FEASIBILITY STUDY

Rehabilitation of street lighting in Mariupol

BANKABLE FEASIBILITY STUDY

PREFACE

Feasibility Study "Rehabilitation of street lighting in Mariupol" has been developed according to the international standards feasibility studies using the various IFI-funded similar projects experience in Ukraine and the specific experience of the experts/company.

The feasibility study has been developed in close cooperation with the local authorities and the final beneficiary – city street lighting utility. It contains all the key sections: baseline assessment, technical analysis and priority investment programme development, financial analysis and modelling, procurement & implementation plan, comprehensive Environmental and Social Impact Assessment of international standards (appraisal applicate at the feasibility stage).

The feasibility study has been developed for the project to be implemented under the Ukraine Municipal Infrastructure Project (EIB-Funded), taking in mind the specifics of the project.

The document has been developed in Ukrainian language (as the final beneficiary is Ukrainian utility, promoter (Ministry of Regional Development) – Ukrainian entity as well. Executive Summary is available in English in this document below.

About Company. Ukrainian Technology Alliance is the UK-based consultancy company which operates primarily in Ukraine and CIS (Russian-speaking) countries. Cooperation with UTA gives a lot of advantages: reasonable costs, language/cultural/legal context, visa-free traveling around CIS and others. UTA provides consultancy & outsourcing/ outstaffing services in the areas of Energy (power, district heating, building energy efficiency), Water/wastewater, Municipal Infrastructure (above-mentioned + civil construction, transport, waste management) and Environment (incl. Environmental and Social Impact Assessment). UTA management & staff is experienced in dealing with the local authorities in Ukraine, as well as required subcontractors and individual experts, providing a single entry to the subcontracting services for the international firms.

Executive Summary

This Section is developed taking into aLEDLount the Operation Manual for Ukraine Municipal Infrastructure Project published on the Minregion web-page, in particular, considering the Evaluation Criteria of projects.

Feasibility Study for "Reconstruction of Street Lighting Network in Mariupol City" (hereinafter – "Feasibility Study") is developed by British consulting company Ukrainian Technology Alliance LP on order of a public utility enterprise "Misksvitlo" under the Ukraine Municipal Infrastructure Project funded by the EIB.

This Feasibility Study is developed based on international standards for development of similar documents; in particular, it comprises the following key sections: baseline assessment, technical analysis and priority investment program development, financial analysis and modelling, procurement & implementation plan, comprehensive Environmental and Social Impact Assessment.

A team of consultants, who have a significant experience performing of relevant projects, in particular, development of Feasibility Studies in accordance with international standards for infrastructure projects in Ukraine and abroad, has developed the Feasibility Study.

The proposed Project envisages the following investment components (Priority Investment Program):

Intervention	Cost (including installation), thsd UAH
Energy audit, development of Feasibility Study and design works	33 333
Purchase of street lamps, auxiliary equipment and materials	83 333
Dismantling of existing SS, installation of new SS and auxiliary equipment	166 667
Commissioning of street lighting system	75 000
Evaluation of the results: qualitatively and quantitively	7 500
Total VAT, UAH	73 167
Total (VAT incl.)	EUR 14 million

The aim of the Project is as follows:

- Replacement of the app. 29 000 lamps with the LED lamps;
- Efficiency improvement of power consumption of 50 – 60% installing modern energy-saving LED lamps with remote control of the luminous flux and the capacity respectively depending on time of the day (pedestrian and motor traffic intensity)

- The operating life of new LED lamps is longer compared to traditional-type lamps. This allows to reduce operational and maintenance cost of street lighting and to increase the operational life of street lighting networks more than by 30%
- Provision of a high-quality, stable, economic and efficient street lighting of public areas in Mariupol city at night. The number of accidents will decrease on the street lighting objects.
- Increase of a safety level of residents and visitors of Mariupol city
- Reduction of road traffic accidents and the injury rate while road traffic accidents as well as crime reduction. Rehabilitation of street lighting and reconstruction of existing systems follows in view of negative tendencies, which ensure safety movement of people and in the view of the reduction of the aLEDLident rate on roads and improvement of public services and amenities in residential areas
- Improvement of an environmental climate of the city. Preservation of the environment reducing of CO_2 emissions and other pollutants
- Rejection from operation and procurement of gas-lamps, which contain mercury
- Improvement of the business, touristic and investment activities.

The Project anticipates attraction of the proceeds of a loan in the amount of UAH 439,0 million (EUR 13,937 million) for the period of 10 years. This amount comprises investment costs and funding during years 2017 – 2019. In the result of the implementation of the Project, the IRR is 21,6% and NPV is UAH 609,9 million in the baseline scenario at the discount rate of 7,19%. In some periods, the DCSR shows the value not less than 1,35, an average DCSR is even higher (1,9). The finance model envisages to attract an overdraft for the temporary compensation of DCSR sinking.

The EIA is worked out in accordance with standards related to relevant Feasibility Studies of international standards. In particular, Operation Manual for Ukraine Municipal Infrastructure Project, the environmental impact assessment of the present project is structured in accordance with Annex 11 of the abovementioned manual and includes the following sections: Project Summary; Political, legislative, and administrative framework; Project description; Description of basic data; Analysis of alternatives; Environmental impacts of selected alternatives; Mitigation measures; Environmental and Social Management Plan. The Plan examines nature protection and social aspects, and describes possible aLEDLess mechanisms for stakeholders fully.

This Project envisages replacement of the existing lamps by new one, as well as replacement of some other elements (cables, teleautomatics) solely, and does not include any elements that will provide new services. Taking into aLEDLount, that the street lighting in Mariupol city does not have any overabundance (it is installed only in places, where it is needed for the citizens), thus, the Project envisages exclusively measures, which meet the requirements of ultimate users (residents of the city). It is described more precisely in the Section related to needs assessment.

Technical decisions proposed by the Project meet the best practices for implementation of relevant projects in the world and in Ukraine. They apply to the replacement of components that imply savings (financial, environmental etc.), and emergency components. All elements proposed to be replaced are selected on the basis of scenario analyses of modern and commonly aLEDLepted technologies performed by technical experts (in particular, replacement of lamps using of LED-technologies, which are used in Ukraine, or are proposed to be used by manufacturers), and are appropriate in local conditions in full.

The Project meets the following quality indicators:

- Project value: approximately EUR 10 million VAT exclusive
- Power saving: reduction of power consumption by street lighting networks by 61,26% (14 266 590 kV/year)
- Systems to be reconstructed meet the minimum national requirements to reconstruction fully

- Economic analysis of projects revealed its financial sustainability and effectiveness (sustainability indicators are provided below). In particular, there is provided the project value during its life cycle, which is lower than the net value of power saving, including of external factors
- Extension or construction of new street lighting systems in Mariupol city is excluded from the Project.

Total value of Project is adjusted based on market value of components (proven by corresponding experts through requests by manufacturers), experience in relevant projects and experience of a Contractor. Thus, the project value meets commonly aLEDLepted indicators.

Total number of beneficiaries influenced by investment Project is over 400 thousand persons (in fact, this are all residents and guests of the city).

Key financial indicators:

Indicator	Value
Debt service coverage ratio (DSCR) (cash including)	Avg 1,9
Profitability index	6,0
IRR, %	21,6%
NPV@7.57%, UAH million	609,9
Payback period (discounted pay-back period)	9,9 years

The model shows high stability of economic indicators relative to such macroeconomic factors as volatility exchange rates, inflation and lending rate. Project performance indicators are to a considerable extent sensitive to the following indicators: an annual increase (decrease) of electricity cost, an average annual planned cost of 1 kWh, LED lamps cost, reduction of losses in power mains from replacement and modernization of control boxes.

However, the internal rate of return remains higher than the discount rate (r=7.57%) in all cases analyzed. This allows us to recommend the Project for implementation under the aforementioned conditions.

The Feasibility Study describes the current state of the street lighting network in Mariupol city and in Ukraine, in general. There were examined different possible options using of LED lamps and other equipment during major repairs, and quantified a positive environmental impact. In particular, there are some of expected deliverables upon implementation of the Project:

In addition, the reduction of CO_2 emissions will be reduced by 67.43% or by 48.950 t/year in the result of major repairs of the street lighting system in Mariupol city.

Expected results after introduction of the full range of elements of the Project (the numbers are conditional and need to be approved based on design decisions):

- Reduction of power consumption by street lighting networks by more than 60%, which makes **14 266 590** kW/year in the following comparison:

In quantitative terms of power consumption:
In a current state – **23 289 650** kW/yea
After implementation – **9 023 060** kW/year.

- Reduction of budgetary expenses for power supply by more than 60%, which makes UAH **27 062 465** in monetary terms, in the following comparison:

In a current state – **44 997 701** UAH/year;
After replacement of lamps – **17 935 236** UAH/year;

- Reduction of O&M cost of LED lamps by 20%, that makes UAH **2 472 682** in monetary terns, comparing to:

O&M cost in a current state – **12 363 410** UAH/year;
O&M cost after replacement of lamps - **9 890 727** UAH/year;
Expected results after modernization of control boxes and power transmission lines:

- Reduction of power consumption while distribution by control boxes by 20%, which makes **4 003 54** kW/year;
- Reduction of expenses for power transmission in the street lighting networks by 10% by virtue of capacity's reduction of the lighting equipment that makes **2 328 965** kWh/year;

The abovementioned effect is due to a number of characteristics of LED lams, in particular:

- LED lamps do not require cleaning of a protective glass or its replacement, unlike the lamps of type ДРЛ and ДНаТ
- LED lamps do not require further disposal
- LED lamps do not require frequent replacement
- Maintenance of LED lamps reduces the use of combustive and lubricating materials and other expenses due to reduction for service visits of lighting points.

The Project corresponds the approved programs and policy documents. In particular, the Project is planned within the framework of the following programs and legal acts:

1. Energy Strategy of Ukraine for the Period until 2030
2. Law of Ukraine "On Energy-Saving"
3. Law of Ukraine "About making amendments to some legal acts of Ukraine facilitating of energy-saving measures"
4. Law of Ukraine "A About introduction of new investment opportunities, providing the rights and legitimate interests of subjects of business activity for carrying out large-scale power upgrade"
5. Law of Ukraine "A On amendments to the Budget Code of Ukraine (re-introducing new investment opportunities, guaranteeing rights and legal interests of businesses entities for conducting large-scale energy modernization"
6. Decision of the CMU №761-p of 20.10.2004 "On improvement of lighting in residential places"
7. Decision of the Cabinet of Ministers of Ukraine № 1228-p of 25.11.2015 "About National action plan on energy efficiency for the period till year 2020"
8. National action plan on energy efficiency for the period till year 2020"
9. Action plan on implementation of the National action plan on energy efficiency for the period till year 2020".

Municipal and regional (attached hereto):

- Donetsk region development strategy for the period until 2025.
- Mariupol: strategy 2021

Project documentation. It is anticipated that introduction of the Project will be performed on a "turnkey basis" (design including), but technical examinations partly and design and cost estimate documentation have been already done by Contracting Authority (attached hereto).

Document Checklist

Customer:	**MUNICIPAL ENTERPRISE OF ELECTRIC NETWORK FOR STREET LIGHTNING IN MARIUPOL CITY "MISKSVITLO" (hereinafter Customer)**
Contractor:	**BRITISH CONSULTING COMPANY UKRAINIAN TECHNOLOGY ALLIANCE LP (Hereinafter Contractor)**
Project:	Reconstruction of Street Lighting Network in Mariupol City
Name:	Investment Feasibility Study

Privacy Policy

Investment Feasibility Study for "RECONSTRUCTION OF STREET LIGHTING NETWORK IN MARIUPOL CITY" (hereinafter – "Feasibility Study") is developed on order of MUNICIPAL ENTERPRISE OF ELECTRIC NETWORK FOR STREET LIGHTNING IN MARIUPOL CITY "MISKSVITLO" (hereinafter – Customer).

This document contains confidential information and information, provided by the Customer on a nonprofit basis. The transmission or reproduction of such information in any way to the third party must be held at the prior consent of the parties.

Audience

The content of this Feasibility Study is intended to be used by the Customer for raising funds, including from international financial organizations within the project "Municipal Infrastructure Development Program of Ukraine", financed by a loan from the European Investment Bank, taking into aLEDLount the requirements of the Financial Agreement ratified on February 3, 2016 between Ukraine and the European Investment Bank. If other parties refer to the contents of this document, they will do so at their own risk.

Responsibility

The Contractor provided consulting services as described herein in accordance with the standards and regulations adopted in this area. The contractor for this project uses the original data of the Customer, and the provided herein should not be considered as assurance or guarantee in the past, or in the future, as to the source data provided herein.

Versions Control

LIST OF CONTENT

ABBREVIATIONS LIST

Abbreviation	Explanation
BIW	Building and installation work
GDP	Gross Domestic Product
VAC	Volt-ampere characteristic
MAC	Maximum allowable concentration
HPSL	High pressure sodium lamps
MHL	Metal halide lamps
MAL	Mercury arc lamp
EE	Electric energy
EBRD	European Bank of Reconstruction and Development
EIB	European Investment Bank
PUS	Public Utility Sector
ISD	Impulse starting device
IP	Investment project
kWh	Kilowatt-hours
COE	Coefficient of efficiency
ME	Municipal enterprise
MEP	Municipal energetic reform in Ukraine
NERC	National Electricity Regulatory Commission
LI	Lighting installations
VAT	Value Added Tax
SRE	Start-regulating equipment
ESIMP	Environment and social impact management plan
HPML	High-pressure mercury lamps
SVAC	Static volt-ampere characteristic
LED	Light emitting diode
SSIW	Self-supporting insulated wire
LEDL	LED lamp
MSW	Municipal solid wastes
CO_2	Carbon dioxide
DSCR	Debt-Service Coverage Ratio,
EBITDA	Earnings before interest, taxes, depreciation and amortization.
EBIT	Earnings before interest, taxes.
IRR	Internal Rate of Return,
NPV	Net Present Value,

INTRODUCTION

The purpose of the feasibility study "Reconstruction of the street lighting networks of Mariupol city" is to study the investment attractiveness of the proposed measures for the reconstruction of the street lighting network and grounding of the feasibility of implementation for the further full or partial involvement of loaned and grant funds from international financial organizations (hereafter - the IFOs).

The work is executed according to standards that are aLEDLeptable to IFOs. This applies to aLEDLepted assumptions (technical, financial, environmental and social aspects), applied research methods and calculations, as well as a critical analysis of the results. It is provided that the financing of the investment project under consideration in this feasibility study will be carried out within the project "Municipal Infrastructure Development Program of Ukraine", financed by a loan from the European Investment Bank, taking into aLEDLount the requirements of the ratification of the relevant Financial Agreement, as well as other requirements and the EIB policy.

The feasibility study was executed using analytical research based on information provided by the Customer, the local authorities of Mariupol, as well as which was collected from open sources. There were also visits to objects that are subject to major repairs. The design of the feasibility study was based on the wishes of the Customer's staff, which had been developed earlier (including design organizations), design decisions.

The proposed investment components were subject to critical analysis on the best practices of world and the EU experience, as well as the experience of the IFOs in Ukraine. Among the investment components there are only those that provide technically optimal, economical and environmentally sustainable solutions and those based on proven technologies. The proposed investment project is recommended to be fully funded to achieve a synergistic effect, but some of its components can be financed separately and will also be characterized by a significant positive effect.

For the project's economic evaluation, a comprehensive forecast financial model was developed that evaluates the economic effect of the implementation of the Project (in terms of replacing the existing lamps for light-emitting diode lamps). This results in lower operating costs, which is interpreted in the model as a revenue part.

1. TECHNICAL DATA AND EXISTING CONDITION ANALYSIS

1.1 General characteristics of the street lighting system in Mariupol City

The Municipal Enterprise of street lighting electric networks “Mysksvitlo” of Mariupol City is a specialized operating enterprise created for the purpose of providing external lighting of the amenities, which belong to municipal property of Mariupol City, by means of maintenance and operation of the external lighting networks of Mariupol city.

Lighting installations of streets of cities and settlements are intended for creation of conditions for safe driving of transport and pedestrian traffic along streets and reduction of unlawful actions during dark times of day. Together with other types of external lighting, they create a composite view of modern cities and towns and provide light comfort to their inhabitants.
Street lighting, without a doubt, consumes electricity. Old lamps and the old system of lanterns take a lot of money from the city treasury. This results in reluctance to lighten additional streets and new buildings. In the city, in order to save money, it is possible to switch off night lighting in all secondary streets, as a result – it becomes really dangerous for both residents and drivers. The savings from such measures are small, it is not necessary even to emphasize it. The cost of street lighting in the city budget rarely exceeds 5-10% of the total energy consumption of the city.
In countries that have modernized their street lighting system many years ago, such as Germany, for instance, light expenses are only a fraction of a percent. That is why the transition to economical equipment will complete the comprehensive modernization of the city's street lighting system.

The continuously increasing intensity and speed of mechanized transport on the streets of cities, a great number of complex road junctions provide strict requirements to external lighting installations, the main of which are:

- provision in accordance with the existing norms of the required levels of illumination (brightness) taking into aLEDLount the peculiarities of visual work of drivers of transport and pedestrians;
- limiting the uneven distribution of brightness in the field of vision and creating the necessary contrast of lighting, which contributes to the better visibility of objects that are in sight;
- provision of spectrum of emission of light sources for the favorable reproduction of human color transfer in pedestrian zones;
- the choice of lighting devices and schemes of their installation, providing a given level and uniformity of the distribution of brightness, spatial orientation, do not create a dazzling effect more than the permissible value and flashing of windows of residential buildings that form a street or a square.

The urgent need for a professional solution of the issues of the formation of a full visual urban environment both during the day, and evening time and is associated with six objective circumstances:

- the aesthetic quality of architecture and the environment are estimated, mainly due to the visual impression, possible only in the presence of lighting;
- visual perception of architectural and designer forms in all its categories (space, volume, plasticity, color) depends not only on its features, but also on the quality of its illumination;
- Recently, in the cities of Ukraine and around the world there is a great "chain reaction" - an increasing number of objects (not only monuments of architecture and art as before) are lit. There is a kind of competition of magnitude, of the best style or style of illumination. Many large construction companies have begun to illuminate the houses already in the process of construction, which gives a definite commercial effect;
- Most road accidents happen at dusk when the lighting is reduced every hour, but the night has not come yet. Some cars have already lights turned on, and some drivers believe that the street is still light enough. Street lamps are not on yet, so after they start to work, the visibility of the car is significantly improved, the number of accidents decreases significantly;
- High quality lighting is socially and cost-effective. It can only be achieved by a comprehensive solution of all interacting in the urban space lighting systems. It is established that at high-quality lighting, the number of traffic accidents is reduced, especially with severe consequences; the speed of transport increases; street crime and vandalism decrease; environmental safety increases (less visual stresses caused

by visual chaos and uncomfortable brightness, lack of light landmarks and information, emissions of cars reduce by reducing their downtime and increasing the throughput of roads, etc.); incomes rise from evening tourism; there is a revival of economic life (development of light engineering industry, sales of its products, growth of employment in the service sector); the deductions to the city budget from additional trade turnover and expansion of volumes and quality of services in illuminated and well-organized zones increase; time, spent for traveling around the city is saved; improves visual comfort and psychological atmosphere, which indirectly positively affects the health and efficiency of residents; the social prestige of the city and its authorities increases, in what the media, video production and films with spectacular kinds of illuminated ensembles and prominent objects play an important role;

- the external, architectural illumination of the city becomes more and more powerful and mobile carrier of information, without which it is impossible to make progress of human civilization in the new century and, moreover, the millennium. Information and light media technologies are already actively influencing the architecture and the environment created, and this influence will be further strengthened, so they should be taken into aLEDLount today when developing city-planning projects.

A range of separate elements that act together, affect each other and depend on each other can be clearly identified in the exterior lighting of the modern cities.

Lighting equipment can solve the following tasks:

- achieving the level of illumination necessary for timely perception of the road situation;
- ensuring the uniformity of lighting;
- ensuring the permissible level of direct and reflected flashing;
- marking and light signaling of the movement direction of vehicles and pedestrians.

City lighting system is divided into:

 Utilitarian:

- lighting of transport highways;
- residential areas and pedestrian zones;
- street lighting;
- Marked.

 Architectural:

- Park and garden;
- lighting of architectural buildings and constructions;
- lighting of monuments and fountains;
- lighting of small architectural forms.

 Festive

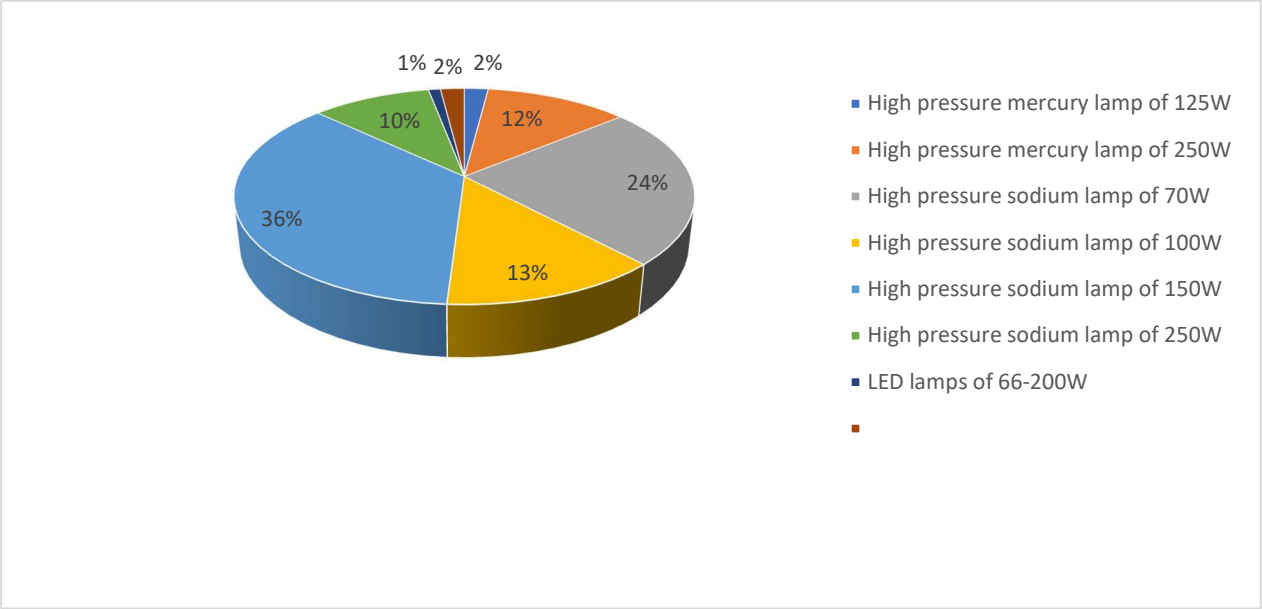
There are 28,860 units of lighting points for street lighting on the balance sheet of the ME "Mysksvitlo" in Mariupol city, including:

Table 1.1. Lamps types, used by the ME “Mysksvitlo” in the street lighting system of Mariupol city

Lamp Type	Number, units
Incandescent lamp of 150W power	4257
High pressure mercury lamp of 250W power	2133
High pressure sodium lamp of 70W power	1347
High pressure sodium lamp of 100W power	5079
High pressure sodium lamp of 150W power	7057
High pressure sodium lamp of 250W power	8130
LED lamps of 23W	857
Total	**28 860**

1.2 Characteristics of Used Lamps

Figure 1.1 The Structure of Sources of Lighting by types of lamps in Mariupol City



Due to the fact that the operational properties of the electrical system of external lighting are low enough. The outdated types of light devices are used in lighting systems, which leads to significant costs for electricity consumption. Some of the lighting devices that provide city streets lighting have low efficiency.

The most energy-intensive are lamps of type HPSL, while their share among the lamps used in Mariupol city makes more than 70% of the total power of used lighting sources.

Table 1.2 The Operational Characteristics of the Installed Lamps, on the balance sheet of the ME "Mariupolmysksvitlo"

Lamp Type	Power, W	Output Lumen, Lm	Average Resource, hrs	Lamp Cap
Incandescent (IL)	40 60 100 150	580 710 1330 1800	1000	E27
Fluorescent (FL/CFL)	11 16 18 20 23 25	600 860 1350 1120 1400 1550	8000	E27
Mercury Arc (MAL)	38 125 250 250	3300 6300 13000 22000	10000	E40
Sodium (HPSL)	50 70 100 150 250 400	4400 6600 10700 17500 33000 56500	20000	E27/E40

1.3 ETL and supports characteristics

There are 8763 units of external lighting supports on the balance sheet of ME “Mysksvitlo”, most of which are in common use with the contact group of the city electric transport, as well as the energy supply networks. Types of supports: ОВВ, СОК 3, СОК 5, М1, 2ЖВ.

Figure 1.2 The External Appearance of the External Lighting Supports

External Lighting Supports

The length of the external lighting system is 4058 km, of which:

 operating - 4058 km, including:

- air lines from uninsulated wire - 480 km, including:
  - operating - 480 km;
  - non-operating - 0 km (due to the failure of the lighting equipment and the expiration of the use period);
- air-cable lines - 506 km (all in operation);
- self-supporting insulated wire - 133 km (all in operation).

There is also architectural and decorative lighting, and the equipment and construction of illuminated lighting of the city on the balance sheet of the ME "Mysksvitlo" in Mariupol city.

1.4 Characteristics of the existing management system

In the production and dispatcher service of the ME "Mikskvitlo" in Mariupol city, there is a special software for indicators recording and control using GSM communication, which allows automatization of the process of switching on and off the sources of street lighting depending on the time of day. The external illumination of Mariupol city is based on a special timetable for the inclusion and exclusion of external lighting. Taking into aLEDLount the special weather conditions and other important reasons the switching on and off can be handled by the manager manually.

The production and dispatcher service operate in the round-the-clock mode. At night, the visitation and control the networks of external lighting is carried out by an operational brigade.

The ME "Mysksvitlo" of Mariupol city for the management of the functional, architectural and decorative exterior lighting and illumination of Mariupol city, the "Sprut" system was introduced. The system consists of a dispatcher center and terminals of execution points, the number of terminals depends on the branching of external lighting networks.

The dispatcher station and the terminals of the executive points exchange information between each other via GSM communication.

The main function of the system is the scheduled automatic switching of the full (standby and operating) lighting; switching to standby, turning on the predawn of full and turning off the lights.

The operation of the system allows operating of the controller from the workplace as a separate point of inclusion, as well as receiving information about the status of objects of street lighting control by the group, programming of the schedule of the lighting switching on/off, receiving information about the amount of electricity consumed by a separate inclusion point (cabinet) and other.

Possibilities (and modes) of the system's operation:

- Batch operation mode;
- Manual operation mode;
- Emergency mode.

The control is conducted in the cabinet I-710 by these channels at:

- Phase failure;
- Standby starter failure;
- Operational starter failure;
- Doors opening;
- Power control at input lines;
- Remote operation with the multirate meter;

The control cabinets - 258 units, all of which are in working condition, have differentiated (multirate) at the time of the day electricity meters such as ЦЭ 6822, НИК 2303 - 258 units.

Description of the dispatcher service: the dispatcher service operates in the round-the-clock mode.

In Mariupol, the dispatcher service operates in the round-the-clock mode. It consists of three brigades, which include the operator at the control panel, the electrician, the driver of the car. It carries out operative repair of damages in the networks of external lighting and carries out scheduled works and current tasks.
The operator of the control panel monitors the work of networks, remotely manages the control system, aLEDLepts requests for idle equipment, interacts with production areas.

At present the enterprise has more than 90 employees in its staff, including:

- 4 operational and technical areas: Central, Primorsky, Ordzhonikiumsky and Kalmiusky districts of the city;
- Production and dispatcher service;
- Electrotechnical laboratory;
- Emergency and dispatcher service;
- Garage.

The operation mode characteristics of the lighting system of Mariupol city

- The average annual number of hours of lamps operation per year is – 4879.4 hrs.

In order to regulate the use of electricity, daily shutdown of sources of artificial external lighting in the period from 1.00 to 4.45 (except for responsible objects) is provided.

According to the schedule of external lighting switching on the estimated value of the lamps is 2748.1 hours.

- According to the information provided in the letter of the National Commission for Energy and Utilities Regulating (NERC), of 19.12.2016 Nr13675/17.2.1/7-16 from 19.12.2016 the following is known:
    - By Resolution of NERC of November 24, 2016, Nr2021 "On Amendments to the Resolution of the National Energy Regulation Commission of Ukraine of March 11, 2010 Nr.218", the amendments

were made to the Resolution of the National Energy Regulation Commission of Ukraine dated March 11, 2010 Nr. 218 "On Approval of Rates for electric energy for children centers "Artek" and "Moloda Hvardiya", religious organizations and urban electric transport", registered in the Ministry of Justice of Ukraine on March 24, 2010 under Nr. 241/17536 (with amendments), which, in its turn, set a separate (preferential) rate for electric energy for urban electric transport, by excluding from the mentioned electricity consumers category "urban electric transport".

- The above changes will lead to the fact that starting from January 1, 2017, the electric energy supply for urban electric transport will be carried out at retail rates of the corresponding voltage class.

- By the Resolution of the NERC of December 15, 2016, Nr. 2210 "On the Recognition of the Resolution of the National Commission of Ukraine as invalid", was recognized as invalid by the resolution of the National Energy Regulation Commission of Ukraine of October 22, 2004 Nr.1030 "On Procedure of differentiation of electricity rates per hours of the day used for external lighting of settlements", which established that calculations for electric energy, which are provided for external lighting needs of settlements, is carried out at the single retail rate of the corresponding class of voltage using a coefficient of 0.6 within the zones of the day.

The mentioned changes will result in the fact that starting from January 1, 2017, the realization of electric energy for the needs of external lighting of settlements will be carried out at retail rates of the corresponding voltage class.

