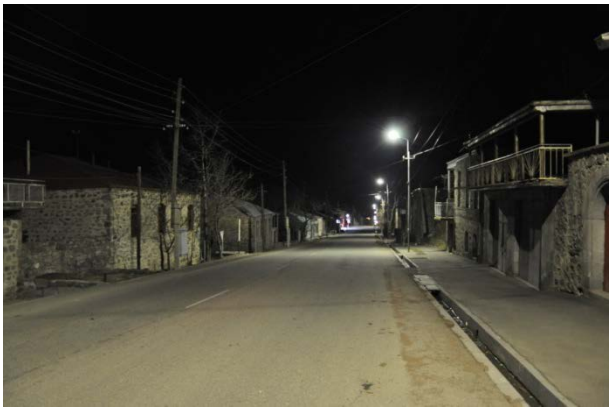
The key expected results of the pilot are as follows:

- Reduction of system capacity (kW): 18,48 kW

[5] Actual results in terms of annual energy and costs savings, GHG emission reduction and simple payback shall be evaluated at the end of the project after collection and analysis of actual monthly saving data.

- Reduction of annual power consumption: 32,44 MWh (47%)
- Reduction of GHG emission: 14,4 tCO_2/year
- Expected annual O&M costs saving: 3415 USD
- Improvement of illumination quality
- Simple pay-back: 8,1 years
- Number of beneficiaries: 20.300 (Goris population) and the transit traffic drivers

Picture 40: Old luminaries with 250W MV lamp



Picture 41: Night time view on Syuniq street

Picture 42: On-site measurements of lighting level and other parameters performed by the project experts in Goris

2. Modernization of lighting system in Ararat town and Avshar and Ararat villages, Ararat Region

This is the first pilot that covers not only urban but also rural communities. Five streets in Ararat town (A.Serob and Shahumyan) and Avshar and Ararat villages (Araratyan, Griboedov and Yeghiazaryan) with total length of 4.2 km were selected as pilot sites after consultation with local municipalities and analysis of measurement results.

The project developed technical specification and organized procurement of 163 new 60W LED street lights to replace the existing 250W HPS based street luminaries. Goris municipality will repair and pain damaged poles and brackets, install and adjust new luminaries. Completion of all works under the pilot is planned in June 2016. Municipal funds for accumulating cost savings will be established in all communities immediately after completion of the pilot.

The key expected results of the pilot are as follows:

- Reduction of system capacity (kW): 36,68 kW
- Reduction of annual power consumption: 64,39 MWh (79%)
- Reduction of GHG emission: 28,6 tCO_2/year
- Expected annual O&M costs saving: 6090 USD
- Improvement of illumination quality
- Simple pay-back: 4,5 years
- Number of beneficiaries: 33.800 (total population of 3 communities)

Picture 43: Typical old luminaries with 250W HPS lamps installed on the pilot streets in Ararat Region

Picture 44: Day-time and night-time views of the pilot street in Ararat

Table 3: Summary of the expected results of the ongoing pilot projects

N	Municipality	Reduced capacity	Annual energy saving	Annual cost saving	GHG emission reduction	Simple payback
		kW	MWh	USD	tCO_2	years
1	Goris	18,48	32,44	3415	14,4	8,1
2	Ararat + 2 villages	36,68	64,39	6090	28,6	4,5
TOTAL		**55,16**	**96,83**	**9505**	**43**	**-**

16.2. Ongoing pilot projects on energy efficient roadway tunnel lighting

After successful completion of the pilot project on Isakov Avenue and in the light of ongoing modernization of Mashtots Avenue, the Municipality of Yerevan approached the project with the request to design and implement a project on improvement of internal illumination of the Mashtost Avenue Tunnel that connects Isakov Avenue with Mashtots Avenue. The request was accepted by the project because of the following reasons:

- lighting system of the tunnel is based on low-quality and inefficient 250W HPS lamps that are power consuming and do not provide illumination as per requirements of the acting norms,
- illumination of the tunnel should be brought into compliance with retrofitted street lighting of Mashtots Avenue in order to ensure adequate level of visual comfort and traffic safety.

Given the technical specificities and complexity of design and implementation of tunnel illumination and taking into consideration importance of the tunnel as a one of the main traffic arteries connecting centre of the city with the Zvartnots International Airport, it was decided that the local project team should be supported by an international expert with appropriate knowledge and experience in tunnel illumination.

Picture 45: Enter to the tunnel from the Victory Bridge and its internal illumination system

For that reason International Consultant on Roadway Tunnel Illumination Systems was contracted in April 2016 and tasked to implement the following activities:

- on-site investigation of the current condition of the tunnel and its lighting system,
- collection and analysis of available baseline information,
- development of a list of recommendations on renovation of the tunnel interior walls and ceiling to ensure effective operation of a new illumination system to be proposed,
- design of a new energy efficient illumination system for the tunnel in line with the applicable international norms and standards as well development of respective technical requirements (specifications) for procurement of modern energy efficient illumination and respective auxiliary equipment,
- provision of on-line consultation to the project and Yerevan municipality at equipment procurement and installation stage.

It is envisaged that modernization of the tunnel illumination system will be completed by September 2016; however, final timing will depend on the outcomes of the tendering process.

16.3. Ongoing pilot projects on energy efficient indoor lighting

Under this subtask the project established cooperation with "World Vision Armenia" International Relief and Development Organization, an international charitable organization working to create lasting change in the lives of children, families and communities living in poverty[6].

WV supports projects aimed at ensuring the sustained well-being of children with the special focus on education and health and partners with the Government of Armenia, regional and local authorities, Armenian Church, UN agencies, USAID and other international donor organizations, international and local NGOs and communities to effectively implement its projects.

The cooperation framework set in the Statement of Intent to be signed by UNDP and WV in late April envisages design and implementation of two pilot projects on energy efficient modernization and improvement of indoor illumination in the following objects:

1. Mush development centre located in Gyumri municipality, and
2. Up to 50 apartments and houses of low-income residents of Aparan urban community.

Along with key objective to ensure energy saving, both projects are also intended to optimize indoor lighting, thus, setting better working environment in the development centre and improved living conditions in apartments and homes.

The project team visited Mush Development Centre in March 2016 to collect necessary baseline information on a number of lighting points and rooms, number, type and capacities of lamps, dimensions and allocation of rooms, duration of lighting system operation and well as to perform necessary measurement of actual illumination level in classes and other rooms.

[6] www.wvarmenia.am


Picture 46: Interviews with the management of Mush DC and measurements of indoor lighting level

Based on the obtained information, the project developed a proposal for modernization of the lighting system that envisages replacement of all 48 incandescent lamps with total capacity of 4.3 kW with 76 LED luminaries with total capacity of 2.3 kW, thus, ensuring annual energy saving of about 2900 kWh (140.000 AMD) and improving indoor illumination level from 100-150 lx to 350-400 lx.

The proposal for the pilot has been communicated to the WV team for consideration and will be implemented jointly immediately after signing of SoI. The project will organize procurement of the LED luminaries, whereas WV will organize proper installation, operation and periodic monitoring of the system.

As regards to second pilot, WV provided the project with the list of 50 apartments and houses that are suggested to be included in the pilot project. The list will be carefully considered by the project and selection of pilot project participant will be made. Discussion on the scope of this pilot (data collection, audit, design and implementation, monitoring and reporting) will be organized after signing the SoI. Both pilots are planned to be realized before September 2016.

17. Financial and institutional mechanisms for scaling up municipal EE lighting programs

Successful implementation of the above described pilot projects on improvement of energy efficiency of municipal street lighting has demonstrated immediate cost-saving and emission reduction benefits and contributed substantially to changing of decision-makers mentality both on local (municipalities) and national level thanks to the awareness raising campaign aimed at dissemination of these success stories and lessons learned. From now on municipal lighting is considered as the sector where drastic improvement of public service can be achieved through cost-effective investments into energy efficient technologies available on the local market.

The number of municipalities interested in piloting new lighting systems or willing to expand already implemented pilots is increasing; however, shortage of municipal funds, limited access to loans, unattractiveness of municipal sector for private capital because of lack of regulations and high risks as well as other factors are limiting capabilities of local governances to realize these plans. Therefore, the project team is tasked to develop a set of financial, institutional and legal proposals aimed at overcoming the mentioned barriers and facilitating investments in municipal energy efficient lighting.

In this chapter, project activities on establishment of a municipal revolving fund, development of replication programs and involvement of private sector are described.

17.1. Establishment of municipal energy efficient lighting funds

As mentioned in the Chapter 5.1, statements of intent signed with partner municipalities include “requirement to establish a specific purpose revolving fund for financing energy efficiency measures in outdoor lighting system”. Thus, demonstration projects are also aimed at ensuring establishment of operational, financial and institutional mechanisms to ensure sustainable financing for replication of

municipal lighting modernization activities based on the piloted energy saving and energy efficient technologies

In order to assess incremental costs of energy efficiency improvement of street lighting systems as well as to estimate expected energy and cost savings from implemented pilots, the project carried out respective feasibility studies for Yerevan and Alaverdi (the first two municipalities where pilot projects were implemented).

Based on the results of these studies, a concept for establishment and operation of the municipal revolving fund was developed along with its procedure, fund operation rules and methodology for monthly saving estimation. The concept was discussed with and adopted by the partner municipalities. Sample concepts developed for Yerevan municipality is introduced in the Annex VIII.

According to the concept, the partner municipality has to establish a municipal revolving fund (an off-budget special account) where actual cost savings (electricity, operation and maintenance) achieved via implementation of pilot projects shall be transferred and accumulated on a monthly basis. Accumulated funds can be used only to finance development (design) and implementation of energy efficient lighting projects based on modern technologies. It is worth mentioning that only 10% of available funds can be spent for project design purposes, whereas 90% of allotments are to be used for financing lighting energy efficiency improvement projects.

Noteworthy, according to the concept, a representative of the UNDP-GEF project is a mandatory member of the municipal revolving fund resources management council. This enables the project to oversee that the resources will be used for implementation of energy efficient reconstruction of lighting systems in urban communities.

To avoid additional tax obligations (e.g., profit tax for Yerevan case) as well as the necessity to return the undisbursed savings' amounts to the state budget as of end of each fiscal year by other municipalities, it was proposed to use the amounts accumulated into the special accounts during the same budgetary year. For future sustainability of the established revolving fund, there may be a need to work in parallel on required legal and regulatory changes that would allow municipalities to accumulate funds into the energy efficiency fund over two or more consequent years for more substantial investments.

According to the Yerevan Mayor's decision #2354-A of July 30, 2015, in the frames of the SoI as per the implementation of street lighting pilot project in Isakov Avenue, a special account was opened at Yerevan Municipal Illumination CJSC. The account has been operational since April 2015, while the savings are calculated according to the agreed methodology and the respective amount is transferred to the account on a monthly basis.

Similar documents for establishment of municipal revolving energy efficiency funds account were approved by municipal councils of Alaverdi, Abovyan and Spitak and it is at approval stage in Sevan municipality.

All mentioned communities were granted permissions to open special off-budget accounts from the Ministry of Territorial Development of RA and from the Ministry of Finance of the RA.

Regardless of other circumstances, the procedure for calculating the savings from the implemented pilots was approved by all the above mentioned municipalities and actual monthly savings are monitored and reported by bilateral acts signed between the project and the municipality. The calculated amount is transferred to the special off-budget account – revolving fund.

Similar procedure is envisaged also for other partner municipalities (e.g. Goris and Ararat) where pilots are to be implemented within 2016. In the table below, savings achieved as a result of the pilot projects implemented in 5 partner municipalities from March 2015 to March 2016 period are summarized.

Table 4: Estimated annual savings and actual savings achieved through pilot projects implementation

N	Cities	Estimated annual savings 1000 AMD	Actual savings as of April 2016 1000 AMD
1.	Yerevan (Isakov)	22945,1	22367,3
2.	Abovyan	2648,8	680,1
3.	Alaverdi	1465,8	1188,3
4.	Spitak	919,9	314,1
5.	Sevan	1345,8	353,3
6.	Yerevan (Mashtots)	10199,1	-
7.	Goris	1639,1	-
TOTAL		**41163,6**	**24903,1**

It has been agreed with the municipalities that revolving fund will remain operational (i.e. saving will be accumulated from implemented and new projects) at least until the end of the project. Firm arrangements for functioning of the funds after completion of the project are still to be made with the partners. One possible option could be to continue the operation of the Fund until the complete pay-back of investment done for the respective pilot project. If so, the operation duration of each fund can be defined as ratio of pilot costs to annual savings with the following approximate results.

Cities	Investments		Fund operation duration, years	
	Costs of luminaries	Total project cost	Pay-back of luminaries cost	Pay-back of all investments
Yerevan (Isakov)	292743	362000	5,9	7,77
Abovyan	19008	24558	3,3	4,41
Alaverdi	13090	16240	4,1	5,23
Spitak	13650	50025	7,1	25,77
Sevan	13728	14100	4,7	5,08
Yerevan (Mashtots)	53100	74855	2,5	2,75
Goris	28463	27500	8,1	8,05
TOTAL	**433782**	**569278**	**5,1**	**8,44**

The long payback of total investments for the pilot project in Spitak municipality is explained by major investments (about 70% of total costs) into complete renovation of street lighting infrastructures i.e. installation of new poles and feeding system. It shall be noted that the above results are not discounted.

The simple pay back periods provided are valid only for the applied investment scheme.

Alternatively, the municipal Fund (or specific account) could continue to accumulate savings from all new EE lighting projects and reinvest those savings into new projects until the set targets for a complete EE lighting retrofit of the city has been achieved. A more detailed discussion on this option can be found from Annex I "Recommendations".

17.1.1. Replication of EE lighting technologies financed by the municipal revolving fund in Yerevan

In November 2015, Yerevan city municipality applied to the project with a letter proposing extension of pilot using the resources accumulated in the revolving fund. According to the cost sharing agreement signed between Yerevan city Municipality and UNDP on December 24, 2014 the Yerevan Municipality transferred to UNDP 15 million AMD for energy efficient reconstruction of street lighting of Victory Bridge and Mashtots Avenue up to the intersection with Sayat-Nova Street (the streets are continuation of previous pilot). The cost estimates done for that section are assessed at 30 mln AMD, including 15 mln AMD to be allocated by the project and another 15 mln AMD from Yerevan municipality. Application of UNDP procurement procedures enables supplying the city with luminaries of the same quality and similar features as those installed in Isakov Street. More information on this replication project is presented in Chapter 6.

According to the preliminary calculations, the annual savings due to this new project will grow by more than 9 million AMD.

The project is planning to use similar scheme of cooperation with other partner municipalities to support the implementation of similar replication activities. However, it is most likely that savings accumulated in the funds of small communities will not be sufficient to cover total costs of replications; hence, is important to leverage additional financing in support of the municipal lighting programs. Project already initiated negotiations with donors and banks. Further discussion on this can be found from Chapter 10 "Recommendations"

17.1.2. Development and delivery of an application to financial institutions and facilities for funding EE lighting investments in Yerevan

In 2014-2015 EBRD initiated feasibility study for modernization of the Yerevan lighting system. The contractor of the task has discussed the scope of the study and all available information on the city lighting system was shared with them.

Based on the outcomes of the EBRD study, the Ministry of Finance of Armenia and the Municipality of Yerevan city signed an agreement in May 2015 to allocate a co-financing grant of €1.9 million to support the modernization of street lighting in the city of Yerevan. The grant was provided by the E5P fund (Eastern Europe Energy Efficiency and Environment Partnership), which is managed by the EBRD and pools donor contributions from the European Union and a number of donor countries including Armenia, and supplemented EBRD €3.7 loan committed by the Bank for modernization of Yerevan's street lighting system by introducing new energy-efficient technologies that will benefit the city's residents. In such a way about €6 million has been secured for renovation and energy efficient modernization of lighting system of 28 streets in Yerevan based on LED technology. The project will be implemented by YIC as the borrower of the loan.

As it was later acknowledged by the Yerevan municipality and officially communicated to the UNDP Armenia (the letter of Mr. Kamo Areyan, First Deputy Mayor of Yerevan), the positive experiences from the UNDP/GEF supported pilot projects and related awareness raising and building of the trust of the key decision makers on EE street lighting retrofits by using the LED technology contributed significantly to the approval of the EBRD loan by the National Assembly of RA.

Since the EBRD financed project has already covered certain project activities as it concerns, in particular, the planned comprehensive audit of the public lighting system of Yerevan and development of related funding proposal, it has been decided to reallocate the resources initially assigned for this purpose within the UNDP/GEF project for other project tasks in order to avoid duplication of efforts and ensure synergy with other ongoing projects.

According to preliminary assessment, the total energy saving potential of the modernization of illumination of 28 streets by the EBRD loan is up to 2,6 GWh. Considering project's contribution in the development of this loan application (baseline information on Yerevan illumination was provided by the project), approval by high-level decision makers (by reducing the perceived risks and building trust by successfully implemented pilot projects) and implementation (constant consultations between the project experts and YIC team) these energy savings and associated GHG emission reduction can be included into the accounting of project's indirect GHG reduction impact.

