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ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS) CLEAN ENERGY PROGRAM

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Energy Expenditure Reduction Potential of Street Lighting and Lighting Systems of Building Facades, Parks and Squares in Mtskheta



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DISCLAIMER

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Contents

1	Introduction	1
2	Project Prerequisites	1
2.1	Problem Description	1
2.2	Project Goal.....	2
2.3	Partners and Beneficiaries	2
2.4	Barriers to Project Implementation.....	3
3	Description of Existing Street Lighting System in the City of Mtskheta	4
3.1	Inspection Results (Conclusions and Recommendations).....	5
3.2	Expected Savings from the Planned Measure	6

Tables

Table 1.	Energy Consumption and Expenditure of Street Lighting Sector in City Mtskheta in 2014	4
Table 2.	Parameters and Features of Street lighting Bulbs in City Mtskheta	4
Table 3.	Existing Street Lighting Fixtures in City Mtskheta and Types and Capacities of their Energy-Efficient Substitutes	6

1 Introduction

In July-August 2016, the analysis of energy expenditure reduction potential of street lighting and lighting systems of building facades, parks and squares was conducted in the city of Mtskheta in case of installing the LED bulbs and setting up solar power unit. Activities have been defined according to analysis of existing lighting systems, solving of specific task in case of utilization of new energy-efficient LED system bulbs, and comparative economic analysis of existing and suggested lighting systems.

2 Project Prerequisites

2.1 Problem Description

Since 2010, the process of undertaking voluntary commitments has been launched in Georgia under the Covenant of Mayors (CoM) which means that the cities joining this initiative aim to reduce the GHG emissions from their territories by 20% for 2020.

Main sectors considered by the EU cities within the frames of this initiative are transport and buildings; however, the cities may include some other sectors as well (street lighting, waste management, landscaping, etc.).

Following Tbilisi, other self-governing cities of Georgia enthusiastically embraced this initiative and started to join this process. Today, 13 self-governments have already joined this initiative, including 9 self-governing cities and 4 municipalities.

The Sustainable Energy Action Plans (SEAP) already have been developed for eight self-governing cities and one monitoring report - for Tbilisi. Main sectors considered by the cities of Georgia include transport, buildings, street lighting, waste management and landscaping.

City of Mtskheta joined the Covenant of Mayors on 15 May, 2015. At present, "Sustainable Energy Action Plan" for city Mtskheta is being developed, in which one of the significant components is devoted to measures to be implemented in Lighting Sector.

The Municipality has neither an appropriate experience nor skills or enough technical staff to plan or manage sustainable energy development process of city Mtskheta and implement the SEAP.

It should be noted that on the territory of Mtskheta Municipality historical monuments are disposed, included in the list of UNESCO World Heritage Sites. The population of the city makes up 7.7 thousand (by 2002). Here are a railway station, food and light industry enterprises, and Zemo Avchala HPP. There are a number of cultural (higher educational institutions, a theatre, a museum) and architectural (Svetitskhoveli, Samtavro, Bebris Tsikhe, Jvari Monastery, etc.) monuments and all these buildings require exterior lighting.

In the city of Mtskheta there are 50 streets, 4 squares, one central park, 4 small stadiums, and bridges. All these constructions need illumination. According to 2015 data, 85% of Mtskheta streets are illuminated.

2.2 Project Goal

Goal of the present project survey is to develop energy efficiency measures for lighting systems in Mtskheta Municipality and the methodology of their implementation. These measures will ensure not only the reduction of expenditure and provide economical consumption of energy but will also reduce greenhouse gas emissions.

Implementation of the project will help to introduce high technology lighting systems which will replenish the deficit of awareness in this area.

As a result of the project, street lighting expenditures of city Mtskheta will be reduced and the measures of transferring the city's street lighting to low emissions phase will be implemented.

Project monitoring and recommendations based on statistics analysis will provide significant findings to plan long-run activities of making energy-efficient street lighting in the region. It will ensure development and implementation of new projects, and remove the barriers to raising knowledge and awareness in this respect.