For accounting of electric energy in the project it is provided the usage of the rate differentiated by periods of time:

Table 1.3 Differentiated by Time Periods Rate

For triple-zone rates, differentiated by the time periods, the following rate coefficients are set (Resolution of NERC dated 20.12.2001Nr.1 241 (with amendments and additions), Fax message of SE «NPC «Ukrenergo» of 08.12.2016 Nr.03/03/13844):

		Rate zones limits:	
Night period	0.25	Since 24 o'clock till 7 o'clock.	7 hrs
Half-peak period	1.02	since 7 o'clock till 8 o'clock since 11 o'clock till 20 o'clock since 23 o'clock till 24 o'clock	11 hrs
Peak period	1.8	since 8 o'clock till 11 o'clock since 20 o'clock till 23 o'clock	6 hrs

Taking into aLEDLount the provided time periods – the operational hours numbers of the lamps is distributed as follows:

Table 1.4 The Lamps' Operational Hours Number

	Rate zones limits:	**The Lamps' Operational Hours Number**
Night Period	Since 24 o'clock till 7 o'clock	1970 hrs
Half-peak period	since 7 o'clock till 8 o'clock since 11 o'clock till 20 o'clock since 23 o'clock till 24 o'clock	906 hrs
Peak period	since 8 o'clock till 11 o'clock since 20 o'clock till 23 o'clock	1005 hrs

Taking into aLEDLount the unstable internal and external economic situation, the financial model provides an annual growth of 10% of the planned average cost of 1 kWh during 2018-2020.

Planned cost of 1kWt in 2017 is: 1.93209[1] UAH / kWh (VAT included).

- The external lighting of Mariupol city operates according to a special schedule for the switching on and off of external lighting. The Dispatcher Service of the ME "Mysksvitlo" has a special software for readings taking and control using GSM communication, which allows automatization of the process of turning on and off of the sources of street lighting depending on the time of day. Taking into aLEDLount the special weather conditions and other important reasons the switching on and off can be provided manually by the manager. In this case, a cascade switching system is used, which allows including or excluding a separate area of external lighting networks.

[1] Resolution of NERC of Ukraine dated 24.04.2017 Nr.538

Table 1.5 The Switching on and off Schedule of the External Lighting

	January		February		March		April		May		June		July	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
1	16:24	6:41	17:05	6:23	17:46	5:40	19:28	5:40	20:13	4:40	20:55	4:00	21:10	3:59
2	16:24	6:41	17:05	6:23	17:46	5:40	19:28	5:40	20:13	4:40	20:55	4:00	21:10	3:59
3	16:24	6:41	17:05	6:23	17:46	5:40	19:28	5:40	20:13	4:40	20:55	4:00	21:10	3:59
4	16:24	6:41	17:05	6:23	17:46	5:40	19:28	5:40	20:13	4:40	20:55	4:00	21:10	3:59
5	16:24	6:41	17:05	6:23	17:46	5:40	19:28	5:40	20:13	4:40	20:55	4:00	21:10	3:59
6	16:30	6:40	17:12	6:16	17:52	5:30	19:36	5:29	20:20	4:32	21:00	3:57	21:07	4:03
7	16:30	6:40	17:12	6:16	17:52	5:30	19:36	5:29	20:20	4:32	21:00	3:57	21:07	4:03
8	16:30	6:40	17:12	6:16	17:52	5:30	19:36	5:29	20:20	4:32	21:00	3:57	21:07	4:03
9	16:30	6:40	17:12	6:16	17:52	5:30	19:36	5:29	20:20	4:32	21:00	3:57	21:07	4:03
10	16:30	6:40	17:12	6:16	17:52	5:30	19:36	5:29	20:20	4:32	21:00	3:57	21:07	4:03
11	16:36	6:39	17:19	6:08	17:59	5:21	19:43	5:19	20:27	4:25	21:04	3:54	21:04	4:07
12	16:36	6:39	17:19	6:08	17:59	5:21	19:43	5:19	20:27	4:25	21:04	3:54	21:04	4:07
13	16:36	6:39	17:19	6:08	17:59	5:21	19:43	5:19	20:27	4:25	21:04	3:54	21:04	4:07
14	16:36	6:39	17:19	6:08	17:59	5:21	19:43	5:19	20:27	4:25	21:04	3:54	21:04	4:07
15	16:36	6:39	17:19	6:08	17:59	5:21	19:43	5:19	20:27	4:25	21:04	3:54	21:04	4:07
16	16:42	6:36	17:26	6:02	18:06	5:12	19:50	5:10	20:34	4:16	21:07	3:53	21:00	4:12
17	16:42	6:36	17:26	6:02	18:06	5:12	19:50	5:10	20:34	4:16	21:07	3:53	21:00	4:12
18	16:42	6:36	17:26	6:02	18:06	5:12	19:50	5:10	20:34	4:16	21:07	3:53	21:00	4:12
19	16:42	6:36	17:26	6:02	18:06	5:12	19:50	5:10	20:34	4:16	21:07	3:53	21:00	4:12
20	16:42	6:36	17:26	6:02	18:06	5:12	19:50	5:10	20:34	4:16	21:07	3:53	21:00	4:12
21	16:49	6:32	17:33	5:54	18:13	5:02	19:57	5:00	20:42	4:11	21:09	3:54	20:54	4:18
22	16:49	6:32	17:33	5:54	18:13	5:02	19:57	5:00	20:42	4:11	21:09	3:54	20:54	4:18
23	16:49	6:32	17:33	5:54	18:13	5:02	19:57	5:00	20:42	4:11	21:09	3:54	20:54	4:18
24	16:49	6:32	17:33	5:54	18:13	5:02	19:57	5:00	20:42	4:11	21:09	3:54	20:54	4:18
25	16:49	6:32	17:33	5:54	18:13	5:02	19:57	5:00	20:42	4:11	21:09	3:54	20:54	4:18
26	16:57	6:29	16:40	5:47	18:21	4:51	20:05	4:50	20:49	4:05	21:10	3:56	20:47	4:25
27	16:57	6:29	16:40	5:47	18:21	4:51	20:05	4:50	20:49	4:05	21:10	3:56	20:47	4:25

Continuation of Table 1.5

	January		February		March		April		May		June		July	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
1	16:57	6:29	16:40	5:47	18:21	4:51	20:05	4:50	20:49	4:05	21:10	3:56	20:47	4:25
2	16:57	6:29			18:21	4:51	20:05	4:50	20:49	4:05	21:10	3:56	20:47	4:25
3	16:57	6:29			18:21	4:51	20:05	4:50	20:49	4:05	21:10	3:56	20:47	4:25
4	16:57	6:29			18:21	4:51			20:49	4:05	21:10	3:56	20:47	4:25

Continuation of Table 1.5

	August		September		October		November		December	
	On	Off	On	Off	On	Off	On	Off	On	Off
1	20:39	4:33	19:43	5:16	18:42	5:58	16:48	5:40	16:18	6:20
2	20:39	4:33	19:43	5:16	18:42	5:58	16:48	5:40	16:18	6:20
3	20:39	4:33	19:43	5:16	18:42	5:58	16:48	5:40	16:18	6:20
4	20:39	4:33	19:43	5:16	18:42	5:58	16:48	5:40	16:18	6:20
5	20:39	4:33	19:43	5:16	18:42	5:58	16:48	5:40	16:18	6:20
6	20:31	4:41	19:32	5:24	18:32	6:06	16:41	5:47	16:16	6:26
7	20:31	4:41	19:32	5:24	18:32	6:06	16:41	5:47	16:16	6:26
8	20:31	4:41	19:32	5:24	18:32	6:06	16:41	5:47	16:16	6:26
9	20:31	4:41	19:32	5:24	18:32	6:06	16:41	5:47	16:16	6:26
10	20:31	4:41	19:32	5:24	18:32	6:06	16:41	5:47	16:16	6:26
11	20:23	4:48	19:22	5:31	18:22	6:12	16:34	5:54	16:16	6:31
12	20:23	4:48	19:22	5:31	18:22	6:12	16:34	5:54	16:16	6:31
13	20:23	4:48	19:22	5:31	18:22	6:12	16:34	5:54	16:16	6:31
14	20:23	4:48	19:22	5:31	18:22	6:12	16:34	5:54	16:16	6:31
15	20:23	4:48	19:22	5:31	18:22	6:12	16:34	5:54	16:16	6:31
16	20:14	4:55	19:12	5:38	18:13	6:18	16:29	6:01	16:17	6:34
17	20:14	4:55	19:12	5:38	18:13	6:18	16:29	6:01	16:17	6:34
18	20:14	4:55	19:12	5:38	18:13	6:18	16:29	6:01	16:17	6:34
19	20:14	4:55	19:12	5:38	18:13	6:18	16:29	6:01	16:17	6:34
20	20:14	4:55	19:12	5:38	18:13	6:18	16:29	6:01	16:17	6:34
21	20:05	5:02	19:01	5:44	18:04	6:25	16:25	6:07	16:19	6:37

Continuation of Table 1.5

	August		September		October		November		December	
	On	Off	On	Off	On	Off	On	Off.	On.	Off.
22	20:05	5:02	19:01	5:44	18:04	6:25	16:25	6:07	16:19	6:37
23	20:05	5:02	19:01	5:44	18:04	6:25	16:25	6:07	16:19	6:37
24	20:05	5:02	19:01	5:44	18:04	6:25	16:25	6:07	16:19	6:37
25	20:05	5:02	19:01	5:44	18:04	6:25	16:25	6:07	16:19	6:37
26	19:54	5:09	18:51	5:50	17:56	6:32	16:21	6:14	16:21	6:38
27	19:54	5:09	18:51	5:50	17:56	6:32	16:21	6:14	16:21	6:38
28	19:54	5:09	18:51	5:50	17:56	6:32	16:21	6:14	16:21	6:38
29	19:54	5:09	18:51	5:50	17:56	6:32	16:21	6:14	16:21	6:38
30	19:54	5:09	18:51	5:50	17:56	6:32	16:21	6:14	16:21	6:38
31	19:54	5:09			17:56	6:32			16:21	6:38

1.5 Description of implemented investment projects in Mariupol city

Table 1.6 The Installed Lanterns

№	Supplier Company	Appearance, name	Notes
	LLC "Shreder"	 	In accordance with the pilot investment project the LED lanterns of 23W power (Shreder Ambar LED) are installed in all districts of Mariupol City. Considerable savings and visual effect after the lanterns installation give confidence in the right choice of this measure.

1.5 Physical characteristics of light sources

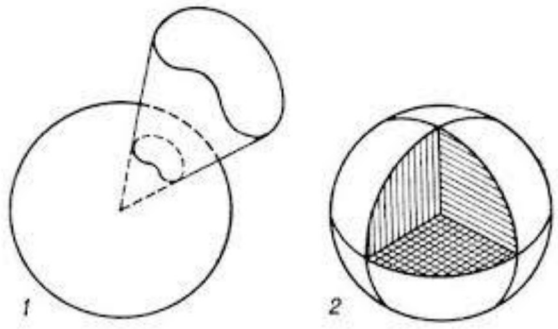
The city's lighting involves observing the specified brightness or illumination values, including the surfaces of road coverings. Thus, the norms regulate the value of brightness (illumination) of road coverings depending on the intensity of traffic, determine the permissible values of the uneven distribution of brightness along the surface of the road surface in the longitudinal and transverse directions, as well as the aLEDLeptable value of the characteristic of dazzling action of street lamps. These limitations are the limiting values of the quality characteristics of the lighting. As the external lighting of cities is an element of the habitat of the citizens, it can affect their everyday life. Depending on the characteristics of lighting devices, the latter have a positive and negative impact on the quality of life of the citizens and the environment.

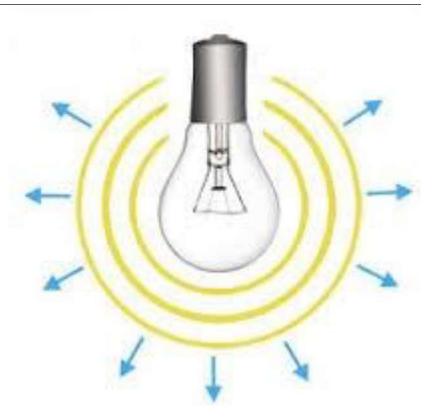
When lighting the streets as a linear object, the major part of the light flux should be directed along two opposite sides along the street, while creating uniform illumination along its entire length. Practice shows that for the optimal solution of this problem it is necessary to have lamps having the maximum force of light, directed at an angle of about 65-75 ° to the vertical in two opposite directions. Such a transformation of the light flux of a lamp is possible with the help of mirrors and refractors, which are provided in the majority of modern street lamps.

The light flux of the lamp is equal to the sum of the light fluxes of the lamps, multiplied by the efficiency of the lamp. When calculating the level of lighting it is necessary to take into aLEDLount that during the operation of the lighting installation the level of illumination decreases as a result of decreasing the light flux of the lamps due to their aging, reducing the efficiency of the lamps by reducing the reflection coefficient and deformation of the reflectors, reducing the light flux of the lamps due to prolonged use or changes in power supply. Light flux loss in various lamps ranges from 10 to 45% (on average 30%) and depend on the efficiency of the reflector in the lamps.

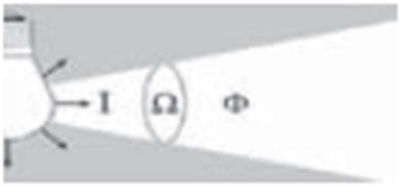
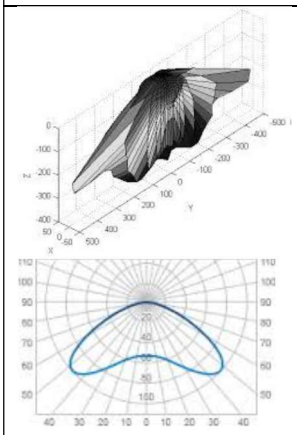
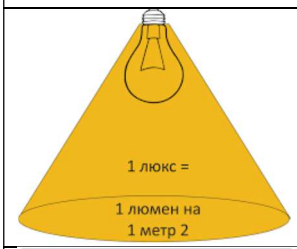
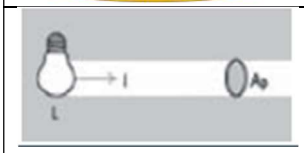
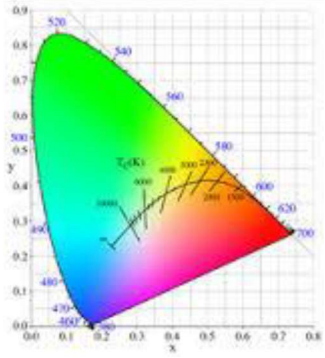
For partial prevention of adverse effects associated with these phenomena during the calculation, the safety factor is taken into aLEDLount, which is regulated by construction codes depending on the level of pollution, light source and lamp operational group.
A choice of lighting equipment is crucial for the quality, reliability and efficiency of the lighting installation, which is projected. The major indicators that determine the choice of lamp are: construction of the lamp, and the work conditions, the lamp light distribution, its energy efficiency, the allowable costs for operating, economic efficiency.

Table 1.7. Basic Physical Characteristics of Light

Schematic Drawing	Physical Characteristics Description
	Solid angle is part of space, limited by an open surface. In general, the solid angles, limited by different conical surfaces, are used. The measure of the solid angle with the point in the center of the sphere is the ratio of the square of the spherical surface on which it rests, to the square of the radius of the sphere. The unit of solid angle is steradian [SR].

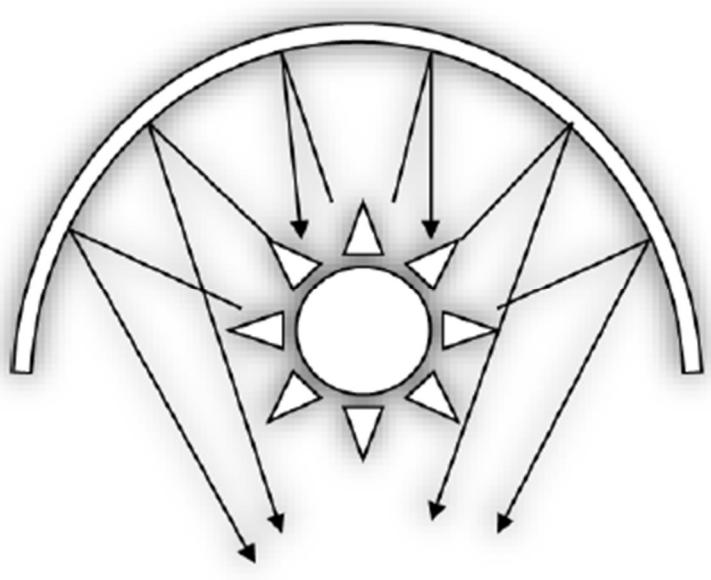
	Light flux - a quantitative characteristic of radiation emitted by a light source. The light flux of the lamp is created when working in the lamp. Part of the light flux emitted by the lamps is absorbed inside of the lamp and emitted out of the corner of radiation. It is connected with the efficiency of the lamp with respect to the light flux emitted by the lamp to the nominal luminous flux emitted by the lamp used in the lantern. The unit of measurement is lumen [lm]

Continuation of Table 1.7

Schematic Drawing	Physical Characteristics Description
	**Candlepower** – is the special density of the light flux in the solid angle or the light sources power, measured in candela (Cd). This is a light power that generates a monochromatic emission in a certain direction with a frequency of 540 – 1012 Hz, the radiation intensity of which in this direction is 1/683 W/steradian; The measurement unit is candela [cd = lm/sr].
	**Light Intensity Distribution Curve** - characterizes the distribution of light intensity of a lighting device in space. It is represented as a graph in polar or rectangular Cartesian coordinate system. The value of light intensity is given in the lanterns catalogs in the conditional units given for the light flux of 1000 lm [cd/klm].
 люкс – lux люмен - lumen метр - meter	**Illumination –** the density of the light flux on the enlightened surface. The measurement surface is lux [lx].
	**Brightness –** the luminous intensity, emitted from the unit of the area. The measurement unit is the luminous intensity in 1 cd from the area of 1 m^2 in the perpendicular direction [cd/m^2].
	**Temperature of the light source.** The temperature of the light source is determined by comparison with the so called “black body” and is represented by the “Planckian locus”. If the temperature of the “black body” increases, then the blue spectrum component increases, and the red component decreases. The incandescent lamp with a warm white light has, for instance, the color temperature of 2700 K, and the fluorescent lamp with the chromaticity of the day light is 6000 K.

The main losses of the lamp with arc tubes are caused by the design features of the lamp: the light is emitted in all directions, as a result, the part is lost on the reflector of the lantern housing (manufacturers make more emphasis on performance improvements than the illuminating parameters then part of the light is absorbed), there are also losses because of the shadowing by the lamp itself and the light refraction at the edge of the reflector:

Figure 1.3 The structure of the light flux of the lantern with the arc tube



The lanterns specially designed for the certain lamps type are used for the street lighting networks of the city:

- The lanterns of the series РКУ, РТУ are used for the lamps of MAL type of different power;
- For the lamps of HPSL type – ЖКУ, ЖТУ, ЖСУ;
- For incandescent lamps the lanterns of НКУ series are used, where:
- РКУ – Р – mercury lamp, К – console, Т – torcher, С - rope (mounting manner), У – for external lighting;
- ЖКУ – Ж – sodium, К – console, Т – torcher, С - rope (mounting manner), У – for external lighting;
- НКУ – Н – incandescent lamp, К – console, У – for external lighting;

These lanterns are out-of-date and worn equipment, their housings have deep and penetration corrosion.

Technical characteristics

Each separate ЖКУ lantern's parameters are different.
ЖКУ/НКУ/РКУ-77–002 (77 – series) is the most widespread version:

Housing	Alloy steel
Lamp	solid
Nominal power, W	70
Cap **Efficiency, %**	E27 70
Series	002
Additional refinement	Dome, protected glass with sputtering

The efficiency of the lantern decreases the efficient light flux of the installed lamp, and the continuous operation and aging of all elements of the lantern decrease this value even more.

1.7 General characteristics of light sources by type of lamps

Incandescent Lamps

The incandescent lamps are the representatives of the heat light sources and are widely used in the household and different industrial spheres. The powers range of the incandescent lamps of general purpose, used in the external lighting, is within the limits from 60 to 500 W. As a rule, the lamps of these powers are produced for the voltage of 215-225, 220-230, 230-240, 235-245 V.

The light efficacy of the lamps of the main series is within the range of 7-19 lm/W and increases with the increase in unit lamp power and decreases with the increasing of nominal voltage. Nominal lamp life is 1000 hours.

The emission of incandescent lamps differs significantly from daylight. Due to the advantage of visible light in the orange and red components of the incandescent lamps spectrum and its lack in blue and violet components, the distortion of the color transfer oLEDLurs, that is, the "warm" color tones (red, orange, brown) are intensified and the "cold" (green, blue, purple) are weakened.

The operation of the incandescent lamps does not practically depend on the environment conditions, including the temperature. But, the incandescent lamps properties are very sensible for the increasing voltage level. At 1% voltage deviation from the nominal the light flux of the lamps varies ±3.7%, the power +1.5%, light efficacy ±2.2%, operational life ±14%.

The advantages of the incandescent lamps are as follows:

- Low cost;
- small sizes;
- the maturity of mass production for a wide range of voltage;
- the ability to work at any type of current;
- active electrical resistance, power factor cos φ = 1;
- fast operational mode start, takes a fraction of a second;
- absence of start-up equipment;
- the absence of toxic components and, as a result, the absence of a need for collection and recycling infrastructure;
- absence of flickering when operating at alternating current;
- no humming when operating at alternating current;
- a continuous spectrum of emission, pleasant and habitual in the home;
- resistance to low and high temperatures of the environment and condensate;
- simplicity of design;
- Good color rendering.

The disadvantages are:

- Low efficiency (5-15%);
- Embrittlement, sensitivity to shock and vibration;
- Reduction of light efficacy and operational life at high voltage power;
- IL are fire dangerous and require heat-resistant fittings of the lanterns;
- Low light efficacy;
- Short operational life (about 1000 hours);
- High sensitivity to voltage changes.

Incandescent lamps are used for domestic, local, emergency lighting.

High Pressure Mercury Lamps (HPML)

These lamps are characterized by the long operational life and high nominal efficiency, as well as the necessity in additional electric devices for their stabilization during operation.

The high-pressure mercury arc lamps with luminiferous cover at shell are produced of power from 50 to 2000 W, the lamps of power from 80 to 400 W are used in installations of the city lighting.

The operational life of lamps of 80-400 W power is 12-15 thousand hours, and, by the end of the operational life, the light flux is reduced to 70% of the nominal. Lamps are characterized by significant fluctuations in light flux. The environment's temperature affects the lamp's parameters. At negative temperatures, a higher voltage is required for start-up, but the lamps are reliably turned on and light with existing types of start-control devices at temperatures up to -25ºC.

The operational mode of the lamps is determined by the supply line voltage. With the voltage change for ±1% the light lux changes for ±2.5%, the power for ±2%. The lamps reliably operate only at voltage not less than 90% of nominal.

The advantages of high pressure mercury lamps are:

- High brightness;
- Respectively low cost;
- Great range of powers;
- High light efficacy (30-60 lm/W);
- Great operational life (to 12000 hours);
- Operation at low temperatures.

The disadvantages are:

- Respectively high cost;
- Lamps' fluctuation;
- Presence of start-control devices;
- Sensibility to the drop of temperatures (to -25 ºC);
- Poor color rendering;
- The lamp's operational mode starting for about 5-7 min.;
- The lamps restrike after the lamp's cooling (for about 10 min).

Table 1.8 Technical characteristics of MAL:

The lighting source	Nominal power, W	Power with respect of the losses (start-control device), W	Lamp light flux, Lm	Lantern light flux, Lm	Lantern light efficacy, Lm/W	Nominal operational life, hrs
High pressure mercury lamp MAL-125	125	140	6300	4110	29	12000
High pressure mercury lamp MAL-250	250	280	13000	9100	32.5	12000
High pressure mercury lamp MAL-400	400	420	22000	15400	32.0	12000

High Pressure Sodium Lamps (HPSL)

Nowadays they are widely used for streets, highways, public buildings lighting, etc. The HPSL have the highest light efficacy among the gas discharge lamps and are characterized by the lower value of the light flux decrease during continuous operation. Because of the high ripple rate and a large deviation of the lamp emission spectrum in the red component area, which disturb the object's color rendering, the HPSL are not recommended for lighting of the workshops and aLEDLommodation facilities.

There is a great dependence of the color rendering and the starting voltage of HPSL on the composition and pressure of the internal gas and the temperature. Thus, the burners have great requirements for the production quality and operational conditions of HPSLs. That is why for the effective operation of HPSLs it is necessary to provide the "comfortable" operational conditions – high stability of the power supply, environmental temperature from -20ºC to +30 ºC. The deviation from the "comfortable" operational conditions result in the severe reduction of the lamps operational life and the light efficacy decrease.

The operational life of the HPSLs is also influenced by the used pulse starting devices. Nowadays there is a widespread mistake, that replacing of HPSLs leads to improved lighting quality and energy savings. It isn't considered, that the HPSLs of the same power at a higher light flux either has the higher consumption current. Moreover, the advantage of the red spectrum from the HPSLs worsens the overall visibility picture of illuminated objects, which is especially dangerous for the highway's lighting.

Table 1.9 Technical characteristics of HPSLs:

The lighting source	Nominal power, W	Power with respect of the losses (start-control device), W	Lamp light flux, Lm	Lantern light flux, Lm	Lantern light efficacy, Lm/W	Nominal operational life, hrs
High pressure sodium lamp HPSL-70	70	84	6600	4620	55	12000
High pressure sodium lamp HPSL-100	100	120	10700	7490	62	16000

Continuation of the Table 1.9

The lighting source	Nominal power, W	Power with respect of the losses (start-control device), W	Lamp light flux, Lm	Lantern light flux, Lm	Lantern light efficacy, Lm/W	Nominal operational life, hrs
High pressure sodium lamp HPSL-150	150	170	17500	12250	72	16000
High pressure sodium lamp HPSL-250	200	280	33000	23100	82.5	20000
High pressure sodium lamp HPSL-400	400	440	56000	39200	89.1	32000

Metal halide lamps of MAL type

They are lamps with the design like the lamps of MAL types with the starters and without them or with one ignition electrode. The MHL lamps are produced in lamps bulbs of MAL type or in special cylindrical bulbs. The position during lighting have significant effect on the lamps' parameters: the light flux in the horizontal position is 15-18% lower than in the vertical position.

The temperature of the environment effects the starting voltage. But when using the PSD, the starting voltage increases, and the environmental temperature decrease have no effect on the ignition, because the PSD gives a voltage pulse with the stock.

The mains voltage has the same effect on the MHL lamps parameters as on other HPMLs, that is at the voltage change for ±1% at operation with the standard throttle the light flux of the lamps changes for ±2.5% and the power for ±2.2%.

The light flux pulsation of MHL lamps is lower than the MALs, and is about 30%. The operational life of the modern MHLs is an average of 7500-12000 hours, and the light flux decrease to the end of the operational life is higher than the MAL type.

So, the lamps of MAL and HPSL type have the highest light efficacy, while they are the most used in the general list of the lamps for external lighting of Mariupol city. The MALs have somewhat lower light efficacy, but they don't require additional high-voltage starting devices.

Start-control devices (SCD, throttles) for MAL, HPSL, MHL lamps

Each lantern (aLEDLept ML) has in its design additional start-control devices for the stable operation of the mercury and sodium lamps. This leads to additional (parasite) energy consumption for the energy transformation.

SCD are used in lanterns, used for lighting of the streets and uneven-volume roads, railway platforms and stations, yards, functional-decorative lighting of parks, avenues, housing communities etc.

The start-control device is an electro-technic device, with the help of which the power supply of the discharge lamps is conducted from the mains, which provides the necessary starting modes, run-up and operation of lamps and is designed as a single device or several separate blocks.

The start-control devices (throttles) of independent or inbuilt type are designed for the provision of the starting mode and the current stabilization of the high-pressure lamps of MAL or HPSL type.

Figure 1.4 The start-control devices (throttles) of independent and inbuilt construction

So, the start-control devices are necessary for:

- Starting the discharge lamp, that is, a test of the interelectrode gap and the formation of a necessary type of discharge in it. This function is usually performed by a starting device, which is often an integral part of the SCD. For reliable starting of a lamp, the SCD must have certain output parameters in idle mode, that is, in the mode of operation of the starting circuit when the lamp is off. These include the form, the value of the voltage applied to the lamp electrodes during its start-up, and, if necessary, the value of the current of the preheating of the electrodes, etc.,

- The run-up of the discharge lamp, that is the process of setting the operating parameters of the lamp after its start-up. The duration of the lamp run-up, as well as the current change type in it during this process depends not only on the gas filling of the lamp and the ratio of temperatures, its bulb in the cold or operating state, but on the type of the SCD parameters.

- maintaining the stability of the operating mode of the discharge lamp in the circuit, which is the ability of the circuit to automatically restore the initial value of the current with its fluctuation changes. The presence of this function in the SCD, which is performed with the help of current limiting elements (current stabilizers), is related to the specifics of the static voltage-ampere characteristics of the lamps (SVAC). It is fundamentally impossible to provide a stable operation from a voltage source without limiting element-ballast for discharge lamps with incident VACs.

Technical characteristics:

Table 1.10 Technical characteristics of SCD for MALs

Name	SCD for Lamps of MAL type		
Nominal	125	250	400
Current of device setting (A)	1.15	2.15	3.25
Voltage of setting (V)	154	153	146
Nominal voltage, V	220±10%	220±10%	220±10%
Freqency, Hz	50	50	50
Power losses, W (approximately)	14-20	21-35	25-40
Power coefficient, not more	0.53	0.53	0.53
Operational life, years	10	10	10

Table 1.11 Technical characteristics of SCD for HPSLs

Name	SCD for Lamps of HPSL type		
Nominal	100	150	250
Current of device setting (A)	1.2	1.8	3.1
Voltage of setting (V)	175	175	187
Nominal voltage, V	220±10%	220±10%	220±10%
Freqency, Hz	50	50	50
Power losses, W (approximately)	17	25	29
Power coefficient, not more	0,43	0,43	0,43
Operational life, years	10	10	10

2. DEVELOPMENT OF THE PRIORITY INVESTMENT PROGRAM

.1 Needs Assessment

The external lighting is one of the most important criteria by which you can estimate the level of economic development of the city and the social standard of living of its inhabitants.

An important part of a safe and comfortable stay of a person in the streets of the city during the dark season is the presence of an effective network of external lighting. Efficiency of the system is the implementation of qualitative work to create a light environment of streets and highways of cities under given conditions at lower costs. To create an efficient light environment, modern light engineering designs of light sources are used that meet the requirements of normative documents and energy-efficiency indicators. The most effective option for today is to install and replace existing light sources on LED lanterns.