17.1.3. Development and delivery of an application to financial institutions and facilities for funding EE lighting investments in other municipalities

Unlike Yerevan – the biggest city of Armenia with highest loan absorbing potential and capacities making it attractive for various lending institutions, other municipalities need support in getting funds for implementation of energy saving measures.

Within the scope of this task, the project has established and maintained communication with ACBA-CREDIT AGRICOLE BANK. The bank is interested in setting up a new mechanism for direct crediting of municipalities without sovereign guarantee and collateral and by offering interest rates that are lower

than the average commercial rate in Armenia. A number of meetings were held between the project team and bank representatives to discuss funding and compensation mechanisms specifically for municipal street lighting sector. The bank is interested in practical experience of the project with respect to implemented pilots and established municipal revolving funds.

The project provided the bank with a list of most promising replication proposals on energy efficient upgrade program in each of the partner municipalities with technical and financial data. This information will serve as a basis for the development and testing of new municipal funding (lending) mechanism to be prepared by the bank. The project will continue cooperation with the bank and the municipalities with the aim to help the latter with the development and submission of applications for funding from the new facility.

17.1.4. Organization of a tender for at least one ESCO to provide energy efficient lighting services

Another mechanism aimed at facilitation of private investments into municipal energy efficient lighting sector and considered at the project inception phase, was organization of a tender for at least one ESCO project to provide and install energy-efficiency upgrades for part or all of the municipal lighting program in at least one city outside Yerevan, and if applicable, also for Yerevan itself. This activity had to be combined with assessment of the possibility of using project funds to reduce financial risk for ESCOs and associated investors and lenders.

Involvement of ESCO would help to bring necessary technical capacities and good knowledge (even know-how) of modern lighting technologies as well as capabilities to attract private capital and investments needed for realization of modernization measures usually lacking in local municipalities.

Unfortunately, there are no yet so-called “classic” ESCOs in Armenia i.e. commercial or non-profit businesses providing a broad range of energy solutions (particularly, in lighting sector) including design and implementation of energy saving and energy efficiency projects, operation and maintenance of systems, energy infrastructure outsourcing, power generation and energy supply. The provision of integrated energy services in the lighting sector via ESCOs or similar vehicles does not yet exist in Armenia also due to limited technical and financial capacity. However, a number of local companies and NGOs are providing certain consultancy and technical support services that are close to the scope of ESCO activities.

In order to assess potential interest of such local quasi ESCOs in cooperation with the project and in involvement into municipal lighting sector, a series of meetings and communications with Mr. Mikhail Martirosyan, President of the Association of Energy Service Companies of Armenia, were organized. During the communication the project team introduced a draft concept of ESCO integration on the concrete example of energy efficient modernization of street lighting system of Abovyan municipality.

The concept envisaged that within the framework of a trilateral agreement signed by the municipality, ESCO and the project, the ESCO would invest into modernisation of lighting system of a number of selected streets and ensure proper operation and maintenance of the upgraded system during a certain period of time to be agreed and set in the agreement. The municipality would compensate initial investments and running cost of the ESCO via monthly payments made from the actual savings achieved through the modernization project. After full compensation of costs of the ESCO (including certain reasonable profit) the upgraded system shall be “transferred” back to the municipality and run by the municipal service company, unless municipality would like to continue cooperation and expand the upgrade project.

During the communication various combinations of the proposed concept were discussed including risk reduction intervention of the project (e.g. via provision of initial funding for procurement of the LED street lights) aimed to identify a scheme that is both attractive for the ESCO ENGO and feasible for the municipality. As a result of these discussions, a number of factors that are holding back ESCOs’ involvement in urban lighting sector of Armenia were identified. These factors are:

- lack of financial and technical capacities of local municipalities
- insufficient experience in implementation of bilateral municipal energy saving activities
- lack of experience in developing bankable proposals for green urban lighting project

- limited interest of local banks in financing energy efficiency projects, particularly in municipalities
- lack of track records on private sector participation in the municipal energy sector, low credit worthiness of municipalities and associated risks that usually reduce interest of private investors
- lack of understanding by local authorities of cost reduction potential of energy saving measures that require high initial investments but ensure complete cost recovery and benefits in the long run
- low motivation of local authorities for implementing energy saving projects because of state subsidies to the municipalities
- high costs of quality energy efficient lighting equipment resulting in too high initial investments
- lack of regulation and other risks

It was decided that a broader discussion on the existing barriers for ESCOs and private sector involvement into municipal energy sector shall be organized with participation of respective decision-makers from the government, local authorities, financial institution and landing organizations, private sector and expert society.

17.2. Development and approval of the city-wide program on public lighting in Yerevan

As mentioned in Chapter 7.1.2, the initial plans of the project to organize a comprehensive audit of the municipal lighting system of Yerevan have been revised to avoid unnecessary duplication of efforts with newly launched EBRD project. Nevertheless, this revision does not reduce the need to facilitate the development and approval of a city-wide program for Yerevan that shall cover all municipal street lighting infrastructures.

The program will be prepared based on the experience and knowledge gained by the project team since launching of the project and it will take into consideration all recent and perceptive developments in the sector (e.g. activities of the municipality, EBRD, ADB and other parties). The key objective of the program is to assess technical and financial capacities needed for full modernisation of the street lighting infrastructure of Yerevan based on LED and other energy saving technologies (including smart control and optimization schemes), to evaluate energy and cost saving potential of the proposed measures and identify most feasible funding mechanisms including state subsidies, municipal investments, loans and grants from financial and donor organizations.

The document will be developed by the International Expert on Energy Efficient Lighting contracted by the project in April 2016 to analyse the potential for enhancing energy efficiency of Yerevan city street lighting system, prepare recommendations for the development of comprehensive upgrade programme for the city street lighting system and provide consultancy on the overall implementation of project as per request of the project team. The expert will be supported by the team of local experts that will work in cooperation with YIC and Yerevan municipality. Completion of this task is expected in September 2016.

17.3. Facilitation of public lighting modernization programs in other cities in Armenia

Another subtask of the project under its third component is facilitation of public lighting modernization programs in other communities in Armenia based on lessons learned from Yerevan, but also recognizing the particularities of each region.

As mentioned in the Chapter 5.1, within the reporting period the project team carried out audit of public lighting systems in 8 partner municipalities. Based on the obtained results, optimal technical proposals for energy efficient modernization of entire municipal street lighting systems for each of the community were developed and summarized in the respective reports adopted by the local authorities.

The basic technical solution proposed for all municipalities (and tailored for each partner based on its specificities) is replacement of existing inefficient lighting systems composed of HPS and CF lamps with modern luminaries saving LED street luminaries. The proposals also contain assessment of investments needed for procurement of the lamps, energy and cost saving benefits and simple pay-back.

The table below summarizes the key benefits to be achieved through the proposed programs. More information on the proposed solution is presented on the Annex IV.

Table 5: Summary of key benefits to be achieved through municipal lighting upgrades programs

Municipality	Number of luminaries to be preplaced	Annual savings and reductions			Total procurement cost (in USD)	Simple payback period (year)
		Energy (MWh)	Costs (USD)	Emissions (tCO_2)		
Abovyan	816	346,2	37415	153,7	182480	4,9
Ararat	287	131,0	13178	58,2	54530	4,1
Goris	858	272,2	27372	120,8	163020	5,9
Kapan	883	270,1	28470	120,0	211680	5,9
Spitak	496	211,3	16775	93,8	173600	10,4
Sevan	412	162,2	17636	72,1	99350	7,6
Stepanavan	1371	439,7	38743	195,0	246780	6,4
Alaverdi	492	270,2	11735	119,9	66420	5,6
TOTAL	**5615**	**2102,9**	**191324**	**933,5**	**1197860**	**6,35**

Note: No information on Yerevan is provided in the table because city-wide municipal lighting upgrade program has not been developed yet (see Chapter 7.2.)

Based on the data provided in the above table it is possible to roughly estimate specific (averaged) costs and benefits that can be theoretically achieved in case of replacement of one HPS street light with LED luminary.

Table 6: Specific benefits to be achieved through replacement of one street light

Procurement cost (USD)	Annual savings and reductions			Simple payback	GHG emission reduction cost (USD/tCO_2)
	Energy (MWh)	Costs (USD)	Emissions (tCO_2)		
213,3	0,375	34,1	0,166	6,3	1283

The results show that even with current high costs of quality LED technologies, municipal street lighting modernization programs provide relatively short simple payback if properly designed and implemented.

It shall be noted that the above estimation: (i) does not consider installation costs; (ii) assumes that operation and maintenance costs for the new system are close to zero; (iii) does not take into account the effect of depreciation. At the same time, change in electricity tariff and decreases of market cost of LED technologies are also ignored. Meanwhile, 15% one-time increase of electricity tariff and 20% drop of the technology cost may considerably improve certain specific parameter such as annual cost saving – 40 USD, average payback – 4,5 year and GHG emission reduction cost – 1070 USD/tCO_2.

Reports with information on the proposed modernizations programs for 8 communities are made available via the project website and submitted to various interested stakeholders (e.g. EU Delegation to Armenia, ACBA-CREDIT AGRICOLE BANK, etc.).

After completion of audit and program development activities for 2 more municipalities, all information on the proposed upgrades will be summarized and introduced to the local and international stakeholders and financial institutions at a donor coordination event to be organized in late 2016 aimed at facilitation of discussion and decision-making on financing green urban lighting activities.

18. National policies, codes, and standards on EE lighting

According to the ProDoc the project is to focus on the development and implementation of broad policy instruments to promote energy-efficient lighting in Armenia. These planned instruments include a legislative mandate for phase-out of incandescent and other inefficient lighting; technical standards for lighting products; lighting provisions in codes on building energy performance and health; and procurement law and accompanying rules for public institutions. Such policies would not only support the municipal lighting programs, but would have an expanded cross-sectoral impact, especially in the public and residential building sectors. These policy-related activities shall be fully consistent with the legal and political processes and priorities of Armenia. The activities are intended to make up an integrated whole,

mutually reinforcing each other. But the policies are also designed to be effective individually even if one or more of the others proves impossible to implement.

In order to evaluate the existing legislative and regulatory framework relevant to lighting sector of Armenia and identify existing gaps and barriers, a comprehensive overview of the acting law, governmental decision, ministerial orders, construction norms and standards was conducted by the project. The study also covered such documents us draft decisions on energy saving, international and European directives, intestate norms and standards, procedure of development, approval and enforcement of urban develop norms, procedures of technical regulations and national standards. The following main barriers and recommendations made in the study will to be taken into consideration under the 4th component of the project:

Barriers

- Actual technical parameters of luminaires (power, luminosity, lifetime etc.) are often non-compliant with the indicators marked upon the lighting devices;
- Currently, there are no restriction on indoor lamp power in Armenia;
- Construction norms on natural and artificial luminosity refer to illumination level of outdoor and indoor areas, while requirements per energy efficiency are quite limited;
- Currently, national legislation is in effect on standard qualities of goods/produce, including technical standards on lighting devices, however, these focus on health issues and safety regulations with little to no reference to energy efficiency;
- The Law “On Procurement” requires for state procurement that devices be bought based on preliminary price and not accounting for the costs to be covered within the operation period (no proper “value for money” assessment procedure in place); this does lead to buying energy efficient luminaires that are cheaper in operation and have longer lifetime than conventionally used ones;
- No state policy to encourage energy efficient lighting produce/production is enacted.

Recommendations

- Revise construction norms CN II-8.03-96 “Natural and artificial lighting” based on the complex of relevant codes enacted in Russia;
- Adopt/harmonize relevant standards to ensure implementation of technical regulations and code requirements. Prioritize standards to be developed based on the following criteria: energy indicators, mercury content, operation lifetime and illumination quality;
- Develop draft decision of the RA Government to stipulate the following:
    - List of energy efficient devices, pre-fabricates and produce threatening human life and/or environment (containing hazardous substances);
    - Procedure for circulation in the RA internal market and utilization upon disposal of energy efficient devices, pre-fabricates and produce so enlisted;
- Develop draft decision of the RA Government to stipulate the labeling procedure of energy consuming devices (including lamps and luminaires) by their energy efficiency level;
- Develop technical regulations on energy efficiency requirements for electrical energy consuming devices;
- Develop draft decision of the RA Government on phase-out of incandescent lamps;
- Support development and adoption of new procurement rules for buying energy efficient lighting devices by/for the state organizations;
- Establish cooperation between “Market surveillance inspectorate” of the Ministry of Economy of the RA and the Project to improve legal and normative-technical documentation.

18.1. Phase-out of incandescent lighting and/or other major national policies on EE lighting

Under this task the project will carry out a comprehensive review providing technical and policy justification for a phase-out of inefficient incandescent lighting in Armenia. This review will include comparative analysis of energy consumption, life-cycle costs, and environmental effects of incandescent lighting and potential replacement technologies, including CFLs and LEDs, in Armenia.

The review will also present international experience (focusing on Russian Federation and Kazakhstan) with laws, regulations, and enforcement mechanisms with regard to phase-out of incandescent lighting, as well as market-based or tax-related incentives for EE lighting. It is planned that the review will prove the base to facilitate joint efforts of the project and relevant governmental body (Ministry of Energy and Natural Resources of RA) in drafting and building support towards adoption of proposed legislation and enforcement mechanisms.

This subtask will be completed by the local team of experts by the end of 2016. Contracting of a new local expert to support the project team will be considered depending on the scope of particular tasks to be performed.

It is well acknowledged that the adoption of a phased ban on incandescent lamps (ILs) may be a challenging task both technically and politically. Phased out ILs could be replaced in the short term largely by compact fluorescent lamps (CFLs), which one can expect to be unpopular among many stakeholders for various reasons. Their initial price is about 2-3 times higher than that of equivalent incandescent lamps in Armenia.

Although lower energy costs and longer operating life should in theory pay back the initial price difference many times, many CFLs available in Armenia are of low quality and reliability, thus presenting a perceived risk for consumers that payback might not actually be achieved. Moreover, CFLs are still widely considered to be visually less comfortable and useful for household use than ILs because of their shape and typically cold light quality. Another problematic issue is mercury content of CFLs that need special attention for safe collection and disposal. In this context it is to be noted, however, that the LED lamps do not pose similar safety hazards with mercury, while their costs have also been rapidly decreasing and are already approaching the costs of the CFLs. As such, a leap from ILs directly to LEDs rather than CFLs is likely to become an increasingly attractive option for many households and can be viewed positively also by its environmental merits.

18.1.1. Residential energy consumption survey

In order to have realistic picture of energy saving potential of the phase-out initiative as well as to assess awareness of population on energy efficient indoor lighting technologies and readiness to shift from traditional illumination practice based on ILs to energy efficient one based on CFLs and LEDs, the project organized a holistic survey on residential energy consumption. The survey was conducted specifically for residential sector as the biggest and most sensitive group of ILs users, since public and commercial sectors have already shifted to energy efficient indoor lighting (predominantly CFLs, but with growing share of LED lamps). The survey was conducted by Economic Development and Research Center in October 2015 and covered 2417 households in 22 cities and 64 villages of Armenia. Along with lighting the survey covered also such sectors as heating, hot water supply, air conditioning, home applications and fuels.
Main findings of the study relevant to the project objectives are listed below.

- The main option used for lighting in Armenia is incandescent lamps, although energy-saving lamps also became popular.
- About 95% of households have incandescent lamps; however, only 53% use only incandescent lamps. About 43% of households combine lamps (energy-saving and non-saving), while 5% use only energy saving lamps. The most widespread energy-saving lamps are compact luminescent lamps.
- Use of LED lamps is relatively high in Yerevan: they are used by 6% of households.
- According to estimates, on average one household consumes 1,1 kWh electricity daily for lighting.
- The share of electricity consumption for lighting constitutes 18% of total in summer months.
- About 62% of households are aware of energy efficient lamps.

- 41% or respondents acknowledged high efficiency of energy-saving lamps and 48% agreed that these lamps have longer lifetime.
- High cost was mentioned by 47% of respondents as the main “disadvantage” for energy-saving lamps, whereas 20% mentioned that they do not like the color of the light.
- TV (29%) and shops (15%) were mentioned as the main sources of information on energy-saving lamps.

The study provides the most recent, relevant and unique information on the current situation with indoor illumination in residential sector of Armenia that will help the project to realistically assess energy saving potential to be achieved in case of enforcement of phase-out requirement as well as to propose necessary awareness raising, consumer behavior change and “mitigation” measures to ensure smooth transition from incandescent to energy efficient illumination.

18.1.2. Development of proposals on safe management and disposal of mercury containing lamps

Mercury-containing lighting equipment is a large group of lamps (e.g. CFLs) that contain mercury and may represent significant environmental and human health hazard when transported and disposed in landfills without necessary care, precautions and treatment. A ban (phase-out) on incandescent lamps to be replaced partially also by energy-saving CFLs would create a significant increase in the mercury content of municipal waste, via both spent and broken compact fluorescent lamps. Whereas, proper recycling of such products allows recovering of the mercury, glass, plastic and other materials and elements contained in the lamps.

However, at present, Armenia does not have separate facilities for separation, containment, and processing of mercury wastes. Therefore, approval of a phase-out of incandescent lamps would also have to be accompanied by a robust plan as well as development and enforcement of necessary legislation and regulation to address proper management of such type of waste in Armenia. The same problem is already experienced with the mercury vapor lamps still commonly used for street lighting and for which no waste treatment facility in Armenia currently exist after the lamps are taken out of use.