2.3 Partners and Beneficiaries

Partners:

- **Mtskheta City Hall** – Mtskheta City Hall is the main partner and beneficiary of this project apart from its function as the main implementing link. The City Hall should allocate funds to substitute existing lighting systems with the LED systems, as well as, to install new lighting systems and set up Solar Power Unit.
- **Mtskheta-Mtianeti Region** – Mtskheta-Mtianeti Region Administration will be the partner to the project in recruiting potential local staff, raising awareness and disseminating the findings to other municipalities of the region.
- **Ministry of Environment and Natural Resources Protection of Georgia (as the CoM coordinator in Georgia)** – The Ministry bears responsibility to carry out Climate Change Convention Principles throughout the whole territory of Georgia. Besides, it coordinates the CoM process and provides support to the signatory cities and municipalities as far as possible with both methodology and the available data. Therefore, it may play an important role in developing the project activities.
- **Ministry of Energy of Georgia (as the CoM coordinator in Georgia)** – Together with the Ministry of Environment and Natural Resources Protection of Georgia it also coordinates the CoM process. The processes/strategies/action plans projected by the Ministry at countrywide level are directly reflected in the “Sustainable Energy Action Plans” for the CoM signatory cities and municipalities. These plans play an important role in providing sustainability of local population and resolving the issues related to increasing energy efficiency. The Ministry actively cooperates with the municipalities and cities during preparation of the plan and provides them with parameters assessed at the nationwide level (GDP, population growth, different sector flexibility values, etc.);

- **Ministry of Regional Development and Infrastructure of Georgia** – This Ministry is directly related to the implementation of “Sustainable Energy Action Plan” and a big part of the actual activities is planned in collaboration with mentioned Ministries and is financed partially.
- **NALAG (National Association of Local Authorities of Georgia)** – NALAG can make special contribution to awareness raising programs on climate change, sustainable development, etc., prepared for municipalities, and provide much to these processes.

Beneficiaries:

- **Mtskheta City Hall** – Mtskheta Municipality City Hall will get reduced expenses, energy efficient low emission lighting sector;
- **Mtskheta-Mtianeti Region** – On its side, Mtskheta-Mtianeti Region will get opportunity of new workplaces that will be resulted from dissemination of this innovation in other municipalities;
- **Local population of City Mtskheta**, as they will be able to adopt certain skills which will increase the chances of their employment;
- **Ministry of Environment and Natural Resources Protection of Georgia**, as it bears responsibility to implement the GHG emissions reduction measures throughout the country, and provide with relevant strategies and action plans;
- **Georgian Government**, which is interested in decentralization of the regions and emerging strong regions that is urgent for the country’s security and independence. Strong regions may make significant contribution to carrying out the commitments undertaken in frames of Climate Change Convention;
- **Project implementation support factors:** International commitments undertaken by the country and the self-governing entities (Association Agreement; Covenant of Mayors; future commitments undertaken in frames of Climate Change Agreement);
- Urgency of the issue and potential of demonstrating the outcome in short-term period by showing the results;
- Abundance of grant resources and their availability.

2.4 Barriers to Project Implementation

- Gaps existing in procurement law. Procurement law is currently based only on the principle of the lowest price that has seriously damaged the quality of a number of implemented projects. This problem should be solved and the law should be improved through joint efforts of the municipalities and cooperation with the central government. In particular, during carrying out procurement, a bidding document shall contain lighting fixture type and necessity of submission certificates of origin and quality assurance to avoid delivery of low-quality products.

- Insufficient qualification of decision makers in preparing bidding/project assignments for such type of activities.
- Insufficient budgetary resources - to prepare grant application; cooperation with private sector seeking support from them.
- Lack/absence of well qualified staff. Capacity building measures (donors' support required);
- Keeping trained employees – building motivation (including financial) (donors' partial support).

3 Description of Existing Street Lighting System in the City of Mtskheta

There are 50 streets, 4 squares, one central park, 4 small stadiums, and bridges in city Mtskheta. All these constructions need illumination. According to 2015, data 85% of streets in Mtskheta are illuminated.

Table I shows energy consumption and expenditure of street lighting sector in city Mtskheta in 2014.

Table I. Energy Consumption and Expenditure of Street Lighting Sector in City Mtskheta in 2014

Infrastructural Facilities	Energy Consumption (KWh)	Financial Expenditure (GEL)
Street Lighting of City Mtskheta	964 783	154 145.38
Total	964 783	154 145.38

As the Table shows, energy consumption by city Mtskheta in 2014 made a bit less than 965 thousand KWh that cost more than 154 thousand GEL. In 2014, 1 614 lighting fixtures were installed in the city, types and capacities of which are given in the Table below.

