



# Increase of energy efficiency in Pereyaslav-Khmelnytsky, Kyiv region, Ukraine

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Client

**NEFCO**



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Document title

**Business Plan**

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iC consulenten Ukraine  
Volodymyrska str., 61 b,  
Kyiv 01033, Ukraine  
T: +38 044 38 44 337  
[www.ic-consulenten.com.ua](http://www.ic-consulenten.com.ua)

**DOCUMENT CONTROL SHEET****PROJECT NUMBER:** 61x180468**PREPARED BY:** **iC consulenten LLC**  
Volodymyrska str., 61 b,  
Kyiv 01033, Ukraine  
T: +38 044 38 44 337  
[www.ic-consulenten.com.ua](http://www.ic-consulenten.com.ua)**PREPARED FOR:** **NEFCO**  
Fabianinkatu 34  
FI-00100-Helsinki, Finland  
Tel: +385 10 618 003Contact person:  
Alexey Dumik  
a.dumik@nefco.org.ua**DATE:** 07.02.2019**EDITOR:** iC – Denis Vlasov, Dmytro Ocheretyaniy, Valerii Vyshniakov

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## Preface

This report is a Business Plan prepared as part of the assignment Contractor iC consulenten LLC has with Nordic Environment Finance Corporation (NEFCO) to give technical assistance to Ukrainian municipalities and companies to prepare for investments in cleaner production and sustainable business under the NEFCO facilities for Cleaner Production Credits and Energy Saving Credits. This is the business plan for the project on increasing energy efficiency in Pereyaslav-Khmelnytsky city.

NEFCO provides the free technical assistance with financing from the Swedish International Cooperation Agency (SIDA). The objective is to ensure that companies seeking to invest in environmental improvement and energy efficiency measures are able to prepare and present feasible projects that can be successfully implemented and lead to reduction of industrial pollution through efficient resource and energy utilisation.

This report is based on the following input:

1. Project proposal received from NEFCO;
2. Information assessed during site visit and discussions in November 2018; discussions with mainly the following participants: mayor, head of project implementation unit (PIU) from the city, energy manager of the city administration of Pereyaslav-Khmelnytsky city, chief of economic development department, head of lighting maintenance department of the city and city architect;
3. Collected data from the site visit;
4. Information provided by the city;
5. Developed measures from iC consulenten.

Project title <b>Increase of energy efficiency in Pereyaslav-Khmelnytsky, Kyiv region, Ukraine</b>	Project no. 61x180468	Date <b>05.02.2019</b>
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## 1. **EXECUTIVE SUMMARY**

This Business Plan (BP) is focused on the reconstruction of the street lighting system of Pereyaslav-Khmelnytsky city.

At the time of the BP preparation, the streets suggested for the project, are illuminated by 1 210 lighting fixtures. Most of the fixtures are outdated and cannot comply with modern Ukrainian standards for street illumination. In many different locations in the city lighting fixtures, sometimes lampposts (lighting supports) and electrical cables are missing or damaged. The baseline assumes that all lighting fixtures are in operation, which has not always been the case at time of BP preparation.

The project foresees the street lighting system reconstruction including installation of 1 055 new LED fixtures instead of existing fixtures with mercury containing lamps, introduction of new remote-control and dispatching systems as well as installation/replacement of lampposts, and cable.

The project covers 15 streets and side streets.

**The project objectives are the following:**

1. Reduction of the electrical energy consumption by the street lighting (SL) system;
2. Reduction of annual operating and maintenance (O&M) costs;
3. Enhancement of effectiveness and reliability of SL system operation;
4. Complete removal of lamps containing hazardous mercury from operation.

**Social effect of the project implementation:**

1. Reduced road traffic accidents, which consequently increases road traffic safety and movement of people;
2. Improved safety on the streets;
3. Increased comfort for local community and city visitors.

Equity capital	UAH	1 765 000
NEFCO	UAH	14 454 000
<b>Total investment</b>	<b>UAH</b>	<b>16 219 000</b>
<b>Annual Net Savings</b>	<b>UAH</b>	<b>3 143 000</b>
Overall payback period	years	5,2

**Table 1.1 – Financing plan and profitability**

<b>Saving Elements</b>	<b>Dimensions</b>	<b>Savings</b>
Electricity	MWh/a	1 040
CO <sub>2</sub> emission reductions	tons/a	832

**Table 1.2 – Environmental benefits from project implementation**

## 2. **PROJECT OWNER**

The Pereyaslav-Khmelnitsky city is the owner of all assets related to the project and will be the borrower under the NEFCO loan.

### 2.1. **THE BORROWER**



**Territory.** Pereyaslav-Khmelnitsky is a city in Kyiv Region, Ukraine. Administratively, it is recognized as a city of regional significance. It serves as the administrative centre of the Pereyaslav-Khmelnitsky region. The city is located 110 km from the Ukrainian capital Kyiv. City population is approximately 27 400 (2017 year) people. The population density is 860 persons/km<sup>2</sup>. The total area is 32 km<sup>2</sup>.

**Cultural and social sphere.** The City Council is actively involved in the cultural and social development of the city residents. The most famous of the main tourist object of the City is the open-air ethnographic museum of folk architecture and household, which is one of the largest museums in Ukraine. In total there are 27 museums in the city. The city was founded in X<sup>th</sup> century and was a cultural and religious centre of Ukraine.

**Education and healthcare.** The educational sector is well developed. The city counts eight general education institutions which are six secondary schools, one primary education school, one gymnasium and five kindergartens. Total number of students and children of these institutions is about 2 000 people. There is an orphanage boarding school, existing since 1961. In 1954, the technical engineering school was established. Nowadays it is a recognized engineering school, which is spread over 20 km<sup>2</sup> territory. The largest higher education facility of the city is "Pereyaslav-Khmelnitsky Hryhorii Skovoroda State Pedagogical University" where more than 6 500 students study at nine faculties.

The healthcare system employs 675 people, 491 of them are medical workers. The number of doctors in all specialties is 114 people.

**Industry.** Various industrial facilities and manufactures such as food processing and agricultural processing (16,7%), textile and clothes production (14,1%), construction materials production (0,9%), metal processing (5,5%), electrical and electronic equipment production (40,6%) are developed in the city.