Therefore, one of the specific tasks of the project to be performed within the scope of the fourth outcome is envisaging the development of a proposal on setting the national regulations for environmentally safe collection, transportation, recycling and disposal of used mercury-containing lighting equipment.

Within the reporting period the project has developed ToR for local expert on safe disposal of mercury-containing lighting products who will be tasked to: (i) analyze the acting legislation of the Republic of Armenia in the field of hazardous waste management and develop overview of all relevant legal and normative documents regulating management of used mercury containing lamps; (ii) analyze the international legislation and practice on environmentally safe management of mercury-containing lighting products: collection, transportation and recycling and neutralization of used mercury-containing lamps; iii) assess the approximate investment and O&M costs of required treatment and collection chains and facilities for such waste; and iv) develop recommendations for necessary legal/normative framework for establishment of infrastructures and typical mechanisms for safe management of used mercury-containing lamps in Armenia.

Completion of this task is planned by the end of 2016.

18.2. Development and adoption of new standards for lighting quality, lighting design in buildings and construction, and lighting issues in public health

This subtask envisages development and adoption of new standards for lighting quality, lighting design in buildings and construction, and lighting issues in public health. It is expected that the adoption of the IL phase-out or other major national policies will trigger the need for accompanying technical standards and/or construction codes for energy-efficient lighting. The UNDP-GEF project is to support the development of all relevant standards, which will likely cover energy performance, mercury content, operating lifetime, and lighting quality, and will include not only performance criteria but also test procedures.

18.2.1. Development of a draft Law of RA "On making an amendment and an addition into the RA law "On energy efficiency and renewable energy"

Within the reporting period the project team jointly with "Improving Energy Efficiency in Buildings" UNDP-GEF project experts participated in development of the draft Law of RA "On making an amendment and an addition into the RA law "On energy efficiency and renewable energy", proposing a package of proposals whose adoption enables the following:

- Besides voluntary principle for actors in the energy saving sector also application of compulsory so as to create legislative bases of stipulating energy efficiency requirements on buildings and lighting equipment/lamps in legal acts (e.g. via adoption of the respective technical regulations);
- Stipulating mandatory requirements on energy efficiency and energy saving for the newly constructed residential multi-apartment buildings as well as for facilities being constructed (reconstructed, renovated) under the state funding;
- Identification of economy sectors of the Republic of Armenia as featuring high, medium and low energy intensity which will enable to implement regular organization of statistics on energy consumption in lighting systems and buildings;
- Adoption of labeling of energy consuming equipment and devices and identification of label form to contribute to wider use of those (including lamps and lighting equipment) in buildings, outdoor lighting and other systems;
- Clarification of regulatory issues for energy audit implementation;
- Compilation of a list of energy efficient devices, appliances and other products identified as hazardous for human life and/or environment (containing dangerous substances), as well as procedure for circulation of those in the RA internal consumer market and utilization of those upon disposal, including issues relevant to mercury containing lamps.

On 15 March, 2016 the National Assembly finally adopted the package of legislative amendments to the RA law "On Energy Saving and Renewable Energy" and adjacent ones. It is expected to be adopted by 2nd reading by mid-April, 2016.

18.2.2. Decision of RA Government "On implementation of energy saving and energy efficiency improvement measures in facilities being constructed under the state funding"

Another document developed with participation of project experts is the decision of RA Government "On implementation of energy saving and energy efficiency improvement measures in facilities being constructed (reconstructed, renovated) under the state funding (adopted by the RA Government on December 25, 2014, decision #1504-N) incorporates the proposals developed in the frames of the project.

The list of the proposed energy saves and energy efficiency measures to be implemented in facilities being constructed (reconstructed, renovated) under the state funding includes:

1. Insulation of building envelopes;
2. Application of volume-planning solutions ensuring possibly minimal surfaces of building envelopes;
3. Application of paints with coating, plastering, waterproof and heat-resistant mixtures to ensure protection of external wall surfaces;
4. Application of energy efficient windows and entrance doors;
5. Sealing of joints of openings', external walls' and covers 'elements;
6. Application of certified insulation construction materials;
7. Application of energy saving heating, ventilation, air conditioning, hot water supply, **lighting systems and equipment**;
8. If feasibility/cost effectiveness assessed positively, application of alternative energy systems – solar water heating and photovoltaic devices and heat pumps.

The following are the proposed directions to support enforcement of the above-mentioned legal acts by UNDP Armenia climate change projects:

- Arrangement of seminars to present the proposals on enforcement options and to develop further steps;
- Development and dissemination of printed and on-line information materials;
- Elaboration and dissemination of advisory handbook on procurement practices by state agencies to ensure energy efficiency in buildings and lighting systems;
- Consultations for stakeholder parties on development of terms of reference on design and construction/installation of energy efficient buildings and lighting systems;
- Provision of information to stakeholder parties on suppliers of construction insulation materials, and energy efficient lighting equipment and lamps;
- Implementation of activities aimed at elaboration of the relevant sub-legislative acts and normative and technical documentation.

18.2.3. Update of the existing norms of RA on natural and artificial illumination

Regulations on lighting design and installation in Republic of Armenia are integrated in building codes and health codes. The current building code on natural and artificial lighting regulates the amount of light delivered into given indoor or outdoor spaces, with very limited requirements for energy efficiency. There exists a national law on product standards, including technical standards on lighting, but these existing lighting standards deal with health and safety, not energy efficiency. At the same time, in the Russian Federation and European Union respective norms on natural and artificial lighting have been substantial updated to refer to the recent developments in lighting technologies with the special focus on LEDs.

In order to reflect new international requirements toward illumination quality, the project activities with regard to codes and regulations envisage development of respective recommendations to the Ministry of Urban development of RA on enhancement of the building code “Natural and Artificial Lighting” currently acting in Armenia. Under this subtask a local expert on codes and standards has been recently contracted to perform the following activities:

(i) Comparative analysis of SNiP 52.13330.2011 «Natural and artificial lighting» of Russian Federation and similar/adequate norm(s) of the European Union (e.g. EN 13201:2015) including overview of standards (GOSTs) referred to in the analyzed documents.

(ii) Development of recommendations on localization/adaptation/approval of lighting sector construction norms and standards with main objective to stimulate energy efficiency, and the roadmap for that harmonization process in accordance with current practice in RA.

(iii) Translation, adaptation and localization of the recommended document (SNiP or EU norm) and development of all relevant supporting documents, justifications, etc., required for receiving consent prior adoption of the document in line with RA legislation.

(iv) Support the project in presenting the document to the respective authorized body in RA.

The ultimate objective of this assignment is to facilitate adoption and enforcement of the updated norms by the Ministry of Urban Development of RA. Once become mandatory the new requirements will enable broader penetration of modern lighting technologies, thus, contribution to overall improvement of energy efficiency lighting for new public and residential buildings, educational institutions, streets, parks, etc.

18.3. Development and adoption of new rules for state agencies on procurement of energy-efficient lighting

The current state procurement law requires purchase of equipment based on initial lowest costs, without taking into account specific technical parameters, including minimum energy performance standards and consideration of life-cycle costs, to the detriment of EE lighting, which costs less to operate and usually lasts longer than conventional lighting. There is also no state policy regarding promotion of energy-efficient lighting products. As a result, the vast majority of lighting equipment procured by municipalities and state organizations via state procurement procedure do not meet basic energy efficiency and quality requirements leading to reduced quality if illumination and increased operational and maintenance costs.

Under this subtask development and adoption of new rules for state agencies on procurement of energy-efficient lighting is envisaged. Based on best practices in other countries, including European nations as well as Russia and Kazakhstan (where procurement is one focus area of analogous UNDP-GEF projects), the project in Armenia is to elaborate and deliver recommended processes and criteria, including performance and life-cycle costs, for public agencies to use in bulk procurement of lighting products.

As a first step a manual of energy efficient procurement of lighting systems/equipment is currently being developed. Second step is the analysis of the RA Law on procurement and secondary legal acts (currently underway). Meanwhile, the above-mentioned 1504-N decision is also being considered by project staff to be amended for introducing MEPR for lighting equipment.

19. Conclusions

Component 1: Municipal Energy Audits and Technical Capacity Building

The following activities were implemented by the project under this component:

- **Inception workshop** for 96 participants;
- Establishment of **Technical Advisory Committee**;
- **Audit** of municipal lighting systems for 8 communities;
- Development of draft **methodological guide for audit** of municipal lighting systems;
- Development of **Guide on Energy Efficient Lighting for Students**;
- Development of eight **factsheets, a manual, a guide and a reference book**;
- Development and presentation of **Educational Module on EE Lighting** for 180 **college students**;
- Development of **Educational Module on Light and EE Technologies** for **universities**;
- Development and broadcast of a twenty-minutes **video** on the pilot projects;
- **Study tour** on advanced technologies in urban lighting for 6 people;
- **Five workshops and seminars** on EE lighting for 160 stakeholders;
- **Training** on proper installation of new EE LED luminaries for 20 municipal specialist;
- Translation and adaptation of **SEAD lighting evaluation tool**;
- Two pilot project **inauguration event** for 80 participants.

In total the project awareness raising and capacity building activities covered more than 540 stakeholders without consideration of distributed leaflets and the move to be broadcasted by 2 national TV channels.

In the table below progress of the project toward the targets set in the Logframe is demonstrated.

	Targets	Achievements	Comments
1	Methodology will be established and shared with municipalities.	The methodology is drafted.	Achievable target The manual will to be finalized and disseminated before in 2016.
2	At least 10 comprehensive audits of public lighting completed in Yerevan and other cities.	Audit of municipal lighting systems is carried out in 8 municipalities.	Achievable target Audits will be organized in 2 more municipalities.
3	At least 20 specialists from private sector and municipalities are trained on EE lighting and energy audit.	Capacity building events (study tour, training, educational module, etc.) are organized for more than 50 specialists and materials (guide, manual, etc.) are developed for stakeholders.	Achieved target New events will be organized and materials will be developed depending on identified training and capacity building needs.
4	Media releases on outcomes of each pilot.	Factsheets for each of the completed pilot are developed, disseminated and published on the website. A	Achieved target

		twenty-minute video on the pilot projects is developed and broadcasted.	
5	Awareness raising materials available for general public.	Events, materials, articles are developed and disseminated and made available for the public via the project website.	Achieved target New events will be organized and materials will be developed depending on identified awareness raising needs.

Component 2: Demonstration projects

The following activities were implemented by the project under this component:

- Design and completion of **8** pilot projects on EE modernization of **street lighting**;
- Design and completion of **1** pilot project on EE modernization of **park (garden) lighting**;
- Organization of **2** pilot projects on EE modernization of **indoor lighting** (to be completed in 2016);
- Organization of **1** pilot project on EE modernization of **tunnel lighting** (to be completed in 2016).

Through completion of 9 pilots (streets and a park) the project has achieved the following key results:

- Annual energy saving: **983 MWh**;
- Annual electricity costs saving: **91000 USD**;
- Annual greenhouse gas emissions reduction: **436 tCO_2**.

In the table below progress of the project toward the targets set in the Logframe is demonstrated.

	Targets	Achievements	Comments
1	At least five demonstration projects on a number of efficient lighting technologies completed for indoor, outdoor and street lighting.	Nine demonstration projects on street and park lighting are completed and 3 pilots on street, indoor and tunnel lighting are planned.	The target will be 100% achieved by the end of 2016 after completion of ongoing and planned pilots.
2	Direct energy savings of up to 1,2 GWh per year by completion of all pilots.	Direct energy savings of 0,983 GWh per year are achieved through implemented 9 pilots.	Implementation of new pilots will be decided based on consultations with the project partners and stakeholders.
3	100% LED for outdoor (park) and indoor lighting pilots.	100% LED lighting used in park illumination.	Achieved target
4	40% LED included in street lighting pilots.	100% LED lighting used in street illumination.	Achieved target

Component 3: Replication via municipal programs and associated financial instruments

The following activities were implemented by the project under this component:

- Establishment of municipal revolving fund for replication of EE lighting projects in 5 municipalities;
- Implementation of a replication project finance from the municipal fund in Yerevan;
- Development of municipal lighting upgrade programs for 8 communities.

In the table below progress of the project toward the targets set in the Logframe is demonstrated.

	Targets	Achievements	Comments
1	Municipality of Yerevan develops and adopts program for upgrades of municipal lighting.	The task on comprehensive audit of Yerevan street lighting system has been reconsidered to avoid replication of efforts with the EBRD finance project on modernization of street lighting in Yerevan.	International expert is hired to develop recommendations on city-wide upgrade program for Yerevan by the end of 2016.

2	Similar programs are adopted in other cities of Armenia.	Program for upgrade of municipal lighting are developed for 8 communities.	Achieved target Needs for development of new upgrade programs will be decided within a course of the project.
3	Savings of 20 GWh per year from municipal lighting programs.	Up to 1,2 GWh direct annual energy saving is achieved through the pilot projects. 2,6 GWh saving will be achieved through EBDR project.	The target can be achieved in case of implementation of the city-wide street lighting modernization program in Yerevan that can ensure up to 18,5 GWh annual power saving.
4	US $10 million for EE municipal lighting secured.	About 6 mln USD was allocated by EBRD and E5P for Yerevan street lighting modernization program. Additionally, about 200.000 USD was allocated by the partner cities as co-financing of pilot projects.	Achievable target
5	Establishment of financing mechanisms for Yerevan and other municipalities from savings achieved from piloted EE actions.	Municipal revolving energy efficient lighting funds are established and operational in 5 communities.	New funds will be established in new partner municipalities after completion if pilots.
6	Support in preparation of funding proposals (including tenders for ESCOs) for cities of Armenia.	No progress with this component has been achieved yet.	Cooperation with the banks, ESCOs and private sector.

Component 4: National policies, codes and standards on lighting

The following activities were implemented by the project under this component:

- Overview and analysis of the acting local and international legislation, norms and standards on energy efficient lighting, identification of gaps and provision of recommendations;
- Collection and analysis of information necessary for development of proposal for phase-out of incandescent lighting and/or other major national policies on EE lighting;
- Organization of residential energy consumption survey with a special focus on composition and power consumption of indoor lighting systems;
- Development of ToR for elaboration of recommendations on safe management and disposal of mercury containing lamps;
- Development of draft Law of RA “On making an amendment and an addition into the RA law “On energy efficiency and renewable energy“;
- Participation in development of decision of RA Government “On implementation of energy saving and energy efficiency improvement measures in facilities being constructed under the state funding”;
- Contraction of a local expert for update of the existing norms of RA on natural and artificial illumination;
- Collection and analysis of information necessary for ddevelopment and adoption of new rules for state agencies on procurement of energy-efficient lighting.

In the table below progress of the project toward the targets set in the Logframe is demonstrated.

	Targets	Achievements	Comments
1	Proposed improvement to existing legislation addressing minimum energy performance requirements for lighting appliances.	Analysis of the acting local and international legislation, norms and standards is carried out to identify gaps and propose solutions.	

2	A national phase-out plan of conventional incandescent lighting is adopted.	Baseline data for development of a national phase-out plan is collected and analyzed.	The recommendation package will be completed by 2016.
3	Other adopted policies and supporting standards.	A local expert is contracted to update national standard on natural and artificial illumination.	The standard will be updated by September 2016.
4	New criteria for incorporation in state procurement procedures for lighting applications are developed.	Baseline data for development of recommendation for incorporation in state procurement procedures for lighting applications is collected and analyzed.	Recommendations will be prepared by the end of 2016.

Additional benefits

The following additional benefits were achieved:

- Capacity building of municipalities for collection and analysis of baseline information and assessment of the municipal lighting system performance via direct involvement of municipal specialists into data collection and audit process together with the project experts.
- Improvement of overall quality of technical proposals submitted by the local companies participating in the project tenders for procurement of EE lighting equipment.

Annex I: Recommendations of the Project International Consultant (developed by V.Rutanen)

End of project targets at the project objective level and related GHG Accounting

While the project has made good progress in the area of energy efficiency (EE) street lighting retrofits and should be able to achieve the direct energy saving and GHG reduction targets of 1,2 GWh and 474 tons of CO_{2eq} per year by the end of the project, until now it has had less emphasis on other areas of EE lighting improvements such as indoor lighting in public and private residential buildings in particular. Unless complementary efforts will be made during the second half of the project to address also these areas, it will be difficult for the project to claim indirect energy saving and GHG reduction benefits at the level of 125 GWh and 50,000 tons of CO_{2eq} per year, respectively. In the project design, this indirect project impact was foreseen to primarily result from the adoption and implementation of a national lighting policy to improve the energy efficiency of indoor lighting, including a gradual phase out of less inefficient lighting fixtures in line with the adopted policies in the EU and some Eurasia Custom Union countries such as Russia and Kazakhstan. Therefore, additional attention to this particular area will be paid during the remaining project implementation period.