Mariupol is a city of regional importance in Ukraine, Donetsk region, on the shore of the Azov Sea. It is a significant port and industrial center of the country. There are two large metallurgical complexes in the city (Mariupol Iron and Steel Works named after Ilyich and Azovstal) and the largest machine-building enterprise in Ukraine, Concern “AzovMash”, the products of which make up a significant part of Ukraine's exports.

Today, the system of external lighting in Mariupol city is characterized by the presence of a large number of outmoded and physically obsolete lanterns. Another point worthy of note is the problem of using the incandescent lamps in lanterns, which leads to the consumption of a large amount of electricity and additional costs of the funds to pay for consumed electricity. These lanterns have been used for more than 20 years and do not provide adequate normative lighting due to their outdated technological characteristics and higher modern requirements for street lighting in the city. Moreover, unsatisfactory lighting of the roadway and the streets of the city due to the low level of lighting leads to significant inconveniences during travel, as well as the traffic accidents in the dark and injuries of pedestrians, in particular, in the poorly lit and unlit streets of the city.

Implementation of this project is primarily related to the social aspect of the issue and is aimed at improving living conditions in Mariupol city. As far as the lack of lighting in residential areas and on the roads of the capital is one of the main reasons for the increase of the crime situation and accidents on the roads of the city. Relating to this, there is a general negative impression from Mariupol city, both at the visitors and tourists of the city, and in its inhabitants. Moreover, this is seen in the level of development of the tourism industry. Since there are many ancient cultural monuments in the city that have a great historical significance for our region and Ukraine in general. A large percentage of supports, air and cable lines of the external lighting system have already completed their operational life.

It should be noted that the implementation of this Project will significantly improve the quality of the city's external lighting, reduce the cost of maintenance and payment for consumed electricity. This is due to the fact that currently physically aged and technically outdated lanterns with lamps consuming a large amount of electricity are used to a large extent. The project proposes replacing existing worn out lanterns with more modern and efficient, LED ones, replacement of air and cable lines of power supply, modernization and installation of new distribution cabinets. At the same time, it is not planned to expand the existing external lighting network of the city, which doesn’t result in increasing of the level of financial burden on the city budget and, accordingly, will not affect the welfare of the population. Due to this, the project fully meets the needs of end users of services – the residents of Mariupol city.

2.2 Component 1 - Modernization of street lighting networks in Mariupol City. Replacement of mercury and sodium lamps for the LED.

2.2.1 Statement of component need

In most cities of Ukraine there is a strong physical aging of lighting equipment, the roads lighting is 2-3 times lower than the norm, the lanterns have an outdated design (the reflector’s operation without protection from moisture and dust leads to loss of lighting characteristics and reduction of efficiency), the lanterns use mercury lamps of MAL and HPSL types, which make up most of the park of light sources for streets lighting.

The experience of the leading European capitals, which have long and suLEDLessfully implemented city-wide programs on the conceptual lighting of roads, bridges, houses, adjoining territories, buildings, cultural heritage sites, squares, proves that the issues of organizing of cities external, architectural, festive (illuminated) lighting are relevant. The largest capitals and metropolises of European countries, such as: London, Rome, Barcelona, Paris, Vienna, Lyon and others, are the examples for imitation.

The analysis of external lighting in Mariupol city shows that about 90% of street lamps do not meet current requirements and norms. Due to the low efficiency of the lanterns and light sources installed in them, the share of electricity consumption for lighting in Mariupol city is almost 1.7 times higher than in western capitals. The main reasons for this state are:

- The operation of outdated, physically aged lanterns, the reflectors' and diffusers' parameters of which have much decreased, the efficiency coefficient of the lanterns has 25-40% decreased;
- The operation of the light sources of low efficiency in the lanterns (mercury lamps MAL and sodium HPSL);
- The operation of the lanterns with the light misallocation;
- Non-implementation of regular measures to ensure the necessary lighting conditions of lighting equipment.

To reduce electricity consumption in external lighting installations in Mariupol city, it is possible to use lighting equipment with sodium lamps (HPSL), which allow the same levels of illumination at lower electricity consumption. At the same time, there is the need for the introduction of a new generation of lighting equipment, which meets the modern design, cost efficiency and anti-vandalism requirements. In this case, special attention should be paid to LED external lighting.
Now, planning and financing of electricity consumption for the needs of street lighting systems is based on the financial capabilities of local budgets, and not the real needs.
The above said suggests that the actual state of external lighting system in Mariupol city does not meet modern requirements and does not meet the needs of the population in the lighting. The physical and technological obsolescence of the installed equipment is far ahead of the pace of its reconstruction and modernization due to insufficient financing.
Since the condition and high-quality functioning of external lighting systems have important social significance, necessary to conduct the set of measures for renewal, further development and modernization of these systems, as soon as possible.

The provided summary of the road lighting situation in Mariupol city shows the need for the introduction and development of modern perspective lighting systems based on the latest achievements in science and technology, semiconductor instrumentation, optics and electronics in order to increase road safety, significantly reduce the cost of lighting systems servicing, reduce costs of energy for lighting, reducing the negative impact on the environment and improving the quality of lighting in general. Additional criteria for determining the efficiency of LED light sources may be the maximum allowable set power, the maximum allowable power consumption per lumen of useful light flux, the maximum permissible power consumption per lux of created illumination.

The volume of electricity consumption for lighting was at about 11590.4 thousand kWh in 2016. It should be noted that part of the existing lighting networks does not work at full power for various reasons, and the level of illumination and brightness of the road surface often does not meet the requirements of existing standards and norms. In addition, there is no lighting in places and in sections of roads, where, in accordance with the requirements of the current normative and regulatory acts, it should be.

Proper lighting of roads also provides a significant social and economic effect, based not only on energy saving, but also on reducing the number of accidents, and reducing of injuries in accidents, and reducing of crime.

Electricity consumption for lighting needs in Ukraine is increasing annually. Electricity tariffs and service costs are also rising, which increase the cost of lighting. Also, additional costs will appear due to the transition to a complete cycle of lamps' lighting without switching off at night.

Table 2.1 Energy consumption in Ukraine in 2015-2016.

2015	2016
8348 kWh	11590.4 kWh

PROJECT GOAL:

- Improving the efficiency of electricity consumption for more than 50-60% by installing modern energy saving LED lanterns with the possibility of remote control of light flux and, accordingly, power consumption, depending on the time of day (intensity of pedestrian and motor transport).
- The resource of new LED lamps is much higher compared to the traditional types of lanterns. This reduces the cost of maintaining of the street lighting and extends the operational life of external lighting networks for more than 30%.
- Provision of high-quality, stable, economical and efficient lighting of streets and public areas of Mariupol city at night time. The number of emergencies at external lighting objects will decrease.
- Improving the safety of residents and guests of the capital of Ukraine in Mariupol city.
- Reducing of the number of accidents and injuries in accidents, as well as reducing of crime. Restoration of external lighting and reconstruction of existing systems come from the consideration of negative trends taking place in ensuring the safe movement of people and to reduce the level of accidents on the roads and improve the conditions of improvement in settlements.
- Improvement of the ecological state of the city. Preservation of the environment by promoting the reduction of CO_2 and other harmful substances emissions.
- Refusal from operation and purchasing of gas lamps containing mercury.
- Increasing of business, tourism and investment activities.

Thus, because of the reconstruction, the street lighting rate will be achieved in accordance with the sanitary norms of illumination, which will positively affect the road transport situation in the city and create favorable conditions for improvement of the criminal situation.

Safe lighting of streets and highways of developed cities is related with the use of LED equipment, in which the lamps have a large range of brightness. For this purpose, the reflector lamps were used before. The reflectors collect and focus light only onto a small area of the road, or to a place that according to the plan should be lit. In this case, powerful lamps are used up to 400 watts. To create a large and powerful light flux, the lanterns are raised on special high supports. This applies to highways. Auxiliary roads are equipped with lamps of lower power, in the range of 150-200 watts, the height of the supports is from 8 to 10 meters. The reflector and diffused light is used at secondary roads.

To achieve these goals, it is necessary to use modern energy-saving external light sources, which are LED lamps. They have very low (compared to traditional lamps) power levels and longer operational life, which allows at least 50-80% reducing of lighting costs.
The introduction of energy saving technologies, the replacement of old types of lamps with modern LEDs will solve both the issue of saving funds for the local budget in a difficult economic situation and reduce the environmental impact, including stopping global environmental problems.

LED Lamps (LEDL)

Among the most important parameters that determine the technical and economic efficiency of the operation of any type of lamps for external lighting is the efficiency of the lamp - the efficiency of the lamp and the duration of its operation. In most existing technologies there is a warming up of the body or area, which consumes energy. Unlike other technologies, LEDs have a very high efficiency - not less than 90%. Due to its high efficiency, LED technology provides low power consumption and low heat release.

This investment project suggests replacing of existing worn lamps with MAL and HPSL type lamps with more modern and efficient LED lanterns.
LEDs themselves have been used for a long time, mainly for indication. The light emission by a light emitting diode by recombination of photons in the p-n transition area of a semiconductor during the current passage. The breakout in the field of LEDs, which took place several years ago, was primarily due to the acquisition of new semiconductor materials that more than 20 times increase the brightness of LEDs.

Unlike other technologies the LEDs have a very high efficiency - 90-98% with a luminous efficiency of 90-180 Lm/W. Most existing technologies have a heating of the body or area, which requires additional energy costs. Due to its high efficiency the LED technology provides low power consumption and low heat release. Moreover, due to the very nature of illumination receival, LEDs have a set of characteristics that is inaLEDLessible for other technologies. There is mechanical and temperature stability, resistance to voltage fluctuations, long operational life, excellent contrast and colors transfer. Moreover, there are ecological properties, lack of flickering and even light. These are the quality of modern technology.

In addition to energy saving (in terms of electricity), the modernization of street lighting systems reduces power consumption. This is especially important for areas in which there is a lack of powers.

Also, the systems of external lighting, when the intensity of traffic is reduced, it is possible to use a system of regulation of the power of light sources, their consumption of electric energy, without a significant deterioration in the quality of lighting, which can reduce energy consumption up to 50%. This makes the problem of establishing the basics of energy saving and efficiency in urban lighting systems crucial. And this, in turn, requires the creation and construction of an information channel for management systems of lighting installations, devices for controlling the power of external lighting installations, creating of more aLEDLurate methods for assessing the quality of streets lighting and highways of the city. All these in general will allow to raise the quality of lighting at rational use of electric energy.

Main advantages of installation of the LEDs:

- 2-5 times reduction (depending on the characteristics of the old lantern and the installed lamp) the amount of energy resources consumption (electricity) by using energy efficient lighting equipment, which, accordingly, significantly reduces the total amount of emissions of hazardous and harmful substances, greenhouse gases;
- appropriate reduction of street lighting costs for local governments and significant savings in local budgets;
- savings on system maintenance;
- explosion safety;
- increased electrical safety during operation;
- operational life of LEDs is not less than 50-100 thousand hours. The use of guaranteed high-quality LEDs and manufacturers of drivers of current power from world leaders;
- the indicator of the use of light flux of street console LEDs is approaching to 99%, while standard streetlights is 60-75%. Powerful LEDs represent ideal point sources of light with built-in corrective

optics, which ensures the perfect formation of the given diagrams of the direction of the light flux (the task is practically impossible for existing light sources);

- stable operation in all climatic conditions from +60 °C to -40 °C. The lanterns currently used for street lighting with MAL and HPSL lamps are unstably started at low temperatures (approximately 3% of the lamps);
- traffic safety and health protection - ensuring better visibility, border clarity and perception of the depth of space at the expense of greater contrast;
- Color rendering index is 80-85%;
- reduction of the consumed current without increasing the starting current, which eliminates the danger of overloading of the electric power supply at the moment of switching on. The current consumption of LED street lamps is 0.4-0.6 A, while the current consumed by the gas-discharge lamp is 4.6 A, and the starting is 7.8 A;
- reduction of losses in the transforming and transmitting elements of the lighting system;
- environmental safety and environmental protection. LED console street lights do not require special recycling because they do not contain mercury, its derivatives and other poisonous or harmful components, as well as being recycled for reuse;
- explosion safety;
- increased electrical safety during operation;
- reduction of consumed current without increase of starting current;
- The power supply for LED street and industrial lighting needs a smaller cross-section;
- stable operation at voltage drops. The lanterns used during the daytime voltage fluctuation (for street lighting with MAL and HPSL lamps) operate unstably at voltage drops, considering the time for a restart of 10-15 minutes. (approximately 3% of the lamps);
- LED street lanterns (unlike lanterns with a gas discharge lamp) can adjust the light flux by reducing the voltage supply. To save electricity it is allowed 30-50% reducing of the level of illumination for street lighting at night. This does not change the spectral composition of emission and color rendering;
- improvement of the facilities of the settlements' territories with a reduction in the number of accidents and emergencies.

The achievement of the above advantages is much dependent on the solution of the following issues:

- **Operational life of LEDs**. 50-100 thousand hours of continuous operation - this is the uninterrupted operation of the LED lamp (by passport). However, this figure depends largely on product quality, on terms of use, and on the criteria for assessing the reliability of LEDs. Even with the use of high-quality components, the reduction of light flux is inevitable - this is due to many factors, such as: heat elimination conditions, environmental temperature and ventilation, humidity and other parameters. Reliability, especially in terms of the rate of degradation, often depends on the component supplier.
- **The presence of degradation of the active area**.
- **Electrostatic discharge and electric overload**. Breakdown due to overload and ESD is a significant problem for LEDs. Most commercial InGaN / GaN LEDs are with non-conductive sapphire lining. This results in a residual electric charge in the instrument, which makes it more sensitive to damage caused by electrostatic discharge and overload.
- **Thermal fatigue and short circuit**. The difference in the coefficient of thermal expansion in the connected parts and the welds leads to the appearance of mechanical stresses during the manufacturing process associated with thermocycling, which can cause stratification in the combined parts. When a powerful device is subjected to cyclic loading, the behavior of devices manufactured, for example, with a solid and a soft weld, may vary. Thermal fatigue is usually observed in devices made using a soft weld, while devices made using a solid weld are stable at cyclic thermal loading. Sometimes an inappropriate weld and inadequate technological control can lead to short circuits in the device. Thanks to the relatively high wetting, tin weld can spill over the edge of the contact area and form a shortcut. Failures associated with the housing assembly may be caused by sealant, electrode outputs and phosphorus. The thermal stresses in the sealant are the most common cause of failure in LEDs. If, due to electrical overload or high external temperature, the temperature of the housing reaches the transition temperature of the glass filler of the sealant (Td),

the resin begins to expand rapidly. The difference in the coefficient of thermal expansion of the internal components of the LED can lead to mechanical damage.

- **Problems of using of low-quality LEDs in street lighting**. Several approaches exist for heat elimination and reducing the transition temperature, and leading companies (Osram, Nisha Corp, Cree, etc.) have mastered these advanced technologies, providing high quality products. When designing a lamp, many manufacturers neglect the problem of heat elimination, even though the heat elimination on the LED board should not exceed 40°. This is one of the main characteristics, because when the temperature rises, the crystal of the LED starts to degrade substantially. It should also be remembered that the use of low-quality materials in the development of LED boards, can also lead to degradation of LED (When heating the LED on the board the chemical compounds that destroy the crystals of LED can be eliminated). Small manufacturers and consumers of LED chips have significantly fewer tools to reduce the cost of LED light, therefore, trying to reach many economic indicators, participate in the unfair competition, for example, the cheap crystals are installed in bright white LEDs (available from the market), designed for operation at other currents (up to 5 mA), which do not withstand continuous operation at currents ~ 20mA without significant degradation. According to the initial parameters, these LEDs are recognized as capable for operating due to brightness, light flux, axial force, voltage drop across the transition. But up to 1000 - 1500 hours of operation, a significant part of them significantly degrades - the light flux is reduced to 50%, the change in color parameters is observed.

Figure 2.1 The example of the problems of the streets lighting in Mariupol city

The social side of the lamp replacement

The modern existing electric lighting in any city of the world, is a compulsory element of its engineering and technical infrastructure. Lighting realization has always been interesting to the public, and opportunities, standards and expectations are steadily growing relating to the progress in light engineering and raising of the people standard of living.

The issues of ecology and energy saving are very important today. They are appearing more and more and will appear relating to the transition from old and inefficient lighting systems to a new generation of lighting systems – a LED one. And all European equipment that is discarded, consisting of mercury and sodium lamps, will come to the CIS market. After all, nowadays the fluorescent lamps make up 80% of the total street lighting in Europe. And they will be replaced by just LED devices.

Exterior lighting is an important component of the facilities of settlements in the country. It can increase the safety of road transport, reduce the level of vandalism and theft, which in turn leads to a decrease in material and human losses. Therefore, the importance of external lighting cannot be overestimated.

The reconstruction of the street lighting system leads to many important social aspects. It is known that social and economic spheres are closely linked, and social changes usually usually cause the changes in the financial sector.

High-quality street lighting provides citizens with a sense of safety and comfort that allows people getting rid of "fear of night streets." Brightly lit streets of the city in the evenings allow parents not worrying about the safety of children, which makes it possible to organize their leisure in the best way (visiting sports sections, music schools, etc.).

According to statistical data, raising the level of lighting directly affects the criminal situation in the city, reducing the number of street crimes. Reducing crime in the streets of the city in the dark time is not only a positive social factor, but also allows saving budget funds.

Table 2.2 Comparison of different types of lanterns

Lamp type	MAL	HPSL-100	Average Lanterns of 50W LED Type
Starting light emission incl. lantern's efficiency (only lamps)	35 Lm/W (55 Lm/W)	60 Lm/W (83 Lm/W)	115 Lm/W (150 Lm/W)
Light flux decreasing in 3 months (1 year of operation)	30% (40%)	12% (20%)	2% (4%)
Light emission incl. the lantern's efficiency in 3 months (in 1 year of operation)	23 Lm/W (28 Lm/W)	51 Lm/W (59 Lm/W)	112 Lm/W (140 Lm/W)
Actual operation period, hours Energy efficiency class	12 thousand "B", "C"	15 thousand "B", "C"	To 100 thousand "A", "A+"
Operational property	low	average	different
Contrast and color rendering	low	very low	different
Mechanical strength Temperature resistance	Average low	Average very low	Different Different
Drops resistance	low	low	Different
Time for transition to the operational mode	10-15 minutes	10-15 minutes	prompt
Warming	strong	strong	weak
Environmental safety	Lamp has up to 100 mg of mercury vapors	Lamp has sodium-mercury and xenon	Completely save

Also, it should be noted that the lamps of MAL and HPSL type have an aging effect. After 400 hours of operation, the drop in the light flux at the MAL lamps is more than 20%, and by the end of life - more than 50%. Most of the operational life of the lamp emits only 50-60% of the nominal light flux. This is clearly seen on the curve of the fall of the light flux. In HPSLs, the situation is even worse, due to their lower temperature resistance. LEDs have no the same parameters. LEDs keep their settings at the original level throughout their service life. There is only a slight drop to the end of the term.

Declared values of the parameters of the MALs and HPSLs concern only the initial period of operation and will constantly fall along the curve from the very beginning.

Unlike other technologies, LEDs have a very high efficiency - not less than 90% (95-98%). In most existing technologies there is a warming up of the body, which requires enormous energy consumption. Thanks to its high efficiency LED technology provides low power consumption and low heat release. Moreover, due to the very nature of receiving of radiation, LEDs have a set of characteristics that is unattainable for other technologies. Mechanical and temperature stability, resistance to voltage drops, long service life, excellent contrast and color rendering. It also includes environmental safety, lack of flicker and even light.

Efficiency of using of different types of lanterns.

MAL. It is the most simple and affordable technology. Low initial costs in the absence of strict lighting requirements justify its use.

HPSL. The best light emission among gas-discharge lamps is the only major advantage over the MAL. But a very weak indicator of color rendering and sensitivity to the temperature of the outside air. When lighting, the use of HPSLs can be considered as justified in comparison with MALs if the color rendering requirements are not high (Ra => 25).

LEDs. Greater energy efficiency, longer operational life, operating costs, a wide range of voltages; the overvoltage protection. It is necessary to note that the high environmental and ergonomic characteristics of the LEDs:

- do not require special disposal conditions;
- have no stroboscopic effect,
- have no noise,
- have spectrum of radiation - sunny white,
- have anti-vandal performance.

1.2.2 The detailed description of the component

The operational properties of the electric networks of external lighting are very low, the technical characteristics of the elements of the lighting system have lost their nominal values. In lighting systems, outdated types of light devices are used, which cause significant costs for electricity consumption. Part of the light devices that provide the streets lighting of the city have low efficiency. In addition, excessive aging of electrical networks and obsolete equipment reduces the efficiency of the operation of the lighting system.

There are 28860 units of traffic lighting points maintaining the street lighting, of which 23746 are mercury and sodium in balance of the ME "Mysksvitlo" in Mariupol city. Part of the lanterns are in nonoperational state, which further reduces the streets lighting.

The project involves major overhaul of the lighting system with the use of energy-saving technologies to save energy and funds for the maintenance of the external lighting system of Mariupol city, due to the replacement of inefficient incandescent, mercury and sodium lamps with high-performance LED lamps.

Table 2.3 The characteristics of the light sources of ME "Mysksvitlo" in Mariupol city

Light source type	Lantern type	Nominal power, W	Quantity, units	Light flux of the lamp, Lm	Light flux of the lantern, Lm	Light efficacy of the lantern, Lm/W	Nominal operational year, hours
Incandescent lamp	РКУ	150	4257	2200	1500	10	1000
High pressure mercury lamp MAL-250	РКУ, РСУ	250	2133	13000	9100	30.3	12000
High pressure sodium lamp HPSL-70	ЖКУ, ЖСУ	70	8347	6600	4620	55	18000

High pressure sodium lamp HPSL-100	ЖКУ, ЖСУ	100	5079	10700	7490	62	18000

Continuation of Table 2.3

Light source type	Lantern type	Nominal power, W	Quantity, units	Light flux of the lamp, Lm	Light flux of the lantern, Lm	Light efficacy of the lantern, Lm/W	Nominal operational year, hours
High pressure sodium lamp HPSL-150	ЖКУ, ЖСУ	150	7057	17500	12250	68	18000
High pressure sodium lamp HPSL-250	ЖКУ, ЖСУ	250	8130	33000	23100	77	18000

The HPSL type lamps are the most energy consuming, while their share among the used in Mariupol city is more than 68% from the general number of the light sources.

The financing and taking measures aimed at capital repair of the street lighting system in Mariupol city are planned to be conducted for three years, starting since 2017.

Table 2.4 The steps of implementation of the investment project

2017	2018	2019
12100 units	12100 units	10803 units

1.2.3 Quantitative characteristics and valuation

The options of external lighting lamps replacement in Mariupol city

The investment project suggests 13 options of replacement of the used constructions of the external lighting in Mariupol city with LED lighting:

For the previous calculation of the LED lantern the lantern with the gas-discharge lamp was chosen of the specified type and power, perfect optical system with the high coefficient of the optics usage and the operational level. The average height of the lantern mounting and the step between the supports were primary specified.

Using the specified lighting parameters: height, step and the maximum allowable width of the traffic way, the selection of LED lamps is made to obtain comparative data on power, light efficacy and average illumination. All data are recorded in the table and compared with the results obtained in the previous step.

In places where lamps are used based on powerful (400 W) HPSLs on supports above 12 m height, it is not always possible to replace "1 by 1" with an adequate LED lantern. In these cases, an additional recalculation is required. In this project it is technically and economically advantageous to use two low-power LED-lanterns instead of one emitter on one bearing support, either lowering the height of the mounting, or the use of additional supports.

The project provides the transmission to the 3-area accountancy of the energy consumption and 50% lighting decrease at night time.

To accurately select the power of the LED lantern to replace the old ones, design and survey works will be carried out, which will consider all the parameters of the equipment selection (height of installation, necessary illumination, etc.). It is also necessary to rely on the operational requirements for LEDs, which are planned to be installed because of reconstruction of the external lighting system of Mariupol city.

Table 2.5 The options of replacement of the used designs of the external lighting of Mariupol city with LED lighting

Lamps type	Lantern type	Replacement with LEDL1 type	Replacement with LEDL2 type	Replacement with LEDL3 type	Replacement with LEDL4 type	Replacement with LEDL5 type	Replacement with LEDL6 type	Replacement with LEDL7 type	Replacement with LEDL8 type	Replacement with LEDL9 type	Replacement with LEDL10 type
Incandescent lamp 150	СПО, НКУ	Type 27	ULSL-35	KEDR SKU 50W	SMKU-02-1-50	ST-50-04 50W	Jooby Cobra LED-КУ 60/5000К-УХЛ1	LS-OPTIMAL LED 50W	STELS (PSKS35)	SDV 02-36 A1	BGP303 LED73-3S/740 PSU II 42/60
High pressure mercury lamp MAL 250	РКУ, РСУ	Type 53	ULSL-70	KEDR SKU 100W	SMKU - 02-1-80	ST-100-04 100W	Jooby Cobra LED-КУ 80/5000К-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS140)	SDV 02-36	BGP303 LED122-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 70	ЖКУ, ЖСУ	Type 27	ULSL-35	KEDR SKU 50W	SMKU - 02-1-50	ST-50-04 50W	Jooby Cobra LED-КУ 60/5000К-УХЛ1	LS-OPTIMAL LED 50W	STELS (PSKS35)	SDV 02-36 A1	BGP303 LED73-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 100	ЖКУ, ЖСУ	Type 53	ULSL-50	KEDR SKU 75W	SMKU - 02-1-80	ST-100-04 100W	Jooby Cobra LED-КУ 80/5000К-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS50)	SDV 02-36 A1	BGP303 LED122-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 150	ЖКУ, ЖСУ	Type 77	ULSL-70	KEDR SKU 100W	SMKU - 02-1-80	ST-100-04 100W	JOOBY Cobra LED-КУ 120/5000 К-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS70)	SDV 02-54	BGP303 LED122-3S/740 PSU II 42/60

High pressure sodium lamp HPSL-250	ЖКУ, ЖСУ	Type 104	ULSL-100	KEDR SKU 200W	SMKU - 02-4-50	ST-150-04 150W	Jooby Cobra LED-КУ	LS-OPTIMA	STELS (PSKS140)	SDV 02-90	BRP373 LED224/NW

Continuation of Table 2.5

Lamps type	Lantern type	Replacement with LEDL11 type	Replacement with LEDL12 type	Replacement with LEDL13 type
Incandescent lamp 150	СПО, НКУ	STREETLIGHT 30 44 W 3DIM	WALK LED KU 40W/750-01	L-STREET 24
High pressure mercury lamp MAL 250	РКУ, РСУ	STREETLIGHT 30 88 W 3DIM	AVENUE LED KU 80W/750-01	L-STREET 48
High pressure sodium lamp HPSL 70	ЖКУ, ЖСУ	STREETLIGHT 30 44 W 3DIM	WALK LED KU 45W/750-01	L-STREET 24
High pressure sodium lamp HPSL 100	ЖКУ, ЖСУ	STREETLIGHT 30 70 W 3DIM	AVENUE LED KU 70W/750-01	L-STREET 48
High pressure sodium lamp HPSL 150	ЖКУ, ЖСУ	STREETLIGHT 30 105 W 3DIM	AVENUE LED KU 120W/750-01	SUPER STREET 110
High	ЖКУ,	STREETLIGH	HIGHWAY	SUPER STREET

pressure sodium lamp HPSL-250	ЖСУ	T 30 140 W 3DIM	LED KU 200W/750-01	150

Table 2.6 Current state of the lighting system

Mounted street lighting lamps	Quantity of lamps	Lamp power (+ SCD), kW	Capacity, kW	Consumption, kWh/year	Cost of the electricity consumpted+ oper., UAH.	Nominal light flux, thoussnd lm	Efficiency of the lantern
Incandescent lamp 150	4257	0.15	638.55	2478213	4788130	0.15	638.55
High pressure mercury lamp MAL 250	2133	0.27	575.91	2234185	4316647	0.27	575.91
High pressure sodium lamp HPSL 70	8347	0.084	701.15	2721155	5257517	0.084	701.15
High pressure sodium lamp HPSL 100	5079	0.12	609.48	2365392	4570150	0.12	609.48
High pressure sodium lamp HPSL 150	7057	0.17	1199.69	4655997	8995805	0.17	1199.69
High pressure sodium lamp HPSL-250	8130	0.28	2276.40	8834708	17069452	0.28	2276.40
Total:	**35003**		**6001.18**	**23289650**	**44997701**		

Modernization option #1 (LEDL1):

Table 2.7 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
Street lantern 27 W	**HPSL 70-100, MAL-125**
Street lantern 53 W	**HPSL-150, MAL-250**
Street lantern 77-104 W	**HPSL-250, MAL-400**
Street lantern 156 W	**HPSL-400, MAL 700-1000**

Advantages:

- The Chip-on-Board technology is used;
- High light efficacy – to 170 Lm/W;
- Integral aluminum housing, the highest values of heat abstraction and tightness;
- The quick lighting source replacement possibility without the lantern removal;
- The power source is designed for operation in unstable networks.

Table 2.8 The cost of the consumed energy by the light source of LEDL1 type

LED lanterns (type 1)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
Type 27	3879.40	12604	0.027	340.31	985532	1958953	4.2	0.98
Type 53	3879.40	7212	0.053	382.24	1106955	2200308	8.4	0.98
Type 77	3879.40	7057	0.077	543.39	1573655	3127970	12.5	0.98
Type 104	3879.40	8130	0.104	845.52	2448626	4867161	16.5	0.98
Total		**35003**		**2111**	**5114768**	**12154391**		

Modernization option #2 (LEDL2):

Table 2.9 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
ULSL-35	**HPSL 70-100, MAL-125**
ULSL-50	**HPSL-150, MAL-250**
ULSL-70	**HPSL-250, MAL-400**
ULSL-100	**HPSL-400, MAL 700-1000**

Advantages:

- Low consumption power of the light source;
- High light efficacy – to 120 Lm/W;
- The power source is designed for operation in unstable networks.