Borrower	Pereyaslav-Khmelnitsky city council
Organizational-legal form of organization	Executive Committee of Pereyaslav-Khmelnitsky City Council
EDRPOU	33201806
Legal address	08400, Kyiv region., Pereyaslav-Khmelnitsky, Bogdana Khmel'nitskogo St., 27/25
Telephone	+380 4567 52503
Web site	<a href="http://phm.gov.ua">http://phm.gov.ua</a>
E-mail	ua907@ukr.net
Contact person	1. Serge Lyovkin; 2. Matsayenko Iryna
Telephone	1. +38067 571 03 15; 2. +380 4567 52503
Position	1. External Consultant to City Council; 2 - Chief Specialist of the Department of Economics and

Borrower	Pereyaslav-Khmelnytsky city council
	External Relations of the Economy Department of the Executive Committee of the City Council

**Table 2.1 – Contact details of the borrower**

Article	Completed during the reporting period, ths of UAH		
	UAH		
	2015	2016	2017
<b>I. Expenditures (including transfers)</b>	145856,9	210193,3	303918,1
- sources received from the general budget fund for the budget development (Special Fund)	1635,23	12849,4	17615,98
<b>II. Revenues</b>	146450,04	215622,69	306642,63
General fund revenues of local budgets:	143385,83	211208,49	299590,46
- Tax revenues	49224,19	72848,18	101810,4
- Non-Tax revenues	979,42	1513,67	2188,43
- Income from capital transactions	10,7	6,3	1
- Official transfers	93171,52	136840,34	195590,63
including:			
- grants	-	-	-
- subsidies	93171,52	136840,34	195590,63
Special fund revenues of local budgets:	3064,21	4414,2	7052,17
- Tax revenues	-11,77	24,83	30,58
- Non-Tax revenues	2470,27	4205,73	3535,96
- Income from capital transactions	161,74	1,9	9,04
- Trust Funds	161,47	181,74	281,77
- Official transfers	282,5	-	3194,82
including:			
- subsidies	282,5	-	3194,82
Budget execution, % (revenues /expenditures)	100%	97%	99%

**Table 2.2 – Information about Peryyaslav-Khmelnitskiy city budget (2015-2017)**

Table 2.2 above shows that the City executes almost all budget costs for the last three years, has positive tax revenue value and strong borrowing capacity given the stable City budget growth for the last three years.

Borrower	Employment data
Number of employees	124
Male workers	19
Female workers	105
Percentage of women in leading positions	24%

**Table 2.3 – Employment data for Pereyaslav-Khmelnytsky City Council**



### **3. PROJECT INFORMATION**

This project relates to energy efficiency measures in SL system in the City of Pereyaslav-Khmelnytsky.

The project scope was identified by the city mainly on the basis of information about categories of the city roads, length of the streets and amount of the lighting poles and fixtures.

The scope of work to be implemented in the framework of the Project is based on the prepared Business Plan and contains information regarding implementation of measures for the Street Lighting (SL) system aimed to decrease energy consumption and increase comfort in the Pereyaslav-Khmelnytsky city, Kyiv region, Ukraine.

The main project goals are:

- Modernization of SL system of the city on 15 main and side streets;
- Replacement of old lighting fixtures (equipped with mercury lamps), with new LED energy efficient fixtures;
- Introduction of the new illumination level control system to allow additional savings;
- Achievement of sufficient illumination of the streets, which will correspond to Ukrainian standards;
- Improvement of the environmental safety by removing hazardous materials.

#### **3.1. CURRENT SITUATION**

The street lighting service is provided by KP "Pereyaslav-Khmelnytske VUKG".

The total length of lighting networks of the City – 138 km. The total length of lighting networks subject to modernization is 15 km. The total number of lighting points of the City - 3663 pc. The total number of lighting points on the chosen streets is 1 210, control cabinets – 20. Electricity meters "Energiya 9" are installed in all control cabinets.

According to the base line, total electricity consumption of chosen SL system under the project, is around 1 310 MWh/a.

It is possible to determinate few main problems with existing SL system:

- Insufficient illumination of the main transport roads and crosswalks;
- Use of high energy consuming DRL lamps which contain hazardous materials;
- Manual operation of the SL system and system operating hours. At the moment during the "winter" period it is six hours and three hours of work during the "summer" period;
- Lack of centralized control and proper metering systems.

##### **3.1.1. Electricity line poles**

There are two types of poles on the city streets. The reinforced concrete and metal (galvanized) poles. In general, the lighting poles are in satisfactory condition, although some of the concrete poles are damaged or have cracks. It is proposed to replace the poles, which are in emergency

condition and install new poles where it is necessary. Pillars have different height, up to 10-12 meters. Different lighting poles are presented on Figure 3.1 below.



**Figure 3.1 – Existing electricity poles**

### **3.1.2. Fixing brackets**

Fixing bracket is a separate element made of metal and installed over the lighting pole. Almost all of the existing brackets are covered with rust. Some of the brackets (two-branches type) foresee the installation of the two lighting devices, but in general only one fixture is installed.

Generally, brackets are installed at the top of the pole, but it is possible to regulate the position of the bracket along the pole. To achieve maximum efficiency from the new energy efficient lamps new brackets can be installed at a lower height.



**Figure 3.2 – Existing fixing brackets**

### **3.1.3. Lights power supply system**

Controlling of the SL system was provided within the districts – one control cabinet for each district. It means that one street can be powered from different control cabinets – depending on which districts it pathing through. Streets are merged in the control cabinets where

electrical meters and emergency switching system are installed. Basic modernization of the control cabinets was done during the last two years. Modernization included replacement of the electrical switchers and meters. Control cabinets itself consist of metal box with simple secure lock.



**Figure 3.3 – Existing control cabinets**

#### **3.1.4. Fixtures**

Most of the existing lighting fixtures are old and obsolete, sometimes fixtures are missing from the bracket. Dimming system is not available for the installed fixtures thus street illumination is regulated manually. At the moment, the SL system works from three to six hours per day, depending on the season. Such working schedule can be explained by high energy consumption of the SL system and single electricity tariff for the day and the night time.

Existing fixtures are equipped with mercury arc DRL and compact fluorescent lamps (CFL). Although, DRL lamps ensure relatively good illumination they are non-energy efficient and high energy consuming. Another issue is that lamps contain hazardous substances (lead, mercury etc.) which are dangerous for people as well as for the environment. CFL lamps provide low illumination level. It is important to mention that most of fixtures have no reflectors installed Even if there are reflectors they don't function , considering the long-time use and lack of maintenance. They are not capable to perform their functions in their present condition.