As defined by the STAP Guidance Document for Calculating GHG benefits of GEF EE Projects[7], "Direct GHG emission reductions are those achieved by project investments such as technology demonstrations and discrete investments financed or leveraged during the project's supervised implementation period (from the project start to the project closure). In contrast, GHG emission reductions achieved, for example, as a result of market facilitation and development through project-supported policy and institutional frameworks, capacity building, information gathering, and replication effects of demonstration activities, are considered as indirect GHG emission reductions. In addition, a third category, direct post-project emission reductions, has been used to quantify the GHG emission reductions of GEF-supported revolving financial mechanisms that are still active after the project's closure (ex post)." By building on these definitions, the project may claim GHG emission reduction benefits under all three categories by assuming that the revolving funds established with the participating municipalities will continue their operation also after the project.

The targeted GHG reduction impact of the project was reassessed and slightly amended at the project inception phase, but neither the project document nor the inception report was calculating the direct project impact over the entire lifetime of the investment, which would make the assessment consistent with the recommended GEF methodology and other GEF funded climate change mitigation projects. While the latest GEF methodology for EE lighting products and appliances is suggesting a highly generic default lifetime of just 5 years[8], for good quality LEDs it can be assumed to be considerably longer. For the GHG accounting of this project, it is reasonable to refer to the typical expected lifetime of the installed lighting fixtures[9] rather than to a general default lifetime of 5 years. Beside continuing to calculate the annual savings and GHG emissions reductions (so as to be consistent with the current project results framework), all future reporting of the project's direct, indirect and direct post project impact will include also the calculations over the expected lifetime of the made investments, in order to bring the project reporting into compliance with the respective GEF methodologies.

The project results framework also includes a target of "direct energy savings of 20 GWh and 8000 tons of CO_{2eq} per year from replication of demonstration projects via municipal programs". It is not likely, however, that the implementation of these municipal programs can be finalized by the end of the project. Therefore, this target should be considered either as an indirect or direct post-project target, rather than a direct GHG emission reduction target to be achieved by the end of the project. Alternatively, this target could be reformulated as "adoption and start of implementation of municipal EE lighting retrofit programs with aggregated potential to reach energy savings of at least 20 GWh and GHG emission reduction of at

[7] http://www.stapgef.org/revised-methodology-for-calculating-greenhouse-gas-benefits-of-gef-energy-efficiency-projects-version-1-0/

[8] http://www.stapgef.org/revised-methodology-for-calculating-greenhouse-gas-benefits-of-gef-energy-efficiency-projects-version-1-0/

[9] For good quality LED lamps, for instance, 10 years could still be considered as adequately conservative estimate

least 8000 tons of CO_{2eq} per year by successful completion of the programs within 10 years after the project end." Decision on this matter will be taken at the project mid-term evaluation stage based on recommendations to be made by the expert carrying out project mid-term evaluation in May 2016.

Indoor lighting

As it concerns the indoor lighting of public buildings, observations and analysis of information on the indoor lighting systems in the structures of partner municipalities such as town hall, kindergartens, etc., made by the project team demonstrates that in the majority of structures CFLs or tube-type fluorescent lamps (LFLs) are used providing fair illumination and ensuring certain energy saving. Given the limited daily duration of indoor lighting systems' operation and their relatively low costs, replacement of the existing system with LED based technology has been considered by the project to be expensive and financially not justified. It shall be also noted that simple replacement of existing compact fluorescent light bulbs to LEDs, for instance, would not yield the best results, but changing luminaires should be considered as well, which correspondingly would increase the costs.

However, these considerations made at the beginning of the project shall now be revised since the current prices of good quality CFL and LED light bulbs are assessed to be approximately the same in Armenia, so any cost difference in this respect is not anymore seen as a major barrier to switching from CFLs to LEDs. No comprehensive analysis of the technical potential, economic and financial feasibility of the public sector indoor EE lighting improvements has been done by the project yet, however.

If so decided and also subject to the conclusions and recommendations of the upcoming mid-term evaluation, there would still be enough time during the second half of the project to select a few representative public buildings of different type for more detailed energy audits not addressing only lighting, but their energy consumption in general (so as to contribute to the formulation of broader municipal EE programs later on). Before that, the project shall also search similar studies in other countries and/or earlier ones in Armenia so as not to start from scratch what may have already been done in the frame of the other projects in Armenia or elsewhere. As it concerns, the technical and operational characteristics of the lighting fixtures installed in public buildings, it can be assumed that the situation in Armenia is not very different from other transitional economies. Obviously this assumption still needs to be verified, however.

An issue shared by both residential and public sector lighting products (luminaires and lamps) is that no adequate quality control scheme for them currently exists. This is both a barrier and a risk slowing down the expanded use of the most energy efficient lighting fixtures (such as LEDs), since the people have concerns and doubts about their quality, promised lifetime and real savings in the light of their considerably higher prices compared to incandescent light bulbs. In order to effectively remove the barriers to residential and public sector indoor lighting EE improvements and reach the stated indirect impact of the project, product quality is an area that the project is recommended to seriously look at during its remaining implementation period by reviewing the quality control, market monitoring and surveillance mechanisms used in other countries and after that concluding what realistically could be supported, advocated and adopted in Armenia. Further co-operation opportunities in this area could also be found with the consumer protection agencies operating in Armenia (either public or CSO based). Specific components to be supported during the remaining project implementation period for this subcategory may include: i) outlining the structure, required legal and regulatory changes, institutional arrangements and related advocacy work for the adoption of voluntary or mandatory certification schemes with related market surveillance, continuing training and capacity building of the key stakeholders on quality control related issues; ii) complementary project support for product testing in domestic or, as needed, international testing laboratories based on a representative number of random samples from the biggest retail stores/chains; and iii) publishing the test results in public media.

Beside quality control, other key area to be taken into account when considering to phase out incandescent and other inefficient lighting fixtures are possible affordability constrains and social consequences resulting from higher upfront costs of more energy efficient lighting technologies. There are options to address these constrains such as integrating support for EE lighting investments into the

already existing social support programs and/or launching new programs e.g. in co-operation with the local electric utility and/or distribution companies and/or local CSOs. Such complementary support programs would still need to be thought and worked out with the key public authorities and other stakeholders, however.

Revolving funds, municipal programs and project exit strategy

One of the most innovative and inspiring results of the project so far has been the set up of the revolving funds (RF) by building on the agreements with all the municipalities hosting the pilot projects. In the agreements signed between UNDP and the participating municipalities, it is stipulated that all savings from the supported pilot projects should be directed into this extra-budgetary account and reinvested into new EE lighting retrofit projects.

For its remaining implementation period, the project should build on the initial success of this mechanism both in Yerevan (where the first reinvestments by using the Fund resources are already made) and ensuring its continuing use also in other municipalities in accordance with the agreements signed. Besides, the results and benefits of such revolving funds as an alternative to simple "one time grant" funding of EE projects should be actively marketed to the relevant financing authorities in Armenia (including the Ministry of Finance and the financing/investment departments of municipal administration), other international donors operating with grant funding as well as domestic and international lending institutions. Organising a specific seminar and donor co-ordination event for financing sustainable low carbon development in Armenian municipalities could also be considered during the second half of the project, where the first results and experiences from the revolving funds can be presented to a wider audience.

To support this endeavour, it is recommended to prepare "dynamic road shows" to visualize and demonstrate the operation of the RF financing modality based on the projects implemented so far. With favourable financing parameters in place (the shorter the pay-back the better), the impact can grow exponentially within quite a short time frame, as illustrated in the figure 1 below, while the required external grant funding or other public support would be only a fraction of what it would be with more traditional direct grant support. At a later stage and when not required anymore for EE lighting retrofits, the accumulated savings could be used for other municipal EE investments.

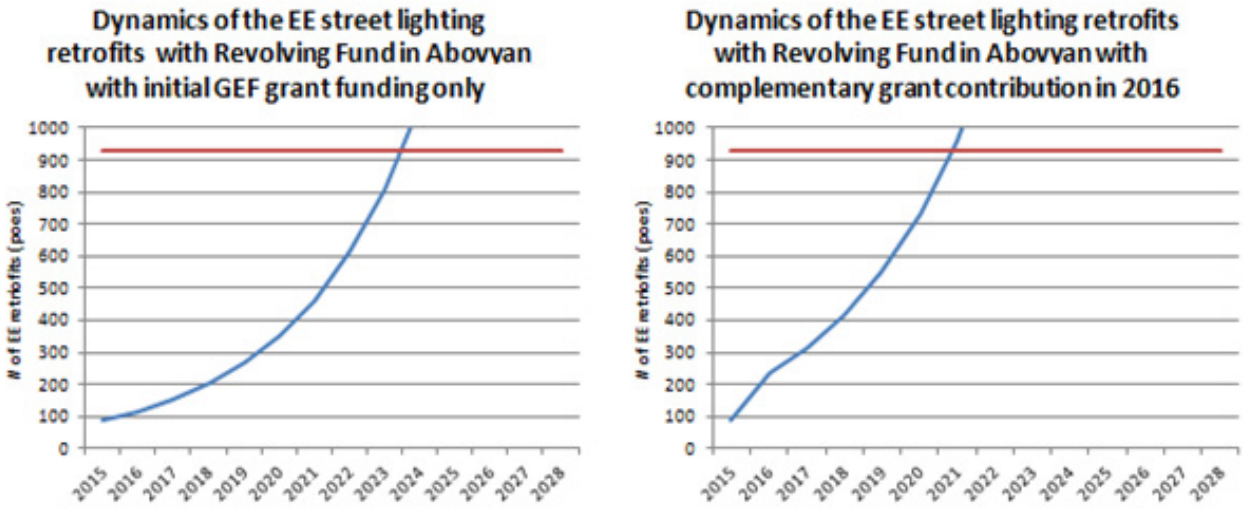


Figure 1: Dynamic of the EE street lighting retrofit with revolving fund in Abovian municipality

On the figure above a simple simulation example of the dynamics of a complete EE street lighting retrofit program in Abovyan municipality (for 926 light poles and 975 luminaires) by assuming that all the savings from the implemented pilot EE street lighting retrofit projects will be reinvested into new EE retrofits is demonstrated. The year 2015 marks the pilot investment of USD 24,346 supported by GEF grant resources, while in the graph at the right side the impact of complementing the initial GEF grant by a

second similar grant contribution in 2016 is simulated. The total retrofit costs of 926 light poles are estimated at about USD 182,500.

The revolving funds established in each supported municipality provide an excellent financing platform for more comprehensive municipal EE lighting retrofit programs that may continue to operate also after the end of the UNDP/GEF project, thereby contributing to the indirect or direct post-project targets, as discussed in chapter 10.1. During the remaining project implementation period, the formulation of such comprehensive retrofit programs and leveraging complementary financing for them from other financing sources can be supported by project's remaining TA resources.

Knowledge management

Having worked over 20 years in managing and supporting the GEF funded climate change projects in Armenia for a variety of subsectors ranging from the initial, 2nd and 3rd national communications to municipal heat and hot water supply, transport, building energy efficiency, forest adaptation and energy efficient lighting, the Climate Change Information Center (CCIC) hosted by the Ministry of Nature Protection has accumulated a wealth of expertise, contacts and information on various aspects of climate change mitigation and adaptation. While the CCIC website (http://www.nature-ic.am) is already now facilitating access to several useful documents and other information on the already completed projects and those currently under implementation, much of this information remains "hidden" in the CCIC's internal server and can be easily found only by those, who may have the institutional memory from which folders to search. This despite the fact that much of this "hidden information" could be open and useful also for broader public use, if properly organized and made available.

Given the above, one distinct complementary activity either under the EE lighting project or any other climate change related project could be to systematically go through, assess and organize all the available guidance documents, reports, databases, surveys, presentations, training materials etc. that could be anticipated to be of interest also to a broader audience and make them available and "downloadable" through a searchable database or other appropriate ICT platform. In other words, further developing the CCIC platform towards a real virtual CC library by using the wealth of materials collected over 20 years and already existing in electronic format. Despite the standard provisions within most UNDP/GEF supported projects to have a specific emphasis on national, regional and global knowledge management, too often these activities earn much less emphasis than they should - not least because such KM is not really effectively required, facilitated or credited at the UNDP corporate level either. The CCIC could be a front-runner also in this respect both in Armenia and in the regional context by further developing the already good CCIC web-platform and document repository by using state of the art knowledge, data and information management tools and opportunities and investing some time and project resources for this.

Another common challenge in many countries is to compile the best experts and services to contribute to the implementation of the particular tasks and needs of any given project or activity. Over the past 20 years, tens of Armenian experts have been building up their capacity to professionally contribute to the development and implementation of climate change related projects in various subsectors within the projects supported by UNDP and the GEF, while the CCIC, on the other hand, has built up an extensive network of professional contacts, who can contribute to its work on as needed basis. Those capacities can and should be used also after the project not only in Armenia, but, as applicable, also in other countries, while also creating new job opportunities for the experts concerned. While the CCIC website is already containing a good list of experts that are or have been working within the different project teams, this roster could be further developed towards a more comprehensive, cross-sectoral and searchable database with downloadable CVs and description of key qualifications of each expert included in the roster. This would help public authorities in the supported municipalities as well as other professionals to build up teams and consortiums that match the specific needs and expectations of the required services.

The CCIC and project website also includes an excellent "Reference Book on Organizations and Services Provided in the Lighting Sector of Armenia", which is expected to be regularly updated during the project implementation period. Again, however, there are several ICT options to develop and eventually expand the publication into a more interactive and sustainable source of information not only for lighting, but

sustainable energy equipment vendors, service providers and organisations in a broader sense with an interface, through which these entities would be able to update the information of their particular company/organisation themselves (based on agreed standard templates).

As it concerns other project specific KM products, it is suggested that a series of target group specific "road shows" and training packages to address the municipal decision makers, engineers of illumination companies, financing entities and others will be prepared by highlighting the project results and recommendations, but tailored to the specific interest area and training needs of each stakeholder group.

Last but not least, an analytical, thorough and, as required, also critical "Lessons Learnt Report" summarizing experience and findings of this project would highly benefit other similar projects and UNDP in general. As a part of that, an analysis of the pilot project tender results and their evolution over the time in line with the capacity built would also have some broader KM value as the correlation based on the initial review of the tenders is quite clear. As such, it is recommended that some project resources are invested to compile such "lessons learnt" reports to contribute to the project's KM, learning and information dissemination strategy.

Other recommendations

Other specific conclusions and recommendation for the remaining project implementation period and for the consideration of the project mid-term review are discussed below, clustered under the main project components and outputs as presented in the project results framework and annual work plan for 2016.

1: Knowledge and capacities for urban green lighting

1.1: Audits of public lighting systems

- Organize the design and execution of technical audits of public lighting systems to define baseline technical information and energy saving potential for municipal plans and financial proposals for specific sets of upgrades to be carried out.
- Development of a methodological guidance (manual) for energy audit of municipal lighting systems based on the best international practice and with consideration of local specificities.

Comments/Recommendations: The methodological guidance/manual should be relatively straight forward undertaking by building on the audits already conducted in the frame of the UNDP/GEF project as well as on the information that can be drawn from the comprehensive EBRD studies done for the preparation of EBRD Street Lighting Project.

1.2: Study tour to GEF Public Lighting project in Central Europe

- Organize a study tour to CEE on best practices in urban lighting design, organization and financing for key personnel of involved municipalities and other responsible agencies.

Comments/Recommendations: Already completed

1.3: Technical training and capacity building for the respective specialists

- Development of training and capacity building materials on EE lighting including information on practical application of the municipal lighting energy audit methodology manual developed under subcomponent 1.1and available material from pilot projects interim results.
- Organize and deliver at least two half-day capacity-building seminars on energy efficient lighting for technical specialists from municipal agencies, lighting companies, and building design institutes.

Comments/Recommendations: The mid-point of the project provides good timing and opportunity for reassessing the remaining capacity building and training needs and for continuing the preparation of target group specific, replicable and easily accessible (online) training package(s) to address those needs. Based on an initial interviews, required areas for complementary training and capacity building could be

in areas such as: i) photometry[10]; ii) selection of luminaires for indoor and outdoor lighting; iii) illumination of historical buildings iv) lighting system audits; v) feasibility assessments, economic and financial analysis; vi) project financing options (budget financing, credits, Revolving Funds, EPC + Third Party Financing, ESCOs) and how to structure financing for project by considering different sources of financing (own financing, EU programs, international development banks, bilateral donors, municipal bonds, crowd-sourcing, local Funds (R2E2, Territorial Fund different financing modalities; and vii) "green" public procurement.

However, there is also a need to create a culture for public authorities to use professional services such as procurement guidance, evaluation of offers, supervising the implementation and others in areas that the municipalities may not have sufficient capacity of their own. As an example, the technical staff in charge of street lighting typically has a very good understanding of the electrical part of the system, but eventually not so much on photometry.

1.4: Increased awareness and support among the general public for green urban lighting programs.

- Organize media coverage and other public outreach on energy-efficient lighting, to build support for the urban programs and also to promote EE lighting in the residential sector.

Comments/Recommendations: Similar to output 1.3, the mid-point of the project is providing a good opportunity for assessing project's public outreach strategy and impact so far in terms of whether the PR channels currently used are adequate and most effective ones, are all the key stakeholders adequately addressed and are they served by content that is gaining support and/or is resulting the desired behavioural changes.

To monitor market changes and assessing the influence of the project on consumer behaviour, surveys and interviews can be conducted in lighting equipment stores and among importers, while also verifying the results by available sales and other statistics.