Table 2.10 The cost of the consumed energy by the light source of LEDL2 type

LED lanterns (type 2)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
ULSL-35	3879.40	12604	0.035	441.14	1277541	2539383	4.8	0.9
ULSL-50	3879.40	5079	0.05	253.95	735439	1461841	7.1	0.9
ULSL-70	3879.40	9190	0.07	643.30	1862997	3703099	9.6	0.9
ULSL-100	3879.40	8130	0.1	813.00	2354448	4679962	14.2	0.9
Total		**35003**		**2151**	**6230425**	**12384285**		

Modernization option #3 (LEDL3):

Table 2.11 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
KEDR SKU 50W	**HPSL 70-100, MAL-125**
KEDR SKU 75W	**HPSL-150, MAL-250**
KEDR SKU 100W	**HPSL-250, MAL-400**
KEDR SKU 150W	**HPSL-400, MAL 700-1000**

Advantages:

- Low consumption power of the light source – not more than 100W;
- High light efficacy – to 120 Lm/W;
- The power source is designed for operation in unstable networks;
- The energy savings are twice more than the MAL-type lamps;
- The quick lighting source replacement possibility without the lantern removal.

Table 2.12 The cost of the consumed energy by the light source of LEDL1 type

LED lanterns (type 3)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
KEDR SKU 50W	3879.40	12604	0.05	630.20	1825059	3627690	5.3	0.9
KEDR SKU 75W	3879.40	5079	0.07	355.53	1029615	2046577	7.9	0.9
KEDR SKU 100W	3879.40	9190	0.1	919.00	2661424	5290142	10.5	0.9
KEDR SKU 200W	3879.40	8130	0.2	1626.00	4708896	9359924	21.0	0.9
Total		**35003**		**3531**	**10224994**	**20324333**		

Modernization option #4 (LEDL4):

Table 2.13 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
SMKU-02-1-50	**HPSL 70-100, MAL-125**
SMKU-02-1-80	**HPSL-150, MAL-250**
SMKU-02-2-80	**HPSL-250, MAL-400**
SMKU-02-4-50	**HPSL-400, MAL 700-1000**

Advantages:

- Low consumption power of the light source – not more than 20W;
- High light efficacy – more than 90 Lm/W;
- The power source is designed for operation in unstable networks;
- The quick lighting source replacement possibility without the lantern removal.

Table 2.14 The cost of the consumed energy by the light source of LEDL4 type

LED lanterns (type 4)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
SMKU-02-1-50	3879.40	12604	0.05	630.20	1825059	3627690	5.7	0.88
SMKU-02-1-80	3879.40	14269	0.09	1284.21	3719072	7392441	9.1	0.88
SMKU-02-4-50	3879.40	8130	0.22	1788.60	5179789	10295917	22.6	0.88
Total		**35003**		**3703**	**10723917**	**21316047**		

Modernization option #5 (LEDL5):

Table 2.15 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
ST-50-04 50W	**HPSL-70, MAL-125**
ST-50-04 100W	**HPSL-100, HPSL-150, MAL-250**
ST-50-04 150W	**HPSL-250, HPSL-400, MAL-400**

Advantages:

- Low consumption power of the light source – not more than 15W;
- High light efficacy – more than 95 Lm/W;
- The power source is designed for operation in unstable networks;
- The power source is designed for 95-265W voltage;
- Energy consumption class "A+"

Table 2.16 The cost of the consumed energy by the light source of LEDL5 type

LED lanterns (type 5)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
ST-30-04 50W	3879.40	4257	0.03	127.71	369848	735151	2.7	0.9
ST-50-04 50W	3879.40	8347	0.05	417.35	1208646	2402438	4.5	0.9
ST-50-04 100W	3879.40	14269	0.1	1426.90	4132302	8213823	9.0	0.9
ST-50-04 150W	3879.40	8130	0.15	1219.50	3531672	7019943	13.5	0.9
Total		**35003**		**3191**	**9242468**	**18371355**		

Modernization option #6 (LEDL6):

Table 2.17 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
Jooby Cobra LED-KU 60/5000K-UHL1	**HPSL 70-100, MAL-125**
Jooby Cobra LED-KU 80/5000K-UHL1	**HPSL-100, MAL-250**
JOOBY Cobra LED-KU 120/5000K-UHL1	**HPSL-150**
Jooby Cobra LED-KU 150/5000K-UHL1	**HPSL-400, MAL 400, HPSL-150**

Advantages:

- High light efficacy – more than 110 Lm/W;
- The power source is designed for 85-265W voltage;
- DSTU IEC 60598-2-3:2009,
- DSTU IEC 60598-1:2002,
- DSTU CISPR 15:2007.
- Certificate UkrSEPRO

Table 2.18 The cost of the consumed energy by the light source of LEDL6 type

LED lanterns (type 6)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
Jooby Cobra LED-KU 60/5000K-UHL1	3879.40	12604	0.06	756.24	2190071	4353228	6.5	0.9
Jooby Cobra LED-KU 80/5000K-UHL1	3879.40	14269	0.08	1141.52	3305842	6571058	9.6	0.9
Jooby Cobra LED-KU 150/5000K-UHL1	3879.40	8130	0.15	1219.50	3531672	7019943	16.5	0.9
Total		**35003**		**3117**	**9027585**	**17944230**		

Modernization option #7 (LEDL7):

Table 2.19 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
LS-OPTIMAL LED 30W	**-**
LS-OPTIMAL LED 50W	**HPSL 70-100, MAL-125**
LS-OPTIMAL LED 100W	**HPSL-100, MAL-250, HPSL-150**
LS-OPTIMAL LED 150W	**HPSL-400, MAL 400, HPSL-150**

Advantages:

- High light efficacy – more than 100 Lm/W;
- The power source is designed for 85-265W voltage;
- The power source is designed for operation in unstable networks;

Table 2.20 The cost of the consumed energy by the light source of LEDL7 type

LED lanterns (type 7)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
LS-OPTIMAL LED 30W	3879.40	4257	0.03	127.71	369848	735151	3.0	0.9
LS-OPTIMAL LED 50W	3879.40	8347	0.05	417.35	1208646	2402438	5.0	0.9
LS-OPTIMAL LED 100W	3879.40	14269	0.1	1426.90	4132302	8213823	10.0	0.9
LS-OPTIMAL LED 150W	3879.40	8130	0.15	1219.50	3531672	7019943	14.4	0.9
Total		**35003**		**3191**	**9242468**	**18371355**		

Modernization option #8 (LEDL8):

Table 2.21 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
STELS (PSKS35)	**HPSL-70, MAL-125**
STELS (PSKS50)	**HPSL-100**
STELS (PSKS70)	**HPSL-150**
STELS (PSKS140)	**HPSL-250, MAL-250**
STELS (PSKS200)	**HPSL-400, MAL 400,**

Advantages:

- High light efficacy – more than 130 Lm/W;
- The power source is designed for operation in unstable networks;
- The power source is designed for 180-265W voltage;
- Energy consumption class "A+"

Table 2.22 The cost of the consumed energy by the light source of LEDL8 type

LED lanterns (type 8)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
STELS (PSKS35)	3879.40	12604	0.035	441.14	1277541	2539383	4.7	0.95
STELS (PSKS50)	3879.40	5079	0.05	253.95	735439	1461841	6.7	0.95
STELS (PSKS70)	3879.40	9190	0.07	643.30	1862997	3703099	9.4	0.95
STELS (PSKS140)	3879.40	8130	0.14	1138.20	3296227	6551947	18.8	0.95
Total		**35003**		**2477**	**7172205**	**14256270**		

Modernization option #9 (LEDL9):

Table 2.23 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
SDV 02-36 A1	**HPSL 70-100, MAL-125**
SDV 02-36	**MAL-250**
SDV 02-54	**HPSL-150**
SDV 02-72	**MAL400**
SDV 02-90	**HPSL-250**
SDV 02-108	**HPSL-400**

Advantages:

- High light efficacy – more than 115 Lm/W;
- The power source is designed for 180-280W voltage;
- The power source is designed for operation in unstable networks;
- Compliance with standards IEC 60598-1, IEC 60598-2-3, CISPR 15, IEC 61000-3-2, IEC 61000-3-3, IEC 61547

Table 2.24 The cost of the consumed energy by the light source of LEDL9 type

LED lanterns (type 9)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
SDV 02-36 A1	3879.40	17683	0.07	689.64	1997189	3969834	7.6	0.92
SDV 02-36	3879.40	2133	0.078	166.37	481819	957717	9.0	0.94
SDV 02-54	3879.40	7057	0.115	811.56	2350263	4671644	13.5	0.94
SDV 02-72	3879.40	8130	0.152	1235.76	3578761	7113542	18.0	0.94
Total		**35003**		**2903**	**8408032**	**15712738**		

Modernization option #10 (LEDL10):

Table 2.25 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
BGP303 LED73-3S/740 PSU II 42/60	**HPSL 70, MAL-125**
BGP303 LED122-3S/740 PSU II 42/60	**HPSL-100, MAL-250, HPSL-150**
BGP373 LED244/NW 220W 220-240V DM MP1	**MAL 400, HPSL-250**
BGP373 LED244/NW 220W 220-240V DM MP1	**HPSL-400**

Advantages:

- High light efficacy – more than 110 Lm/W;
- The power source is designed for 180-280W voltage;
- The power source is designed for operation in unstable networks;

Table 2.26 The cost of the consumed energy by the light source of LEDL10 type

LED lanterns (type 10)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
BGP303 LED73-3S/740 PSU II 42/60	3879.40	17683	0.058	1025.61	2970178	5903178	6.4	0.95
BGP303 LED122-3S/740 PSU II 42/60	3879.40	9190	0.108	992.52	2874338	5713353	10.2	0.95
BGP303 LED73-3S/740 PSU II 42/60	3879.40	8130	0.22	1788.60	5179786	10295917	22.0	0.95
Total		**35003**		**3807**	**11024302**	**21913125**		

Modernization option #11 (LEDL11):

Table 2.27 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
STREETLIGHT 30 44 W 3DIM	**HPSL 70, MAL-125**
STREETLIGHT 30 70 W 3DIM	**HPSL-100**
STREETLIGHT 30 88 W 3DIM	**MAL-250**
STREETLIGHT 30 105 W 3DIM	**HPSL-150**
STREETLIGHT 30 140 W 3DIM	**MAL 400, HPSL-250, HPSL-400**

Advantages:

- High light efficacy – more than 100 Lm/W;
- Fire-proof glass;
- Modern design;
- Swivel mounting;
- High reliability.

Table 2.28 The cost of the consumed energy by the light source of LEDL11 type

LED lanterns (type 11)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
STREETLIGHT 30 44 W 3DIM	3879.40	12604	0.044	554.58	1606052	3192367	4.65	0.98
STREETLIGHT 30 70 W 3DIM	3879.40	5079	0.07	355.53	1029615	2046577	7.5	0.98
STREETLIGHT 30 88 W 3DIM	3879.40	9190	0.088	808.72	2342053	3655325	7.4	0.98
STREETLIGHT 30 140 W 3DIM	3879.40	8130	0.14	1138.20	3296227	6551947	15.0	0.98
Total		**35003**		**2857**	**8273947**	**16446216**		

Modernization option #12 (LEDL12):

Table 2.29 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
WALK LED KU 40W/750-01	**MAL-125**
AVENUE LED KU 80W/750-01	**MAL-250**
AVENUE LED KU 135W/750-01	**MAL 400**
WALK LED KU 45W/750-01	**HPSL 70**
AVENUE LED KU 70/750-01	**HPSL-100**
AVENUE LED KU 120/750-01	**HPSL-150**
HIGHWAY LED KU 200W/750-01	**HPSL-250**
HIGHWAY LED KU 340W/750-01	**HPSL-400**

Advantages:

- Power supply voltage: 110 … 260W (50Hz)
- Color temperature: 5000 K (cold white heat)
- Type LDC – L
- Color transfer index: 70 Ra
- Power coefficient: 0.9
- Angle of mounting on the plate: 10 … 30 degrees
- Sealed housing provides protection IP65
- Resource at 12 hours operation – not less than 10 years

Table 2.30 The cost of the consumed energy by the light source of LEDL12 type

LED lanterns (type 12)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
WALK LED KU 40W/750-01	3879.40	12604	0.04	504.16	1460047	2902152	4400	0.95
AVENUE LED KU 80W/750-01	3879.40	2133	0.08	170.64	494173	982274	9200	0.95
AVENUE LED KU 70/750-01	3879.40	5079	0.07	355.53	1029615	2046577	8000	0.95

Continuation of Table 2.30

LED lanterns (type 12)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed energy, UAH	Nominal light flux, thousand Lm	Lamp's efficiency
AVENUE LED KU 120/750-01	3879.40	7057	0.12	846.84	2452449	4874759	13800	0.95
HIGHWAY LED KU 200W/750-01	3879.40	8130	0.2	1626.00	4708896	9358824	23000	0.95
Total		**35003**		**3503**	**10145180**	**20165686**		

Modernization option #13 (LEDL13):

Table 2.31 Replacement comparison table

The lamps type of the lantern	The lamps type of the lantern
L-STREET 24	**MAL-125 HPSL 70**
L-STREET 48	**HpSL-100, MAL-250**
SUPER STREET 110	**HPSL-150**
SUPER STREET 150	**HPSL-250 MAL 400**
SUPER STREET 340	**HPSL-400**

Advantages:

- Power supply voltage: 140 … 265W (50Hz)
- Color temperature: 5000 K (cold white heat)
- Light efficacy – more than 100 Lm/W
- Color transfer index: 70 Ra
- Power coefficient: 0.93
- The housing provides protection IP66
- Operational temperature – 60+ 50ºC

Table 2.32 The cost of the consumed energy by the light source of LEDL13 type

LED lanterns (type 13)	Tav., y.	Number of lamps	Lamp's power	Load, kW	Consumption, kWh/year	Cost of the consumed	Nominal light flux, thousand	Lamp's efficiency

						energy, UAH	Lm	
L-STREET 24	3879.40	12604	0.04	504.16	1460047	2902152	4662	0.9
L-STREET 48	3879.40	7212	0.08	576.96	1670876	3321219	9324	0.9
SUPER STREET 110	3879.40	7057	0.12	846.84	2452449	4874759	12780	0.9
SUPER STREET 340	3879.40	8130	0.344	2032.50	5886120	11699905	35500	0.9
Total		**35003**		**3960**	**11469492**	**22798035**		

2.2.4 Estimation of resource saving from the modernization of lighting system project implementation

Basing on the given data, the average cost of all proposed "equivalents" of LED lanterns was calculated, and the approximate average cost of replacement of lanterns with gas-discharge lamps was determined, and the following indicators were calculated:

- Estimated expenses for electricity savings:
  Due to the fact that existing street lanterns with mercury, gas discharge lamps are energy-consuming and dangerous, of which:

- 15% of lanterns do not meet the operational requirements and are in an unstable state of operation (are often repaired);
- 90% of street lanterns do not meet current requirements and standards for high-quality energy-saving lighting.

- Estimated operational expenses savings:

The results expected after implementation of the complete set of elements of the project (figures are conditional and need to be clarified according to the design decisions):

- The decrease of energy consumption by the external lighting networks more than 60%, which is **14266590** kW per year in the following comparison:

In the quantitative display of energy consumption:
In the actual state is **23289650** kW per year;
After implementation is **9023060** kW per year.

- The decrease of the budget funds for the energy supply more than 60%, in the monetary equivalent – **27062465** UAH, in the following comparison:

In the actual state is **44997701** UAH per year;
After the lanterns replacement is **17935236** UAH per year.

The 20% decrease of expenses for the LED lamps maintenance, that is **2472682** UAH per year in the monetary equivalent in the following comparison:
The amount of funds in the actual state – **12363410** UAH per year;
The amount of funds after the lanterns replacement – **9890727** per year.
The savings are possible due to:

- The LED lanterns, unlike lanterns with the MAL and HPSL lamps, do not require the cleaning of the protection glass or its replacement;
- The LED lanterns do not require the further recycling;
- The LED lanterns do not require the frequent replacement;
- The maintenance of the LED lanterns decreases the usage of the combustible and lubrication materials at the decrease of the drives for the lighting points handling.

2.3 Component 2 - Modernization of control cabinets and ETL replacement

2.3.1 Statement of component need

Works on the introduction of new LED lanterns do not end only with the physical replacement of the lantern. To achieve the maximum effect from implementation, it is necessary to ensure reliable and safe performance and operation. For these purposes, it is necessary to establish a system of supply, management and communication with the control center.
During the implementation and modernization of external lighting systems, the work is carried out with the use of modern technologies and materials, the introduction of automated control systems for external lighting, which will reduce the expenses for control, the lighting systems switching on/off, as well as use zoning per work hours of a day (3- zones schedule) for payment of consumed electricity, which will reduce the expenses of money in this direction.

Measures for the reconstruction and modernization of external lighting systems include the replacement of existing power supply points with new ones, the modernization of dispatch control panels, the creation of control systems based on new software using electronic charts and information obtained during the inventory of external lighting systems.
The main goal is the energy saving - reducing the consumption of electricity and the economic effect, which is achieved at the expense of several factors:

- the use of energy saving LED lanterns,
- automatic control of the consumption of the lanterns, considering illumination,
- lighting control according to the criterion of presence,
- "scheduled" lanterns controlling from the server.

Energy saving

Savings on payment for electricity from the implementation of the street lighting control system were considered in the calculation of electricity consumption by LED lanterns. This saving is due to the reducing of electricity consumption.

Due to the street lighting control system, external lighting can be adapted to various changes. The separate lanterns can be flexibly combined into separate groups, which light the streets and pedestrian crossings. The street lighting control system also allows controlling the operation of separate lanterns and managing them both individually and in groups, depending on the specific purpose

Energy saving and reduce of operational costs
The street lighting control system allows influencing the energy consumption and CO_2 emissions. It is possible to get rid of unnecessary energy losses because the lighting is switched on without the need, regulating the power of light in certain areas of urban development, on separate roads, or even in separate lanterns. Thus, lighting management allows achieving effective and constant energy savings of up to 50% per year. Street lighting control system also affects maintenance costs: the system offers functional possibilities for centralized continuous monitoring and analysis of the light installation, which greatly simplifies the maintenance planning process.

The economic effect of implementing a city lighting control system is ensured by:

- strict compliance with the schedule of switching on, the absence of a human factor in the operation of the system in automatic mode;
- the presence of informational feedback on the necessary mode switching on, which allows shortening the time of the response of the dispatcher to an emergency;
- Remote control of operating modes allows excluding drives, related to checking the lighting switching on and off;
- the possibility of setting the schedules individually by regions (for example, "outskirts" and "center") with optimally selected shifts in the time of inclusion and exclusion;
- remote technical consideration of energy consumption, which allows shortening the working time and transport expenses necessary for drives to take readings;
- the ability to detect changes in power consumption, allowing to quickly detect unauthorized connections;
- using algorithms for optimal coding of information, which allows reducing the size of the most frequently transmitted data packages and thereby reducing the time of transmission of information.

Enhancement of safety

Lighting should be reliable, especially important is: the resistance to current emissions and the impact of weather conditions, as well as the protection of communications lines between distribution cabinets and a lantern. Power distribution cabinets are intended for receiving and distributing electric energy of three-phase alternating current in distributive networks with a dead earthed neutral of residential buildings, constructions and public buildings, as well as for the protection of outgoing lines from overloads and short-circuit currents.

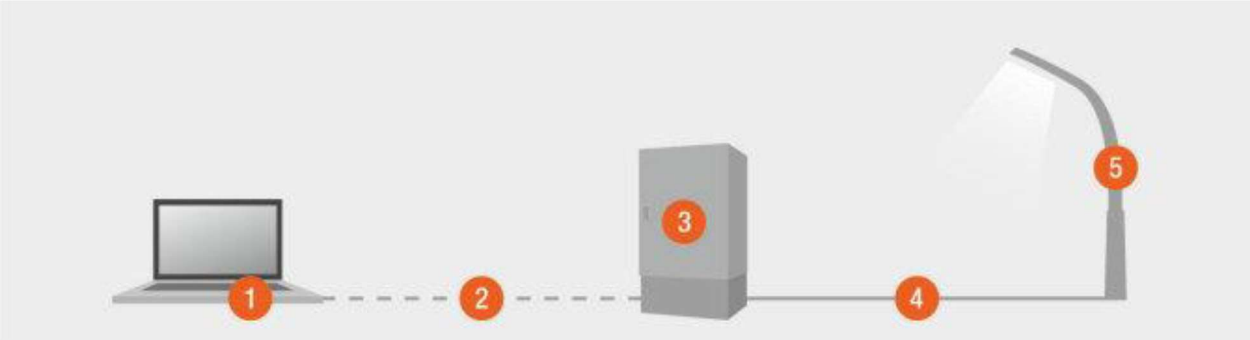
They are designed for installation in residential, housing or public facilities. In most cases, they are made in the form of metal cabinets of one-sided service, hinged or sloping.

2.3.2 The detailed component description

The project provides the replacement with the modernization of all old cabinets of external lighting control with new cabinets with integrated control elements and information exchange with a dispatching system in the amount of 258 pieces for the management and taking readings from new LED lanterns.
As a result of the implementation, a mechanism for introducing the remote control of the external lighting objects through the radio channel with data processing by computer technology and control from the central dispatching panel will be created and implemented, which will allow efficient use of energy resources with the appropriate provision of a stable level of service quality; to reduce expenses connected with maintenance of networks of an external illumination; have the opportunity to quickly regulate electricity consumption; minimize the human factor; to obtain a stable, clearly defined operation of the system of external lighting; quickly detect and eliminate defects, malfunctions, accidents.

Efficient remote control of the LM network operating modes is based on the application of GSM/GPRS technologies and allows quick receiving of information about the current state of equipment and its operating modes.

Figure 2.2 Lighting system and its components:



1. **Software**
   - Central interface between the user and the interactive system
   - Management, programming and operation analysis of the lighting system
   - An individual user can see only the distributed functional areas
2. **Internet protocol (IP)**

The connection between the program and the gateways at the street level is through a secure IP connection using GPRS, Ethernet or fiber optic cable.

3. **Distribution cabinet**

Protection of equipment from overloads, short circuits, etc.
Each cabinet is equipped with electricity, relay and automation accounting equipment. Also there are the integrated devices for storing, processing and broadcasting of management commands and queries issued by the program from the control point.

4. **Power channel**

It provides the power supply, data exchange between the cabinet and the lanterns (as provided).

5. **LED lantern**

The controllers of each lantern perform the functions of power supply, protection, control and management of the lanterns operation.
It is possible to conduct the commutation of the separate lanterns.

The control cabinet

New street light control cabinets provide the possibility of management of four groups of external lighting:

- External street lighting:
  - Night (emergency);
  - Evening;
- Architectural lighting of the buildings and constructions;
- Sign lighting.

The electrical energy accountancy is performed in accordance to the project by the direct or transformer switching meters.

The outgoing lines protection is performed by:

- The automatic switchers;
- Safety cut-offs.

Inclusion point terminal

The inclusion point terminal is a special device, designed for the performance of the automation tasks of the urban lighting objects.

The terminal, as a part of the urban lighting control system, can be provided by the company as a part of new cabinets and the existing lighting cabinets (modernization).

The terminal has the possibility:

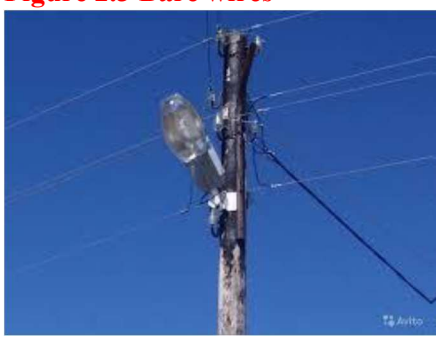
- control of the presence of voltage at 15 points of the executive point;
- control of the opening of the entrance door of the cabinet of the execution point;
  control of two executive devices (contactors), in accordance with the program of autonomous work (schedule of switching on) or the operational commands of the dispatch center;
- establishment of individual shifts for the events of the autonomous schedule of switching on, for each event, within a day with a one-minute step;
- data reception via RS-485 port and other interfaces (current loop, RS232) from the electric energy meter;
- To carry out two-way exchange of data packages with the dispatch center through GPRS, CSD and DTMF-packages in the voice path;
- implementation of the remote setting for a specific configuration of the switching point (number of safety cut-offs, contactors, etc.);
- connection of digital interfaces expansion plates.

To enhance reliability, the terminal is equipped with a watchdog timer that controls the execution of the main terminal program. The terminal is equipped with two sources of backup power. The first one provides all chains of the terminal with stand-alone power supply for 5 hours, the second one is designed for supplying the real-time clock (RTC) chains that are part of the terminal.

Replacement of cable-conductor products

The air electric power lines are made with an insulated wire, the average length of operation is over 30 years, morally outdated and physically worn. The operational life of cable networks is 30 years. The airlines wires are physically obsolete and with increased wind load, as well as under the influence of solar radiation and precipitation, also become unworthiness. Bare wires often close and are dangerous for operation.

Figure 2.3 Bare wires



The project provides the replacement of the uninsulated airline power supply system with the self-supporting insulated wire, that will increase the lighting system network reliability and operational safety. The self-supporting insulated wire: a strand for the air electric power lines, which has the insulated cores and the bearing element, designed for the fastening or suspension of the wire.

The main purpose of the SSIW is the transmission and distribution of the AC electrical power in the lighting networks and the power networks of 0.4-1 kW voltage.

Фазная токопроводящая жила – metal clad conductor
Нулевая жила, несущая, неизолированная – Neutral conductor, bearing, uninsulated
Стальной сердечник – steel core
Изоляция - insulation

The SSIW has become widely used during the construction of the main air electric power lines and various branches to the inputs to the dwelling premises and utility buildings.

It is a harness twisted from the insulated phase conductors, made from aluminum and the neutral bearing conductor. The phase conductors are equipped with the insulation, made from the light-stabilized high-pressure polyethylene, painted black, which is resistant to ultraviolet radiation. In the center of the neutral conductor there is a steel core, twisted around with the aluminum wires.

The main advantages of the SSIW are:

- Possibility of construction of the electric power line without cutting of the fire-breaks;
- the possibility of a joint suspension with a telephone line on the supports;
- the possibility of using of existing supports and supports of lower height for new lines;
- reduction of operating costs by eliminating the replacement of damaged insulators;
- reduction of volumes of emergency repair works;
- high reliability and uninterrupted power supply of consumers;
- reduction of operating costs due to the elimination of systematic clearing of tracks, replacement of damaged insulators, reduction of volumes of emergency repair works;
- service safety - no risk of damage when contacting the phase wires that are under voltage;
- Possibility of work under voltage, simplicity of repairs;
- practical impossibility of short circuit between phases and neutral wire or on the ground;
- less weight and long duration of snow sticking, increased reliability in areas of intense ice formation;
- safety of works near the SSIW lines;
- reduction of voltage drops due to small reactive resistance - 0.1 Ohm/km (0.35 Ohm/km - bare wire);
- the possibility of laying on the buildings facades;
- the possibility of the join laying on the same supports of the AL and SSIW to 1 kW and the AL 6-10 kW

2.3.3 The quantitative characteristics and valuation

The project provides the replacement and modernization of all old control cabinets of the external lighting with the new cabinets with the control elements and the data exchange with the dispatch system in the number of 258 items for the management and the readings taking from the new LED lanterns.

The expenses for the cabinets and terminals purchase are:

The average cost of a single telemechanical complex is 73000 UAH.

*258 items * 73000 UAH = 18834000 UAH*

The expenses for purchase and laying of the cable and wiring products are:

*91000 UAH/1 km * (480 km + 506 km) = 89726 thousand UAH*

The average cost of 1 km of bare wire replacement with the SSIW cable is 91 thousand UAH/1km

2.3.4 Estimation of resource saving from the modernization of control cabinets and ETL replacement

The predicted savings of the operational expenses:
The expected results after the modernization of the control cabinets and the ETL replacement:

- the 20% decrease of the expenses for the electric power distribution by the external lighting cabinets, that is **4003541** kW per year;
- the 10% decrease of the expenses for the electric power transmission in the lighting systems networks due to the decrease of the lighting installations power, that is **2328965** kW per year.

2. FINANCIAL AND ECONOMICAL ASPECTS

3.1 General approach

A comprehensive financial forecast model has been prepared, which includes a forecast statement of a cash flow, earnings and highlight report, and a project-specific coefficient based on the specification for the duration of the planning period.

The reference conditions for financial forecasting are the estimated investment costs of the project, forecasted income in the form of savings from the introduction of new technologies and financial conditions. The financial model calculates the forecast of the development of the suggested Project and determines its effectiveness.

The financial efficiency of the project is defined as the ability of the company to meet its operational costs and debt service costs throughout the project implementation period. The main indicators of the economic viability of the project are:

- Net Present Value (NPV> 0);
- The internal rate of return is higher than the discount rate (IRR> Dr);
- The ability of the project to generate and maintain positive cash balances throughout the whole planning period;
- The project's ability to maintain a debt service ratio (DSCR) of 1.35 or higher over the loan maturity (which is expected to be the standard value in accordance with the loan agreement between the Borrower and the Credit Institution).

2.2 Method of discounting of cash flows

The prepared for the analysis comprehensive financial forecast model uses the discounted cash-flow model, SCF (Discounted cash-flow).

This method is based on the concept of the present value of future cash flows of the estimated project in terms of separate periods. Using this method, the corresponding investment decisions are made on the basis of the comparison of absolute values: the present value of income and expense cash flows that are the result of investments within a specific project. At the same time, the discount rate, which is used in calculations of the present value, is given.

The appropriateness of financial investments to the project is determined by bringing to the present value of the expected net cash flows from investing and comparing the total value of these flows with the size of investments (including expenses for the use of borrowed capital, if it is planned). The resulting indicator is one of the main indicators in the project evaluation by the DCF method: Net Present Value, NPV. When comparing the projects at other equal conditions, the alternative projects with a higher NPV are more preferred.

Another significant indicator is IRR, Internal Rate of Return (IRR). The IRR can be defined as a discount rate at which NPV of a project is zero. Thus, the IRR can be considered as indicating the economic feasibility of investing the project under IRR> 0. In this case, the projects with a higher IRR under other equal terms are more preferred.

The above indicators are key to analyzing a portfolio of projects, in a situation where there are several projects that claim limited investment. The calculation of NPV and IRR for various projects allows a fairly aLEDLurate comparison of the economic potential of alternative projects. It is not recommended to use these indicators separately, because there are situations when, for example, at NPV1> NPV2, the company prefers the second option because, despite a larger discounted cash flow, the profitability of the second project is greater simply because of different scale of projects (project 1 is much larger than project 2). That is, the NPV represents a quantitative estimation, as opposed to the IRR, which reflects the profitability of the project, but does not show the scale of the project. One can imagine a situation when IRR1> IRR2, and project 2 is simply very small in size and rejected by a major investor. In this way, the NPV and IRR are complementary.