**Figure 3.4 – Existing lighting fixtures**

### **3.2. THE PROPOSED PROJECT**

It is planned to make modernization of the SL system of 15 Pereyaslav-Khmelnytsky streets focused on five main actions:

- Action No. 1: Replacement of existing fixtures
- Action No. 2: Utilization of old lamps
- Action No. 3: Replacement of the control units and arrangement of the dispatching system
- Action No. 4: Replacement of lighting poles and wire, installation of the brackets, fixtures grounding arrangement.
- Action No. 5: Related actions – design works, technical supervision, project management.

The Project includes the replacement of 1 210 old fixtures with mercury lamps by new LED luminaries (including self-regulating dimming system), also modernization of control system and arrangement of dispatching system. Modernization of control system includes installation of the 20 new electrical cabinets with switchers, GSM control units and electrical meters. New input cable from distribution grid is also foreseen in the scope of control cabinets modernization.

The final scope and exact capacity of the fixtures will be defined after completion of the design documentation.

Examples of proposed equipment is presented at the Figure 3.5 below.



Figure 3.5 – Examples of proposed lighting equipment

### 3.2.1. Action No.1 – Replacement of the lighting fixtures

Description of action				
It is proposed to replace existing fixtures equipped with DRL and halogen lamps with new low energy consuming LED fixtures. Dimming system is already included in the cost of every new lighting fixture.				
Fixtures type	Existing power, W	Power after replacement, W	Quantity before, pcs.	Quantity after, pcs.
LED fixtures, 50W	0,065	0,050	22	44
LED fixtures, 140W	0,25	0,140	377	250
LED fixtures, 107W	0,25	0,107	362	303
LED fixtures, 60W	0,25	0,061	221	321
LED fixtures, 40W	0,25	0,042	228	137
All fixtures	-	-	1 210	1 055

Table 3.1 – Proposed lighting fixtures

### 3.2.2. List of streets for lighting modernization

List of the streets considered for lighting modernization was provided by the city. List consist of 15 streets, which have different road categories:

Name of the street	Road category*	Street length**, m	Street width, m	Light centre height, m	Pole distance, m
Bohdana Khmel'nyts'koho St.	A	4 900	9	10	35
Heroyiv Dnipro St.	A	2 000	7	10	35
Novokyyivs'ke shose St.	A	3 000	9	10	35
Pokrovs'ka St.	A	750	7	10	35
Chervonoarmiytsiv Av.	A	1 300	14	10	35
Soborna St.	B	3 100	7	9	35
Skovorody St.	A	800	7	10	35
Shkil'na St.	B	1 800	12	9	35

Name of the street	Road category*	Street length**, m	Street width, m	Light centre height, m	Pole distance, m
Shevchenko St.	B	1 100	7	9	35
Yarmarkova St.	A	2 700	7	10	35
Himnaziyna St.	B	700	7	10	40
Mazepy St.	B	600	7	10	40
Mozhays'ka St.;	B	600	7	10	40
Nebesnoyi sotni St.	B	750	7	7	40
Mykhayla Hrushevs'koho	B	2 900	7	9	40

**Table 3.2 – List of streets proposed for the project**

\* - Road category according to Ukrainian legislation

\*\* - Proposed for the project

**3.2.3. Action No.2 – Utilization of the old lamps**

Description of action	
In general, the existing installed bulbs are mainly DRL type and some of CFL type. Such bulbs are containing hazardous materials, such as lead and mercury. Therefore, such lamps must be properly utilized.	
Quantity, pcs.	1 114

**Table 3.3 – Quantity of lamps for utilization****3.2.4. Action No.3 – Replacement of the control units and installation of the dispatching system**

Description of action	
It is proposed to replace existing control cabinets. New control points must be equipped with new switchers and fusers. Also new metering system will be installed together with GSM modules which allow organization of the dispatching system for easy monitoring and regulation of the street illumination. Proposed LED fixtures will include self-regulating dimming system allowing regulation of illumination level automatically.	
Type of action	Quantity, pcs.
Replacement of the control units	20
Installation of the dispatching system	1

**Table 3.4 – Additional actions****3.2.5. Action No.4 – Supporting actions**

Description of action				
In addition to the fixtures and bulbs replacement, some supporting measures need to be implemented due to long time use of the existing SL system. Number of the lighting poles (lamppost/pillars) are damaged or in some places, pillars are missing, electrical wire is old, deteriorated and does not have proper isolation, brackets are covered with rust. All above mentioned equipment is proposed for replacement. New cable routing including erection kits, grounding of fixtures arrangement is included to the list of supporting measures as part of the project.				
Type of action	Units	No. to dismantle	No. replace	No. to install additionally
SIP electric cable 4x16 mm <sup>2</sup>	km	15	15	-
Cable erection kit	pcs.	2 520	2 520	-
Lighting pole (reinforced concrete)	pcs.	70	70	194
Grounding of fixtures	pcs.	-	1 055	-
Brackets (deinstallation)	pcs.	1 210	1 055	-

**Table 3.5 – Actions not related to energy saving**



It is necessary to implement a number of supporting actions to enable proper operation of the SL system. Such measures include installation of the new lampposts, brackets and fasteners, and reconnection (lopping) of some electrical tree branches and cutting the trees branches where it deemed necessary. Supporting actions regarding every street are included in the project and are further presented in the table below.

Name of the street	Supporting actions					
	Cable replac, [km]	Lighting poles replac./inst., [pcs.]	Brackets replac., [pcs.]	Deinstall. of fixtures, [pcs.]	Replac. of fixtures, [pcs.]	Utilization of old lamps, [pcs.]
Bohdana Khmel'nyts'koho St.	2,5	59	127	254	127	180
Heroyiv Dnipro St.	1	20	124	124	124	124
Novokyyivs'ke shose St.	1,3	30	123	123	123	123
Pokrovs'ka St.	1	0	25	84	25	84
Chervonoarmiytsiv Av.	1	22	44	22	44	0
Soborna St.	0	0	60	60	60	60
Skovorody St.	0,4	8	84	84	84	84
Shkil'na St.	0	100	202	102	202	102
Shevchenka St.	0	0	59	59	59	59
Yarmarkova St.	1,2	25	70	70	70	70
Himnaziyna St.	1	0	20	50	20	50
Mazepy St.	0,8	0	20	46	20	46
Mozhays'ka St.	0,8	0	20	38	20	38
Nebesnoyi sotni St.	1	0	20	37	20	37
Mykhayla Hrushevs'koho St.	3	0	57	57	57	57
<b>Total</b>	<b>15</b>	<b>264*</b>	<b>1 055</b>	<b>1 210</b>	<b>1 055</b>	<b>1 114</b>

\* - Total sum of the lampposts for replacement (194 pc.) together with new (70 pc.) lampposts to install.