Since changing the yellow HPS lamps to bright LED lamps will change the night-time city image quite significantly, it is also suggested to conduct a few night-time surveys among the pedestrians using the streets on how they feel about the changes. The first survey could be conducted immediately after the retrofit and the second survey one year later to see whether any changes in views over time. Similar surveys could also be conducted among other frequent street users such as taxi and bus drivers. Any changes in the frequency of accidents or criminal acts could be checked with the insurance companies and/or police, which information could then be used in project's further PR and public awareness raising activities.

1.5: Establishment of a testing laboratory for lighting equipment and educational laboratory in a university.

- Establishment of a testing laboratory for checking conformity of lighting equipment and establishment of an educational laboratory in a university.

Comments/Recommendations: Already underway. It shall be assessed whether any complementary outreach is required e.g. for universities to encourage the effective use of the laboratory for research and educational purposes by a variety of stakeholders.

2: Pilot urban green lighting projects

2.1: Design, completion, and documentation of demonstration projects on street lighting

- Identification of pilot streets, collection of baseline information, development of design for pilot demonstration projects and implementation of pilot demonstration projects.
- Monitoring and documentation of the achieved results as well as dissemination of achieved results.

Comments/Recommendations: Well underway already. The content of the project factsheets compiled so far are not fully consistent with each other, however. Some standard template could be considered.

Another issue is that no detailed and reliable information on inventory and technical condition of existing street lighting infrastructure or their energy consumption, operation and maintenance costs is systematically collected and stored by any municipality yet. To support this, the project team may start to prepare ground already now for broader introduction of Energy Management Information Systems (EMIS) in Armenian cities for the street lighting part. The main components of such an information system may consist of: 1) complete Inventory of the street lighting fixtures in use and their technical characteristics; 2) monitored energy consumption at the specific substation/district level; and 3) schedule for inspections, repairs etc. Some good work in this respect has already been done in the frame of the UNDP/GEF Serbia EMIS project, which could be contacted for further information about integrating street lighting subcomponents into EMIS. Also it is reasonable to take stock and build on the work to be done in this area under the EBRD project in Yerevan.

2.2: Design, completion, and documentation of demonstration project in municipal public buildings

- Identification of public buildings, collection of baseline information, development of design and implementation of pilot demonstration projects.
- Monitoring, documentation and dissemination of the achieved results to the relevant stakeholders.

Comments/Recommendations: Partly already addressed in chapter 10.2. To be assessed whether there would be a need for a more comprehensive baseline study and intervention strategy for this particular component. Co-operation opportunities with other projects supporting public building EE retrofits shall be assessed. Need for development of procurement guidelines for the replacement of old CFLs and LFLs shall be considered.

2.3: Design, completion, and documentation of demonstration project on lighting of outdoor spaces

- Identification of pilot outdoor spaces, collection of baseline information, development of design and implementation of pilot demonstration projects.
- Monitoring, documentation and dissemination of the achieved results to the relevant stakeholders.

3: Financial and institutional mechanisms for scaling up municipal EE lighting programs

3.1: Support for private, international, and innovative municipal financing for EE urban lighting programs.

- Design of a financial mechanism (e.g. a municipal revolving fund) for recovery and reinvestment of funds saved from the energy efficiency lighting upgrades in Yerevan.
- Assistance to the Municipality of Yerevan and other interested municipalities in development and delivery of applications to financial institutes and facilities for credit for energy efficient lighting investments.
- Organization of a tender for at least one ESCO to provide and install energy-efficiency upgrades for part or all of the municipal lighting program in at least one city outside Yerevan, and if applicable, also for Yerevan.

Comments/Recommendations: Discussed already in Chapter 10.3. Suggested complementary actions: i) Preparation of road shows and PR to attract more donor funds for the capitalisation of the RFs; ii) Advice and templates for municipalities for MoUs, audit reports, technical specifications, solicitation documents and model contracts for different kind of implementation and financing modalities (direct procurement, EPCs, ESCOs etc.) together with analytical tools to conduct lighting system audits, technical, economic and financial feasibility assessments etc.

A related question is that how the complementary TA services that may still be required by the municipalities to implement the municipal EE programs and run the revolving funds will be organized after

the end of the project? This may apply to all different stages of the implementation process starting with audits and followed by preparation of technical specifications and bidding documents to reflect the latest technological advances, evaluation of proposals received and supervision of implementation. Even if outside experts will be used for delivering such services, the municipal authorities still need to have at least basic understanding on the scope and approximate costs of such services and capacity to prepare ToRs and conclude contracts, which ensure the delivery of these services at a high quality and cost-effective manner. **This is one of the topics to be addressed also by the project exit strategy, the drafting of which is suggested to be started already before or during the mid-term review.**

Another issue concerning the future operation of the revolving funds is that the funds collected from savings need to be reinvested during the same year in order to avoid tax obligations or negative consequences for next year budget. For larger retrofit programs this may not always be the best disbursement strategy from the technical, economic or financial point of view. Whether some complementary legal and regulatory changes would be required to address this issue to facilitate the most effective operation of the RFs may still be assessed and considered during the remaining project implementation period.

3.2: Development and approval of the city-wide program on public lighting in Yerevan

- Assistance to the Municipality of Yerevan in development and adoption of a program for upgrades of public lighting system.

Comments/Recommendations: Largely addressed by the EBRD Yerevan Street Lighting project already, but eventually worth continuing the discussion with the YM about the retrofit strategy for the remaining streets not included among the 28 streets covered by the EBRD project. Another topic for discussion would be the eventual indoor EE lighting retrofit needs in public buildings.

3.3: Facilitation of analogous programs in other cities in Armenia

- Support to the interested municipalities in Armenia in development and implementation of public lighting upgrades programs analogous to the Yerevan program.

Comments/Recommendations: The pilot projects and the revolving fund mechanism provide an excellent basis for this work. A specific donor seminar may also be considered to support the up-scaling of the project results. For public sector indoor lighting, see discussion in chapter 10.2.

4: National policies, codes, and standards on EE lighting

4.1: Phase-out of incandescent lighting and/or other major national policies on EE lighting

- Development of a comprehensive review of the present best international practice with regard to phase-out of inefficient incandescent lighting, including overview of the experience in neighbouring countries.
- Development of technical and policy justification for a phase-out of inefficient incandescent lamps in Armenia.
- Support to the Government of RA in drafting and adoption of the proposed legislation and enforcement mechanism of phase-out of conventional incandescent lighting.

Comments/Recommendations: To start with: 1) a comparative analysis of the EU vis a vis Russia + Kazakhstan phase out plans by benefitting from a study done in the frame of the Kazakhstan EE lighting project by a Russian institute; 2) Drafting recommendations and an action plan for Armenia on the basis of adequate background studies, including a social impact assessment and proposed mitigation measures.

The Russian Standard for Illumination from 2011, which is to be updated in 2016, is one of the tracks to be followed up and considered for possible adaptation/adoption in Armenia.

4.2: Development and adoption of new standards for lighting quality, lighting design in buildings and construction, and lighting issues in public health

- Support the development of relevant legislation, standards and requirements on quality and performance of lighting equipment also covering testing procedures and public health aspects.

Comments/Recommendations: For quality control related issues, see discussion in chapter 10.2

- Development of recommendations for environmentally safe collection and disposal of used mercury-containing lighting equipment.

Comments/Recommendations: To start with: i) review of international practices and technologies and their approximate costs that could be used for safe treatment of mercury containing lighting products; ii) liaison with waste management projects supported by other donors (EBRD, UNIDO) for exchange of information and assessing opportunities for co-operation; iii) an "in-house" interim report/study on this particular topic, including suggestions and recommendations for the next steps.

4.3: Development and adoption of new rules for state agencies on procurement of energy-efficient lighting

- Elaboration and provision of recommended processes and criteria for selection of EE products to be incorporated in state procurement procedures for lighting applications.

Comments/Recommendations: This should be able to largely build on the similar work done in other countries i.e. the work can be started with a good web-search. Also to make sure that the procurement advise and guidelines include specific safeguarding elements such as emphasizing the importance to have in any lighting equipment supply contract adequate product guarantees and an allowance/guarantee to test the illumination levels etc. still after delivery and return the products that do not meet the agreed criteria.

Annex II: Project Logframe and Performance Analysis

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
Project Objective To remove barriers to energy-efficient lighting in Armenia, by means of technical assessment, facilitation of financing, and development and implementation of municipal programs and national policy	Quantity of energy saved and GHG emissions avoided	Street lighting: 40 GWh of electricity consumed for street lighting in 2011, accounting for about 16,000 tons of CO_2 emissions.	Direct energy savings of **1,2 GWh** per year from demonstration projects (**474 tons of CO_2 emissions**).	Reports on energy audits conducted by the project (baseline data verification, adjustment to the required lighting standards) Reports on GHG reduction according to the GEF Guidelines. Pilot project monitoring reports. Survey reports on status of municipal street lighting done at the project midterm and last year.	**Status as of May 2016** Total annual energy saving of 9 pilot projects is **0,983 GWh (436 tons of CO_2 emissions)** Accomplishment: 82% of target value. Completion of new pilots will help to meet the set target be the end of 2017. **Achievable Target**
		Average fixture power consumption is 210W in 2011.	Direct energy savings of **20 GWh** per year from replication of demonstration projects via municipal programs (**8000 tons of CO_2 emissions**).		**Expected by the end of project** It is expected that total calculated annual energy saving potential of EBRD project on EE modernization of 28 streets if Yerevan is **2,6 GWh** (**13%** if the target value). **100%** achievement of the target value is possible in case of realization of a city-wide program on complete modernization of street lighting system of Yerevan to be developed by the project in 2016. Estimated energy saving potential of such a program is **18,5 GWh**. **Partially Achievable Target** **ACTION: Elaboration of complete city-wide EE street lighting retrofit programs, scaling up the pilot project, leveraging complementary grant/loan/public funding for the revolving fund mechanisms and, as applicable, facilitates the piloting of new financing and implementation modalities such as the use of ESCOs.**

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
		Residential lighting: 550 GWh consumed for residential lighting in 2011, accounting for about 220.000 tons of CO_2 emissions.	Indirect energy savings of **125 GWh** per year from implementation of national lighting policy (**50.000 tons of CO_2 emissions**)	Residential sector survey reports on indoor lighting.	**Status as of May 2016** Residential sector survey carried out in 2016 allows estimating power consumption for lighting purposes in residential sector. However, this data only is not sufficient for assessment of indirect energy saving to be achieved through legislative ban of inefficient indoor lighting. The target not possible to achieve without effective phase out of incandescent lighting. **ACTION: A reasonable methodology for evaluation of energy saving in residential sector shall be proposed + more emphasis on required activities to reach the stated targets of Outcome 4.** **Partially Achievable Target**
Outcome 1 Municipal energy audits and technical capacity-building	Methodology for energy/lighting audit. Number of municipal lighting systems energy audits conducted. Public media exposure.	Lack of methodology for assessing the feasibility (financial and technical) of an energy efficient lighting technology upgrade. Municipalities are not aware of energy saving potential in lighting sector. No specialized training or training materials on EE lighting is offered in	By the project midterm the **methodology will be established** and shared with municipalities.	Project annual reports. Methodology guide.	**Status as of May 2016** Draft methodology for municipal lighting system audit is developed. The document need to be adjusted based on practical experience on audit gained by the project and shall propose step-by-step guidance for municipal specialist. **ACTION: Finalization of the task before the end of 2016 shall be accelerated. Task can be fulfilled also with consideration of experience of other UNDP EE Lighting projects (e.g. Kazakhstan where similar activities were implemented).** **Achievable Target**

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
		Armenia. Limited broadcasting of information on EE lighting.	At least **10 comprehensive audits** of public lighting (including pilots) completed in Yerevan and other cities (including baseline analysis and recommendations for improvement).	Audit reports.	**Status as of May 2016** Audit and recommendation reports are prepared for **8 municipalities** and **2** more are under development. **Achievable Target**
			At least **20 specialists** from private sector and municipalities are trained on **EE lighting and energy audit**.	Public outreach materials and publications.	**Status as of May 2016** **3** trainings and capacity building events and **1** study tour on EE lighting were organized from more than 20 specialists and stakeholders. **Achievable Target** No trainings on energy audit in lighting have been organized. **ACTION: Completion of task within support of colleagues from Kazakhstan, Russia or others.** **Achievable Target**
			Media releases on outcomes of each pilot. **Awareness raising materials** available for general public.	Project web-site.	**Status as of May 2016** Leaflets of each of the implemented pilot project were developed, disseminated and posted on the website. Facebook page on GUL project objectives and results has been opened and updated regularly. A Reference Book and Guide on EE Lighting for Students were developed and disseminated. A video on the project is developed and broadcasted. **Achievable Target**

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
Outcome 2 Demonstration projects *Pilot projects yield cost-effective energy savings, raising the confidence and capacity of investors and decision-makers about energy efficient lighting*	Efficiency and energy savings of installed EE lighting Share of LED in demo-projects	The majority of fixtures in municipal outdoor lighting sector incorporate inefficient 250W HPS lamps or 400W mercury-vapour lamps. The indoor lighting sector is dominated by inefficient incandescent lamps and fluorescent tubes.	At least **five demonstration projects** on a number of efficient lighting technologies completed for **indoor, outdoor and street lighting**.	Field verification, metering, and other documentation. Project reports and audits.	**Status as of May 2016** **Nine** pilot projects on street and park lighting have been implemented already and 3 more are under implementation. No pilot on indoor lighting has been implemented. **ACTION: Implementation of at least one pilot on indoor lighting and on tunnel lighting.** **Achievable Target**
			Direct energy savings of up to **0.95 GWh** per year by completion of all pilots (subject to final selection of pilot size and technologies).		**Expected by the end of project** Expected annual energy saving from implementation of 11 pilot projects in **0.983 GWh**. **Achievable Target**
			100% LED for outdoor (park) and indoor lighting pilots.		**Status as of May 2016** **100% LED** included in park lighting pilot. Indoor lighting pilot based on LED technology will be implemented by July 2016. **Achievable Target**
			40% LED included in street lighting pilots.		**100% LED** included in street lighting pilots. **Achievable Target**

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
Outcome 3 Replication via municipal programs and associated financial instruments *Municipal lighting programs lead to widespread deployment of EE lighting and associated energy savings*	Municipal programs for EE public lighting. .	Municipal programs for EE public lighting are desired but not com-prehensively designed, financed, or implemented.	Municipality of Yerevan develops and adopts program for upgrades of municipal lighting.	Municipal plans on EE lighting upgrades.	**Status as of may 2016** YM-EBRD joint project on EE upgrade of lighting systems of 28 streets. No comprehensive MEEL program for Yerevan has been developed by the Project because of EBRD intervention. Reasonability of development of such a program can be discussed. **Partially Achievable Target**
			Similar programs are adopted in other cities of Armenia.		**Status as of May 2016** Reports with recommendation on municipal street lighting system EE modernization were developed for and approved by 8 municipalities. **Achievable Target**
			Savings of **20 GWh** per year from municipal lighting programs.		**Status as of May 2016** Approximate total annual energy saving potential of MEEL programs proposed for 7 municipalities is **1.5 GWh.** **ACTION: Similar MEEL program for Yerevan city will be developed. Given that total annual power consumption of all system is about 37 GWh and provided that LED based modernization ensures minimum 50% saving about 18,5 GWh saving can be proposed which together with above mentioned savings will help to achieve the target.** **Partially Achievable Target**

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
			US $10 million for energy-efficient municipal lighting secured.		**Status as of May 2016** EBRD + E5P provide US $ 6 million to Yerevan (60% of target value). Negotiations with IFIs, banks and private sector will be held to ensure additional funding for EE municipal lighting be the end of the project. **Partially Achievable Target**
			Establishment of financing mechanisms for Yerevan and other municipalities (e.g. revolving fund) from savings achieved from piloted EE measures.	Established **separate account/ budget line** in Yerevan Lighting Company for funding of EE lighting projects/ upgrades.	**Status as of May 2016** MEEL Modernization Funds are established and operational in 5 municipalities and are under establishment new partner municipalities. **Achievable Target**
			Support in preparation of funding proposals (including tenders for ESCOs) for cities of Armenia.	Number of investment proposals applied for funding.	**Status as of May 2016** No investment proposals for funding of EE lighting have been prepared yet. **ACTION: Cooperation with IFIs and banks will be facilitated to develop at least one proposal on ESCO involvement.** **Partially Achievable Target**
Outcome 4 National policies, codes, and standards on lighting *New national policies mandate significantly greater energy efficiency and ensure product quality for lighting, particularly in residential*	Existence of regulations that mandate improved energy efficiency of lighting products and installations, including codes, standards, and procurement rules.	Conventional incandescent lighting is available without restrictions and consti-tutes 85 percent of residential lighting in Armenia There is no regulation on energy performance of lighting products in	Proposed improvement to existing legislation addressing minimum energy performance requirements for lighting appliances.	Revised legal and normative documents.	**Status as of May 2016** Analysis of the acting local and international legislation, norms and standards is carried out to identify gaps and propose solutions. Baseline data for development of a national phase-out plan is collected and analyzed. A local expert is contracted to update national standard on natural and artificial illumination.
			A national phase-out plan of conventional incandescent lighting is adopted.	National program on phase out of incandescent lighting.	
			Other adopted policies and supporting standards.		