The discount rate describes the rate of return for which future cash receipts are brought to their present value at the time of valuation. It takes into aLEDLount the investing risk premium of in an assessed enterprise: the higher the risk, the higher the discount rate.

There are different approaches for setting a discount rate.

One of the options is to calculate the discount rate for the purpose of assessing the value of an enterprise based on the use of the weighted average cost of capital model (WALEDL).

Another option is to calculate the discount rate as the sum of its two main components:

1) interest rate with minimum risk (or risk-free): it is recommended to calculate, based on the average market yield on deposit investments; interest rates on hryvnia deposits adjusted for the average annual inflation rate set in them, or rates on foreign currency deposits can be used;

2) cumulative risk premium, which includes various allowances for the risk of investments in a specified enterprise, the premiums also can be provided for:

inaLEDLuracy of forecasting of expected cash flows;
capital structure risk;
high level of current debt;
the risk of false management decisions, the risk of the enterprise's situation deteriorating at the market of factors of production and marketing;
inflation risks (depending on the expected inflation rate).

Attention should be drawn to the need to agree the calculation of the discount rate with the type of expected benefits that are attributed to present value: if future income or cash flows are calculated on the basis of tax payments, the discount rate should also be adjusted for the effect of the tax factor (for example, WALEDLs). On the contrary, pre-tax benefits should be discounted at a rate calculated without the tax rate consideration.

The discount rate was determined by the second method, based on the interest rate on bank loans as determined by the National Bank of Ukraine[2] (8.8%, as of March 2017) and inflation in the Eurozone[3] (1.5% as of March 2017) in the drafted financial model for this project. Thus, the discount rate is 7,19%.

The financial model is actually analyzed by the difference between the current state without the implementation of the project (using the old types of street lighting lamps) and the project implementation scenario (predicted state, taking into aLEDLount the installation of energy efficient and ecological LED lanterns). Implementation of the project results in lower operating costs, which is interpreted in the model as a revenue part.

The LED lanterns of 13 Ukrainian manufacturers were analyzed and compared in the financial model, by which the preliminary price data was received. Their main characteristics, including electricity consumption and estimated costs, were determined. To assess the overall economic feasibility of introducing of new types of lighting, an average set of characteristics was created, a conditional LED lantern was taken as a benchmark. Further calculations were conducted with this benchmark in the financial model.

[2] http://www.bank.gov.ua/files/4-Financial_markets.xls
[3] http://ec.europa.eu/eurostat/statistics-explained/index.php/Inflation_in_the_euro_area

2.3 The situation in Ukraine

Table 3.1 The GDP dynamics in Ukraine since 2002 till

	Nominal GDP (in mln. UAH)			GDP (in mln. USD)		
2002	225810			42393		
2003	267344	+41534	+18.4%	50133	+7740	+18.3%
2004	345113	+77769	+29.1%	64883	+14750	+29.4%
2005	441452	+96339	+27.9%	86142	+21259	+32.8%
2006	544153	+102701	+23.3%	107753	+21611	+25.1%
2007	720731	+176578	+32.5%	142719	+34966	+32.5%
2008	948056	+227325	+31.5%	179992	+37273	+26.1%
2009	913345	-34711	-3.7%	117228	-62765	-34.9%
2010	1082569	+169224	+18.5%	136419	+19192	+16.4%
2011	1316600	+234031	+21.6%	163160	+26740	+19.6%
2012	1408889	+92289	+7.0%	175781	+12622	+7.7%
2013	1454931	+46042	+3.3%	183310	+7529	+4.3%
2014	1566728	+111797	+7.7%	131805	-51505	-28.1%
2015	1979458	+412730	+26.3%	90615	-41190	-31.3%
2016	2383182	+403724	+20.4%	-	-	-

The source: http://index.minfin.com.ua/index/gdp/

As it is shown in the Table 3.1, Ukraine is in the deep crisis since 2014. The real GDP in USD significantly dropped in 2014 and 2015. In 2016 the fall slowed down, but didn't stop.

Figure 3.1 The consumer price index: Ukraine and the Donetsk region, %

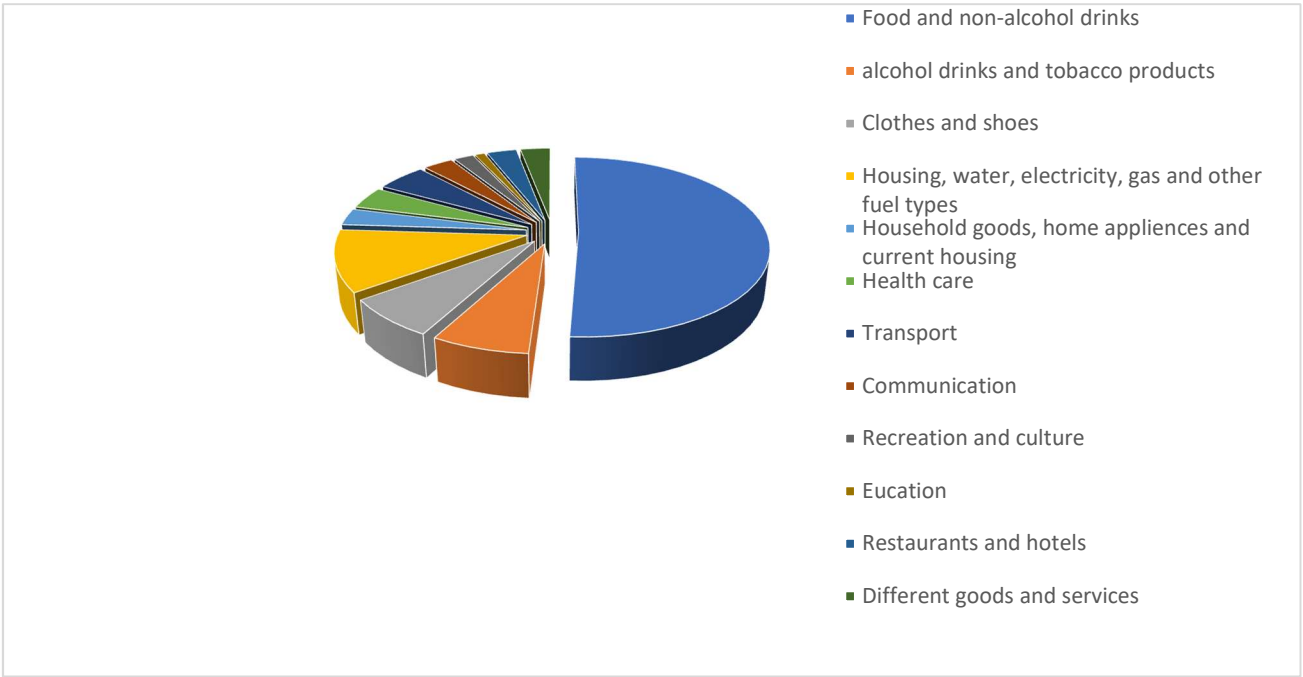
In Mariupol city, since 2009 till 2015, the consumer price index repeated the overall dynamics of the country. For details see figure 3.1. At the same time, the price index was gradually decreasing after the financial crisis of 2008 and till 2013-2014. In 2015 a quick increase oLEDLurred due to the unfavorable external and internal factors in the country.

Figure 3.2 the consumer price index: the general index and the price index for the housing, water, electricity, gas and other fuel types, %

Джерело: https://bank.gov.ua

In 2014, and especially in 2015, due to internal instability, the fall of the hryvnia, energy sources shortages, the Consumer Price Index for “Housing, Water, Electricity, Gas and Other Fuels” significantly jumped, even in comparison with the general increase in the consumer price index in Ukraine. This is shown in Fig. 3.2:

Figure 3.3 the structure of the consumer price index in 2016 and the place of prices for housing, water, electricity, gas and other fuel in it



Source: http://bank.gov.ua

As can be seen from Fig. 3.3, the component of the section "Housing, water, electricity, gas and other fuel types" from 11.3% in the total consumption, is the second largest after food products with 50.8%. This once again confirms that in recent years the population has been in a very vulnerable social position, if more than

half of the income is spent on the most basic needs on average in the country. Thus, it is difficult to overestimate the importance of reducing or preventing higher tariffs for housing and communal costs. The importance of projects related to social infrastructure is extremely important for the country.

2.4 Basic forecasting assumptions

The object of forecasting

The financial model aims to determine the economic feasibility of replacing old street lighting with new LEDs, taking into aLEDLount the costs of installing new LED lanterns, replacing control cabinets (telemechanical complex), debugging and other costs.

Year of the project beginning - 2017.
The project's forecast was based on 100% of financing at the expense of loaned funds.

Depth of planning
The depth of planning is 22 years, that is 2017-2038. The loan payment takes place before the maturity of the loan expires. Investments are expected to be realized in the period 2017-2019. The loan is finally repaid according to the calculations in 2026.

Loan term
The loan term (maximum) is set at length of 15 years. During this period, the borrowed loan must be repaid. According to calculations, the loan is returned in 10 years.

Price level
The analysis is conducted in current (real) prices. Inflation is considered by converting the nominal discount rate in real terms.

The currency used in the analysis
The analysis is conducted in Ukrainian Hryvnia (UAH). It is assumed that all components of the project are paid in hryvnias (UAH). Credits received from international financial institutions are provided and are spent in euros (EUR). Repayment of principal and interest payments are made in euros.

Replacement of basic assets
The forecast does not include a substitution estimation of replacement assets during the planning period.

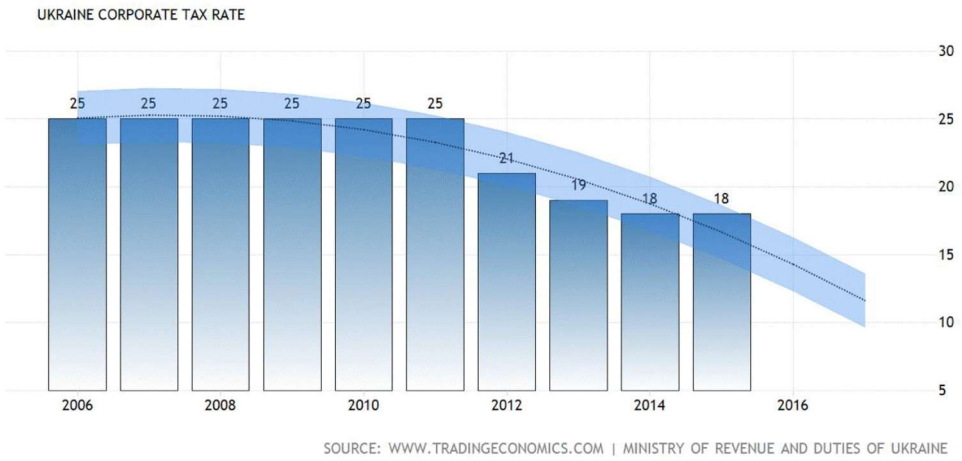
Debt service ratio
The project is supposed to meet the target financial indicators set by the project investors. It is assumed that the company must maintain a debt service ratio (DSCR) of at least 1.35 over the maturity of the loan.

Value Added Tax (VAT)
The VAT rate is currently 20%. Revenues and expenses in the financial model are expressed in amounts with VAT. In addition, most of the investment costs will be subject to VAT, which should be paid with the incoming VAT on sales. It is expected that VAT will only have a short-term effect on company liquidity in certain periods.

Corporate income tax
Corporate income tax in Ukraine is currently 18%. In the long run, the tax rate is projected to remain at 18.00 percent till 2020[4]. For modelling purposes, this rate was used for the entire depth of planning.

[4] Source: http://www.tradingeconomics.com/ukraine/corporate-tax-rate/forecast

Figure 3.4 The income tax rate forecast after 2016



Loan terms

The company was assumed not to have existing loans or other long-term financial obligations. The approximate financing plan for the project provides to 13.94 million EURO (UAH 439.0 million) of loan with 100% of the financing involved.

The terms have not yet been completed in a loan agreement between the Company and the Borrower. For the sake of financial analysis, the following loan conditions are foreseen:

- share of the loan: 100%
- loan currency: EUR
- loan type: credit line
- Duration (max): 15 years
- grace period: 3 years
- Interest: EURIBOR + 2.5% per year
- one-time fee for opening a loan: 0.5%

At the time of preparation of the financial model, the data at the beginning of the month (02.05.2017) for the 9-month and 12-month EURIBOR rates were, -0.179% and -0.129% respectively. Under terms of lending, in the case of a negative EURIBOR rate, its value for the calculation of the loan rate is taken at the value of 0%. Thus, the loan rate is 2.5% in the economic model.

Overdraft

The model includes the ability of the project's aLEDLess to overdraft, covering the temporary lack of funds in the project, except for the principal loan. Overdraft conditions are given below:

- Overdraft currency: UAH
- Overdraft rate: 24%
- Overdraft is fully paid in a year after receipt

Capital expenses

The financial model reflects the introduction of energy effective measures related to investment costs, which are planned to be carried out in the period from 2017 to 2019, which should lead to a decrease in annual electricity expenses, operating costs, etc.
Capital expenses are detailed in Table 3.3.

Table 3.2 Capital expenses cost, million UAH

Indicator	Cost
Equipment, materials, components	330.0
Permission documentation	9.0
Feasibility Study and the project works	10.0
Mounting and adjustment works	90.0

Total capital expenses	439.0

Table 3.3 Quantitative and cost indicators of the capital expenses, thousand UAH

Indicator	General cost	2017	2018	2019
Energy audit, Feasibility study and the project works development	**40.0**	40.0	-	-
Purchase of the street lanterns, equipment and materials	**100.0**	34.2	34.2	31.7
Dismantlement of the current LEDL, installation of new LEDL and equipment	**200.0**	68.3	68.3	63.3
Street lighting system adjustment	**90.0**	30.8	30.8	28.5
Results assessment: quantitative and qualitative	**9.0**	3.1	3.1	2.8
Total capital expenses	**439.0**	**176.3**	**136.3**	**126.3**

Amortization

For purposes of income tax calculating, the model includes the calculation of capital investments amortization.

Calculation of amortization is based on assets' value-added use. The existing tax legislation of Ukraine (Tax Code, Article 138.3.3.) defines 16 categories of fixed assets and their minimum acceptable amortization periods. There are several amortization methods that can be used for both accounting and tax purposes. In this financial model, a straight-lined method is used for all amortized fixed assets.

The main object of investments is equipment and facilities with an operational life of up to 10 years, including for modeling purposes, in groups of amortizations: group 3c is 86%, and group 3b - 14% of the total volume of investments in basic assets.

Table 3.4 The basic assets amortization

Group	Description	Minimum period of value-added use, years	Share in general amount of investments
3a	Constructions	20	0%
3b	Equipment	15	14%
3c	Devices	10	86%
4	Machines and equipment	5	0%

Operational costs

Operational costs for the planning period are expressed in real terms. The model considers operational costs without project implementation (current state) and implementation of the project. The difference between current and possible scenarios leads to decrease of operational costs and is treated in the model as a revenue part. Table 3.5 provides the main indicators of street lighting operation.

Table 3.5 Main indicators of the street lighting operation

Indicator	Value	Units
Electricity tariff[5] since November 1, 2016 (incl. VAT)	2.318508	UAH/kW*h
Coefficient, used for the tariff – Peak	0.25	Part
Coefficient, used for the tariff – Half-peak	1.02	part
Coefficient, used for the tariff – Night	1.8	part
Average annual operational hours of the lamps per year	3979.4	Hours/year
Average annual operational hours of the lamps per year – Peak	1005	Hours/year
Average annual operational hours of the lamps per year – Half-peak	906	Hours/year
Average annual operational hours of the lamps per year - Night	1970	Hours/year
Number of new lanterns to be mounted	35003	It.
The street lighting lamp utilization (old, except mercury)	2.50	UAH/it.
The street lighting lamp utilization (old, mercury)	9.60	UAH/it.
The street lighting lamp utilization (new)	0.00	UAH/it.
Annual operational expenses per lighting point (existing lanterns)	353.07	Hours/year

To assess the overall economic feasibility of introducing of the new types of lighting, an average set of characteristics was created - a conventional LED lantern, taken as a benchmark. The calculations in the financial model were conducted with this benchmark.

Existing lanterns of different types (mostly mercury and sodium), which are planned to be replaced, consume 22214 thousand kWh/year.

To replace with more economical, LED lamps of 13 Ukrainian manufacturers with corresponding technical characteristics were analyzed and compared. Table 3.6 compares the consumption of old and new lanterns, the cost of annual electricity consumption, and the cost of modernization for LED lighting.

[5] http://donetskoblenergo.dn.ua/2009-01-25-14-18-54/51-2012-05-07-08-11-17/3202--c-1-2017-.html

Table 3.6 The comparison of consumption and cost of 13 types of the LED and existing (old) lanterns

LED lantern type	Consumption, 1000*kWh/year	Cost of the consumed electrical energy thousand UAH/year (without VAT)	Cost of the lanterns, thousand UAH (without VAT)
Existing lanterns (of different types)	**22214**	**42490**	**N/A**
Modernization option #1 (LEDL1)	5954	11835	129428
Modernization option #2 (LEDL2)	6014	11955	50142
Modernization option #3 (LEDL3)	9916	19710	225332
Modernization option #4 (LEDL4)	9535	18953	74773
Modernization option #5 (LEDL5)	8934	17757	50411

Continuation of Table 3.6

LED lantern type	Consumption, 1000*kWh/year	Cost of the consumed electrical energy thousand UAH/year (without VAT)	Cost of the lanterns, thousand UAH (without VAT)
Modernization option #6 (LEDL6)	8198	16295	80406
Modernization option #7 (LEDL7)	8934	17757	58072
Modernization option #8 (LEDL8)	6956	13827	92868
Modernization option #9 (LEDL9)	8167	16234	168735
Modernization option #10 (LEDL10)	10715	21299	177159
Modernization option #11 (LEDL11)	8002	15906	N/A
Modernization option #12 (LEDL12)	9898	19675	83109
Modernization option #13 (LEDL13)	11222	22307	168323
Averaged modernization option (benchmark)	**8650**	**16036**	**113230**

Operating income

Planned cost of 1kWh in 2017 is: 2.3185[6] UAH/kWh (with VAT).

Project revenues are generated by saving from the introduction of energy effective technologies in the form of reducing of the volume of electricity consumption, reducing of operational and other costs of maintaining street lighting, which should compensate the initial investment costs. Taking into account the unstable internal and external economic situation, the financial model assumes 10% annual growth of the planned average cost of 1 kWh from 2018. This script is considered as basic. For information, in 2015 and 2016, the tariffs were 20% and 31% raised respectively.

Taking into account the average deviation of prices from suppliers, the averaged cost option (benchmark) of lanterns will be 113230 thousand UAH without VAT, or 135876 thousand UAH with VAT, excluding lanterns mounting costs.

The calculation of the operating costs of new LED lanterns is based on the assumption that the average operational life of new LED lanterns is 50 thousand hours, which is almost 4 times more than the average operational life of existing lamps of the old type.

In general, the introduction of new lanterns is expected to receive a cumulative economic effect from the following sources:

- Reduced electricity consumption by lanterns
- Elimination of the need to purchase and replace old lanterns (as opposed to the expenses for purchasing new lanterns)
- Reduction of electricity consumption as a result of replacement and modernization of control cabinets (telemechanical complexes), including due to the possibility of accurate adjustment of lanterns by time, brightness of illumination (dimming), etc.
- Reduced costs for annual maintenance of light bulbs

[6] The resolution of NKREKP of 23.12.2016 No 2358

- Reduced power losses because of the load decrease on electric lines
- Revenues from the sale of old lanterns as scrap metal

Table 3.7 Economic model revenues' sources, thousand UAH/year[7]

Indicator	Amount
Energy consumption savings from the introduction of new LEDL	28 964
Savings from avoidance of the alternative expenses for the old type lamps purchase	1 547
Losses decrease in the main lines (to 20%) due to the replacement and modernization of the control cabinets	7 735
From the cut of expenses for the lighting point handling	2 060
From decrease of load in lines (to 10%)	1 604

Moreover, the sale of the old lamps to metal scrap is planned with obtaining the revenue in the amount of 1094 thousand UAH.

Summary comparison table of the expenses for the old and new lanterns handling (benchmark option of modernization) is provided in Table 3.8.

Table 3.8 The comparison of the expenses for the old and new lanterns handling, which leads to savings (revenue side)

Indicator	New LEDL lanterns (benchmark)	Old lamps	Units
Average weight lanterns' resource by types	50 000	12 892	hours
Periodicity of the existing lamps/lanterns replacement	17,8	4,6	years
Average weight replacement coefficient by lamps/lanterns types	0,06	0,22	Times per year
Operational costs	9 887	12 359	Thousand UAH/year
Utilization of old lamps costs	–	1 023	Thousand UAH

Planning

The model provides that the investment costs are conducted in the period from 2017 to 2019. The detailed forecasting financial model, which includes the forecasting report on the cash flows, the income report and the basic indicators and the project's coefficients are provided in Table 3.8.

[7] After the secondary implementation of the project and in the terms of the absence of the annual increase of the electrical energy cost

Table 3.9. Executive summary on the project of the street lanterns replacement with the LED lanterns (benchmark)

ALL FIGURES ARE IN THOUSANDS OF UAH, EXCEPT OTHERWISE SPCIFIED

Years		Total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
National Measures																								
Exchange course, UAH/EURO			30.74	31.66	32.45	33.26	33.93	34.43	34.78	35.13	35.30	35.48	35.66	35.83	35.83	35.83	35.83	35.83	35.83	35.83	35.83	35.83	35.83	35.83
Energy cost																								
Energy cost growth ratio (till previous year)	%		1.00	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Energy cost growth ratio (till the first year)	%		1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.59	5.05	5.56	6.12	6.73	7.40
Expanses investment plan (without VAT)																								
Energy audit, feasibility study and project works calculation		33333	33333	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Street lanterns, add equipment and material purchase		83333	28474	28474	26386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
The existing LEDL removal, mounting of new LEDL and other equipment		166667	56948	56948	52771	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Settings of the street lighting system		75000	25626	25626	23747	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Results assessment: quantitive and qualitative		7500	2563	2563	2375	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total of capital expenses (without VAT)		**365833**	**146944**	**113610**	**105279**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Readiness per cent (measures implementation)			**40%**	**71%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Amortization																								
Total Annual Depreciation	***TRUE***	**315090**	**-**	**14009**	**23484**	**31251**	**28231**	**25506**	**23048**	**20829**	**18826**	**17018**	**15386**	**13913**	**12582**	**11381**	**10296**	**9315**	**8430**	**7630**	**6907**	**6254**	**5664**	**5130**
Revenues (without VAT)																								
Savings																								
Energy consumption savings from new LEDL provision	71%	2041582	11634	22691	35046	38551	42406	46646	51311	56442	62086	68295	75124	82637	90900	99990	109989	120988	133087	146396	161035	177139	194853	214338
Savings from the avoidance of the alternative expanses for the old purchase	1%	32657	621	1102	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547
Reduce of expenses in trunks from replacement and modernization of control cabinets	19%	545238	3107	6060	9360	10296	11325	12458	13703	15074	16581	18239	20063	22069	24276	26704	29374	32312	35543	39097	43007	47308	52039	57242
From expenses decrease for lighting point maintenance	5%	145187	827	1614	2492	2742	3016	3317	3649	4014	4415	4857	5342	5877	6464	7111	7522	8604	9465	10411	11452	12597	13857	15243
From load decrease in trunks	4%	113034	644	1256	1940	2134	2348	2583	2841	3125	3437	3781	4159	4575	5033	5536	6090	6699	7368	8105	8916	9807	10788	11867
Metal scrap cost	0%	1094	-	547	547	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total revenues (without VAT)	**100 %**	**2878792**	**16833**	**33270**	**50932**	**55269**	**60641**	**66550**	**73051**	**80201**	**88067**	**96719**	**106236**	**116705**	**128220**	**140888**	**154822**	**170149**	**187010**	**205556**	**225957**	**248398**	**273083**	**300237**
VAT			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
(+) VAT from revenues			**3367**	**6654**	**10186**	**11054**	**12128**	**13310**	**14610**	**16040**	**17613**	**19344**	**21247**	**23341**	**25644**	**28178**	**30964**	**34030**	**37402**	**41111**	**45191**	**49680**	**54617**	**60047**
The revenues, subject to VAT			16833	33270	50932	55269	60641	66550	73051	80201	88067	96719	106236	116705	128220	140888	154822	170149	187010	205556	225957	248398	273083	300237
(-) VAT from capital expanses			**29389**	**22722**	**21056**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Capital expanses subject to VAT			146944	113610	105279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(=) Net VAT balance			**-26022**	**-16068**	**-10869**	**11054**	**12128**	**13310**	**14610**	**16040**	**17613**	**19344**	**21247**	**23341**	**25644**	**28178**	**30964**	**34030**	**37402**	**41111**	**45191**	**49680**	**54617**	**60047**
VAT payment			-26022	-16068	-10869	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAT reimbursement			-	-	-	11054	12128	13310	14310	1857	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAT credit			26022	42090	52960	41906	29778	16468	1857	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Financing structure (with VAT)			.																					
Investor's commitment		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-term loan		439000	176333	136333	126335	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-term loan, thsnd. euro	'000 EUR	13937	5737	4306	3893	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disbursement of EBRD loan																								
Drawdown of the facility		439000	176333	136333	126335	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Credit balance as of the start of the year			176333	317955	452239	463545	405271	342791	276975	209809	140572	70637	-	-	-	-	-	-	-	-	-	-	-	-
Disbursement of the primary loan		482428	-	-	-	66221	67545	68558	69244	69936	70286	70637	-	-	-	-	-	-	-	-	-	-	-	-
Interests		71403	4408	7949	11306	11589	10132	8570	6924	5245	3514	1766	-	-	-	-	-	-	-	-	-	-	-	-
One-off fee for the credit granting		882	882																					
Credit balance as of the end of the year			176333	317955	452239	397324	337726	274233	207732	139873	70286	-	-	-	-	-	-	-	-	-	-	-	-	-
Drawdown of the facility	'000 EUR	13937	5737	4306	3893	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Credit balance as of the start of the year	'000 EUR		5737	10043	13937	13937	11946	9955	7964	5973	3982	1991	-	-	-	-	-	-	-	-	-	-	-	-
Disbursement of the primary loan	'000 EUR	13937	-	-	-	1991	1991	1991	1991	1991	1991	1991	-	-	-	-	-	-	-	-	-	-	-	-
Interests	'000 EUR	2137	143	251	348	348	299	249	199	149	100	50	-	-	-	-	-	-	-	-	-	-	-	-
One-off fee for the credit granting	'000 EUR	29	29																					
Credit balance as of the end of the year	'000 EUR		5737	10043	13937	11946	9955	7964	5973	3982	1991	-	-	-	-	-	-	-	-	-	-	-	-	-

Continuation of Table 3.9

	Total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Credit line - overdraft																							
Overdraft size	17838	172180	620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interests for payment		4132	2141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paid interests	6273	-	4132	2141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Credit repayment	17838	-	17218	620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Financial result report																							
Revenue	2878792	16833	33270	50932	55269	60641	66550	73051	80201	88067	96719	106236	116705	128220	140888	154822	170149	187010	205556	225957	248398	273083	300237
Operational expenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EBITDA	**2878792**	**16833**	**33270**	**50932**	**55269**	**60641**	**66550**	**73051**	**80201**	**88067**	**96719**	**106236**	**16705**	**128220**	**140888**	**154822**	**170149**	**187010**	**205556**	**225957**	**248398**	**273083**	**300237**
Amortization	-315090	-	-14009	-23484	-31251	-28231	-25506	-23048	-20829	-18826	-17018	-15386	-13913	-12582	-11381	-10296	-9315	-8430	-7630	-6907	-6254	-5664	-5130
EBIT (Operational income)	**2563702**	**16833**	**19261**	**27447**	**24018**	**32410**	**41044**	**50003**	**59372**	**69240**	**79700**	**90850**	**102792**	**115638**	**129507**	**144526**	**160834**	**178580**	**197926**	**219050**	**242144**	**267419**	**295107**
Paid interests	-78558	-5290	-12081	-13446	-11589	-10132	-8570	--6924	--5245	--3514	--1766	-	-	-	-	-	-	-	-	-	-	-	-
Pre-tax income	**2485144**	**11543**	**7180**	**14001**	**12430**	**22278**	**32474**	**43079**	**54127**	**65726**	**77934**	**90850**	**102792**	**115638**	**129507**	**144526**	**160834**	**178580**	**197926**	**219050**	**242144**	**267419**	**295107**
Paid taxes	-447326	-2078	-1292	-2520	-2237	-4010	-5845	-7754	-9743	-11831	-14028	-16353	-18503	-20815	-23311	-26015	-28950	-32144	-35627	-39429	-43586	-48135	-53119
Net income/loss	**2037818**	**9466**	**5888**	**11481**	**10192**	**18268**	**26629**	**35324**	**44384**	**53895**	**63906**	**74497**	**84289**	**94823**	**106196**	**118512**	**131884**	**146435**	**162299**	**179621**	**198558**	**219284**	**241987**
Cash flow report																							
EBIT		**16833**	**19261**	**27447**	**24018**	**32410**	**41044**	**50003**	**59372**	**69240**	**79700**	**90850**	**102792**	**115638**	**129507**	**144526**	**160834**	**178580**	**197926**	**219050**	**242144**	**267419**	**295107**
Amortization (+)	315090	-	14009	23484	31251	28231	25506	23048	20829	18826	17018	15386	13913	12582	11381	10296	9315	8430	7630	6907	6254	5664	5130
Gross operating cash flow	**2878792**	**16833**	**33270**	**50932**	**55269**	**60641**	**66550**	**73051**	**80201**	**88067**	**96719**	**106236**	**116705**	**128220**	**140888**	**154822**	**170149**	**187010**	**205556**	**225957**	**248398**	**273083**	**300237**
Paid taxes	-447326	-2078	-1292	-2520	-2237	-4010	-5845	-7754	-9743	-11831	-14028	-16353	-18503	-20815	-23311	-26015	-28950	-32144	-35627	-39429	-43586	-48135	-53119
Net operating cash flow	**2431466**	**14756**	**31978**	**48412**	**53031**	**56631**	**60705**	**65297**	**70458**	**76236**	**82690**	**89883**	**98202**	**107406**	**117577**	**128807**	**141199**	**154865**	**169929**	**186528**	**204812**	**224948**	**247118**
Paid interests	-78558	-5290	-12081	-13446	-11589	-10132	-8570	-6924	-5245	-3514	-1766	-	-	-	-	-	-	-	-	-	-	-	-
Current debt payment	-500265	-	-17218	-620	-66221	-67545	-68558	-69244	-69936	-70286	-70637	-	-	-	-	-	-	-	-	-	-	-	-
Pre-investment cash flow	**1852643**	**9466**	**2679**	**34345**	**-24778**	**-21046**	**-16423**	**-10872**	**-4723**	**2436**	**10287**	**89883**	**98202**	**107406**	**117579**	**128807**	**141199**	**154865**	**169929**	**186528**	**204812**	**224948**	**247117**
Capital expenses	-365833	-146944	-113610	-105279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAT payment	-52960	-26022	-16068	-10869	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAT return	52960	-	-	-	11054	12128	13310	14610	1857	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pre-financing cash flow	**1486810**	**-163500**	**-127000**	-81803	-13724	-8918	-3113	3738	-2866	2436	10287	89883	98202	107406	117576	128807	141199	154865	169929	186528	204812	224948	247117
New long-term obligations	439000	176333	136333	126335	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity contributions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overdraft	17838	17218	620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow after financing	**1943647**	**30050**	**9953**	**44532**	**-13724**	**-8918**	**-3113**	**3738**	**-2866**	**2436**	**10287**	**89883**	**98202**	**107406**	**117576**	**128807**	**141199**	**154865**	**169929**	**186528**	**204812**	**224948**	**247117**
Cash at the beginning of the year	**9673857**	**-**	**30050**	**40003**	**84534**	**70810**	**61892**	**58779**	**62518**	**59652**	**62088**	**72374**	**162257**	**260459**	**367865**	**485441**	**614248**	**755448**	**910313**	**1080242**	**1266770**	**1471582**	**1696530**
Net change in cash	**1943647**	**30050**	**9953**	**44532**	**-13724**	**-8918**	**-3113**	**3738**	**-2866**	**2436**	**10287**	**89883**	**98202**	**107406**	**117576**	**128807**	**141199**	**154865**	**169929**	**186528**	**204812**	**224948**	**247117**
Cash at the end of the year	**11617504**	**30050**	**40003**	**84534**	**70810**	**61892**	**58779**	**62518**	**59652**	**62088**	**72374**	**162257**	**260459**	**367865**	**485441**	**614248**	**755448**	**910313**	**1080242**	**1266770**	**1471582**	**1696530**	**1943647**