**Table 3.6 – Supporting actions for each street**

### 3.2.6. Action No.5 – Related actions

Description of action	
Additional actions that accompany the project throughout different project stages.	
Type of action	Amount
Design documentation development	1
Project management	1
Technical supervision	1

**Table 3.7 – Actions related to a different project stages**

### 3.3. IMPLEMENTATION TIME

Estimated implementation timeframes are shown in the Table 3.88 below.

Activity	2019												2020
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I
Project management													
Procurement													
Design and planning													
Supply and installation													
Technical Supervision													
Start-up and adjustment													

**Table 3.8 – Implementation schedule****3.4. PROCUREMENT**

Procurement of goods and works will be carried using NEFCO rules. It is planned that the entire scope of work of the project (engineering, supply of fixtures, auxiliary equipment and materials, dismantling, installation and commissioning) will be procured in one lot through open tender.

Design and cost estimation documentation will be developed by the winner of the tender with the following state expertise approval.

Design, technical supervision and project management can be procured using local procurement rules, which is acceptable for NEFCO.

**3.5. ORGANIZATION**

The project will be managed by the Consultant - iC consulenten in partnership with Pereyaslav-Khmelnytsky City Council. Project Implementation Unit (PIU) was created prior to the project implementation start and support of the PIU will be carried out by the Consultant. The list of the members of the working group is presented in the Table 3.9.

Name	Representative	Position	Contact phone	Email
T. Kostin	Pereyaslav-Khmelnytsky	Mayor	+38 (04567) 5 23 03; +38 (067) 270 56 64	<a href="mailto:kostintaras@gmail.com">kostintaras@gmail.com</a>
S. Lyovkin	Pereyaslav-Khmelnytsky	External Consultant to City Council	+38 (067) 571 0 315; +38 (063) 553 9 843	<a href="mailto:serge.lyovkin@gmail.com">serge.lyovkin@gmail.com</a>
I. Macsayenko	Pereyaslav-Khmelnytsky	City energy manager and economist	+38 (099) 224 8 133	<a href="mailto:economicsit.i.m@ukr.net">economicsit.i.m@ukr.net</a>
Y. Zharko	Pereyaslav-Khmelnytsky	City financial expert	+38 (04567) 5 18 31	<a href="mailto:mfup@i.ua">mfup@i.ua</a>
M. Chernrtskiy	Pereyaslav-Khmelnytsky	City light department expert	+38 (098) 903 3 759	-
D. Vlasov	iC consulenten	Team leader	+38 (067) 448 18 61	<a href="mailto:d.vlasov@ic-group.org">d.vlasov@ic-group.org</a>
D.Ocheretyany	iC consulenten	Deputy team leader	+ 38 (050) 294 30 44	<a href="mailto:d.ocheretyany@ic-group.org">d.ocheretyany@ic-group.org</a>
I. Omelianenko	iC consulenten	Local procurement expert	+ 38 (066) 509 58 56	<a href="mailto:i.omelianenko@ic-group.org">i.omelianenko@ic-group.org</a>
V. Vyshniakov	iC consulenten	Assistant to energy auditor	+ 38 (095) 130 01 45	<a href="mailto:v.vyshniakov@ic-group.org">v.vyshniakov@ic-group.org</a>

**Table 3.9 – Information about PIU**



#### 4. ENVIRONMENTAL AND SOCIAL BENEFITS

##### 4.1. ENERGY SAVINGS AND EMISSION REDUCTIONS

Energy efficiency in general contributes to reduction of energy consumption and energy related costs, as well as CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and dust reduction. The effects of the implemented measures can also be seen on the amounts of greenhouse gases (GHG) emissions by using emission factors for each specific fuel. The table below presents emissions' reduction, which is calculated using emission factors for each of the GHG and dust, as well as comparison of the baseline and estimated post-renovation emissions.

Parameter	Units of measurement	PRE Project	POST Project	Saving	Net savings UAH/year
CO <sub>2</sub>	tons/a	1 048	216	832	-
SO <sub>2</sub>	tons/a	0,927	0,191	0,736	-
NO <sub>x</sub>	tons/a	0,386	0,080	0,307	-
Dust	tons/a	0,631	0,130	0,501	-
<b>Economic savings</b>					
Electricity	MWh/a	1 310	270	1 040	2 538 000
Savings on O&M	UAH	-	-	-	605 000
<b>Total project saving</b>	<b>UAH</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3 143 000</b>

**Table 4.1 – Total reductions of GHG and energy saving**

##### 4.2. ADDITIONAL BENEFITS

SL is one of the most important systems for safety in the city and keeps cityscape lit at night. It considerably improves safety for drivers, bike riders, and pedestrians. SL provides safety advantages for the car drivers at the road junctions and along the streets and also improves safety for pedestrians, particularly at crosswalks. There are many reasons why SL based on LED lighting are considered to have much more advantages in comparison with the other lighting systems, especially when it comes to street and area lighting. One of the reasons is that they have a higher lighting output and illumination compared to conventional lights. Another advantage is that LED lights are free from hazardous chemicals such as mercury and lead, which makes them environmentally friendly and offers reduced maintenance costs.

Major advantages of the new SL among others include:

- **Safety for the road users**

The new lighting system will improve the quality of SL by a more even distribution of the light along the street. The LED fixtures give the cold white light, which provides better colour rendering and makes streets safer for pedestrians. Also, LED lighting allows drivers to spot the danger from further distances and avoid dangerous road situations and car accidents. LED lights do not need time to warm up, hence they can be switched on immediately and they are better concentrated on the pavement, preventing light escaping upwards. All the mentioned factors tend to improve safety on the roads. In addition, modern control systems can increase

lighting system efficiency and provide better traffic management. LED lighting extends equipment lifetime through dimming.

- **Decrease of the criminal activities**

Better street lighting tends to prevent crime activities. By improving street lighting, a potential offender is supposed to be at higher risk of being noticed by other people while residents are believed to grow in their sense of safety. It is proved that better lighting increases a sense of community and community pride. Proper street lighting makes it easier for police to provide night inspections and city patrolling. Such renovation of the streets also will allow local police forces to redirect more resources to other important tasks.