Objectives and Outcomes	Indicator	Baseline	Targets: End of Project	Source of verification	Comments
buildings		Armenia.	New criteria (including performance and life cycle costs) for incorporation in state procurement procedures for lighting applications are developed.	Technical specifications for ensuring MEPS for public procurement of lighting equipment	Baseline data for development of recommendation for incorporation in state procurement procedures for lighting applications is collected and analyzed. **Partially Achievable Target** **ACTION: Initiating the development of a national phase-out policy for incandescent and other inefficient lighting fixtures by taking into account the required quality control and affordability constrains and elaborating measures, policies and actions to address them (such as adequate quality control and social support schemes) by building on the experiences and lessons learned from other countries.**

Annex III: Project Work Plan for 2016

ANNUAL WORKPLAN FOR 2016 WITH TASKS ALLOCATION
"Green Urban Lighting" UNDP-GEF project

Award ID: 00074869, Project ID: 00087057

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
1: Knowledge and capacities for urban green lighting														
1.1: Audits of public lighting systems														
Activities:														
• Organize the design and execution of technical audits of public lighting systems to define baseline technical information and energy saving potential for municipal plans and financial proposals for specific sets of upgrades to be carried out.	X	X	X	X	X	X	X						Completed energy audit of at least 5 public (municipal) lighting systems. Target municipalities are informed on the results of the audit through provision of summary report. Results provide baseline information of Component 2 (Demonstration Projects).	**Key Expert:** Karen Sargsyan **Supporting:** Armen Gulkanyan and Artem Kharazyan **Deadline:** ongoing till July 2016
• Development of a methodological guidance (manual) for energy audit of municipal lighting systems based on the best international practice and with consideration of local specificities.			X	X	X								A municipal lighting energy audit methodology manual developed, discussed with stakeholders and provided to municipalities as recommended guidance.	**Key Expert:** Artur Tsughunyan **Supporting:** technical experts and Hovhannes Nunyan **Deadline:** May 2016
1.2: Study tour to GEF Public Lighting project in Central Europe														
Activities:														
• Organize a study tour to CEE on best practices in urban lighting design, organization and financing for key personnel of involved municipalities and other responsible agencies.													Completed study tour to CE Europe.	This task was completed in October 2015.

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
1: Knowledge and capacities for urban green lighting														
1.3: Technical training and capacity building for the respective specialists														
Activities:														
• Development of training and capacity building materials on EE lighting including information on practical application of the municipal lighting energy audit methodology manual developed under subcomponent 1.1and available material from pilot projects interim results.		X	X	X	X	X	X	X					Training and capacity building materials are developed: (i) Module on EE Lighting for NPUA; (ii) Module on EE Lighting for college students; (iii) Brochure on Lighting for students and junior schools; (iv) Presentation on lighting systems audit manual.	**Key Experts:** Artak Hambaryan and Artur Tsughunyan **Supporting:** Armen Gulkanyan and Karen Sargsyan **Deadline:** August 2016
• Organize and deliver at least two half-day capacity-building seminars on energy efficient lighting for technical specialists from municipal agencies, lighting companies, and building design institutes.		X			X			X					Technical training and capacity building on EE lighting for appropriate technical specialists and stakeholders delivered: (i) Workshop with VNISI; (ii) Workshop on EA of Lighting Systems; (iii) Training on EA for local municipalities; (iv) Seminar of EE Lighting for Tunnels; (v) Seminar on EE Indoor Lighting; (vi) Capacity building events for students of 5 colleges (completed).	**Key Experts:** Armen Gulkanyan and Artur Tsughunyan **Supporting:** relevant local and/or international experts. **Deadline:** August 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
1.4: Increased awareness and support among the general public for green urban lighting programs.														
Activities:														
• Organize media coverage and other public outreach on energy-efficient lighting, to build support for the urban programs and also to promote EE lighting in the residential sector.		X	X	X	X	X	X	X	X	X	X		Media coverage and public outreach on energy efficiency lighting is organized: (i) development and broadcast of a movie on the results of GUL Project; (ii) regular update of the project website and FB page: (iii) development of leaflets on new pilot projects.	**Key Expert:** Ruzanna Grigoryan, Marianna Arzangulyan and Artur Tsughunyan **Supporting:** the project team and CivilNet **Deadline:** ongoing task
1.5: Establishment of a testing laboratory for lighting equipment and educational laboratory in a university.														
Activities:														
• Establishment of a testing laboratory for checking conformity of lighting equipment and establishment of an educational laboratory in a university.	X	X	X			X	X	X					A testing laboratory is established at the premises of a partner organization and equipped with basic laboratory equipment including software and manuals. An educational laboratory with basic equipment and software is established at the premises on a partner university. The operation manual developed / translated and staff training organized. The SOI signed with YIC, UNDP and may be cooperation framework with Shincertificat LLC.	**Key Expert:** Armen Gulkanyan **Supporting:** Karen Sargsyan and Vladislav Harutyunyna **Deadline:** August 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
2: Pilot urban green lighting projects														
2.1: Design, completion, and documentation of demonstration projects on street lighting														
Activities:														
• Identification of pilot streets, collection of baseline information, development of design for pilot demonstration projects and implementation of pilot demonstration projects.	X	X	X	X	X	X							At least 4 pilot projects on street lighting in regional municipalities are identified; appropriate pilot projects are designed, agreed with relevant stakeholders and implemented.	**Key Expert:** Karen Sargsyan and Armen Gulkanyan **Supporting:** Artem Kharazyan and Vladislav Harutyunyan **Deadline:** June 2016
• Monitoring and documentation of the achieved results as well as dissemination of achieved results.	X	X	X	X	X	X	X	X	X	X	X	X	Implemented pilots are monitored and the achieved results are documented. Results are analyzed and disseminated among stakeholders and incorporated into updated training materials.	**Key Experts:** Karen Sargsyan and Artur Tsughunyan Supporting: Artem Kharazyan, Vladislav Harutyunyan and Armen Gulkanyan **Deadline:** ongoing
2.2: Design, completion, and documentation of demonstration project in municipal public buildings														
Activities:														
• Identification of public buildings, collection of baseline information, development of design and implementation of pilot demonstration projects.						X	X	X	X				At least one pilot public building is identified and pilot project activities are initiated.	**Key Experts:** Karen Sargsyan ***Supporting:*** *Armen Gulkanyan and Artem Kharazyan* **Deadline:** September 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
• Monitoring, documentation and dissemination of the achieved results to the relevant stakeholders.									X	X	X		Implemented pilot is monitored and the achieved results are documented and disseminated and incorporated into updated training materials.	**Key Experts:** Karen Sargsyan and Artur Tsughunyan Supporting: Artem Kharazyan and Armen Gulkanyan **Deadline:** November 2016
2.3: Design, completion, and documentation of demonstration project on lighting of outdoor spaces														
Activities:														
• Identification of pilot outdoor spaces, collection of baseline information, development of design and implementation of pilot demonstration projects.			X	X	X	X	X	X	X				At least 1 pilot outdoor lighting space is identified and pilot project activities are initiated.	**Key Experts:** Karen Sargsyan and Vladislav Harutyunyan **Supporting:** Armen Gulkanyan and Artem Kharazyan **Deadline:** September 2016
• Monitoring, documentation and dissemination of the achieved results to the relevant stakeholders.									X	X			Implemented pilot is monitored and the achieved results are documented and disseminated and incorporated into updated training materials.	**Key Experts:** Karen Sargsyan, Vladislav Harutynyan and Artur Tsughunyan Supporting: Artem Kharazyan and Armen Gulkanyan **Deadline:** October 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
3: Financial and institutional mechanisms for scaling up municipal EE lighting programs														
3.1: Support for private, international, and innovative municipal financing for EE urban lighting programs.														
Activities:														
• Design of a financial mechanism (e.g. a municipal revolving fund) for recovery and reinvestment of funds saved from the energy efficiency lighting upgrades in Yerevan.	X	X	X	X	X	X	X	X	X	X	X	X	Potential options for establishment of a financial mechanism are identified and documented. NOTE: Financial mechanism (municipal fund) was identified. Updated outputs of this task are introduction of the fund in the target municipalities, regular monitoring of savings and support with utilization of fund sources.	**Key Expert:** Hovhannes Nunyan **Supporting:** the project team **Deadline:** ongoing.
• Assistance to the Municipality of Yerevan and other interested municipalities in development and delivery of applications to financial institutes and facilities for credit for energy efficient lighting investments.				X	X	X	X	X					Potential financial institutes and facilities for financing implementation of EE lighting activities in municipalities are identified and documented.	**Key Expert:** Financial Expert (to be recruited) **Supporting:** the project team **Deadline:** August 2016
• Organization of a tender for at least one ESCO to provide and install energy-efficiency upgrades for part or all of the municipal lighting program in at least one city outside Yerevan, and if applicable, also for Yerevan.						X	X						A tender for one ESCO for provision and installation of EE upgrades in at least one city outside Yerevan is organized.	**Key Expert:** Armen Gulkanyan **Supporting:** the project team **Deadline:** July 2016
3.2: Development and approval of the city-wide program on public lighting in Yerevan														
Activities:														
• Assistance to the Municipality of Yerevan in development and adoption of a program for upgrades of public lighting system.			X	X	X	X							A city-wide program for upgrades of public lighting in Yerevan developed and proved.	**Key Experts:** Vesa Rutannen **Supporting:** the project team **Deadline:** June 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
3: Financial and institutional mechanisms for scaling up municipal EE lighting programs														
3.3: Facilitation of analogous programs in other cities in Armenia														
Activities:														
• Support to the interested municipalities in Armenia in development and implementation of public lighting upgrades programs analogous to the Yerevan program.		X	X	X				X	X	X			Analogous public lighting upgrades programs are facilitated.	**Key Experts:** Karen Sargsyan, Hovhannes Nunyan and Artem Kharazyan **Supporting:** Armen Gulkanyan **Deadline:** October 2016
4: National policies, codes, and standards on EE lighting														
4.1: Phase-out of incandescent lighting and/or other major national policies on EE lighting														
Activities:														
• Development of a comprehensive review of the present best international practice with regard to phase-out of inefficient incandescent lighting, including overview of the experience in neighbouring countries.				X	X								A review on best international practice in incandescent lighting phase-out is developed.	**Key Expert:** local or international expert to be recruited **Supporting:** the project team **Deadline:** May 2016
• Development of technical and policy justification for a phase-out of inefficient incandescent lamps in Armenia.					X	X							Justification of incandescent lighting phase-out in Armenia is developed and submitted to the relevant stakeholders for consideration.	**Key Expert:** local or international expert to be recruited **Supporting:** the project team **Deadline:** June 2016
• Support to the Government of RA in drafting and adoption of the proposed legislation and enforcement mechanism of phase-out of conventional incandescent lighting.						X	X						A national policy on incandescent lighting phase-out is adopted.	**Key Expert:** local or international expert (to be recruited) **Supporting:** the project team **Deadline:** July 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
4: National policies, codes, and standards on EE lighting														
4.2: Development and adoption of new standards for lighting quality, lighting design in buildings and construction, and lighting issues in public health														
Activities:														
• Support the development of relevant legislation, standards and requirements on quality and performance of lighting equipment also covering testing procedures and public health aspects.				X	X	X	X	X					New legislation, standards and regulation on EE lighting (including street lighting fixtures) are drafted.	**Key Expert:** Local Exert on Norms and Standards (to be recruited) **Supporting:** Armen Gulkanyan **Deadline:** August 2016
• Development of recommendations for environmentally safe collection and disposal of used mercury-containing lighting equipment.													Existing international best practice on environmentally safe collection and disposal of used mercury-containing lighting equipment is studied and a strategy for RA proposed.	**Key Expert:** Local Expert on Safe management of Mercury Containing Lamps (to be recruited) **Deadline:** task will be implemented in 2017
4.3: Development and adoption of new rules for state agencies on procurement of energy-efficient lighting														
Activities:														
• Elaboration and provision of recommended processes and criteria for selection of EE products to be incorporated in state procurement procedures for lighting applications.					X	X							New EE and quality criteria for incorporation in state procurement procedures for lighting applications are drafted.	**Key Expert:** Armen Gulkanyan, Karen Sargsyan and Local Exert on Norms and Standards **Deadline:** June 2016

Outcomes/Outputs/Activities	2016												Output	RESPONSIBILITIES
	1	2	3	4	5	6	7	8	9	10	11	12		
5: Project Management														
5.1. Project Board subsequent meeting													tbd	
5.2. The Technical Advisory Committee subsequent meeting		X											Completed (combined with the workshop with VNISIS)	
5.3. Establishment of Project Team													Completed	
5.4. Development of Inception Report													Completed	
5.4. Development of quarterly and annual progress reports			X			X			X			X		
5.5. Conduct regular field visits			X			X			X			X		
5.6. Monitoring and evaluation			X			X			X			X		
5.7. Mid-term and final evaluation													tbd	

Annex IV: Detailed information on results of the municipal lighting system audit

1	Name of community	**Abovyan town**		
2	Date of visits	April-May 2015		
3	Brief information on municipality	Abovian is a town in Armenia within the Kotayk Province. It is located 16 km northeast of Yerevan and 32 km southeast of the province center Hrazdan. As of the 2011 census, the population of the town is 43495, down from 59000 reported at the 1989 census. With a motorway and railway running through the city connecting Yerevan with the areas of the northeast, Abovyan is considered a satellite city of the Armenian capital. Therefore, Abovyan is generally known as the "northern gate of Yerevan". The town covers an area of 11 square km.		
4	Number of streets	Illuminated		20
		Non illuminated		0
5	Information on infrastructure	Type and number of lighting poles pcs	Steel	926
		Type and number of lighting fixtures (plastic)	250W HPS	829
			250W Mercury	146
6	Metering system	Single tariff		25
7	Average annual duration of system operation (hours/year)	1830		
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		471300
		Energy expenses in 2014 (mln. AMD)		18,63
		Total expenses (mln. AMD)		35,43
9	Service organization	"Abovyan Municipal Utilities" CNPO		
10	Results of measurements	Average Illumination level	By norms	By measurement
			15,0 lx	18,85 lx
		Average uniformity	0,4	0,33
11	Modernization proposal	Replace 74 luminaries equipped with HPS 250W lamps with 74 LED luminaries of 65W for main streets.		
		Replace 742 luminaries equipped with HPS 250W lamps with 742 LED luminaries of 52W for secondary streets.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		346,2
		Annual energy cost savings (USD)		37415
		Annual reduction of GNG emissions (tCO_2)		153,7
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		182480
		Simple payback period (year)		4,9

1	Name of community	**Ararat town**			
2	Date of visits	October 7, 2015 and January 18, 2016			
3	Brief information on municipality	Ararat is a town in the Ararat Province of Armenia, located 42 km southeast of Yerevan and 18 km south of the provincial center Artashat. As of the 2011 census, the population of the town is 20235.			
4	Number of streets	Illuminated		13	
		Non illuminated		4	
5	Information on infrastructure	Type and number of lighting poles pcs	Steel	326	
			Concrete	8	
			Wooden	23	
		Type and number of lighting fixtures (plastic)	250W HPS	269	
			150W HPS	47	
			250W Mercury	20	
6	Metering system	Single tariff		8	
		Double tariff		5	
7	Average annual duration of system operation (hours/year)	1830			
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		122700	
		Energy expenses in 2014 (mln. AMD)		4,5	
		Total expenses (mln. AMD)		5,5	
9	Service organization	Ararat Municipality			
10	Results of measurements	Average Illumination level	By norms	By measurement	
			10 lx	16.96 lx	
		Average uniformity	0,35	0,16	
11	Modernization proposal	Replace 287 luminaries equipped with 250W HPS lamps with 287 LED luminaries with of 65W.			
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		131,03	
		Annual energy cost savings (USD)		13178	
		Annual reduction of GNG emissions (tCO_2)		58,17	
		Illumination level and uniformity		Improved	
		Total procurement cost (USD)		54530	
		Simple payback period (year)		4,1	

1	Name of community	**Goris town**			
2	Date of visits	February and November 2015			
3	Brief information on municipality	Goris,is a town in the southern Syunik Province of Armenia. Located in the valley of river Goris, it is 254 km away from the Armenian capital Yerevan and 67 km from the provincial center Kapan. As of the 2011 census, the population of the town is 21000.			
4	Number of streets	Illuminated		24	
		Non illuminated		5	
5	Information on infrastructure	Type and number of lighting poles pcs	Steel	850	
			Wooden	107	
		Type and number of lighting fixtures (aluminum and plastic) pcs	250W Mercury	852	
			170W HPS	20	
			70W HPS	50	
			60W LED	35	
6	Metering system	Single tariff	“Mercury”	87	
		Double tariff	“SEM-1”	12	
7	Average annual duration of system operation (hours/year)	1755			
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		122700	
		Energy expenses in 2014 (mln. AMD)		4,5	
		Total expenses (mln. AMD)		5,5	
9	Service organization	“Goris Tntesutyun” municipal company			
10	Results of measurements	Average Illumination level	By norms	By measurement	
			15 lx	4.9 lx	
		Average uniformity	0,4	0,3	
11	Modernization proposal	Replace all existing 858 luminaries equipped with 858 LED luminaries of 80W.			
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)			272,2
		Annual energy cost savings (USD)			27372
		Annual reduction of GNG emissions (tCO_2)			120,8
		Illumination level and uniformity			Improved
		Total procurement cost (USD)			163020
		Simple payback period (year)			5,9