Continuation of Table 3.9

	Total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Funds sources and usage purposes																							
Funds sources																							
Funds, generated by the enterprise	2878792	16833	33270	50932	55269	60641	66550	73051	80201	88067	96719	106236	116705	128220	140888	154822	170149	187010	205556	225957	248398	273083	300237
Financing																							
Credit	439000	176333	136333	126335	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contributions to equity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAT return	52960	-	-	-	11054	12128	13310	14610	1857	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total financing	3370751	193166	169603	177267	66322	72769	79860	87661	82059	88067	96719	106236	116705	128220	140888	154822	170149	187010	205556	225957	248398	273083	300237
Growing sum financing	32591616	193166	362769	540035	606358	679127	758987	546648	928707	1016773	1113492	1219727	1336432	1464652	1605540	1760362	1930511	2117521	2323077	2549034	2797432	3070515	3370751
Funds usage																							
Investments	-365833	-146944	-113610	-105279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Credits payment	-500265	-	-17218	-620	-66221	-67545	-68558	-69244	-69936	-70286	-70637	-	-	-	-	-	-	-	-	-	-	-	-
Interests payment	-78558	-5290	-12081	-13446	-11589	-10132	-8570	-6924	-5245	-3514	-1766	-	-	-	-	-	-	-	-	-	-	-	-
Taxes payment	-447326	-2078	-1292	-2520	-2237	-4010	-5845	-7754	-9743	-11831	-14028	-16353	-18503	-20815	-23311	-26015	-28950	-32144	-35627	-39429	-43586	-48135	-53119
VAT payment	-52960	-26022	-16068	-10869	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total funds usage	-1444942	-180334	-160270	-132735	-80047	-81687	-82973	-83922	-84924	-85631	-86432	-16353	-18503	-20815	-23311	-26015	-28950	-32144	-35627	-39429	-43586	-48135	-53119
Growing sum funds usage	-21365917	-180334	-340603	-473338	-553385	-635072	-718045	-801968	-886892	-972523	-1058955	-1075308	-1093810	-1114625	-1137936	-1163951	-1192901	-1225045	-1261672	-1301011	-1343687	-1391822	-1444942
Cash at the end of the year	9673857	-	30050	40003	84534	70810	61892	58779	62518	59652	62088	72374	162257	260459	367865	485441	614248	755448	910313	1080242	1266770	1471582	1696530
Cash flow of the current year	1925810	12832	9333	44532	-13724	-8918	-3113	3738	-2866	2436	10287	89883	98202	107406	117576	128807	141199	154865	169929	186528	204812	224948	247117
Overdraft usage	17838	17218	620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash at the end of the year		30050	40003	84534	70810	61892	58779	62518	59652	62088	72374	162257	260459	367865	485441	614248	755448	910313	1080242	1266770	1471582	1696530	1943647
Indicators and coefficients																							
DSCR 1.35		**2.79**	**1.09**	**3.44**	**0.68**	**0.73**	**0.79**	**0.86**	**0.94**	**1.03**	**1.14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
DSCR with cash 1.91		**6.04**	**2.14**	**6.29**	**1.77**	**1.64**	**1.59**	**1.63**	**1.77**	**1.84**	**2.00**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sales revenue		56%	18%	23%	18%	30%	40%	48%	55%	61%	66%	70%	72%	74%	75%	77%	78%	78%	79%	79%	80%	80%	81%
Revenue from the investments		**-7%**	**7%**	**14%**	**10%**	**7%**	**6%**	**6%**	**5%**	**5%**	**5%**	**13%**	**22%**	**31%**	**41%**	**51%**	**62%**	**73%**	**84%**	**96%**	**108%**	**121%**	**133%**
EBITDA margin	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Discounted revenue (discounted EBIT)			19162	27437	24018	32410	41044	50003	59372	69240	79700	90850	102792	115638	129507	144526	160834	178580	197926	219050	242144	267419	295107
Discounted investments		164501	135631	126288	-	-	-	-	-	-	-	-	-	-	-	-							
NPV and IRR																							
Investments	-365833	-146944	-113610	-105279	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net operating cash flow	2431466	14756	31978	48412	53031	56631	60705	65297	70458	76236	82690	89883	98202	107406	117576	128807	141199	154865	169929	186528	204812	224948	247117
Project cash flow		-132188	-81633	-56867	53031	56631	60705	65297	70458	76236	82690	89883	98202	107406	117576	128807	141199	154865	169929	186528	204812	224948	247117
Project cash flow, cumulative		-132188	-213821	-270689	-217657	-161026	-100321	-35025	35434	111669	194360	284242	382445	489850	607427	736234	877433	1032298	1202227	1388755	1593567	1818515	2065632
Payback period (nondisc.) **8.**	-	-	-	-	-	-	-	-	8.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Project cash flow (disc.) **609891**		-123319	-71046	-46172	40168	40016	40017	40156	40423	40803	41288	41868	42674	43542	44467	45446	46476	47554	48678	49848	51062	52319	53619
Project cash flow (disc.), cumulative		-123319	-194368	-240537	-200368	-160352	-120335	-80179	-39756	1047	42336	84204	126878	170420	214888	260334	306810	354363	403042	452890	503952	556271	609891
Payback period (disc.) **10.0**		-	-	-	-	-	-	-	-	9.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Income index 6.0																							
NPV@7.19% **609891**																							
IRR 21.6%																							

2.5 Key results and alternatives analysis

Table 3.10 Key indicators of the project by benchmark-lantern

Indicator's name	Value
Debt service coverage ratio (DSCR) (with cash)	1.9 on average
Profitability index	6.0
IRR, %	21.6%
NPV@7,19%, mln. UAH	609.9
Payback period (discounted)	9.9 years

As can be seen from Table 3.10 above, the project shows positive values (positive NPV and rather high IRR), according to the criteria of economic viability, the project can be considered economically grounded.

Table 8.10 below shows the dependence of the internal rate of return (IRR) and the Net Present Value (NPV), discounted at 7.19% to the cost of electricity decrease, under other unchanged conditions. As can be seen from Table 3.11, the economic indicators of the project are very sensitive to changes in the cost of electricity. In further calculations, the growth rate of the cost of electricity is taken as the base option of the project development at level of + 10% annually. For information, in 2015 and 2016, tariffs were 20% and 31% raised respectively.

Table 3.11 The sensitivity assessment of the Net Present Value (NPV) and the Internal Rate of Return (IRR) of the project to annual growth (decrease) of the electricity cost

Indicator	Annual expenses change for servicing					
	-5%	**0%**	**+5%**	**+10%**	**+15%**	**+20%**
NPV	-31,9	96,4	263,6	609,9	1 273,2	2 542,8
IRR	5,4%	11,3%	16,0%	21,6%	27,5%	33,4%

The estimation of the Net Present Value (NPV) and the Internal Rate of Return (IRR) of the project to the main variables of the project (to the baseline) is shown in Table 3.12. The resulting NPV and IRR are compared to the base value for each item of expenditure/savings according to its +/-20% deviation, subject to the unchanged other items.

Table 3.12 The sensitivity assessment of the Net Present Value (NPV) and the Internal Rate of Return (IRR) of the project to major variables of the project (to the baseline)

Item of expenses/savings	Indicator	Indicators change from the base value	
		-20%	**+20%**
Planned average cost of 1kWh	NPV	449,3	776,1
	IRR	18,4%	24,8%
Capital expenses (total)	NPV	665,9	555,4
	IRR	26,0%	18,6%
Lines' expenses cut due to the replacement and modernization of the control cabinets	NPV	576,3	643,5
	IRR	20,9%	22,3%
From the decrease of expenses for the lighting point maintenance	NPV	601,0	618,8

Continuation of Table 3.12

Item of expenses/savings	Indicator	Indicators change from the base value	
		-20%	**+20%**
From the decrease of expenses for the lighting point maintenance	IRR	21,4%	21,8%
From load on lines decrease	NPV	602,9	616,8
	IRR	21,5%	21,8%
Scrap metal cost	NPV	609,7	610,0
	IRR	21,6%	21,6%
Expenses decrease change, total	NPV	560,3	659,5
	IRR	20,6%	22,6%

Taking into account the above, one can conclude that the parameters having the most significant impact on the project are: Annual growth (decrease) in the cost of electricity, Planned average cost of 1kWh, Capital expenditures, Reduction of losses in the highways from replacement and modernization of control cabinets.
In all analyzed cases, the internal rate of return remains significantly higher than the discount rate, which suggests that the project is economically viable for variable factors.

2.6 Conclusions on the financial aspects and economic feasibility of the project

For the project's economic evaluation, a comprehensive forecast financial model has been prepared that assesses the economic effect of the implementation of the Project (in terms of replacing of existing external lamps with LED ones). This leads to a decrease in electricity consumption and operating costs, which is interpreted in the model as a revenue part. To assess the overall economic feasibility of introducing of new lighting types, a conditioned LED lantern, taken as a benchmark, was created based on the averaged set of characteristics, calculated on the basis of indicators of lamps from 13 Ukrainian manufacturers.

The project envisages the attraction of UAH 439.0 million. (EUR 13.937 million) of credit funds for a period of 10 years. This amount is the total investment cost and is funded during 2017-2019. The result of the implementation of the project events in the base scenario is IRR 21.6% and, accordingly, NPV 609.9 mln. UAH at a discount rate of 7.19%. During some periods DCSR shows an indicator's value of not less than 1.35, the average DCSR by the project is even higher (1.9 on average). To compensate the temporary cessation of the DCSR, the financial model provides the use of overdraft. Payback period of the project is 9.9 years.

Taking into account the trends of resent years, as well as the unstable internal and external economic situation, the basic option of the financial model provides the 10% annual growth of the planned average cost of 1 kWh from 2018.

The model demonstrates a rather high level of economic values relative to macroeconomic factors such as volatility of currency rates, inflation and lending rates. The project effectiveness indicators are highly sensible, to the following indicators: annual growth (decrease) of electricity cost, planned average cost of 1kWh, capital costs, reduction of losses in the lines from replacement and modernization of control cabinets.

However, in all analyzed cases, the internal rate of return remained higher than the discount rate (Dr = 7.19%). This gives grounds for recommending the Project for implementation under the above conditions.

2.7 The Project implementation plan and procurement plan

3.7.1 Procurement plan

The procurements for the project "RECONSTRUCTION OF THE EXTERNAL LIGHTING OF MARIUPOL CITY", which will be performed within the project "The development program of the municipal infrastructure of Ukraine" (is financed by the European Investment Bank) and will be conducted in accordance to the Financial agreement between the Bank and Ukraine.

According to this Financial agreement:

- *"Procurement guidelines" means the manual, published on the EIB site, on procurements, which informs the project initiators, fully or partly financed by EIB, about the procedures of procurements of goods, works and services, necessary for the Subproject.*
- *The Borrower ensures that each End Beneficiary will purchase equipment, provide the ordering of services and other works for the Project by an acceptable procurement procedure that is satisfactory to the Bank and complies with its policies and standards specified in its Procurement Guidelines, as set out in the POG;*

Moreover, the procurement regulations are provided by the Program operational guide;

Thus, taking into account the requirements of the EIB Procurement guidelines, the Program operational guide, as well as the procurements peculiarities in accordance to the international procedures (procedures IBRD, EBRD), the following procurement plan has been developed:

№	Tender package name and lots	Cost, 000 UAH, without VAT	Financing source	Procurement category	Procurement procedure/method	Biddings beginning date	Contract signing date
WORKS AND EQUIPMENT							
1	Existing lanterns replacement with LED ones	365 833	Credit of EIB/local co-financing VAT	Designing, supply, works	ICB **	July 2018	January 2019
CONSULTING SERVICES							
1	Consulting services on supporting of the project implementation group	10 000	EIB/Grant funds	Consulting services	ICB2***	October 2017	March 2018

***international one-stage competitive biddings, in accordance to the regulations of IBRD (previously)*

**** international two-stage competitive biddings, in accordance to the regulations of IBRD QCBS (previously)*

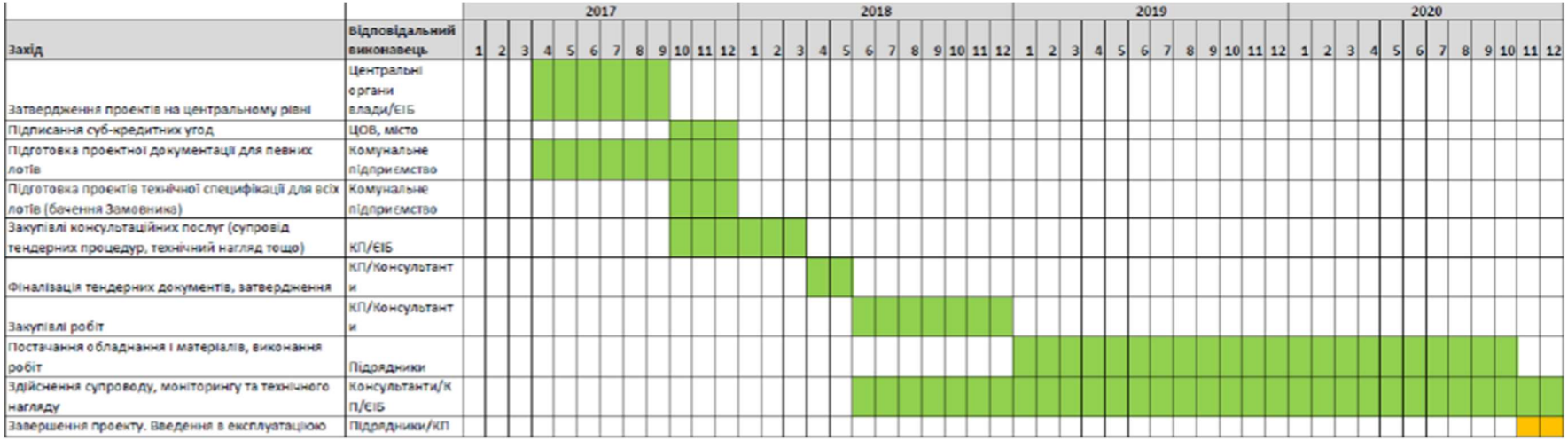
3.1.1 Project realization plan

The project implementation plan was based on the following hypotheses:

- Taking into account the complex implementation process of the financial agreement requirements, the purchases will be started at the beginning of 2018
- The project will be implemented within 3 years (including procurement procedures)
- The EIB together with the Central Executive Committee will help to draw grant funds for consulting services for supporting the project implementation group

It should be noted that it is not feasible to develop a detailed plan for the implementation of the project with components, since the time frame for the operations to be performed by the Central Executive Committee are not fully understood, as well as the kind of support and to what extent the consultations will be provided. Ukraine has a significant experience in implementing the projects funded by the IFO, and as practice shows, in fact, in all such projects, there are significant delays associated with procurements, various approvals, and so on. The Final Beneficiary will do everything possible to avoid such delays, but considering the number of stakeholders (EIB, MinRegion, MoF, etc.) the delays are possible.

The project implementation plan is formed as an enlarged calendar schedule:



Захід - Event
Відповідальний виконавець – Responsible executor
Затвердження проектів на центральному рівні – Projects affirmation at the central level
Підписання суб-кредитних угод – Sighing of the sub-credit agreements
Підготовка проектної документації для певних лотів – Project documents for the certain lots development
Підготовка проектів технічної специфікації для всіх лотів (бачення Замовника) – Technical specifications projects development for all lots (view of the Customer)
Закупівлі консультаційних послуг (супровід тендерних процедур, технічний нагляд, тощо) – Consulting services procurements (bidding procedures support, technical control etc.)
Фіналізація тендерних документів, затвердження – finalization of the bidding documents, affirmation
Закупівлі робіт – Works procurement
Постачання обладнання і матеріалів, виконання робіт – Equipment and materials supply, works execution
Здійснення супроводу, моніторингу та технічного нагляду – Support, monitoring and technical control conduction
Завершення проекту. Введення в експлуатацію – Project finishing. Commissioning
Центральні органи влади – Central authorities
ЄІБ - EIB
ЦОВ, місто – CEC, city
Комунальне підприємство – municipal enterprise
КП - ME
Консультанти - consultants
Підрядники - contractors

3. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

4.1 Summary

Modern external lighting networks of national settlements are characterized by a number of disadvantages, due to which external lighting does not only fully fulfill its functions, but also results in significant operating costs.

Increasing the use of energy resources in lighting installations today is attractive not only because of the fact that artificial lighting uses a fairly significant part of energy resources, but also because this sector provides great potential for electricity saving - not less than 50% of the level of modern consumption. It is known that today it is much more advantageous to reduce the consumption of electricity for lighting at the expense of modern technologies than to create new additional generating capacities in order to meet the growing demand for light energy. So, for a visual comparison, to generate 1 kW of new generating capacities from $ 1,000 to $ 3,000 is spent, and to save 1 kW of power in lighting systems $200-300 is enough. Thus, in many countries special programs of energy saving for external lighting are created. The general method of reducing of energy consumption (30-50% for 5-7 years) for such programs is the wide introduction of modern lighting equipment. In addition, the additional incentive for transmission to the latest lighting systems is the gradual refusal from usage of incandescent lamps and other types of lamps of the later generation: luminescent, gas-discharge mercury lamps, electromagnetic SCD, which is an extremely important environmental aspect.

The project "Reconstruction of the external lighting system of Mariupol city" consists in the introduction of modern lighting equipment with the use of energy saving technologies, equipped with modern instruments for resources consumption accounting, which will increase the level of satisfaction of the population needs and the economic complex of the city in qualitative and modern lighting services.

The project provides energy-efficient reconstruction of the city's external lighting system by replacing existing lamps with a low light efficacy of 30-80 Lm/W with lamps with light efficacy within 100-120 Lm/W and a higher color reference index. Moreover, the project provides for replacement of the power supply of the uninsulated air line with self-supporting insulated wire, which will increase the reliability and safety of the lighting network, repair and replacement of external lightning supports, and repair of power distribution cabinets.

Thus, the suggested project includes measures aimed at reducing the cost of purchasing electricity for street lighting and maintenance of external lighting networks, reducing the level of pollution by CO_2 emissions, improving the quality of illumination and creating a modern urban environment. It is assumed that the Customer will be fully responsible for environmental and social issues related to the implementation of the project in close partnership with the city administration.

The assessment of environmental and social impacts consists from the following parts:

- Summary.
- Political, legal and administrative structure.
- Description of the project.
- Basic data.
- Analysis of alternatives.
- Environmental impacts of the selected alternatives.
- Results mitigation measures.
- Environmental and social management plan.

The report provides an overview of the main issues on the environmental and social aspects of the operation of the project and the main recommendations for its further implementation.

4.2 Political, regulatory and administrative basis

4.2.1 Regulatory system of Ukraine in the sphere of ecological assessment

It is provided that the project "Reconstruction of the external lighting system of Mariupol city" will fully comply with the requirements of Ukrainian legislation and international agreements on environmental protection, standards and recommendations, including developed by the European Investment Bank. The development of the project will consider the satisfaction of all the above requirements.

The environmental assessment of the projects in Ukraine is subject to the following Ukrainian Laws:

- “On the environmental protection” (1991);
- “On environmental expertise” (1995;
- “On Ratification of the Convention on Environmental Impact Assessment in a Cross-Border Context" (1999);

And he State building regulations of Ukraine SBR A.2.2-1-2003 “The composition and content of the assessment materials of environmental impact (EIA) at designing and construction of the enterprises, buildings and constructions” (2004).

The environmental assessment is defined as the requirement for an environmental review of the planned activities and is regulated by the Law of Ukraine "On Environmental Expertise" (1995). The purpose of ecological expertise is to prevent the negative impact of anthropogenic activities on the state of the environment and public health, assessment of the degree of environmental safety of economic activity and the environmental situation on the territories and objects.

The procedure for the development of EIA materials in the design documentation for the new building, expansion, reconstruction and technical re-equipment of industrial and civilian objects and the basic requirements for the composition and content of these materials is determined by SBR A.2.2-1-2003 "Design. Composition and content of materials for environmental impact assessment (EIA) in the designing and construction of enterprises, buildings and structures "and other national and international legal acts.

When developing the EIA the following provisions of legal acts are used:

- Water Code of Ukraine, dated October 6, 1995;
- Land Code of Ukraine, dated October 25, 2001
- SBR A.2.2-3-2004 "Composition, procedure for development, affirmation and approval of design documentation for construction";
- SBR 360-92 "Urban Development. Planning and building of urban and rural settlements ";
- SBR A.3.1-5-96 Management, organization and technology. Organization of construction production;
- SBR V.2.3.-5-2001 "Streets and roads of settlements";
- SBR 360-92 "Urban Development. Planning and building of urban and rural settlements ";
- SBR V.2.5-16-99 "Engineering equipment of buildings, external networks. Determination of the sizes of land plots for objects of electric networks”
- SCP 173-96 "State Sanitary Rules for Planning and Development of Human Settlements";
- SCP 201-97 "State sanitary rules for the protection of atmospheric air of dwelling areas (from pollution by chemical and biological substances)";
- SBR A.2.2-3-2004 "Composition, procedure for development, approval and approval of project documentation for construction";
- SN 3077-84 "Sanitary norms of permissible noise in premises of residential and public buildings and on the territory of residential buildings";
- SNaP II-12 "Noise protection".
- Law of Ukraine on Environmental Protection, dated July 25, 1991;
- Law of Ukraine on Environmental Expertise, dated February 9, 1995;
- Law of Ukraine on Wastes, dated March 5, 1998;
- Law of Ukraine on the fauna, dated March 3, 1993;
- Law of Ukraine on Protection of Atmospheric Air, dated October 16, 1992;

Thus, the requirements of the Ukrainian legislation, which provide environmental impact expertise and environmental impact assessment, are mainly aimed at assessing the environmental impact of specific projects, are applied to a limited part of the projects, determine the current state of the environment, are of a permissive nature. At the same time, management of changes in the implementation of projects is not conducted. The procedure of environmental expertise of investment projects is not clearly defined and does not make it possible to evaluate the possible environmental consequences of strategic decisions of the territorial development and various programs at the national, regional and local levels in accordance with international requirements. All international financial institutions apply procedures for environmental and social assessment of the effects of the project activity on investment projects financed by them, including the European Investment Bank.

3.2.2 EIB's requirements for environmental and social assessment

Ukraine's cooperation with the European Investment Bank (EIB) began in April 2006 after the ratification of the Framework Contract between Ukraine and the EIB. The purpose of this cooperation is to attract EIB resources for implementation of infrastructure, energy, environmental protection and other investment projects.

On February 3, 2016, the Verkhovna Rada of Ukraine ratified the Financial Agreement between Ukraine and the European Investment Bank. In accordance with this agreement, the project "Municipal Infrastructure Development Program of Ukraine" was started, within which the modernization of the infrastructure of housing and communal services of Ukraine is planned in a number of areas, in particular: heat supply, water supply, drainage, energy efficiency of buildings, treatment of household waste and external lighting of settlements.

The Enterprise of the Electric Networks of external lighting "Mikskvitlo" of Mariupol city (hereinafter referred to as ME "Mysksvitlo") appealed to the Ministry of Regional Development and Infrastructure of Ukraine as a responsible executor under the Financial Agreement with the request to finance its investment project (IP) within the "Development Program of municipal infrastructure" in the sector of "External Lighting of Settlements".

The suggested project is aimed at financing the modernization of the street lighting system in Mariupol city. The project includes measures aimed at reducing the cost of purchasing of electric energy for street lighting and maintenance of external lighting networks, repair of external lighting networks and reducing the level of pollution by CO_2 emissions. It is provided that the company will be fully responsible for environmental and social issues related to the implementation of the project in close partnership with the city administration. Moreover, the suggested investment is a priority for the city, so the territorial community is ready to give the municipal enterprise "Mysksvitlo" municipal guarantees to obtain a loan from the EIB.

An analysis of the requirements of Ukrainian legislation and European Investment Bank policies in terms of environmental impact assessment and environmental management plan demonstrates a significant similarity.

A key requirement common to both systems is the compulsory nature of the environmental impact assessment as part of the project development and the development of design estimates for any project activities that include new construction and/or modernization of existing facilities.

A full Environmental Impact Assessment (EIA) (as specified in Section 2 of the SBR A.2.2-1-2003) is mandatory for all "high ecological danger". In accordance with the legislative and regulatory acts of Ukraine, subprojects fall into the category of "high ecological danger" objects. For objects that do not fall to this category, a shortened version of the EIA may be prepared. The content of this shortened version should be agreed with the local authorities responsible for environmental protection and sanitary and epidemiological issues.

In case of a full EIA, environmental and social assessment requirements, as well as requirements for consultation with stakeholders on environmental assessment, are similar in accordance with Ukrainian legislation and European Investment Bank policies. The main document in Ukraine that regulates the EIA process and establishes the requirements for EIA documentation is the state building norms SBR A.2.2-1-2003.

In turn, the EIB also has four documents related to its principles and procedures of environmental protection policy:

- Environmental Declaration, 2004;
- Environmental Procedures, 2002;
- Declaration on European Environmental Principles, 2006;
- Environmental and Social practices Handbook, 2007.

Three first documents are related to the general environmental principles.

The "Environmental and Social Practices Handbook" describes the EIB project assessment process, as well as international laws, standards and conventions that are used in a number of cases, including environmental issues.

At the same time, it should be noted that although EIA in Ukraine is mandatory for objects of "high environmental danger", in practice it differs from the environmental assessment/environmental management plan in accordance to the World Bank procedures. First, the mitigation measures described in the EIA are general and do not consider local characteristics. Secondly, the responsibility for the implementation of mitigation measures is not fixed at a specific person or organization. Thirdly, the cost of mitigation measures is not specified and the timetable for implementing these measures is absent. To fill in this gap, the above-mentioned aspects (i.e., the focus on specific local mitigation measures, institutional responsibility, cost, and implementation schedule) should be detailed in the technical specification for EIA.

Thus, the requirements of the Ukrainian legislation, which provide environmental expertise and EIA, are mainly aimed at assessing the environmental impact of specific projects, apply to a limited part of the projects, determine the current state of the environment, and are permissible. At the same time, management of changes in the implementation of environmental projects is not implemented. The procedure of environmental expertise of investment projects is not clearly defined and does not make it possible to evaluate the possible environmental consequences of strategic decisions of the territorial development and various programs at the national, regional and local levels in accordance with international requirements.

All international financial institutions, including the EIB, apply environmental and social assessment of the consequences of the project activity to the investment projects financed by them.
The EIB strives to ensure that all projects financed by it are environmentally and socially balanced, take into account and respect the rights of the appropriate workers and communities, as well as been developed and implemented in accordance with the applicable regulatory requirements and international practices.

The environmental assessment of the project is defined as a requirement for an environmental expertise and is regulated by the Law of Ukraine "On Environmental Expertise". The aim of environmental expertise is to prevent the negative impact of human activities on the state of the environment and public health, assessment of the degree of environmental safety of economic activity and the environmental situation on the territories and objects.

Hereafter, the overall environmental and social performance of the company and the potential impact of the suggested project, are assessed in accordance with the relevant EIB policy standards regarding environmental and social policies, namely:

- Standard 1. Assessment of social and economic impacts
- Standard 2. Prevention and environment pollution control
- Standard 3. Impact on biodiversity and ecosystems
- Standard 4. Impact on climatic conditions
- Standard 5. Impact on cultural heritage
- Standard 6. Non-voluntary relocation
- Standard 7. Protection of the rights and interests of vulnerable groups of the population
- Standard 8. Compliance with labor legislation
- Standard 9. Public health, workplace health and safety
- Standard 10. Publication of information and management regarding the stakeholders

3.3 Project Description

The main objective of the project "Reconstruction of the external lighting system of Mariupol city" is to provide high-quality lighting of the streets of the city with simultaneous reduction of expenses for payment for consumed electricity and maintenance of the city's external lighting networks, increasing the level of the city's improvement and traffic safety. Significant improvement of the environmental situation is planned, as the result of the project implementation the use of mercury light sources will be eliminated. Moreover, due to optimization of electricity consumption for the needs of external lighting in Mariupol city, a significant reduction of CO_2 emissions will be observed.