Table 2. Parameters and Features of Street lighting Bulbs in City Mtskheta

#	Existing Lighting Fixture	Features	Quantity
		Capacity, WT	
Street Lighting			
1	Energy-saving 20W	20	144
2	Energy-saving 95W	95	546

3	Metal-halide 150W	150	80
4	Metal-halide 250W	250	2
5	Metal-halide 400W	400	31
6	Sodium 70W	70	206
7	Sodium 150W	150	375
8	Sodium 250W	250	188
9	Sodium 400W	400	13
10	Sodium 1000W	1 000	14
11	Д Р Л -250	250	15
	Total		1 614

According to 2015 data, the amount of bulbs makes 1 614 units, and covers 85% of the whole length of all streets. As the final goal of the City Administration is all the streets/roads to be illuminated in the city, a task was set that in 2016-2018 all the streets that have no lighting at present to be lightened gradually, so that by 2018 all the streets will be illuminated. In addition, in 2017, 10 lampions will be installed at Parnavazi Square with 3 bulbs on each fixture. Capacity of additional bulbs is taken based on the average capacity of the existing lamps (136WT - one bulb). According to these assumptions, by 2020 the total number of bulbs will be 1 929. It was assumed that under the base scenario, additional bulbs will also be the energy-efficient lamps. In addition, in 2019-2020 it is planned to install the street lighting control system in central districts and streets.

3.1 Inspection Results (Conclusions and Recommendations)

Modeling and inspection results may be formulated in the form of conclusions and recommendations, which imply the following:

1. Gradual substitution of the existing 1 614 inefficient lighting fixtures with energy efficient LED lamps during 2017-2020.
2. Remained street length (15%) to be illuminated with efficient bulbs (315 lighting fixtures)
3. Set up a Solar Power Unit at the territory of the Municipality with 100KW capacity which will generate 270 000 KWh energy per year and to reduce with the generated energy the electricity expenditure to zero in case of carrying out effective control and monitoring of street lighting systems.

3.2 Expected Savings from the Planned Measure

In 2014, energy consumption by the Street Lighting Sector made 0.965GWh.

In 2014, emission from street lighting equaled to 100.3t CO₂ eq.

The average emission factor of electric energy grid in 2014 has been taken as the electric energy emission factor – 0.104 t CO₂ /MWh.

According to base year scenario, the street lighting energy consumption will be increased in the future and by 2020, it will equal to 1.153 GWh, and CO₂ emission will reach 119.9t CO₂ per year by 2020.

In Table 3 presented the amount of inefficient lamps existing in street lighting system and their energy-efficient substitutes according to their types, amount, and capacities are presented.

Table 3. Existing Street Lighting Fixtures in City Mtskheta and Types and Capacities of their Energy-Efficient Substitutes

	Existing Lamps				Substituting LED Lamps			
	Lighting Fixture Type	Amount	Capacity WT	Total Capacity KW	Lighting Fixture Type	Amount	Capacity WT	Total Capacity KW
1	Energy-saving 20WT	144	20	2.88	LED 15	144	15	2.16
2	Energy-saving 95WT	546	95	51.87	LED 30	546	30	16.38
3	Metal-halide 150WT	80	150	12	LED 30	80	30	2.4
4	Metal-halide 250WT	2	250	0.5	LED 70	2	70	0.14
5	Metal-halide 400WT	31	400	12.4	LED 110	31	110	3.41
6	Sodium 70WT	206	70	14.42	LED 30	206	30	6.18
7	Sodium 150WT	375	150	56.25	LED 30	375	30	11.25
8	Sodium 250WT	188	250	47	LED 70	188	70	13.16
9	Sodium 400WT	13	400	5.2	LED 110	13	110	1.43

10	Sodium 1000WT	14	1000	14	LED 110	14	110	1.54
11	Д Р Л - 250WT	15	250	3.75	LED 70	15	70	1.05
12	Inefficient 136WT	315	136	42.97	LED 30	315	30	9.45
	Total	1 929		263.24		1 929		68.55