- **Development of tourism**

Pereyaslav-Khmelnytsky is considered to be one of the oldest cities in Ukraine. First mention of the City dated year 907. The city is famous for its historical and cultural sites, which makes it rather attractive tourist destination. However, the existing street lighting makes it practically unavailable in the dark time of the day. Improved street illumination will encourage more people to walk around at night and will give the possibility to organize evening and night events, which may increase the flow of tourists into the city.

- **Increasing the quality of life**

LED street lighting can be used to promote security in urban areas and to increase the quality of life by artificially extending the hours of proper illumination and therefore increase social activities in the city.

- **Economic activity**

Proper outdoor lighting supports economic growth by increasing the amount of time that people can spend on dining and entertainment during the night time.

## 5. PROJECT COSTS AND PROFITABILITY

### 5.1. COSTS

The specific costs are summarised in the \* - **Numbers for works and total specific cost are rounded due to EUR/UAH conversion**

Table 5.1. A technical contingency of 5% has been added to the total project cost, also the financial contingencies and overheads 5% were considered. The total investment amounts to UAH 16,219 million. Details and specific cost per equipment are provided below.

No	Measure	Unit	Equipment specific cost, UAH	Work specific cost*, UAH	Total specific cost*, UAH	Quantity	Total cost, UAH
<b>Dismantling works</b>							
1	Light fixtures	pcs.	-	270	270	1 210	330 000
2	Poles (concrete)	pcs.	-	470	470	70	33 000
3	Brackets	pcs.	-	160	160	1 210	198 000
4	Electrical wire	km	-	17 600	17 600	15	264 000
<b>Installation works</b>							
1	LED fixtures, 50W	pcs.	5 940	810	6 750	44	297 000
2	LED fixtures, 140W	pcs.	8 250	590	8 840	250	2 211 000
3	LED fixtures, 107W	pcs.	7 590	580	8 170	303	2 475 000
4	LED fixtures, 60W	pcs.	5 940	540	6 480	321	2 079 000
5	LED fixtures, 40W	pcs.	5 940	560	6 500	137	891 000
6	Excavation	m <sup>3</sup>	-	250	250	132	33 000
7	Poles (concrete)	pcs.	4 620	630	5 250	264	1 386 000
8	Brackets	pcs.	825	140	965	1 055	1 023 000
9	Electrical cabinets (control units)	pcs.	46 200	3 300	49 500	20	990 000
10	Electrical wire (SIP-4, 4x16)	km	46 200	17 600	63 800	15	957 000
11	Erection kit	pcs.	132	40	172	2 520	429 000
12	Connection cable	pcs.	116	40	156	1 055	165 000
13	Grounding of fixtures	pcs.	33	30	63	1 055	66 000
14	Dispatching unit (PC, UPS, Software, modem)	pcs.	66 000		66 000	1	66 000
15	Mercury lamps utilisation	pcs.	-	30	30	1 114	33 000
16	Design documentation	pcs.	-	429 000	429 000	1	429 000

\* - Numbers for works and total specific cost are rounded due to EUR/UAH conversion

**Table 5.1 – Specific costs for energy saving measures**

### 5.2. SAVINGS AND PROFITABILITY

In order to meet the European standards and to improve the quality of the street lighting as well as to achieve the reduction of the electricity consumption and to reduce CO<sub>2</sub> emissions, the following measures are supposed be applied:

- Installation of the 1 055 new LED lamps;
- Laying a 15 km of SIP cable lines;
- Installation of 264 new concrete lighting poles;
- Installation of the new dispatching system for the lighting system.

Tariff for electrical energy and currency exchange rate used for calculation are presented in the Table 5.2.

Tariff and exchange rate		
Electricity	2,44	UAH/kWh
Exchange rate	33,00	UAH/EUR

**Table 5.2 – Tariffs and rates**

The savings and profitability, and annual net savings are presented in the

Measures	Scope	Investment	Savings on Electricity		Payback
	Units, m, pcs.	UAH	UAH/a	kWh/a	Years
Replacement of lighting fixtures	1 055	7 953 000	2 538 000	1 040	5,2
Utilization of old lamps	1 114	33 000			
Replacement of the control units and installation of the dispatching system	20+1	1 056 000			
Replacement of poles and wire, fixture grounding arrangement	1	4 884 000			
Project Design Documentation	1	429 000			
Project Management	1	200 000			
Technical Supervision	1	278 000			
Contingency, 10%	-	1 386 000			
Savings on Electricity, MWh/a	1 040				
Energy savings, UAH/a	2 538 000				
Savings on O&M, UAH/a	605 000				
Total project saving, UAH/a	3 143 000				
Total Investment, UAH	16 219 000				
Payback, Years	5,2				

Table 5.3 and Table 5.4 respectively.

Measures	Scope	Investment	Savings on Electricity		Payback
	Units, m, pcs.	UAH	UAH/a	kWh/a	Years
Replacement of lighting fixtures	1 055	7 953 000	2 538 000	1 040	5,2
Utilization of old lamps	1 114	33 000			
Replacement of the control units and installation of the dispatching system	20+1	1 056 000			
Replacement of poles and wire, fixture grounding arrangement	1	4 884 000			
Project Design Documentation	1	429 000			
Project Management	1	200 000			
Technical Supervision	1	278 000			
Contingency, 10%	-	1 386 000			
Savings on Electricity, MWh/a	1 040				
Energy savings, UAH/a	2 538 000				
Savings on O&M, UAH/a	605 000				

Total project saving, UAH/a	3 143 000
Total investment, UAH	16 219 000
Payback, Years	5,2

Table 5.3 – Summary of proposed measures – savings and profitability

Saving components	Existing situation		After implementation		Net savings	
	Quantity	UAH/year	Quantity	UAH/year	Quantity	UAH/year
Electricity, MWh/a	1 310	3 196 000	270	659 000	1 040	2 538 000
Savings on O&M, UAH/a		-		605 000		605 000
<b>Total</b>		-		-		<b>3 143 000</b>

Table 5.4 – Net annual savings

Profitability parameters	Dimensions	Amount
Total investments	UAH	16 219 000
Total project savings, of which	UAH/year	3 143 000
Energy savings	UAH/year	2 538 000
Savings on O&M	UAH/year	605 000
Pay-back period	years	5,2

Table 5.5 – Project profitability

## 6. FINANCING PLAN

The project is financed through NEFCO's Energy Saving Credits Facility. The maximum loan amount is equivalent of EUR 500 000 in local currency. Up to 90% of the project costs can be financed by NEFCO and 10% has to be covered by the city. The currency for the credit is local Ukrainian currency. The loan shall be fully repaid in accordance with Annex 1. The financial plan is presented in the Table 6.1.