Municipal enterprise "Mysksvitlo" of the Mariupol City Council of the City Council, the EDRPOU 03342638, is a municipal enterprise and the successor of the State Enterprise of Electric Networks of external Lighting of "Mysksvitlo" created by order №91 dated 29.09.1963 regarding the city department of the national economy in accordance with the order of the municipal department of the municipal economy of March 16, 1978 No. 34, established in accordance with the Resolution of CM of the USSR dated May 18, 1963, No. 575 No. 388-p, and the resolution of the executive committee of the Zhdaniv City Council of Workers' Deputies of September 27, 1963 No. 330.

The main purpose of the company's activity is to ensure the stable and continuous operation of external lighting networks in Mariupol city. ME "Mysksvitlo" and provision of external lighting of the objects of improvement, which belong to the municipal property of the territorial community of Mariupol city, by maintenance, operation, current and capital repairs, modernization, reconstruction and construction of the external lighting networks of Mariupol city, as well as for the purpose of obtaining the profit from self-supporting production and other economic activity.

Lighting of the territories of the city and adjoining territories is carried out by lanterns with:

- incandescent lamps - 4125 items;
- arc lamps of MAL type - 2133 items;
- arc lamps of HPSL type - 21465 items;
- LED lights of 23 W type - 857 items.

The typical external lighting cabinets (И 710) are used as power supplies in the amount of 258 items. From them: 70% of cabinets with an operational life of more than 20 years, 20% - more than 10 years, 10% - less than 10 years.

The management of external lighting networks is carried out by a management and monitoring system. Management is carried out both autonomously and manyally.

Due to the fact that the operational properties of the electrical system of external lighting are sufficiently low, lighting systems use obsolete types of light-emitting devices, which results in significant costs for the consumption of electric energy. Some of the world's devices that provide lighting of the city streets have low efficiency. The most energy-intensive and ineffective are lamps of the HPSL type, while their share among the lamps used in Mariupol city is more than 75% of the total power of the used lighting sources.

On the balance sheet of the company there are 8763 supports, including ground lamp park lighting. 80% of them are supports with a common bias lighting with a TTU contact system and networks of an energy saving organization. In addition, the lamps of the organization are located on the supports of the energy saving organization Mariupol DEN. The supports are represented by the following types - ОВВ, СОК 3, СОК 5, М1, 2 ЖВ.

The external lighting of Mariupol city is based on a special schedule of switching on and off of external lighting. The Dispatching Service of the ME "Mysksvitlo" has a special software for taking readings and control using GSM communication, which allows automating the process of switching on and off the sources of street lighting depending on the time of day. Considering the special weather conditions and other important reasons for switching on and off can be occurred manually by the manager.

The project provides energy-efficient reconstruction of the city's external lighting system by implementation of the following stages:

- Replacement of existing external lighting lamps with the LEDs;
- replacement of cable-conductor lines of power supply;
- replacement and repair of control cabinets;

The investment project suggests the following options for replacing the existing external lighting constructions of Mariupol city with on LED lighting

During the introduction and modernization of external lighting systems, the events are carried out with the use of modern technologies and materials, the introduction of external lighting automated control systems, which will reduce the cost of monitoring, the lighting systems switching on/off, as well as using of work-hours zoning per day (3-zone schedule) for payment of consumed electricity, which will reduce the cost of money in this direction.
The measures for the reconstruction and modernization of external lighting systems include the replacement of existing power items with new ones, the modernization of dispatch control panels, the creation of control systems based on new software using electronic maps and information obtained during the inventory of external lighting systems.
The main objective is saving energy reducing the consumption of electricity and the economic effect, which is achieved at the expense of several factors:

- the use of energy saving LED lamps,
- automatic control on the consumption of lanterns, considering illumination,
- lighting control according to the criterion of presence,
- “scheduled” control of the lamps from the server.

The project provides the replacement with the modernization of all old control cabinets of external lighting with new cabinets with integrated control elements and information exchange with a dispatch system in the number of 258 items for the management and taking readings from new LED lanterns.

As a result of the implementation, a mechanism for introducing the remote control of the external lighting objects through the radio channel with data processing by computer technology and control from the central dispatching panel will be created and implemented, which will allow efficient use of energy resources with the appropriate provision of a stable level of service quality; to reduce expenses regarding the maintenance of networks of an external lighting; have the opportunity to quickly regulate electricity consumption; minimize the human factor; to obtain a stable, clearly defined operation of the system of external lighting; quickly detect and eliminate defects, malfunctions, accidents.

The project also provides the replacement of the power supply system of an uninsulated air line with self-supporting insulated wire of a total length of 986,000 m, which will increase the reliability and safety of the lighting network. Self-supporting insulated wire: strand wire for air lines containing insulated conductors and supporting element, designed for fastening or suspension of wire.

Table 4.1 The combined table of the external lighting modernization options of Mariupol city

Lamps type	Lantern type	Replacement with LEDL1 type	Replacement with LEDL2 type	Replacement with LEDL3 type	Replacement with LEDL4 type	Replacement with LEDL5 type	Replacement with LEDL6 type	Replacement with LEDL7 type	Replacement with LEDL8 type	Replacement with LEDL9 type	Replacement with LEDL10 type
Incandescent lamp 150	СПО, НКУ	Type 27	ULSL-35	KEDR SKU 50W	SMKU-02-1-50	ST-50-04 50W	Jooby Cobra LED-КУ 60/5000K-УХЛ1	LS-OPTIMAL LED 50W	STELS (PSKS35)	SDV 02-36 A1	BGP303 LED73-3S/740 PSU II 42/60
High pressure mercury lamp MAL 250	РКУ, РСУ	Type 53	ULSL-70	KEDR SKU 100W	SMKU - 02-1-80	ST-100-04 100W	Jooby Cobra LED-КУ 80/5000K-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS140)	SDV 02-36	BGP303 LED122-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 70	ЖКУ, ЖСУ	Type 27	ULSL-35	KEDR SKU 50W	SMKU - 02-1-50	ST-50-04 50W	Jooby Cobra LED-КУ 60/5000K-УХЛ1	LS-OPTIMAL LED 50W	STELS (PSKS35)	SDV 02-36 A1	BGP303 LED73-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 100	ЖКУ, ЖСУ	Type 53	ULSL-50	KEDR SKU 75W	SMKU - 02-1-80	ST-100-04 100W	Jooby Cobra LED-КУ 80/5000K-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS50)	SDV 02-36 A1	BGP303 LED122-3S/740 PSU II 42/60
High pressure sodium lamp HPSL 150	ЖКУ, ЖСУ	Type 77	ULSL-70	KEDR SKU 100W	SMKU - 02-1-80	ST-100-04 100W	JOOBY Cobra LED-КУ 120/5000 K-УХЛ1	LS-OPTIMAL LED 100W	STELS (PSKS70)	SDV 02-54	BGP303 LED122-3S/740 PSU II 42/60
High pressure sodium	ЖКУ, ЖСУ	Type 104	ULSL-100	KEDR SKU 200W	SMKU - 02-4-50	ST-150-04 150W	Jooby Cobra LED-КУ	LS-OPTIMA	STELS (PSKS140)	SDV 02-90	BRP373 LED224/NW

lamp
HPSL-
250

Continuation of Table 4.1

Lamps type	Lantern type	Replacement with LEDL11 type	Replacement with LEDL12 type	Replacement with LEDL13 type
Incandescent lamp 150	СПО, НКУ	STREETLIGHT 30 44 W 3DIM	WALK LED KU 40W/750-01	L-STREET 24
High pressure mercury lamp MAL 250	РКУ, РСУ	STREETLIGHT 30 88 W 3DIM	AVENUE LED KU 80W/750-01	L-STREET 48
High pressure sodium lamp HPSL 70	ЖКУ, ЖСУ	STREETLIGHT 30 44 W 3DIM	WALK LED KU 45W/750-01	L-STREET 24
High pressure sodium lamp HPSL 100	ЖКУ, ЖСУ	STREETLIGHT 30 70 W 3DIM	AVENUE LED KU 70W/750-01	L-STREET 48
High pressure sodium lamp HPSL 150	ЖКУ, ЖСУ	STREETLIGHT 30 105 W 3DIM	AVENUE LED KU 120W/750-01	SUPER STREET 110
High pressure sodium lamp HPSL-	ЖКУ, ЖСУ	STREETLIGHT 30 140 W 3DIM	HIGHWAY LED KU 200W/750-01	SUPER STREET 150

250

4.3.1 Activity of ME “Mysksvitlo” “in the sphere of environmental protection”

The policy of the ME "Mikskvitlo" in the field of environmental protection is aimed at protecting the life and health of the population from the negative impact caused by pollution of the environment, rational use and reproduction of natural resources.

The responsible persons for environmental protection activities at the Enterprise and treating of production wastes were appointed by order of the enterprise.

Proper storage of wastes (temporary placement) is carried out in specially designated places on the territory of the enterprise. Services for the transportation of wastes are performed by specialized enterprises on a contractual basis. The contract for the provision of the transportation of household wastes services from the municipal enterprise “Komunalnyk” of Mariupol city, the contract for the provision of services for the reception of solid household and construction wastes for disposal from the ME "Polygon TPV" of Mariupol city, a contract for the provision of services (collection, transportation, and acceptance for storage) on treating hazardous wastes from PE "Ekostandard-T" of Tokmak city were signed.

The current system of issuing environmental permissions in Ukraine is based on an intermediate level of detailing with separate regulatory documents for the protection of atmospheric air, water protection and waste management. A valid permission is required for all sources of atmospheric air and water pollution, which determines the maximum permissible values of emissions into the air and discharges into water objects, as well as establishes requirements for monitoring.

There are separate permissions that determine the rules for waste storage and disposal. To resolve these issues, the Verkhovna Rada of Ukraine adopted the Law "On the List of Permissive Documents in the Sphere of Economic Activity” in 2011. Under this law, business entities must possess only those permissions listed in the Appendix to the law.

The enterprise has a local sewage system. Wastes are generated in the form of sewage

Table 4.2 The wastes, generated because of the ME “Mysksvitlo” activities.

Wastes types	Quantity	Treatment ways
Sewage	23 m^3 per month	They are disposed through the central municipal sewage. The contract on the provision of the services for the central draining from the ME “Mariupol PUVKH” was signed
Solid household wastes	To 600 l	The contract on services for the household wastes transportation from the ME “Komunalnyk” of Mariupol city, the contract for the provision of services for the reception of solid household and construction wastes for disposal from the ME "Polygon TPV" of Mariupol city were signed.
Hazardous wastes	If necessary	The contract for the provision of services (collection, transportation, and acceptance for storage) on treating hazardous wastes from PE "Ekostandard-T" of Tokmak city

The stationary emissions sources are absent due to which the MAC regulations on the polluting substances from the stationary sources were not developed;

3.4 Analysis of alternatives

The major investment element of the planned project is the replacement of the existing lamps of the external lighting; at present the lighting of the city's territories and the adjacent territories is performed by the lanterns with 28580 lamps.

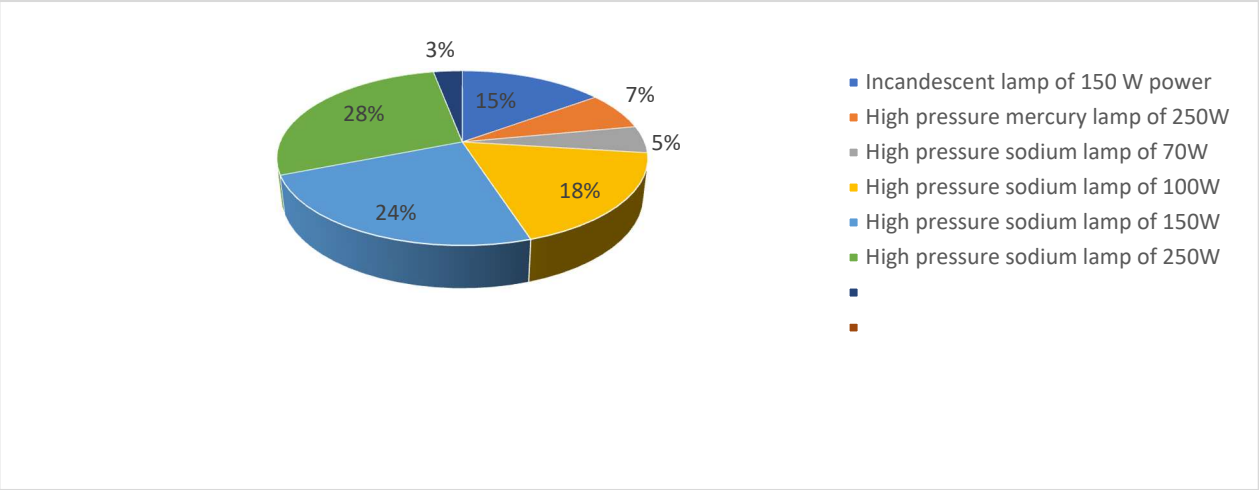
The lighting sources structure regarding the used lamps in Mariupol city is provided below.

Table 4.3 Types of lamps, used in ME "Mysksvitlo" in the external street lighting system of Mariupol city

Lamp type	Quantity, items
Incandescent lamp of 150 W power	4257
High pressure mercury lamp of 250 W power	2133
High pressure sodium lamp of 70 W power	1347
High pressure sodium lamp of 100 W power	5079
High pressure sodium lamp of 150 W power	7057
High pressure sodium lamp of 250 W power	8130
LED lanterns of 23 W	857
Total	**2886**

The necessity of lamps replacement is connected to the external lighting operation issues, that does not meet the technical level of the modern lighting equipment, and the light efficacy of the used lighting sources is rather low. Thus, the technically outdated lanterns with the mercury lamps of MAL and HPSL types, consume a great amount of the energy. Because of the constant energy cost increase the issue of its saving is crucial for the city.

Figure 4.1 The lighting sources structure regarding the lamps types in Mariupol city.



According to assessments, the operational properties of the electrical networks of external lighting are rather low. The outdated types of light devices are used in lighting systems, which leads to significant costs for electricity consumption. Some of the lighting devices that provide the street lighting of the city have low efficiency. The share of the low-efficient sodium lamps of HPSL type is at about 75% of the total power of used lighting sources.

One of the main reasons for the need to replace the lamps is their negative impact on the state of the environment. Damaged or thrown in the garbage fluorescent lamps and any other lamps cause irreversible pollution of the environment by toxic mercury vapors, glass breaking, elements of non-ferrous metals: tungsten, molybdenum, vanadium - which are carcinogenic substances. The proper utilization of fluorescent lamps can save the environment clean.

The disposal of lamps containing mercury vapors, refers to the process of demercurization - isolation from lamps, premises, containers, etc., an extremely dangerous element - mercury. The processing of lamps and their disposal is a task for specialized companies licensed to deal with hazardous wastes.

Another point that needs regulation is the light pollution of the atmosphere. That is, the earth's light sources, first of all, the cities' lighting, interrupt the light of stars, which is even more dispersed and the phenomenon of "glow" of the sky is the result of light pollution: artificial light is directed upwards dispersed by particles of the atmosphere (molecules and aerosols) and produces glow.

At a significant increase of the night sky illumination, the night animals are also suffering. Excessive light badly influences almost all night species. Some of them cannot hunt, and some – propagate the kind, others - just live. For example, reducing the number of insects reduces the area of pollination of plants. As it is known, falling out of the "food chain" at least one link leads to very serious consequences for all other links. Birds are particularly affected. "Light pollution" affects, first, the routes of their migration. The natural rhythm of plants and all living species varies greatly as a result of the "transformation of the night into a day". For example, for plants, the increase in the period of photosynthesis caused using the artificial light, will lead to the supernatural growth of plants, the shift of the phase of flowering and the frequency of photosynthesis.

The artificial light emitted from the city into space darkness is only an indicator of pollution, and it is necessary to fight not with the consequence as with the cause - with the physical obscurity of the atmosphere. The artificial light cannot be compared with the intensity of the sun, so it is not able to illuminate the air on the scale of the whole city if the air is clean. The light curtain appears only in the dirty air of the megacities. The problem of light pollution can be solved in two ways:

- to reduce smoke pollution and clogging of the atmosphere with industrial emissions;
- appliance of new lighting technologies and improving the quality of architectural projects.

Among the possible options for replacing of mercury lamps are HPSL type lamps, which are also on the balance sheet of the enterprise and LED lamps. The comparative characteristics of the lamps are given below in Table 4.4.

Table 4.4 The comparative characteristics of lamps of different types

Lamp type	MAL	HPSL	LED lantern
Primary light efficacy incl. the efficiency of the lantern (only lamps)	33 Lm/W (46 Lm/W)	60 Lm/W (83 Lm/W)	115 Lm/W (150 Lm/W)
Light flux decrease in 3 months (1 year of operation)	30% (40%)	12% (20%)	2% (4%)
light efficacy incl. the efficiency of the lantern in 3 months (in 1 year of operation)	23 Lm/W (20 Lm/W)	51 Lm/W (48 Lm/W)	112 Lm/W (140 Lm/W)
Operational life (average), hrs	12000	15000	80 000-100 000
Mechanical	Average	Average	High

strength			
Time of operational mode switching, min.	10-15 min.	10-15 min.	1-2 sec.
Environmental safety	Lamp contains to 100 mg of mercury vapors.	the lamp contains sodium-mercury amalgam and xenon	safe

Thus, on the basis of the above, it can be concluded that the use of LED lamps is the most optimal option in terms of optimizing of the impact on the environment state and the impact on the city's social environment, which allows us solving the issues associated with increasing security in the city streets at night time and improving the quality of lighting of the city's areas.

4.4.1 An analysis of the impact of the modernization of the street lighting system on the atmospheric air state

The general characteristics of the atmospheric air state of Mariupol city Donetsk region.

According to meteorological conditions, Mariupol city belongs to territories with a high potential of pollution of atmospheric air and unfavorable conditions of dispersion of industrial emissions.

In the Mariupol region there are adverse weather phenomena - fogs, dust storms. The largest number of days in a year with fog is 81, the average is 64, of which in winter - 56. The largest number of days in a year with dust storms is 7.

The maximum recorded wind speed is 33 m/s. The prevailing wind directions in winter are eastern and north-eastern, in summer - northwest.

In recent years, because of the continuing warming of the Earth climate the temperature inversions have become more frequent in the atmosphere of Mariupol city, during which the pollutants are "pressed" to the ground and can be accumulated in the atmosphere, they can be accumulated in the surface layer of the atmosphere for a long time (unfavorable weather conditions UWC of 1, 2nd and 3rd levels of danger).

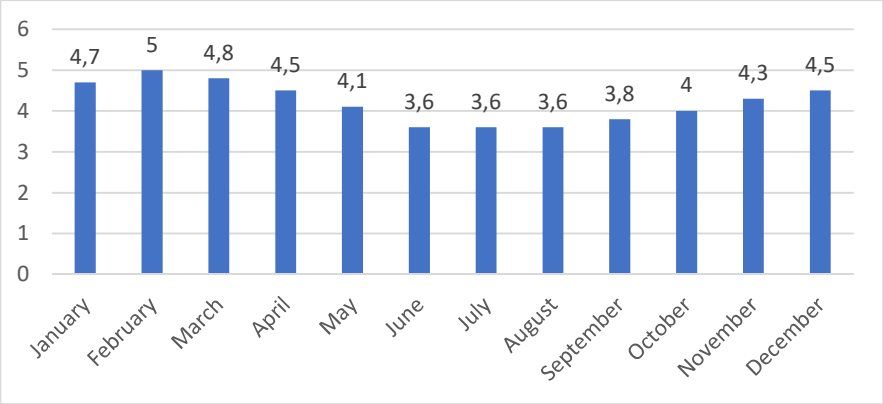
The struggling against increased air pollution during these periods is under the control of the city executive committee according to specially designed programs for all industrial enterprises and transport for all 3 levels of the UWC.

According to the Methodological Guidelines for forecasting of meteorological conditions of the formation of air pollution levels in the cities of Ukraine, the State Hydrometeorological Service, during the forecasting of air pollution in cities located near seas, rivers and large basins, it is necessary to consider local features of circulation. During periods of stagnation, the breeze is often amplified, which causes the concentration of impurities in the surface layer of the atmosphere to decrease. In some periods there is a closed circulation, which leads to the return of impurities that have risen above the source. In the conditions of the city, two maxima of air pollution can be observed depending on the wind speed at the level of an air vane: during zero and weak winds (up to 2 $m \cdot s^{-1}$) and at wind speeds in the range of 4 $m \cdot s^{-1}$ to 6 $m \cdot s^{-1}$. In Mariupol, the highest repetition of high levels of pollution is during zero wind, wind speeds from 3 $m \cdot s^{-1}$ to 5 $m \cdot s^{-1}$ and from 9 $m \cdot s^{-1}$ to 12 $m \cdot s^{-1}$.

Table 4.5 The average wind speed values in Mariupol city

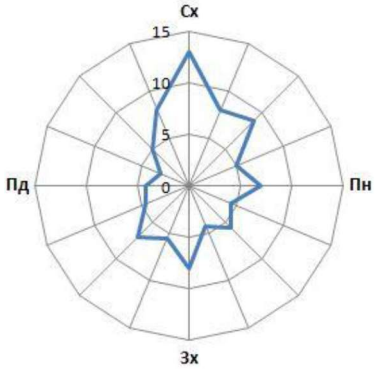
	January	February	March	April	May	June	July	August	Septemper	October	November	December
Wind speed, m/s	4.7	5.0	4.8	4.5	4.1	3.6	3.6	3.6	3.8	4.0	4.3	4.5

Figure 4.2 The values of the average wind speed in Mariupol city, m/s



Wind speed m/s

Figure 4.3 Wind rose of Mariupol city (year statistics)



From the data above, it can be concluded that during the year in Mariupol city the winds of the eastern direction dominate at a speed not exceeding on average of 5 m/s.

Sampling of atmospheric air in Mariupol city is carried out at 5 stationary stations (APOS) located in Kalmiusky, Livoberezhny, Central and Primorsky regions.

In December 2016, 1904 atmospheric air samples were taken and analyzed. The observations were made at 5 stations on the following polluting ingredients: dust, nitrogen dioxide, sulfur dioxide, carbon monoxide, phenol, formaldehyde, hydrogen sulfide and ammonia. Also, the concentration of hydrogen ions (pH) of atmospheric precipitation was determined.

In general, there was an excess of average monthly concentrations in the city in terms of units of MAC a.s. on formaldehyde (3.7 MAC a.s.).

The average monthly concentrations of other ingredients, in general, in the city did not exceed the maximum allowable values.

Concentrations of air pollutants exceeding the average monthly MAC were observed: by dust in the Kalmiusky and Central districts and by formaldehyde - in all areas of the city. The level of pollution with sulfur dioxide, carbon monoxide, nitrogen dioxide, phenol and ammonia did not exceed the maximum allowable norm.

The main contribution to the overall pollution of the city atmosphere is made by the enterprises of ferrous metallurgy - PJSC "MC" Azovstal" and PJSC "MMC named after Illich", emissions of which, according to the Ministry of Ecology and Natural Resources data, make up about 98% of the total city's, then the emissions into the atmosphere from other enterprises of the city were not considered in this Program.

In 2007 before the global economic crisis, at stable work of the metallurgical complex, metallurgical combines in Mariupol 13.2 million tons of steel was produced. Emissions into the atmosphere from these enterprises amounted to ~ 420 thousand tons per year.
During the following years, due to the global economic crisis, the volume of metallurgical production has decreased significantly and in 2009 was 8.9 million tons. Emissions into the atmosphere also decreased and were about 280 thousand tons/Year
In 2010 ... 2014 There was a significant increase in metallurgical production, the volume of products at metallurgical plants was close to pre-crisis: in 2011. Emissions into the atmosphere also increased and were almost 380 thousand tons.

A comparative analysis of the average monthly concentrations of pollutant air ingredients indicates that dust concentrations have increased, the average concentrations of nitrogen dioxide and formaldehyde have slightly decreased, and the concentrations of all other pollutants have remained the same.

Comparing the average monthly concentrations of December 2016 and December 2015, it is possible to note the increase of concentrations of dust, carbon monoxide, nitrogen dioxide and formaldehyde, and decrease of concentrations of phenol. The average concentrations of sulfur dioxide and ammonia remained at the same level.

On average, the specific emissions of pollutants in the city per ton of produced steel were 32kg/t.

Emissions of harmful substances into the atmosphere from industrial enterprises of the city per area unit are 1550 t/km^2, including:

- suspended - 136 t/km^2;
- sulfur dioxide - 88 t/km^2,
- carbon monoxide - 1250 t/km^2;
- nitrogen oxides - 76 t/km^2.

Specific emissions per 1 inhabitant of the city were 0,778 t/person per year, incl.

- suspended - 68 kg/person;
- sulfur dioxide - 44 kg/person;
- carbon monoxide - 628 kg/person;
- Nitrogen oxides - 38 kg/person.

Particularly high concentrations are discovered of formaldehyde content. According to information from the scientific literature, formaldehyde is a product of emissions from chemical production, moto transport, and the production of building materials.

The source of benzopyrene is emissions from coke, petroleum and chemical, asphalt-concrete production, vehicle exhausts and incomplete combustion products of boiler installations. Formaldehyde can also be formed under conditions of high overall air pollution as a product of photochemical reactions (photochemical smog). It is especially in conditions of high solar activity (July, August). During this period, the largest concentrations of formaldehyde are observed. The concentration of this harmful substance in the air remains high (1.5 MAC a.s)

The content of suspended materials remains above the MAC level and is stable at a level that is 1.3 times above the normal value.

Dust concentration values in Mariupol city's air reflect the total amount of suspended solid materials (TSP, Total Suspended Particulates) in all airborne dust particles up to 25 microns. The maximum permissible annual

average density of suspended dust in Ukraine is 150 μg/m^3. The recorded indicators of dust concentration in the air since 2006 reach 1.3 MAC, or 195 μg/m^3 in Mariupol city.

The additional contributing to air pollution in the city is made by moto transport. According to the Ministry of Ecology and Natural Resources of Ukraine, the share of moto transport in general in Donetsk region is about 15%.

The car fleet of Mariupol city is constantly growing. There is a steady trend in the growth of the number of personal motor vehicles of the population. So, over the past 5 years, the number of passenger cars in the city has 50% increased, trucks and buses - 25%.

The peculiarities of mobile sources of emissions are:

- proximity to residential areas;
- higher emission toxicity in comparison with stationary source emissions;
- low location above the earth's surface, which leads to an accumulation of emissions directly in people breathing area and their weak scattering in the atmosphere.

About 30-35 thousand tons of pollutants per year are emitted into the atmospheric air of the city by traffic (carbon monoxide, nitrogen oxides, hydrocarbons, etc.). The main part of them is in the summer season. The greatest impact on the emissions of motor vehicles is on residential neighborhoods adjacent to the main traffic highways of the city (Lenin avenue, Metallurhiv avenue, Budivelnykiv avenue, Chervonoflotska str, Torgova str, etc.).

Table 4.6 The emissions values dynamics in Donetsk region

Year	Emissions volumes			Emissions volumes		
	Total, Thousand tons	Including		Total, Thousand tons	Including	
		Stationary sources thousand tons	Movable sources thousand, tons		Stationary sources thousand tons	Movable sources thousand, tons
2006	1895.2	1659.7	235.5	65.2	65.2	…
2007	1871.2	1653.4	217.8	68.3	65.9	2.7
2008	1767.2	1533.4	233.8	60.3	57.5	2.8
2009	1513.3	1299.8	213.5	55.4	52.8	2.6
2010	1589.9	1378.1	211.8	61.5	59.0	2.5
2011	1729.3	1525.9	203.4	66.2	63.6	2.6
2012	1714.7	1514.8	199.9	63.2	60.7	2.5
2013	1621.8	1448.1	173.7	61.8	60.0	1.8

Table 4.7 The quantitative and qualitative composition of the emissions of hazardous substances into the atmospheric air in Donetsk region

Year	Emissions volumes		
	Total, thousand tons	Including	
		Stationary sources	Movable sources
Pollutants emissions	1138701.6	1043002.4	95699.2
Including:			
Metals and their compounds	10853.2	10853.2	-
methane	226738.9	226417.7	321.2
Nonmethane volatile organic compounds	12467.2	1834.3	10632.9
Carbon monoxide	357223.0	284620.5	72602.5
dioxide and other sulfur compounds	356704.3	355708.0	996.3
From them			
Sulfur dioxide	355839.4	354843.1	996.3
Nitrogen compounds	68973.9	58894.3	10079.6
From them			
Nitrogen monoxides	1245.2	1190.6	54.6
Nitrogen dioxides	67320.0	57295.6	10024.4
Ammonia	401.3	400.7	0.6
persistent organic pollutants	14.3	14.3	
substances in the form of solid suspended particles	105636.1	104575.0	1061.1
other	90.7	85.1	5.6
Moreover, carbon dioxide, million tons	43.5	42.4	1.1

The influence of construction works on the atmospheric air of Mariupol city during the modernization of external lighting systems.

The works related to the reconstruction of external lighting system of Mariupol city relate to:

- excavation work related to the laying/replacement of engineering networks;

- installation/dismantling works related to the installation/replacement of the bases of control cabinets,

which, in turn, involves the release into the atmosphere of:

- dust during excavation and the removal of the asphalt layer and, appropriately, subsequent laying of the soil layer and asphalt covering. Dusts and emissions from construction works can affect neighboring residential areas, hospitals and schools;
- combustion products of the internal combustion engine of motor vehicles, excavation and special vehicles;
- hydrocarbons during the laying of asphalt covering.