It is planned that implementation of the measure will start in 2016 and by this time the existing 1 614 inefficient lamps will be substituted with energy efficient LED bulbs gradually during 2017-2020. To this, the remained 15% of the street length will also be illuminated with energy-efficient bulbs. It comes out that, the amount of the lanterns to be substituted is $1\ 614 / 0.85 + 30 = 1\ 929$ bulbs, or the amount of the new bulbs makes $1\ 929 - 1\ 614 = 315$. And, if at present the average energy consumption by the lighting point is 0.136 KWh and if the energy supply is continued with the type of lamps existing now, then by 2020 the annual energy consumption by the street lighting system in Mtskheta will be $1\ 929(\text{lighting fixtures}) * 0.136(\text{KWt}) * 4\ 380\ (\text{h}) = 1\ 152\ 971\ \text{KWh}$; in case of using energy-efficient LED lamps, the annual energy consumption will be $1\ 929\ (\text{lamps}) * 0.036(\text{average KW}) * 4\ 380\ (\text{h}) = 300\ 226\ \text{KWh}$. Consequently, the energy saving in 2020 will equal to $1\ 152\ 971 - 300\ 226 = 852\ 745\ \text{KWh}$ electric energy, that will be reflected in the reduction of annual expenditure for providing electricity for street lighting by $852\ 745\ \text{KWh} * 0.16\ \text{GEL} = 136\ 439\ \text{GEL}$. Accordingly, the reduction of emission will equal to $(1\ 152\ 971 - 300\ 226) / 1\ 000 * 0.104 = 88.69\ \text{tCO}_2/\text{yr}$.

As the cost of one streetlight replacement is about 320GEL and installation of new lantern costs 800GEL, the cost of the measure makes up $1\ 614 * 320 + 315 * 800 = 768\ 480\ \text{GEL}$.

According to Decree of the GNERC, as of May 3, 2016, on amendments to “Regulations on Energy (Capacity) Supply and Consumption” under “the Resolution № 20, as of September 18, 2008, of the Ministry of Energy and Water Supply Regulatory Commission”, the retail consumer is entitled to join his own micro-capacity (solar collectors electric farm with capacity no more than 100 KW) power unit to the distribution grid and carry out supplying the energy generated by him to the distribution grid following the conditions in compliance with these rules. To this, the installed capacity of the micro-capacity power unit being in the ownership of the retail consumer should not exceed the capacity of the distribution grid to be joined.

In case in the reporting period the total amount of the electric energy generated by the micro-capacity power unit (having moved into the distribution grid) and reflected in the payment receipt in the form of credit (having moved into the distribution grid) is less than the amount of electricity received by the retail consumer from the grid, the difference between the amounts will be considered as the energy consumed (procured) by the retail consumer from the distribution grid, which should be chargeable to the consumer tariff set by the Commission and accordingly, the electricity received from the mentioned difference will be considered as the realization of the distribution licensee.

This regulation gives the Mtskheta Municipality a chance to set up a Solar Power Unit at the territory of the Municipality with 100KW capacity, annually generating 270 000 KWh electricity and to reduce with the generated energy the electricity expenditure to zero, in case of carrying out effective control and monitoring the street lighting systems.

The estimated cost of setting up such energy farm, including control expenses, equals to 2.5 EUR per watt that in case of power unit with 100 KW capacity will make 250 000EUR (that at 2.6 EUR/GEL exchange rate makes up 650 000GEL).

As a result of setting up energy farm and dispatching system the full substitution of electric energy consumed by energy efficient LED bulbs (300 226 KWh) with renewable energy will be completed. The annual reduction of the released emission with this measure will be $300\,226 / 1\,000 * 0.104 = 31.22$ t CO₂, and the expenditure of energy for street lighting will be reduced by $300\,226 \text{ KWh} * 0.16 \text{ GEL} = 48\,036$ GEL.

The total cost of the measures considered under the project makes up 1 419 thousand GEL and will ensure transferring the whole street lighting system on solar energy and zero energy consumption cycle from the distribution grid.

As a result of the proposed measure 1 152 971 KWh saving per year will be reached that in monetary terms will equal to 184 475 GEL savings and reduction of 119.91tCO₂/yr emission.