1	Name of community	**Kapan town**		
2	Date of visits	January 29-30,2016		
3	Brief information on municipality	Kapan is the administrative center of Syunik. The city is located in southeaster Armenia, at the distance of 320 km on south-east from Yerevan. The population of the town in 2015 was 42700 people.		
4	Number of streets	Illuminated		25
		Non illuminated		5
5	Information on infrastructure	Type and number of lighting poles	Steel	990
		Type and number of lighting fixtures (Aluminum and plastic) pcs	250W HPS	690
			150W HPS	300
6	Metering system	Double tariff		26
7	Average annual duration of system operation (hours/year)	1830		
8	Energy cost for the last year	Energy expenses in 2015 (kWh)		509456
		Energy expenses in 2015 (mln. AMD)		22,4
		Total expenses (mln. AMD)		26,35
9	Service organization	“Kapan Utility Service” CNPS		
10	Results of measurements	Average Illumination level	By norms	By measurement
			15 lx	3.5 lx
		Average uniformity	0,4	0,17
11	Modernization proposal	Replace 222 luminaries equipped with 250W HPS lams with 222 LED luminaries of 105W for interstate streets. Replace 161 luminaries equipped 250W HPS lams with 161 LED luminaries of 90W for main streets. Replace 500 luminaries equipped with 250W HPS lamps with 500 LED luminaries of 40W for secondary streets.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		270,1
		Annual energy cost savings (USD)		28470
		Annual reduction of GNG emissions (tCO_2)		120
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		211680
		Simple payback period (year)		5,9

1	Name of community	**Spitak town**		
2	Date of visits	March 6-7,2015		
3	Brief information on municipality	Spitak is a town in the northern Lori Province of Armenia, located 96 km north of the capital Yerevan, and 22 km west of the provincial center Vanadzor. As of the 2011 census, the population of the town is 12881.		
4	Number of streets	Illuminated		21
		Non illuminated		13
5	Information on infrastructure	Type and number of lighting poles	Steel	412
			Concrete	120
		Type and number of lighting fixtures (aluminum and plastic) pcs	250W HPS	142
			80W HPS	470
6	Metering system	Single tariff		
7	Average annual duration of system operation (hours/year)	1755		
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		69824
		Energy expenses in 2014 (mln. AMD)		2,7
		Total expenses (mln. AMD)		6,36
9	Service organization	Spitak Municipality		
10	Results of measurements	Average Illumination level	By norms	By measurement
			15 lx	3,5 lx
		Average uniformity	0,4	0,17
11	Modernization proposal	Replace 496 luminaries equipped with 250W HPS lamps with 496 LED luminaries of 63W.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		211,27
		Annual energy cost savings (USD)		16775
		Annual reduction of GNG emissions (tCO_2)		93,81
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		173600
		Simple payback period (year)		10,35

1	Name of community	**Sevan town**		
2	Date of visits	September 19,2015		
3	Brief information on municipality	Sevan is a town and popular resort in Armenia, located in the Gegharkunik Province on the northwestern shores of Lake Sevan. The town is located at 64 km northeast of the capital Yerevan, and 35 km north of Gavar, the administrative center of Gegharkunik Province.As of the 2011 census, the population of the town is 19229.		
4	Number of streets	Illuminated		23
		Non illuminated		67
5	Information on infrastructure	Type and number of lighting poles	Steel	524
		Type and number of lighting fixtures (aluminum and plastic)	250W HPS	294
			250W Mercury	77
			95W CFL	100
6	Metering system	Single tariff		15
		Double tariff		8
7	Average annual duration of system operation (hours/year)	2100		
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		287100
		Energy expenses in 2014 (mln. AMD)		10,8
		Total expenses (mln. AMD)		14,0
9	Service organization	“Sevan Utility Service” CNPO		
10	Results of measurements	Average Illumination level	By norms	By measurement
			15 lx	17,59 lx
		Average uniformity	0,4	0,19
11	Modernization proposal	Replace 67 luminaries equipped with 250W HPS lamps with 67 LED luminaries of 95W for main streets. Replace 345 luminaries equipped with 250W HPS lamps with 345 LED luminaries of 55W for secondary streets.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		162,2
		Annual energy cost savings (USD)		17636
		Annual reduction of GNG emissions (tCO_2)		72,1
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		99350
		Simple payback period (year)		7,6

1	Name of community	**Stepanavan town**		
2	Date of visits	May 1-2, 2015		
3	Brief information on municipality	Stepanavan is a town in the Lori Province of Armenia. It is located 139 km north of the capital Yerevan and 24 km north of the provincial center Vanadzor, in the center of Yerevan-Tbilisi highway. As of the 2011 census, the population of the town is 13086.		
4	Number of streets	Illuminated		82
		Non illuminated		23
5	Information on infrastructure	Type and number of lighting poles	Steel	1165
			Concrete	21
			Wooden	6
		Type and number of lighting fixtures (plastic)	250W HPS	63
			85W CFL	1373
6	Metering system	Single tariff		3
		Double tariff		32
7	Average annual duration of system operation (hours/year)	2610		
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		286663
		Energy expenses in 2014 (mln. AMD)		10,3
		Total expenses (mln. AMD)		14,0
9	Service organization	“Sevan Utility Service” CNPO		
10	Results of measurements	Average Illumination level	By norms	By measurement
			15 lx	11,8 lx
		Average uniformity	0,4	0,10
11	Modernization proposal	Replace 1371 luminaries equipped with 250W HPS lamps with 1371 LED luminaries of 81W.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		439,7
		Annual energy cost savings (USD)		38743
		Annual reduction of GNG emissions (tCO_2)		195
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		246780
		Simple payback period (year)		6,36

1	Name of community	**Alaverdi town**		
2	Date of visits	April 15, 2014		
3	Brief information on municipality	Alaverdi is one of the urban communities in Lori marz (region), located on the slopes of Debed river gorge and on Sanahin plateau. Alaverdi population is 16500.		
4	Number of streets	Illuminated		21
		Non illuminated		0
5	Information on infrastructure	Type and number of lighting poles pcs	Steel	492
		Type and number of lighting fixtures (plastic)	250W HPS	492
6	Metering system	Single tariff		
		Twice tariff		
7	Average annual duration of system operation (hours/year)	2469		
8	Energy cost for the last year	Energy expenses in 2014 (kWh)		122,69
		Energy expenses in 2014 (mln. AMD)		5,0
		Total expenses (mln. AMD)		9,8
9	Service organization	Alaverdi Municipality		
10	Results of measurements	Average Illumination level	By norms	By measurement
			10 lx	6,40 lx
		Average uniformity	0,35	0,27
11	Modernization proposal	Replace 98 luminaries equipped with 250W HPS lamps with 98 LED luminaries of 113W for main streets. Replace 394 luminaries equipped with 250W HPS lamps with 394 LED luminaries of 50W for secondary streets.		
12	Costs, expected benefits and simple payback	Annual energy consumption reduction (MWh)		270,2
		Annual energy cost savings (USD)		11735
		Annual reduction of GNG emissions (tCO_2)		119,9
		Illumination level and uniformity		Improved
		Total procurement cost (USD)		66420
		Simple payback period (year)		5,65

Annex V: Detailed information on results of the completed demonstration projects

1	Name of community	**Yerevan**
2	Pilot street(s)	Isakov Avenue, Paraqar Street
3	Lengths of streets (m)	9
4	Number of replaced luminaries	756
5	Total costs (USD)	362000
6	GEF co-financing (%)	80,7
7	Municipality (%)	19,3
8	Simple payback (years)	5,9
9	Implemented works	Lighting: Replacement of 756 luminaries equipped with 250W HPS lamps with 274 LED luminaries of 213W and 208 LED luminaries of 99W. Infrastructure: Repair of damaged poles and brackets, dismantling of excess brackets.
10	Reduction of system capacity (kW)	136,5
11	Reduction of power consumption (MWh/y)	503,3
12	Illumination level and uniformity	Before: 16 lx and 0,30 / After: 26 lx and 0,46
13	Reduction of GHG emission (tCO_2/y)	223,5
14	Reduction of O&M costs (USD/y)	478000

1	Name of community	**Yerevan**
2	Pilot street(s)	Zoological Garden
3	Lengths of streets (m)	3
4	Number of replaced luminaries	112
5	Total costs (USD)	83000
6	GEF co-financing (%)	63,9
7	Municipality (%)	36,1
8	Simple payback (years)	-
9	Implemented works	Lighting: Replacement of 112 luminaries equipped with 150W HPS lamps with 112 LED luminaries of 39W. Infrastructure: Installation of new infrastructure and feeding system.
10	Reduction of system capacity (kW)	14,8
11	Reduction of power consumption (MWh/y)	21,4
12	Illumination level and uniformity	Improved
13	Reduction of GHG emission (tCO2/y)	9,5
14	Reduction of O&M costs (USD/y)	1870

1	Name of community	**Alaverdi**
2	Pilot street(s)	Z. Andranik, Sayat-Nova and Shahumyam
3	Lengths of streets (m)	1840
4	Number of replaced luminaries	67
5	Total costs (USD)	16240
6	GEF co-financing (%)	70
7	G2iA NGO and Municipality (%)	20 and 10
8	Simple payback (years)	4,1
9	Implemented works	Lighting: Replacement of 67 luminaries equipped with 250W HPS lamps with 67 LED luminaries of 50W. Infrastructure: Repair and painting of damaged poles and brackets.
10	Reduction of system capacity (kW)	15,8
11	Reduction of power consumption (MWh/y)	24,07
12	Illumination level and uniformity	Before: 7,21 lx and 0,45 / After: 11 lx and 0,6
13	Reduction of GHG emission (tCO2/y)	10,84
14	Reduction of O&M costs (USD/y)	3054

1	Name of community	**Spitak**
2	Pilot street(s)	S. Avetisyan and A. Manukyan
3	Lengths of streets (m)	1350
4	Number of replaced luminaries	50
5	Total costs (USD)	50025
6	GEF co-financing (%)	27
7	Municipality (%)	73
8	Simple payback (years)	7,1
9	Implemented works	Lighting: Replacement of 50 luminaries equipped with 250W HPS lamps with 50 LED luminaries of 120W. Infrastructure: Install of new infrastructure and feeding system.
10	Reduction of system capacity (kW)	8,25
11	Reduction of power consumption (MWh/y)	14,5
12	Illumination level and uniformity	Before: 4,2 lx and 0,27 / After: 13 lx and 0,81
13	Reduction of GHG emission (tCO_2/y)	6,38
14	Reduction of O&M costs (USD/y)	2804

1	Name of community	**Sevan**
2	Pilot street(s)	Shahumyan
3	Lengths of streets (m)	1080
4	Number of replaced luminaries	62
5	Total costs (USD)	14100
6	GEF co-financing (%)	93
7	Municipality (%)	7
8	Simple payback (years)	4,7
9	Implemented works	Lighting: Replacement of 62 luminaries equipped with 250W HPS lamps with 62 LED luminaries of 75W. Infrastructure: Repair and painting of damaged poles and brackets.
10	Reduction of system capacity (kW)	13
11	Reduction of power consumption (MWh/y)	27,3
12	Illumination level and uniformity	Before: 17,3 lx and 0,19 / After: 20 lx and 0,3
13	Reduction of GHG emission (tCO_2/y)	12,1
14	Reduction of O&M costs (USD/y)	2804

1	Name of community	**Abovyan**
2	Pilot street(s)	Yerevanyan
3	Lengths of streets (m)	1350
4	Number of replaced luminaries	87
5	Total costs (USD)	24558
6	GEF co-financing (%)	75
7	Municipality (%)	25
8	Simple payback (years)	3,3
9	Implemented works	Lighting: Replacement of 128 luminaries equipped with 250W HPS lamps with 87 LED luminaries of 75W. Infrastructure: Repair and painting of damaged poles and brackets, installation of a missing pole.
10	Reduction of system capacity (kW)	30
11	Reduction of power consumption (MWh/y)	54,8
12	Illumination level and uniformity	Before: 16,4 lx and 0,29 / After: 20 lx and 0,32
13	Reduction of GHG emission (tCO_2/y)	24,3
14	Reduction of O&M costs (USD/y)	5518

1	Name of community	**YEREVAN**
2	Pilot street(s)	**Victory bridge, Mashtots Avenu up to Sayat-Nova intersection**
3	Lengths of streets (m)	2360
4	Number of replaced luminaries	244
5	Total costs (USD)	74855
6	GEF co-financing (%)	30,7
7	Municipality (%)	69,3
8	Simple payback (years)	2,5
9	Implemented works	Lighting: Replacement of 67 luminaries equipped with 70W HPS lamps, 177 luminaries equipped with 250W HPS lamps with 67 LED luminaries with 36 and 177 luminaries with 139W. Infrastructure: Repair and painting of damaged poles and brackets, installation of missing brackets.
10	Reduction of system capacity (kW)	65,35
11	Reduction of power consumption (MWh/y)	240,8
12	Illumination level and uniformity	Before: 12.77 lx and 0,34 / After: 24 lx and 0,54
13	Reduction of GHG emission (tCO2/y)	107,0
14	Reduction of O&M costs (USD/y)	21248

Annex VI: List of communities, partner organizations and contractors

- Municipality of Yerevan
- Municipality of Alaverdi
- Municipality of Sevan
- Municipality of Abovyan
- Municipality of Spitak
- Municipality of Ararat
- Municipality of Goris
- G2iA NGO
- Shinsertificate LLC
- Yerevan Illumination Company CJSC
- National Polytechnic University of Armenia
- CivilNet
- Schreder (other suppliers)
- Economic Development and Research Center
- Center for Light Emitting Diode and Optic-Electronic Technologies of the National Academy of Sciences of Belarus
- Russian Lighting Research Institute named after S.I. Vavilov
- National Institute of Standards CJSC
- Civilnet
- Design for Lighting LTD, UK

Annex VII: Sample of Statement of Intent

STATEMENT OF INTENT BETWEEN SEVAN MUNICIPALITY AND THE UNITED NATIONS DEVELOPMENT PROGRAMME

This Statement of Intent is concluded between the Sevan Municipality (hereinafter: "the Municipality") and the UN Development Programme Country Office in Armenia (hereinafter: "UNDP"), hereinafter jointly referred to as the "the Signatories".

The Signatories wish to cooperate in areas of mutual concern to enhance the effectiveness of their development efforts, in particular, whereas:

- The present SoI is based on "Green Urban Lighting" UNDP-GEF/00074869 project (hereinafter: "the Project") Document.
- The Signatories, on the basis of their respective mandates, have a common aim to support implementation of a pilot (demonstration) project for inculcation of energy efficient practices in urban lighting system in the Republic of Armenia (RA).
- UNDP, via the Project, contributes to solution of energy efficiency related issues in urban lighting systems, including eliciting the cost-efficacy of their upgrading and disseminating the relevant information for raising awareness among a wide range of beneficiaries;
- The Signatories attach high importance to the necessity of applying advanced technologies and equipment into urban lighting system's upgrade projects as well as the necessity of reiterating and enriching the effective and sustainable financial schemes' elaboration for other similar projects;
- The Signatories are ready to involve other donors in the process upon their request and based on their mandate frameworks and common understanding of the objective of the present cooperation.

The **Signatories** recognize the importance of providing a framework of cooperation and facilitate mutual collaboration, on a non-exclusive basis, in areas of common interest.

The Signatories agree to work together in the future on the basis of mutual trust and in the spirit of friendly cooperation.

The Signatories define that the main objectives of the present cooperation are to plan and organize the energy audit of municipal lighting system of Sevan town as well as to implement a demonstration project on municipal energy efficient lighting in Sevan town and evaluate the outcomes of the pilot.

The Signatories agree to establish a special revolving fund for financing energy efficient technologies' introduction in outdoor lighting system of Sevan town.

The initial allotments to the fund shall be secured from financial savings achieved as a result of implementation of pilot/demonstration project on energy efficiency improvement.

The fund resources shall be targeted towards implementation of measures aimed at introduction of energy efficient technologies in the lighting system of Sevan town.

The Signatories state that documentation to regulate the fund's activities shall be developed jointly in mutual consent.

The Signatories jointly assess needs for lighting system's energy efficiency improvement of selected pilot street(s).

The Signatories jointly elaborate the Terms of Reference (technical specification) of the lighting equipment to be procured for the selected pilot streets as well as the scope of activities needed for proper installation and operation of the procured lighting equipment.

The Signatories agree that the energy efficient lighting system to be developed and upgraded shall be based on light emitting diodes only.

The Signatories note that the tender will be organized and carried out according to UNDP procedures.

The Signatories state that the energy efficiency improvement ensuring measures so identified shall be implemented in accordance with the schedule and implementation model agreed between Signatories and in line with the Project's objectives and UNDP rules and procedures.