Source of financing	Investment	Investment	Share	Interest	Term
	UAH	EUR	%	%	years
NEFCO (NIU)	14 454 000	438 000	89%	3,0%	5,2
Local funding	1 765 000	53 000	11%	-	-
<b>Total</b>	<b>16 219 000</b>	<b>491 000</b>	<b>100%</b>	<b>-</b>	<b>-</b>

Table 6.1 – Financing plan

The detailed financing schedule will depend on the final contracts signed. An estimated schedule and financing distribution of the investments is presented in the tables below.

Activity	Local funding, UAH	NEFCO Amount, UAH	Tranche
Project Design Documentation	429 000	-	I 30%
Equipment	-	4 224 000	
Installation	-	112 200	
Project Management	200 000	-	II 60%
Technical supervision	278 000	-	
Dismantling works and utilization	858 000	-	
Equipment	-	7 418 400	
Installation	-	1 254 000	
Commissioning	-	59 400	III 10%
Contingency	-	1 386 000	
<b>Total</b>	<b>1 765 000</b>	<b>14 454 000</b>	<b>-</b>

<b>Total in EUR equivalent</b>	<b>53 000</b>	<b>438 000</b>	
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**Table 6.2 – Financing plan with tranches**

<b>№</b>	<b>Measure</b>	<b>Total Investment, UAH</b>	<b>NEFCO, UAH</b>	<b>Local funding, UAH</b>
1.1	Replacement of lighting fixtures	7 953 000	7 953 000	-
1.2	Replacement of the control units and installation of the dispatching system	1 056 000	1 056 000	-
1.3	Replacement of lighting poles and wire, fixture grounding arr.	4 884 000	4 059 000	825 000
2	Utilization of old lamps	33 000	-	33 000
3	Project Design Documentation	429 000	-	429 000
4	Project Management	200 000	-	200 000
5	Technical supervision	278 000	-	278 000
6	Contingency, 10%	1 386 000	1 386 000	-
<b>Total</b>		<b>16 219 000</b>	<b>14 454 000</b>	<b>1 765 000</b>
<b>Total in EUR equivalent</b>		<b>491 000</b>	<b>438 000</b>	<b>53 000</b>

**Table 6.3 – Breakdown by measures and financing sources****6.1. SECURITY**

The City guarantees the loan repayment by obtaining the Ministry of Finance approval for local borrowing in accordance with the Procedure for local Borrowings. Decree №110 of the Cabinet of Ministers dated 16.02.2011 Nr.110.

**7. PROJECT RISKS**

The following types of investment risks have to be considered during the project preparation stage:

- The Borrower's risk;
- The Creditor's risk;
- Technological risk;
- Procurement process risk;
- Operational risk;
- Completion risk.

**7.1. BORROWER'S RISK**

The borrower's risk in relation to the specific project is relatively low.

A simple sensitivity analysis has been carried out based on the financial analysis:

- The investment costs will be clearly defined during the procurement process, but there is a margin for some costs' increase in combination with a reasonable profitability;
- Ten percent as an additional contingency is included into the total investment cost.

From the point of view of the Project implementation the Borrower has the following main risks:

## I. Financial risks

### Availability of the financial resources for the loan repayment

Since the project has a long payback period using the energy savings only, it will be necessary to get the City's funds involved for the loan repayment. Without official transfers, the main budget income source is tax incomes; their amount depends on the economic situation in the City and, in general, in the country.

### Project costs overrun

There is a risk of the Project costs overrun, which can be materialized due to the reasons under and beyond the City's control, among which:

- Factors under control of the City:
  - Quality of preparation of the design documents and costs estimate;
  - Quality of preparation and implementation of the tender processes;
  - Control over work implementation by the contractors.
- Factors that are not controlled by the City:
  - Increase of price of materials;
  - Minimal salary growth.

## II. Time

If no due control is imposed by the City (including the technical supervision), as well as the designer's supervision is not properly exercised, a risk of delay in the project works implementation may be materialized.

## III. Quality

The requirements of effective standards and rules shall be met in the course of implementation of any works. If no due control is imposed by the City, (including the technical supervision) as well as the designer's supervision is not properly exercised, a risk of violation of technology and substitution of defined materials can be materialized. Which can lead to the final quality jeopardizing.

## 7.2. CREDITOR'S RISK

Upon the completion of a project, the creditor often becomes dependant on the stable cash flows of the borrower which allow the borrower to service loans.

Future cash flows of the project in municipality depend on standard labour costs, energy costs (i.e. electricity, gas or district heating) and risks associated with settling legal and political issues at the City.

There are few types of major creditor's risks related to the specific project:

- **Operational risk.** Operational risk is a risk associated with the fact that normal current operations do not allow to get a sufficient cash flow to implement the project and service a debt. That is why creditors seek to ensure that the project's operations and maintenance are carried out by an experienced third-party contractor, based on fixed costs. The main question from the creditor's side is whether the

City/municipality has enough experience and resources to manage the project and, if not, whether third parties are able to mitigate the risk of default.

- **Risks associated with the supply of materials and logistics.** Another key creditor's risk associated with the supply of energy and materials to the project. The flow of materials should be guaranteed within the parameters specified in the forecasted technical and financial calculations. In addition, elements such as import and export fees, transportation costs and storage costs may adversely affect the overall cost structure as a whole. These factors should be taken into account in the City's financial calculations to convince the creditor that sufficient cash flows exist and are enough to cover the operating expenses and service debt obligations in accordance with agreements.
- **Risk associated with project partners.** Project partners include contractors, consumers and clients, etc. If any of these parties do not fulfil their obligations, the project may encounter difficulties.  
This can lead to the following potential problems: firstly, there is a potential risk of project default, secondly, the first risk is accompanied by the risk associated with the paperwork, which threatens to turn into costs and loss of time necessary to get out of the current crisis situation.
- **Technological risk.** The technological risk is associated with new untested technologies. Which means that the contractor, at a minimum, must have experience with the technology to be used and provide sufficient guarantee of its ability to service the existing debt to mitigate this risk from the creditor's side.

All of the noticed risks could be considered as low due to:

- Sufficient collateral for the project, supported by the local (municipal) guarantee;
- Proven technologies and materials are proposed to be used in the project;
- The contractors and suppliers will be selected via clear and transparent procurement procedures;
- The maintenance of the newly installed equipment in the buildings is foreseen by the specially trained personnel.

### 7.3. TECHNOLOGICAL RISK

The technological risk can be considered as a low one, because the technologies proposed to be used are well proven. It is recommended to engage turn-key contractors to avoid gaps between different project phases and between different parts of equipment. Nevertheless, part of the work is planned to be carried out by the municipal street lighting company.

Regarding the work itself, the following risks may emerge:

- Noise and vibration;
- Pollution of the surface layers of the atmosphere with fine particles as a result of excavation works;
- Violation of the working regime due to crashes in public transport;
- Possible occurrence of traffic jams;
- Temporary electrical power cuts.



#### **7.4. PROCUREMENT PROCESS RISK**

Procurement risk may appear in case of no proposal is available from potential contractors or qualification of the tenderers is not sufficient for implementation of the planned scope of works. To mitigate this risk prior to commencement of the tender procedure it is necessary to find highly qualified contractors with experience of similar works implementation and inform them on the potential tender.

#### **7.5. OPERATIONAL RISK**

Operational risks are concentrated around the performance of the project in comparison with the planned economic and technical parameters. These risks are important as their occurrence can cause a reduction of cash flows generated by the project, which has direct impact on the project's economic indicators.

The following risks may apply to the project:

- Technology components are not interoperable;
- Technology components lack stable operation;
- Technology components are not reliable;
- Technology causes system outages;
- Components are not maintainable.

This risk is supposed to be considered as rather low due to high quality of proposed equipment for the installation.

#### **7.6. COMPLETION RISKS**

The following risks may apply to the project:

- Failure to complete on time;
- Failure to complete within the budget and scope;
- Failure to bring into the operation;
- Failure to pass the completion test.

This risk can be mitigated by qualified technical supervision and regular monitoring of the whole implementation process by the Consultant.

**8. ANNEXES****8.1. ANNEX 1 – REPAYMENT PLAN**

The first interest repayment will take place in December 2019. The repayment period of the loan starts in September 2020.

Instalment No.	Date	Disbursement	Instalment	Outstanding	Amounts of days	Interest 3%	Total
	16.09.2019	4 336 200		4 336 200			
	15.11.2019	8 672 400		13 008 600	60		
	15.12.2019				30	53 460	53 460
<b>2019</b>		<b>13 008 600</b>			<b>90</b>	<b>53 460</b>	<b>53 460</b>
	20.01.2020	1 445 400		14 454 000	36		
	15.03.2020			14 454 000	55	103 831	103 831
	15.06.2020			14 454 000	92	109 296	109 296
1	15.09.2020		903 375	13 550 625	92	109 296	1 012 671
2	15.12.2020		903 375	12 647 250	91	101 351	1 004 726
<b>2020</b>		<b>14 454 000</b>	<b>1 806 750</b>	<b>12 647 250</b>	<b>366</b>	<b>423 774</b>	<b>2 230 524</b>
3	15.03.2021		903 375	11 743 875	90	93 555	996 930
4	15.06.2021		903 375	10 840 500	92	88 803	992 178
5	15.09.2021		903 375	9 937 125	92	81 972	985 347
6	15.12.2021		903 375	9 033 750	91	74 324	977 699
<b>2021</b>			<b>3 613 500</b>	<b>9 033 750</b>	<b>365</b>	<b>338 654</b>	<b>3 952 154</b>
7	15.03.2022		903 375	8 130 375	90	66 825	970 200
8	15.06.2022		903 375	7 227 000	92	61 479	964 854
9	15.09.2022		903 375	6 323 625	92	54 648	958 023
10	15.12.2022		903 375	5 420 250	91	47 297	950 672
<b>2022</b>			<b>3 613 500</b>	<b>5 420 250</b>	<b>365</b>	<b>230,249</b>	<b>3,843,749</b>
11	15.03.2023		903 375	4 516 875	90	40 095	943 470
12	15.06.2023		903 375	3 613 500	92	34 155	937 530
13	15.09.2023		903 375	2 710 125	92	27 324	930 699
14	15.12.2023		903 375	1 806 750	91	20 270	923 645
<b>2023</b>			<b>3 613 500</b>	<b>1 806 750</b>	<b>365</b>	<b>121 844</b>	<b>3 735 344</b>
15	15.03.2024		903 375	903 375	91	13 514	916 889
16	15.06.2024		903 375	0	92	6 831	910 206
<b>2024</b>			<b>1 806 750</b>	<b>903 375</b>	<b>183</b>	<b>20 345</b>	<b>1 827 095</b>
<b>Total</b>		<b>14 454 000</b>	<b>14 454 000</b>		<b>1 734</b>	<b>1 188 327</b>	<b>15 642 327</b>

Table 8.1 – Repayment plan

**8.2. ANNEX 2 – REQUIREMENTS FOR LED LIGHTING FOR THE OUTDOOR LIGHTING**

Specifications	Fixtures for illumination of highways
1. Operating voltage, V	230 (175 ÷ 260)
2. Overvoltage protection	Overvoltage protection is at least 4 kV
3. Power consumption, W	Expected power 40 and 120 W
4. Colour temperature, K	4.500 ÷ 5.000
5. Power factor, not less than	0,95
6. Working temperature, C°	-40 ÷ +50
7. Light efficiency of the lamp, lm/W	Not less than 110
8. Light flux, lm	4 400 (for 40 W)