UNDP in the frames of the Project has expressed its commitments to:

- Provide technical and financial assistance for caring out public lighting system audit of Sevan town and development of municipal lighting system upgrade concept;
- Provide technical and financial assistance for development and implementation of measures ensuring improvement in energy efficiency and energy saving in municipal lighting sector of Sevan town within the scope of a pilot project;
- Develop technical specification, requirements to the supplier and necessary documents for the procurement of modern energy efficient street lighting equipment within the scope of a pilot project;
- Organize bidding process for procurement of modern energy efficient street lighting equipment on the base of open competitive tender and select the best offer based on submitted bids in accordance with the technical requirements;
- Procure new LED street lighting fixtures for the selected pilot street of Sevan town (Shahumyan street);
- Provide training for the personnel responsible for installation of the new fixtures;
- Organize technical supervision over the quality of installation works under the pilot project;
- Train the street lighting system operating personnel;
- Monitor the overall performance of the newly installed lighting systems on the pilot streets within the period of the Project implementation;
- Develop and disseminate public outreach materials on the implemented pilot.

The **Signatories** recognize the importance of providing a framework of cooperation and facilitate mutual collaboration, on a non-exclusive basis, in areas of common interest.

The Signatories agree to work together in the future on the basis of mutual trust and in the spirit of friendly cooperation.

The Signatories define that the main objectives of the present cooperation are to plan and organize the energy audit of municipal lighting system of Sevan town as well as to implement a demonstration project on municipal energy efficient lighting in Sevan town and evaluate the outcomes of the pilot.

The Signatories agree to establish a special revolving fund for financing energy efficient technologies' introduction in outdoor lighting system of Sevan town.

The initial allotments to the fund shall be secured from financial savings achieved as a result of implementation of pilot/demonstration project on energy efficiency improvement.

The fund resources shall be targeted towards implementation of measures aimed at introduction of energy efficient technologies in the lighting system of Sevan town.

The Signatories state that documentation to regulate the fund's activities shall be developed jointly in mutual consent.

The Signatories jointly assess needs for lighting system's energy efficiency improvement of selected pilot street(s).

The Signatories jointly elaborate the Terms of Reference (technical specification) of the lighting equipment to be procured for the selected pilot streets as well as the scope of activities needed for proper installation and operation of the procured lighting equipment.

The Signatories agree that the energy efficient lighting system to be developed and upgraded shall be based on light emitting diodes only.

The Signatories note that the tender will be organized and carried out according to UNDP procedures.

The Signatories state that the energy efficiency improvement ensuring measures so identified shall be implemented in accordance with the schedule and implementation model agreed between Signatories and in line with the Project's objectives and UNDP rules and procedures.

UNDP in the frames of the Project has expressed its commitments to:

- Provide technical and financial assistance for caring out public lighting system audit of Sevan town and development of municipal lighting system upgrade concept;
- Provide technical and financial assistance for development and implementation of measures ensuring improvement in energy efficiency and energy saving in municipal lighting sector of Sevan town within the scope of a pilot project;
- Develop technical specification, requirements to the supplier and necessary documents for the procurement of modern energy efficient street lighting equipment within the scope of a pilot project;
- Organize bidding process for procurement of modern energy efficient street lighting equipment on the base of open competitive tender and select the best offer based on submitted bids in accordance with the technical requirements;
- Procure new LED street lighting fixtures for the selected pilot street of Sevan town (Shahumyan street);
- Provide training for the personnel responsible for installation of the new fixtures;
- Organize technical supervision over the quality of installation works under the pilot project;
- Train the street lighting system operating personnel;
- Monitor the overall performance of the newly installed lighting systems on the pilot streets within the period of the Project implementation;
- Develop and disseminate public outreach materials on the implemented pilot.

*The **Municipality** has expressed its commitments to:*

- Ensure access of UNDP to all technical documentation and other relevant data for design and implementation of the pilot as well as for assessment of energy performance of the pilot street lighting systems;
- Ensure financing of the costs associated with proper installation of new energy efficient street lighting equipment;
- Ensure quality implementation and timely completion of all reconstruction works aimed at preparation of the pilot street (Shahumyan street) for proper installation of new lighting system in full compliance with requirements (e.g. position, inclination fixtures, corrosion protection of poles, etc.) agreed with UNDP. Check technical conditions of wiring and cabling of poles as well as ensure grounding for each of lighting poles;
- Ensure separate power consumption measurement for the pilot street lighting system via (preferably, by two-tariff) meters;
- Support monitoring of the overall performance of the installed street lighting systems within the period of the Project implementation by UNDP;
- Ensure safe, reliable and targeted operation and proper maintenance of the provided equipment.
- To ensure proper operation of the energy efficient lighting revolving fund establish a separate account for accumulating annual financial savings emerged as a result of energy efficient technologies application. The spending of the fund's resources shall be performed in consent with the Project within its implementation duration.

The **Signatories** agree on the following:

According to the present SoI co-financing commitment assumed by the Municipality enters into force upon ensuring procedures and formulations required for allotting funds as per established procedure.

Materials, devices, construction and other works per the lighting system's upgrade as procured by the UNDP shall be transferred to the Municipality on gratis use and ownership rights after completion of the Project.

During at least five years after the Project's close-out, UNDP will have the right to monitor proper operation and maintenance of the lighting system upgraded in the frames of the present SoI.

Each Signatory shall be responsible for management of its funds, its acts and omissions in connection with this SoI and its implementation.

The Signatories will explore possibilities to enter into a future collaboration in order to establish their partnership.

The Signatories recognize that this SoI is strictly limited to the scope described here above and does not entail any further commitments on either Signatories.

The Signatories agreed that the pilot project implementation schedule, technical specifications and requirements to the suppliers will be developed after signing of this SoI and will be integral part of it.

For the UNDP: **Bradley Busetto,** UN resident Coordinator, UNDP Resident Representative

For the Municipality of Sevan: **Rudik Ghukasyan,** Mayor of Sevan

Annex VIII: Concept of the municipal EE lighting fund, procedure and methodology

C O N C E P T
on establishment and management of special purpose fund
for improving energy efficiency of lighting systems

General provisions

Elaboration of new financial mechanisms for improving energy efficiency of lighting systems in Yerevan city and involvement of additional sources of financing can solve the issue of insufficient capital investment in the sector.

The idea of special purpose fund for improving energy efficiency of lighting systems essentially roots in accumulation of finance (accruals concept) enabling implementation of lighting systems' energy efficiency improvement projects. These cumulative funds originate from financial flows of savings in the frames of similar projects implemented earlier.

The fund operates with a financial mechanism that envisages mandatory return of the invested amounts for further target financing of new energy efficient projects. Reinvestment of the amounts is performed using the savings originated from the improved energy efficiency of lighting systems.

Financing of new projects' implementation with the amounts from the special purpose fund will enable accumulation of funds, involvement of international assistance projects (funding) envisaged for energy efficiency related issues, and will enlarge the fund's equity.

Purpose

In the frames of Statement of Intent signed between Yerevan city Municipality and UNDP in Armenia, "a special revolving fund" is to be established for further development and expansion of outdoor lighting system of Yerevan city, and scaling up the application of energy efficient technologies in it.

Initial financial flows to the fund shall be received from demonstration/pilot projects implemented jointly by Yerevan city Municipality and "Green Urban Lighting" UNDP-GEF project (hereinafter: "the Project"), in the form of annual savings of operation and maintenance costs of the lighting systems due to energy efficiency improvement measures implemented in the frames of the said pilots.

The mentioned savings shall be accumulated at a banking account opened specifically for this purpose in the case of Yerevan or at special off-balance accounts in the case of towns in marzes. The mentioned account is opened by a permission of Yerevan city Mayor or Council.

A separate account is needed to ensure transparent and manageable process of accumulation and disbursement of the fund's amounts. Financial divisions of the respective authorities are in charge for timely and complete transfer of estimated amounts of financial savings to the special purpose fund account with control over the proper implementation of the operations performed by the coordinating department of the municipality in Yerevan and by the Mayors – in other cities.

Procedure and sources for the fund replenishment

Initial financial flows to the fund shall be received in the form of savings originated from demonstration/pilot projects implemented jointly by the Municipality and the Project for outdoor lighting system of a city. The exact amount to be transferred to the fund are identified based on economic estimations underpinning the pilots, as the total of savings on power bill and savings of operation and maintenance costs of the lighting systems due to newly installed energy efficient luminaries.

Other financial flows to the fund may be the following:

- Allotments for energy efficiency improvement from municipal budget by decision of the city council;

- Other grants;
- Other financial flows as not prohibited by the legislation of the RA.

Procedure and requirements for allotment of financial resources from the fund

The fund resources can be allotted for implementation of new projects based on the submitted feasibility studies. Assessment of the proposal rationale and reliability of equipment to be used within their implementation is performed by the respective department of Yerevan city Municipality and approved by the designated Deputy Mayor of Yerevan or the Mayor's authorized person.

Participation of the Project in the assessment of the submissions is mandatory for the period of the Project's implementation, with its comments and recommendations on the feasibility studies' validity subject to mandatory discussion within the decision-making process.

The fund's amounts may be used for the following purposes:

1. Financing energy efficiency improvement projects of outdoor lighting systems of the city with preference to those showing positive net present values and possibly short payback periods;
2. Elaborating projects for implementation of energy efficiency measures in lighting sector;
3. Preparing and disseminating awareness raising materials on energy efficiency and energy saving measures in lighting sector.

The allotments per point 1 above can be made to repay the loans aimed at financing the implementation of energy efficient pilot projects for outdoor lighting systems. The allotments made in accordance with points 2 and 3 above cannot exceed 10% of the fund's available amounts.

To ensure highest possible efficiency of investments from the revolving fund amounts, it is necessary to implement precise and regular accounting and control over energy saving.

The fund's amounts disbursement is allowed only via bank transfers.

Competence of authorities ensuring the fund's operation

The owner of the fund (special account) is the Mayor of Yerevan city or his authorized person. Within the Project implementation, the Project Manager or his appointed authorized person also take part in managing the fund. The comments and recommendations of the Project are subject to mandatory discussion within the decision-making process to reach consent over the final decision. The right to make the final decision on the fund disbursement is that of the Mayor of Yerevan city or his appointed authorized person.

P R O C E D U R E
for using the resources of target fund for improving energy performance of outdoor illumination systems of Yerevan city

1. Subject matter

The present document defines the procedure for using the resources of special account (fund) opened in "Yerevan Municipal Illumination" CJSC (hereinafter: "the Company") according to the provisions of the Statement of Intent signed between the Yerevan city Municipality and the UN Development Program in Armenia. It is aimed to ensure enforcement of the concept "On establishment and management of the special purpose fund for improving energy efficiency of lighting systems" as endorsed by the parties.

2. Sources of replenishment of the special account

Inflow of amounts to the special account is defined as savings of operation and maintenance costs of the outdoor lighting systems due to energy performance improvement measures implemented in the frames of projects funded via the special account.

Initial financial flows to the special account shall be received from demonstration projects implemented jointly by Yerevan city Municipality and "Green Urban Lighting" UNDP-GEF project (hereinafter: "the Project") in Isakov Avenue and Tairov Street, in the form of annual savings of operation and maintenance costs of the lighting systems due to the implemented energy efficiency improvement measures.

For each year, calculation of savings is performed based on both ongoing and commencing projects' estimations. A proposed technique for savings' estimation is attached (see Annex).

The company shall transfer amounts of expected/actual savings from the implemented projects to the special account based on either actual estimation of savings' size per month or estimated amount for a certain period of time with the latter requiring further adjustment.

Other sources for the replenishment of the special account may be the following:

- Allotments for energy efficiency improvement of outdoor street lighting systems from community budget by decision of Yerevan city Council;
- Other grants;
- Other financial flows as not prohibited by the legislation of the RA.

3. Purposes for fund use

The fund may be used for the following purposes:

1. Financing energy efficiency improvement projects of outdoor lighting systems of Yerevan city including loan servicing as received for such purposes;
2. Requesting elaboration of projects for implementation of energy efficiency measures in lighting sector;
3. Preparing and disseminating awareness raising materials on energy efficiency and energy saving measures in lighting sector.

The allotments made in accordance with points 2 and 3 above cannot exceed 10% of the fund's available amounts.

In case of financing projects implemented via loan amounts, annual amount required for loan payback and interest payments shall not exceed annual estimated financial inflow of the fund.

No presence or flow of other amounts is allowed via the special account.

The fund's amounts disbursement is allowed only via bank transfers.

4. Management of the fund

Resources of the special account are managed by Director of the "Yerevan Illumination" CJSC as the authorized person designated by Mayor of Yerevan city.

A committee of at least five persons is established for taking decision on allotments of the fund resources. The committee mandatorily involves the authorized person of UNDP-GEF project, Communal service department and Development and investment programs department of Yerevan city municipality, chief engineer of the Company. Director of the Company shall be the chairperson of the committee.

Expenses made from special account for procurement of goods, works and services shall be performed in accordance with the procedure stipulated by the RA Law "On Procurement".

The tenders for procurement of goods and services for the reporting (current) year are announced at the assessed saving amount of the given year.

Financial resources accruing (emerging to) at the special account are a part of total financial resources of the Company.

5. Procedure for proposal, discussion and adoption of new projects

Investment projects to be financed from the special account can be proposed either separately by the Municipality or jointly by the Municipality and the Project.

Investment projects are subject to discussion if they comply with purposes, tasks and priorities of the concept "On establishment and management of purpose fund for improving energy efficiency of lighting systems".

To implement a project, the respective application is filled out and submitted for discussion of the committee.

The following data shall be included into the application:

- Names of the streets, areas of implementation,
- Number of luminaires subject to replacement,
- Number and type of new luminaires,
- Amount of the required investment (cost of equipment and cost of works),
- Amount of funding to be saved (for the whole period of the project's activities and annually),
- Source of funding,
- Timelines of the project implementation,
- Timelines of the investment payback.

Applications for implementation of such projects can be submitted before September of the current year.

For discussion and approval of the projects, timeline of 15 days is set up.

The Project experts and specialists of stakeholder departments of the municipality partake in the discussions optionally.

At a proposal of the committee's chairperson, if necessary, independent specialists may be involved into the expertise of the project proposals.

The decision to finance the project is based on the submitted documentation that shall include financial, organizational, technological aspects of the project's implementation and the amount of the funding requested.

An investment project is eligible for funding in case it provides highest financial outcome (net present value, payback period etc.). In exceptional cases, based on priorities of the city's development, other indicators may be applied.

Decision made in respect of an investment project is formulated as a written conclusion of the committee and is subject to approval by the respective Deputy Mayor of Yerevan city. Upon the approval, funding may be actually allotted.

6. Expenditure of resources of the special account and supervision over the works performed

General supervision over resources of the special account is implemented by the committee, for which purpose the committee can request of its chairperson and receive information and data on amount of annual savings, status of the works being performed, and flow of amounts of the special account. Such requests can be made twice a year.

Current supervision over resources of the special account and the projects implementation process are implemented by Director of the Company as the chairperson of the committee.

7. Report on the expenditure of the resources of the special account

For each year, before March 1 of the next year, the chairperson of the committee submits to the committee members the report on usage of resources of the special account.

Secretary of the Staff

Methodology
Estimation of annual savings per the energy performance of outdoor lighting systems

Savings in the reporting year are accounted using following baseline indicators: effective power tariffs, prices of lamps, ballasts (throttles, condensers) and impulse switching devices as defined within the respective duly completed tenders, and other operation and maintenance expenses of the luminaires. Change in power tariffs during the reporting year is a basis for recalculation of the savings. To perform estimation of savings, the following baseline indicators of the outdoor street lighting system are considered:

- Number of luminaires/lamps before and after the project implementation,
- Power capacity of the luminaires,
- Approved schedule of street lighting system's operation hours by month – at night and day tariffs,
- Number of lamps, throttles and impulse switching devices being replaced in the selected street annually.

Amount of annual power saving is defined as the product of power capacity difference between the replaced and new luminaires, annual operation hours (differentiated by night and day operation hours), number of luminaires, and power tariffs. Importantly, for the replaced luminaires, their actual hourly power consumption before the project implementation, while for the new ones – their passport data that can be corrected by trials in certain cases. Estimated amount of saved power is applicable for assessment of the savings' magnitude.

To assess actual level of efficiency of the demonstration project implemented, experts of the Project and specialists of the Company jointly performed a comparison of actual power capacities of Isakov Avenue and Tairov Street in Aprils of 2014 and 2015 respectively. The comparison showed that power load in the selected streets decreased by 58% due to replacement of luminaires in the frames of the demonstration project. Given the same operation hours of the system, the decrease in actual power consumption will be equivalent. Therefore, it was decided to consider power consumption savings magnitude equivalent to power load decrease, while, to simplify further estimations, to assume the actual power consumption saving at 55%. Thus, in April 2015, actual power consumption of the demonstration streets reached 34,280 kWh. With the chosen saving proportion, that would be 76,148 kWh, i.e., actual saving constitutes 41,898 kWh. Finding the product of this saving and average power tariff for the selected street yields the savings in monetary terms – the amount subject to transfer to the special account by the Company.

Saving per other operation and maintenance costs are estimated the following way:

- For lamps, impulse switching devices and throttles: product of times of their replacement in the old system of the demonstration streets annually and their price in the reporting year,
- For savings of replacement costs: product of the number of annually replaced lamps, impulse switching devices and throttles in the old system and estimated cost of replacing one electrical device in the reporting year.

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