	13 200 (for 120 W)
9. Level of protection, not less than:	IP 65
- luminaire	
- electrical compartment	IP 65
10. Curve of force of light in a longitudinal plane	According to the technical calculations
11. Colour rendering index, not less than	70
12. Unit of lightning protection, up to, kV	10
13. Minimal operation time, hours	50 000
14. Warranty period, not less than, years	5
<b>Requirements to the design</b>	
15. Method of fixing the luminaire	Console, to pillar Ø42-60 mm
16. Material of the casing of the radiator	Aluminium alloy of high thermal conductivity GOST 4784-97 or analogue
17. Requirements for heat exchange	The radiator housing cannot be located in an additional housing
18. Requirements for protection against damages of the luminaire	The light-generating elements (LEDs and optical elements) must be protected from external factors including the mechanical damage by means of tempered glass (resistance to impact IK-08)
19. Requirements for safety of construction	Fixtures must meet the requirements of DSTU EN 60598-1: 2014 and DSTU EN 60598-2-3: 2014.
20. Requirements for electromagnetic compatibility	Fixtures must meet the requirements of DSTU EN 55015: 2014, DSTU EN 61000-3-2: 2015, DSTU EN 61000-3-3: 2014, DSTU EN 61547: 2014
21. The design and mechanical strength of the luminaire must provide stability to the external influences, safety in accordance with the requirements for operation and maintenance of performance without changing the lighting parameters, which is confirmed by the product's passport.	
22. Structural elements of fixtures, including mounting elements, should have corrosion resistance during the operation and storage due to the use of galvanic protective and decorative coatings.	
23. Documentation:	<ul style="list-style-type: none"> <li>• Mandatory presence of any manufacturer's certificate ISO 9001, UkrSepro;</li> <li>• Compliance of the fixtures with the technical conditions must be confirmed by protocols of measurements of technical parameters, certificates or other relevant documents in accordance with the current national standards of Ukraine, which is confirmed by the copies of declarations of conformity with the requirements of the technical regulation of low-voltage electrical equipment;</li> <li>• Fixtures must have protocols of tests of the accredited centre on the conformity of LED luminaires in accordance with all applicable norms of Ukraine.</li> </ul>
24. Fixtures shall have contact terminals and flexible cables for connecting to the busbar	
25. Availability of the documented experience of the exploitation of the fixtures of this manufacturer, the presence of positive reviews.	

**Table 8.2 – Requirements for LED lighting for outdoor lighting**

All lighting fixtures should be able to have a dimer regulation in future (in case the City will be able to implement high-level SL management electronic system after implementation of the project, which is referred in this business plan).

The implementation of the Project should correspond to the approved programs and policy documents. In particular, the contractor should implement Project within the framework of the following programs and legal acts:

- Resolution №992 of Cabinet of Ministry of Ukraine since 15th of October 2012. "On Approval of Requirements for LED Lighting Devices and Electric Lamps Used in AC Lights for Lighting";
- DBN B.2.5-28:2018 "Natural and artificial lighting";
- DSTU EN 60598-1:2017 "Fixtures. Part 1. General requirements and tests";
- DSTU EN 60598-2-3:2014 "Fixtures. Part 2-3. Additional requirements. Fixtures for illumination of streets and roads";

- GOST 8045-82 "Fixtures for outdoor lighting. General specifications";
- DSTU Б В.2.2-6-97 "Buildings and structures. Methods of measuring the illumination";
- DSTU 4809:2007 "Insulated wires and cables. Fire safety requirements and test methods";
- DSTU EN 60332-1-1:2016 "Fire testing of electrical and fibre optic cables. Part 1-1. Testing of vertical flame spreading of a single insulated wire or cable. Equipment (EN 60332-1-1:2004/A1: 2015, IDT). Amendment No. 1: 2016";
- A.3.1-5:2016 "Organization of construction production";
- PUE. "Rules for the installation of electrical installations (2017)";
- DSTU 3587-97. "Road traffic safety. Automobile roads, streets and railway crossings. Requirements for operating condition";
- Law of Ukraine "On Improvement of Municipal Settlements".

### 8.3. ANNEX 3 – HAZARDOUS WASTE

Dismantled fluorescent and mercury lamps are hazardous waste of the I-grade of danger and are subject to mandatory recycling by companies duly licensed in treatment of hazardous waste under Ukrainian legislation.

The solution may be the following:

The Municipality or the contractor performing the replacement should conclude an agreement with an appropriate Environmental Services Subcontractor for disposal of mercury lamps, which will be dismantled within the Project.

The Environmental Services Subcontractor should collect and transport all lamps to a Final Performer contractor that will make the final processing of the lamps. The Environmental Services Subcontractor should have all proper equipment and documentation to perform the contract such as:

- Licenses for collection, transportation and storage of hazardous waste;
- Availability of special transport;
- Availability of special containers for storage of hazardous waste;
- Agreement with Final Performer contractor as well as the licenses and the permits;
- Provision of the certificate (act) on disposal of lamps;
- Provision of the information on equipment, which utilizes lamps with mercury.

The Final Performer (contractor) of utilization is an industrial enterprise (plant) which directly disposes hazardous waste, has all the working equipment to perform the recycling and permissions to do so. Usually this equipment is used for thermal removal of mercury from fluorescent lamps in the process of destruction in vacuum with subsequent capture of mercury vapours by condensing with liquid nitrogen.

The Final Performer (contractor) should confirm and declare that it is acceptable for NEFCO representatives to visit the site/plant where recycling of lamps (removal of mercury) is performed for check-up.

The Environmental Services Subcontractor should provide certificate (act) on disposal of lamps and confirmation provided by the Final Performer (contractor) that all lamps, which have been removed under the Project are disposed properly (destroyed in a proper manner).

The Environmental Services Subcontractor and the Final Performer (contractor) can be one company if such company can prove to possess all documents, permissions, transport and equipment.

If the City decides not to get rid of lamps dismantled as described above, but wants to use them in other public buildings, proper dismantling and controlled storage shall be carried out, with the provision of records and evidence materials, like acts etc.

## 8.4. ANNEX 4 – PRELIMINARY PROCUREMENT PLAN

No.	Project	Coding of bid	Description	City co-funding, UAH	Loan funds , UAH	Procurement method	Disbursements																	
							Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual		
							Tender invitation		Tender opening		Contract award		Conclusion of contract		Start of works		Tranche 1		Tranche 2		Expected contract completion		Tranche 3	
1	Pereyaslav-Khmelnitskiy	PKh-L1	Turnkey reconstruction of street lighting system	1 287 000	13 068 000	Open tendering (turn-key contract)	not later than in 7 days after TD obtained no-objection	-	45 days since Tender invitation	-	45 days after tender opening	-	14 days after contract award	-	14 days after conclusion of contract	-	28 days after the contract concluded	-	appr. 4 months after 1st* tranche received and upon confirmation of usage of the first tranche	-	4 months after 2nd tranche disbursement	-	21 days after contract completion*	-
2			Project Management	200 000		Local Competitive Tendering																		
3			Technical supervision	278 000		Local Competitive Tendering																		
4			Contingency, 10%		1 386 000																			
			TOTAL	1 765 000	14 454 000																			

Table 8.3 – Preliminary procurement plan