The level of this influence depends on a range of factors, including weather conditions, type of work.
This influence will have a short-term and local character on the air that will be created in the work areas when using construction equipment. The work will be performed by the contractor, the contractor will be selected based on the conducted competitive bidding. Thus, the final quantitative and qualitative composition of equipment and tools of the contractor is not known at present. And, taking into account the requirements of a number of legal acts of Ukraine, in particular: Law of Ukraine "On Automobile Transport" dated April 5, 2001 No. 2344-III, "RULES of usage of wheeled transport", approved by the Order of the Ministry of Infrastructure of Ukraine dated July 26, 2013 No. 550, and RULES of operation of lead-acid starter batteries of wheeled vehicles and special machines made on wheeled chassis, approved by the Order of the Ministry of Transport and Communications of Ukraine of 02.07.2008 N795, the technical condition of the used fleet should be in a satisfactory condition, and all emissions related to the operation of internal combustion engines do not exceed the provided standards. Moreover, this provision should be included to the technical requirements of public procurement when determining the contractor. This will ensure the use of the equipment only in the regular technical state.

- Increase of air pollution by emissions of exhaust gases of ground transport.

This is because one of the main purposes of street lighting networks of Municipal Enterprise "Mysksvitlo" is to ensure the level of roadway lighting of the city - highways. The works related to the modernization of the city's street lighting network, as noted above, will be related to the use of special equipment, including large-scale. During the work it is planned to place it on the part of the roadway (with compliance of all safety requirements). This, in turn, will reduce the lines of the roadway and change the speed mode and, accordingly, the accumulation of motor vehicles, and hence – to the increase of the concentration of harmful substances that will be emitted into the atmosphere along with the exhaust gases.

This impact will have a short-term and local character on the air that will be created in the work areas when using construction equipment. In advance, the informing of the owners of vehicles about the possible complications of the movement by ads in the media will be provided. Also, work will be carried out during the daytime in the time of low density of traffic flow, which significantly reduces the possibility of negative impact on atmospheric air.

- the separation of mercury vapor and sodium, due to the possibility of glass breaking of removed lamps of MAL and HPSL types (gas discharge lamps) from the design of external lighting of Dnipro city.

This type of impact will be minimized or completely absent, due to compliance the requirements by the workers responsible for this type of work in accordance with legal acts regulating the treating of hazardous wastes, in particular: Law of Ukraine "On Wastes" of 05.03.1998 No. 187/98 -BP and "License conditions for conducting business activities related to hazardous wastes".

The state of atmospheric air during the operation of modernized external lighting networks

In general, the implementation of the project will lead to a significant reduction of greenhouse gases (CO_2). Reduction of the greenhouse gas emissions will reduce the environmental impact of external street lighting in Mariupol city.

Electricity consumption "before reconstruction" is **66597005 kW*h/year**
Electricity consumption "after reconstruction" is **15355566 kW*h/year**, which is 44908933 kW*h/year less.

According to the Practical Guide for the preparation of clean energy project proposals developed by the Institute for Local Development within the USAID project "Municipal Energy System in Ukraine project, calculating the base inventory of CO_2 emissions (BIE) in the municipal sector" the following dependence is used:

$$BIE = \sum (NCEEi*CECi) \top CO_2, \text{ where}$$

- NCEE – national coefficient of the energy emissions. According to the calculation methods of the United Nations Framework Convention of Climate Change, the national Ukrainian coefficient of IPCC (International Panel of Climate Changes) of CO_2 emissions is: 1MW*h – 1.09 $\top$ CO_2
- CEC – the consumers electricity consumption (MW*h)

Thus, when implementing this investment project, CO_2 emissions per year will decrease by:
Thus, considering the potential condition of the external lighting network, we will get savings in consumption of CO_2 by 67.43% or by 48.950 tons per year.:

During operation, there will be no emissions of hazardous substances into the atmosphere. Excluding the cases of scheduled repair and maintenance of external lighting systems during which there will be the use of automotive equipment, which involves the release of combustion products of the internal combustion engine of vehicles.

However, this influence will have a short-term and local character on the air that will be created in the work areas when using construction equipment. The work will be performed by the contractor, the contractor will be selected based on the conducted competitive bidding. Thus, the final quantitative and qualitative composition of equipment and tools of the contractor is not known at present. And, taking into account the requirements of a number of legal acts of Ukraine, in particular: Law of Ukraine "On Automobile Transport" dated April 5, 2001 No. 2344-III, "RULES of usage of wheeled transport", approved by the Order of the Ministry of Infrastructure of Ukraine dated July 26, 2013 No. 550, and RULES of operation of lead-acid starter batteries of wheeled vehicles and special machines made on wheeled chassis, approved by the Order of the Ministry of Transport and Communications of Ukraine of 02.07.2008 N795, the technical condition of the used fleet should be in a satisfactory condition, and all emissions related to the operation of internal combustion engines do not exceed the provided standards. Moreover, this provision should be included to the technical requirements of public procurement when determining the contractor. This will ensure the use of the equipment only in the regular technical state.

3.4.2 Landscape, soils and geology

Soils state analysis in Mariupol city and Donetsk region.

The city is located on the upland of the slightly rolling plain, which ends at the sea with a steep ledge. The relief of the area and the presence of constant winds (in winter - boron, in summer - breeze) provides good airing of the city and scattering of dust emissions. The high intensity of these winds and the geographical "equality" of the relief does not allow for a long time for accumulation of pollutants. At the same time, strong winds increase the wind erosion of numerous waste dumps of industrial wastes, sandy and eroded soils.

In soil cover on the territory of research low-humus chernozems common in loess are dominated. Soils of the research area belong to the calcium class of geochemical landscapes with the prevailing ability to accumulate heavy metals, with a content of humus of 3.1-5% and (pH - 6.6-7.5). The territory is characterized by a significant level of man-made load. It is established that because of aerogenic emissions of ferrous metallurgy enterprises, physicochemical and mineralogical properties of soils change. There is a decrease in the pH of the surface layer of soil, cation exchange capacity and soil buffer capacity. The peculiarity of soils determined by the influence of ferrous metallurgy enterprises is the increased content of iron oxides (by 2,6-6,0 times), manganese (1,6-4,7 times) and calcium (2-2,7 times) in compared to background areas.

Lead.
The regional background of this element for the soil of the research area is 18 mg / kg. The average gross content of lead in soils of Mariupol (horizon 0-5 cm) is 259 mg / kg, which 14 times exceeds the background value and 8 times the MAC. In Mariupol there are two man-made anomalies of lead in soils (interval 0-5 cm). The first is in Sadky region, located to the north of the MC "Azovstal", where the gross lead content is 10,000 mg / kg, which is 556 times exceeds the background value and 312 times the MPC. The second technogenic

anomaly is located near the railway station of Mariupol city, the gross content of lead reaches 1000 mg / kg, which 56 times exceeds the background value and 31 - MPC. The minimum value of lead in this soil horizon is 40 mg / kg, which almost 2 times exceeds the regional background. Average gross content of lead in the range of 5-10 cm is 288 mg / kg, which 16 times exceeds the background value and 9 times the MPC.

Copper.
The regional background of copper for the soil of the research area is 20 mg / kg. However, due to the constant flow of copper because of the activity of ferrous metallurgy enterprises and the ability of the surface layer of the soil to accumulate copper, its content in the soil of the city increased. The average gross content of copper in the soils of Mariupol (range 0-5 cm) is 175 mg / kg, which exceeds the background value 9 times, and the MPC - 5. Because of ecological and geochemical mapping, there are two man-made anomalies of copper in surface layer of soil (range 0-5 cm). The first is located to the north of "Azovstal", the second - in the central part of the city. The gross content of copper in certain man-made anomalies reaches 2000 mg / kg, which exceeds the background value 100 times and the MPC - 60.
Zinc.
The regional background value of zinc for the soil of the research area is 78 mg / kg. The average gross zinc content in the soils of Mariupol (range 0-5 cm) is 413 mg / kg, which 5 times exceeds the regional background value and 7 times the MPC. Three technogenic anomalies of zinc were detected in the soil horizon of 0-5 cm. One in the southern part of "MMC named. Ilyich" with gross zinc content in soils of 4000 mg / kg, which 51 times exceeds the background value, and two others in the central and eastern part of the city with zinc contents in soils of 3000 mg / kg, which 38 times exceeds the background value. The most polluted soil of this heavy metal (range 0-5 cm) is in the regions of Zhovtnevy, Ordzhonikidze, and the northwestern part of the city. The value of zinc content, which is equal to or less than the background, is recorded only in the eastern part of the city. The average gross zinc content in the soils of Mariupol (5-10 cm) is 187 mg / kg, which 2 times exceeds the regional background value and 3 times. the MPC. In the horizon of the soil of 5-10 cm, the gross weight of zinc is significantly reduced. This indicates that the accumulation of zinc usually occurs in the surface soils. The maximum value of zinc content for a soil interval of 5-10 cm is 800 mg / kg, which is 10 time more than the background. With this value two man-made anomalies were recorded. One in the western part of the city (near the settlement of Stary Crym), the second - in the southern part of the MC "Azovstal". The content of zinc in the soils of the southwest and south-eastern part of the city (range 5-10 cm) are at the level of background values.

Chrome.
The background content of chrome for territory soil is 50 mg / kg. The average content of chrome in the earth's horizon of 0-5 cm of Mariupol is 214 mg / kg, which 4 times exceeds the background value and the 2 times MPC. Four technogenic anomalies were found with the content of chrome in soils (range 0-5 cm), the gross chrome content of which reaches 450-500 mg / kg, which 9-10 times exceeds the background value and 5 times the MPC. Two anomalies are located in the sanitary protection zones of ferrous metallurgy enterprises: the first in the northern part of the "Azovstal", and in the north-eastern part of the plant "named Ilyich" Two more were registered in the residential area of Mariupol city. Technogenic anomaly with 7 times excess of background value and 3.5 times of MPC is in the eastern part of the city, where agricultural land is located. It should be noted that almost the whole territory of the city except the southern part is contaminated by this element.

Influence on the soil cover during the construction work during the reconstruction of the external lighting network of Mariupol city

The works related to the modernization of the external lighting system of Mariupol city are related to:

- laying/replacement of engineering networks;
- replacement of lighting lamps.

This, in turn, will involve carrying out of construction works related to:

- excavation of foundation pits for supports;
- construction works related to the removal of the asphalt layer.

Modernization (reconstruction) of external lighting networks will take place within existing perimeter of areas and additional areas will not be required.

Construction work involves the use of a range of special vehicles. But, since the work will be performed by the contractor, the contractor, selected based on the results of the competitive bidding, thus, the final quantitative and qualitative composition of equipment and tools of the contractor is not known at present. It is known that the use of large-scale equipment is foreseen. This, in turn, implies:

- the mechanical impact of transport and construction tools, which will be expressed as a compressive effect - an increase in the density of the upper layers of the soil, which was not included to the removable. (due to the heavy weight of technical tools and equipment);
- However, this type of impact will be minimized by prohibiting (if possible) the location of vehicles in areas not asphalt covered.
- mechanical influence at the expense of anthropogenic exhaustion.

This type of impact will also be minimized at the expense of fencing a site with repair work in accordance with the rules and norms.
During future construction work outside the boundaries of asphalt concrete cover, related to drilling or construction work for excavation of pits will have an impact on the upper layers of the soil:

- there will be a violation of the morphological structure of soils.

However, this type of impact will be minimized due to the small localization of works. Also, in order to save the fertile soil layer, it is supposed to remove its upper layer by means of special equipment and its storage in the designated places, which will minimize the loss in soil of such quality as fertility.

- transformational influence - the transformation of the soil is also due to the deposition of building materials to the soil mass, which affects morphology.

This type of effect is because the support in its lower part on a length equal to immersion to the soil, should be waterproof (a layer of bitumen) on the outer and inner surfaces. However, this effect cannot be considered, since it will have minimal or no impact on the soil surface due to the fact that the manufacturer of external lighting supports performs the waterproofing, thus the aggregate bitumen state does not provide the mixing with the soil mass.

The use of construction equipment will also include:

- chemical pollution of the soil as a result of the emission of exhaust gases and the subsequent deposition of heavy metals contained in them, in the upper layers of the soil and possible leakage of fuel and lubricants.

Even though large-scale technology is characterized by significant losses of fuel and lubricants (along with other types of technology), this impact will have a short-term nature. However, with heavy losses of fuel and lubricants (for example, spills in emergency situations), the impact on the soil will be significant, and it also entails an impact on water resources - the underground aquifer. This type of impact will be minimized because of the preliminary development of instructions for dealing with emergencies, in addition, the use of automotive equipment involves the daily registration of a road sign with a mark of the head of the garage, which certifies the inspection of the vehicle and is a measure of prevention of the occurrence of such situations.

- mechanical contamination of soil at the expense of broken glass.

This type of impact will be minimal, if not completely absent, because the storage of spent exhaust from external lighting structures to replace the lamps of MAL and HPSL type in the appropriate places, with appropriate markings and conducting preliminary instructions of designated responsible persons to minimize emissions of leakage.

- mechanical soil pollution due to the settling of dust particles and asphalt during construction work associated with the removal of asphalt cover.

This type of impact will also be insignificant due to the small amount of construction work.

During construction, the landscape surface is interrupted temporarily in the construction site. After the construction the microrelief is restored, it is a prerequisite for construction.

Influence on landscapes, soil cover and geology in the process of operation of upgraded external lighting networks.

Impact on the geological structure or soil cover during operation is not expected. Scheduled repair or inspection of external lighting networks does not involve mechanical impact on the soil because in most cases the work will only be related to the replacement of waste or non-working lamps. This involves the use of a hydraulic lift, which must and can be installed in the area with asphalt covering. However, it is necessary to consider the chemical influence in the form of:

- deposition of heavy metals that are contained in the exhaust gases will be minimal, if tangible at all due to the low frequency and duration of work;
- there can be no leakage of hazardous substances because of the glass breaking due to following the rules of work with hazardous emissions.

The impact on the landscape is not expected due to the low frequency of this type of work, which is associated with the long service life of LED lamps.

3.4.3 Water resources

The water resources state analysis in Mariupol city.

Among the water objects of Mariupol city there are 4 small rivers, as well as 108 basins, with an area of water face of more than 1 hectare, including 6 reservoirs and 72 ponds. The total area of basins and ponds is 640.8 hectares, the volume of water resources is 22460.6 thousand m^3. The main water object is the Kalmius River, and, of course, the Sea of Azov.

The main sources of pollution of the Azov Sea waters near the Mariupol coast area are the Kalmius River, discharges of urban wastewaters, as well as waste water from “Azovstal” and “Ilyich”. At the same time, 80 million of 160 million m^3 of sewage are discharged into the Azov Sea by “Metinvest” holding company. The considered substances getting to the Kalmius below the discharges of industrial waters from the metallurgical combines are given in Table 18. Chlorides, sulfates, phenol, petroleum products and nitrates exceed the maximum permissible concentrations of harmful substances established by national legislation.

The most common index for determining the quality of water is the Water Pollution Index (WPI). According to this index for assessing the quality of water by the hydrochemical indicators, 7 grades of quality are indicated:

I - Very pure water (value of WPI $\leq$ 0.25);
II - pure water (the value of WPI from 0.25 to 0.75);
III - Moderately polluted (WPI from 0.75 to 1.25);
IV - Polluted (WPI from 1.25 to 1.75);
V - Dirty (WPI from 1.75 to 3);
VI - Very dirty (WPI 3 to 5);
VII - Extremely dirty (WPI > 5)

The Kalmius river water pollution index in Mariupol city is 3-5 (very dirty). The monitoring system on marine pollution of the Mariupol Hydrometeorological Observatory consists of 4 stations of the first category (located in close proximity to sources of pollution). Stations of the first category are intended for operational control of the state of pollution of the sea in areas of the population recreation in places of wastewater receiving. At ten stations of the second category the surveillance is conducted twice a year with the help of small-scale fleet vessels. They cover a large area of the Azov Sea and are not directly affected by heavily polluted sewage.

The largest contamination is observed in the riverheads: the content of nutrients (nitrites, nitrates, phosphates, ammonium nitrogen, silicon) is higher here than at other monitoring stations. This is due to the release of insufficiently treated wastewater from industrial enterprises, agricultural complexes and domestic waste waters. In the second place by the influence on the state of the marine environment are ports and shipping companies that pollute water with petroleum products and are potentially dangerous regarding the transportation of fertilizers, oil and its products and other environmentally hazardous substances. Slag wastes and dumps in the

immediate proximity of the sea form the third source of hazardous pollution, so the polluted water is washed away here into the soil and surface waters, which later fall into the Sea of Azov.

Most of the rivers belong to the category of dirty and very dirty. The water quality indicators of the Azov Sea remain unsatisfactory. There is a steady increase in mineralization and pollution of heavy metals of underground and surface waters.

The ecological status of water objects of the city is closely connected with the quality of water in the Kalmius River and its tributaries. Prolonged intensive water consumption and discharge of sewage significantly degraded the state of the local watercourses and the basin of the Kalmius River. The river is fed by spring snowmelting, springs, mine and industrial waters and sanitary water releases from the channel Siversky Donets. During the summer time in Kalmius, when the water level drops, the oxygen content drops sharply and bacterial contamination increases. Water in water objects of the city by many indicators does not meet the requirements of the existing norms.

Analysis of water pollution in the Kalmius river shows that the deviations of water quality indicators from the adopted sanitary norms of surface water protection from pollution are observed in petroleum products, phenol, heavy metals, sulfides, sulfates, suspended solids and dry residue.

The location of the Kalmius River is such that basically all large enterprises are concentrated near the river and are the direct sources of its pollution. In particular, they are such enterprises as the Donetsk Metallurgical Plant, metallurgical combines named Ilyich and “Azovstal”, metallurgical and coke plants in Yenakiyevo, Alchevsk Iron and Steel Works, Alchevsk and Stakhanovsky Coke plants, and mine waters, waste dumps and dumps of household rubbish.

In the upper flow the Kalmius River is intensively polluted by industrial and household wastewater. At this site, of 17 km length, there are a number of sources of dumping with a total cost of about 4000 m^3/h. By pollution the most unfavorable runoff of the mine is Chervonohvardijska, the turbidity of which and the concentration of petroleum products 2-3 times exceed the MPC. In the waste water of other enterprises, the pollution concentration is lower - turbidity is 8-36 mg/l, excess of the MPC for petroleum products is 2-5, phenol - 2-9 times. The mineralization of the Kalmius River fluctuates from 777 mg / l (riverhead) to 2090 mg / l.

The concentration of nutrients from leakage to the riverhead in different seasons varies widely. In all seasons, the concentration of nutrients in the head is reduced. Pollution by volatile and non-volatile phenols of the river's water can be traced along the entire length of the Kalmius River. Especially high values of phenols are observed in spring (up to 1.4 mg / l) near Mariupol city. The most severe pollution of the river's water by petroleum products occurs in the Donetsk and Mariupol cities (from 0.6 to 1.4 mg / l), and in bottom pumps from 0.9 to 15 mg / l.

The number of chromium ions, annually arriving to the Kalmius River, is 1.6 tons / year. Chromium ions fall into the river basically from waste water of metallurgical enterprises, enterprises of mechanical engineering, coal industry. The most toxic are hexavalent chromium compounds, although trivalent compounds are also toxic. They irritate and burn mucous membranes and skin. Bichromates act much heavier than chromates, giving a general toxic effect, irritating the gastrointestinal tract, causing lung cancer, causing severe skin diseases.

One of the main causes of pollution of surface water objects of Mariupol is the discharge of industrial waste water into them, which pose a real danger to the environment. Sewage water contains heavy metals, petroleum products, organic compounds that have toxic properties of cumulative and additive nature, can have a mutagenic and carcinogenic effect on living organisms.

According to the statistical reporting on the use of water resources, there are currently about 200 water users in the Donetsk region, of which 40 enterprises dispose reverse water into the rivers and basins of the city. The amount of fresh water used is an average of 130-140 million m^3 per year. For food and drinking needs, 70% are directed, and 26% of the total amount of fresh water is provided for the production process. The amount of return water exceeds the amount of water used, which is explained by the considerable volume of sewage mine waters.

Analysis of water pollution in the Kalmius river shows that the deviations of water quality indicators from the adopted sanitary norms of surface water protection from pollution are observed in petroleum products, phenol, heavy metals, sulfides, sulfates, suspended solids and dry residue.

The location of the Kalmius river is such that basically all large enterprises of the Donetsk region are concentrated near the river and are the direct sources of its pollution. In particular, they are such enterprises as the Donetsk Metallurgical Plant, which discharges waste water from a catch basin of an electric steelmaking shop in the Kalmius River, metallurgical combines. Ilyich and Azovstal in Mariupol, metallurgical and coke-chemical plants in Yenakiyevo, Alchevsk Iron and Steel Works, Alchevsk and Stakhanovsky Coke-chemical plants, these are the mine water of the Mine named after Gorky and the mines named after O.F.Zasyadko, waste dumps and dumps of household rubbish. The surface runoff from the territory of the cities of Donetsk and Mariupol is a significant source of contamination and clogging of the Kalmius River.

The Azov Sea is a unique natural object. The main source of pollution of the Azov Sea is the basin's rivers, in which a significant amount of inadequately treated industrial wastewater is discharged, as well as wastewater, directly dumped into the Sea of Azov. The processes of self-purification in the streams of the basin are not sufficiently intensive, because of polluting substances that come with sewage, they do not have time to mineralize within the watercourse; about half of their volume goes to the Sea of Azov. Coastal waters of the Sea of Azov, in which the direct sewage and river waters containing harmful substances enter, are most affected by pollution and are characterized by higher concentrations of pollutants in comparison with the waters of the open sea. In recent years, the concentration of rodanides in the sea 12.6 times exceeds the MPC, the content of phenols 7 times exceeds the norm. It should be noted that these concentrations vary from year to year, depending on both the size of wastewater discharges and under the influence of currents that are very variable in time.
Transparency of sea water in Mariupol area is reduced to 0.5 meters, while in the open part of the Azov Sea water transparency is 8 meters. The period of water exchange of the Azov Sea is 60-80 years.

The most common components of pollution of the Azov Sea include petroleum products, phenolic compounds, heavy metals, including chromium compounds, surfactants, pesticides. Influence of oil pollution is most significant in the coastal zones of the sea, including the head of the Kalmius River. The presence of petroleum products in seawater leads to their accumulation in bottom sediments. In the shallow sea, this is quite dangerous, as with intense wind blending, there can be a flow of petroleum from soils into water, causing secondary pollution of water. The content of petroleum products in the waters of the sea decreases from spring to autumn, which is associated with an increase in the rate of decay of pollutants.

The maximum of phenol content is observed in the warm period of the year, which is due to the activation of biochemical degradation of organic substances, the products of which may also be phenolic compounds. Biochemical oxygen consumption is increasing, and self-purification processes are slowed down.

The main sources of pollution of the Azov Sea are industrial enterprises and ports of Mariupol city. "AZOVSTAL", "Ilyich" metallurgical combines, concern "Azovmash" annually dispose more than 800 million m^3 of polluted waste water (up to 99% of the total volume of discharges into the sea). The main pollutant is "Azovstal", which annually discharges more than 850 million m^3 wastes into the sea, accounting 99% of the total discharge of pollutants. In particular, on December 1, 2008, the plant threw off 86118.3 thousand m^3 of sewage into the sea. In wastewater the excess of the maximum allowable concentration (MAC) of ammonia nitrogen, for iron in general, copper, zinc, petroleum products are observed.

Mariupol Sea Commercial Port is the biggest polluter. From the territory of Mariupol's trade port drainage waters are released to the waters of the Sea of Azov within Mariupol through four discharges, which are located within city beaches and are not equipped with sewage treatment facilities.

Large pollutants are a solid domestic waste landfill, located on the banks of the Kalmius River. Its sewage contains organic and inorganic substances in high concentration, the highest excess of MAC of iron, fluorine and rhodanidam; in the amount of limiting and aromatic hydrocarbons.

Particularly dangerous for the ecosystem of the seas are agricultural wastes, which include a large amount of poisonous chemicals, pesticides, intended for the destruction of harmful insects and rodents.

Protection of water objects of Mariupol, especially Kalmius and the Sea of Azov, continues to be an actual task.

Influence on water resources in the process of reconstruction of external lighting networks

Effect on surface water

The network of external lighting is laid with observance of the necessary distances to surface waters, which are defined as airspace over the surface of the reservoir, limited by vertical planes, which are distant on both sides of the outer conductors of the air communication electric cables, provided that they are not deviating from their vertical position. The width of this space for non-navigable rivers, which are the water objects crossing the route of the air lines, is equal to the established protecting zone along the line of land line.

Regarding environmental protection, the support of external lighting networks will not negatively affect the mode and quality of water resources directly and the mode of water objects in one way or another associated with their integrated use.

Supports of external lighting will not violate the steady mode of flood deposits, nor cause flood erosion.

The smallest distance from the sagging part of the wires at the lowest point, at the higher temperature of the air, to the surface of the water is taken in accordance with the table "Rules for the installation of electrical installations" and is 7,5 m.

Construction works include installation and dismantling works in the immediate proximity to surface water objects:

- in the coastal zone;

Construction work involves the use of a range of special vehicles. But, since the work will be performed by the contractor, the contractor will be selected based on the results of the competitive bidding. Thus, the final quantitative and qualitative composition of equipment and tools of the contractor is not known at present. It is known that the use of large-scale equipment is foreseen. This, in turn, provides:

- chemical pollution as a result:
  - the production of exhaust gases by the equipment used in the process of work the settling of heavy metals contained by them, on the water surface is conducted;
  - increasing the level of gas pollution of the surface layer of the atmosphere by increasing the density of the traffic flow at bridge crossings because of reducing the number of lanes for travel during the work, which will result in the settling of heavy metals contained in the exhaust gases on the water surface;
  - pollution of the water surface by the spent fuel and lubricants because of the work of internal combustion engines;
  - Unpredictable spills of used fuel and lubricants.

However, this type of impact will be minimal due to a short period of work, in addition, taking into account the requirements of a number of regulatory legal acts of Ukraine, in particular: Law of Ukraine “on Automobile Transport” dated 05.04.2001 No. 2344-III, "Rules of operation of wheeled vehicles" Approved by APPROVED Order of the Ministry of Infrastructure of Ukraine dated 07/26/2013 № 550, and RULES for the operation of rechargeable lead-acid starter batteries of wheeled vehicles and special machines made on wheeled chassis, approved by the Order of the Ministry of Transport and Communications of Ukraine 02.07.2008 N 795, the technical condition of the used car fleet should be used in a satisfactory condition and all emissions resulting from the operation of internal combustion engines does not exceed the established norms. In addition, this provision should be included to the technical requirements of public procurement when determining the contractor. This will ensure the use of the equipment only in the regular technical state.

The issue of decreasing the speed of automobile traffic will also have a short-term impact since the work will take place in a period with the smallest traffic. In addition, information on time and place of work will be made public in advance for the drivers to be able to use other motor transport connections in the city.

- mechanical pollution - because of uncontrolled pollution:
- household waste of anthropogenic character: paper, cigarette butts, and others;

- parts of external lighting structures;
- spent lamps or their grids.

This type of pollution will be minimized, or it will be absent at all due to the appointment of responsible for the control of waste management, the briefings with employees and equipped with special places and containers with special markings for the assembly, storage and removal of waste in accordance with the norms of the current legislation of Ukraine in the field of waste management.

Groundwater

Impact on groundwater is not expected. Elements set into the ground as foundations, have a small geometric size, with a depth of up to 1 meter. Thus, the hydrodynamic grid of the ground horizons is not disturbed.

During construction works groundwater contamination by fuel and lubricants is possible because of emergency spilling of fuel and lubricants. However, this type of impact will be minimized because of the preliminary development of instructions for handling emergency situations, moreover, the use of automotive equipment involves the daily registration of a road sign with a mark of the garage's head, certifying the inspection of the vehicle and is a measure of prevention of the occurrence of such situations.

Status of water resources in the process of operation of external lighting networks

During operation and maintenance of external lighting networks, impact on surface and groundwater is not provided. The equipment that is planned to be installed does not contain harmful substances that can enter the soil and leak to the groundwater level.

Possible contamination during the planned repair and technical inspection of the structures of the network of external lighting in the form of:

- chemical contamination with heavy metals contained in the exhaust gases;
- spent fuel and lubricants because of the work of internal combustion engines of technical means involved in the planned repair and technical inspection of structures.

However, this type of influence is minimal, if at all tangible. Because due to the long operational life of LED lamps, they do not require frequent replacement, and hence the use of technical means. In addition, the relevant rules of behavior when refueling and repairing construction equipment will be complied with.

4.4.4 Flora and Fauna

The flora and fauna state analysis in Mariupol city and Donetsk region

The floral composition of Mariupol and its suburbs includes 723 plant species. All afforestation of Mariupol region is located in the steppe zone, with most of them planted on lands that are prone to water and wind erosion.

The state of forests is significantly influenced by the load of man-made and anthropogenic origin.

In the Mariupol industrial region there are more than 15 thousand species of animals of various systematic groups, most of them are invertebrate. 98 species of invertebrate and vertebrate of the region are listed in the Red Book of Ukraine, more than 140 species are classified as rare. In the area, the number of all species of wild animals and fishes continues to decrease.

The Ichthyofauna of the Azov Sea currently includes 103 species and subspecies of fish belonging to 76 genuses, and is represented by anadromous, semi- anadromous, marine and freshwater species.

Among the Azov anadromous fish industrial species are the most valuable, such as beluga, sturgeon, starred sturgeon, vimba, shemaya.

Semi- anadromous species for breeding come from the sea to the rivers. However, in rivers, they can be delayed for a longer time than anadromous (up to a year). As for young people, it slides off spawning very slowly and often remains in the river for wintering. Semi-anadromous fish include mass species such as pike perch, bream, rags, shell and some others.

Marine species multiply and feed in salty waters. Among them there are species, constantly inhabiting the Azov Sea. It is pelengas, flounder-kalkan, glossa, percaria and all kinds of gobies. And, finally, there is a large group of sea fish that enters the Azov Sea from the Black Sea, including regular migrations.

Freshwater species usually live permanently in one area of the basin and do not make large migrations. These species usually inhabit desalinated sea areas.

Intensive removal of river runoff and other types of economic activity have led to a sharp decline in fishery significance of the Azov basin. Fish catches have decreased in dozens or hundreds of times. Even in the recent past, valuable industrial fish (starred sturgeon, sterlet, beluga, sturgeon, sazan, pike perch, cat-fish, gulch, gloss, shem, ram, bream, fish, bream, sea cat and other species) have lost their economic value. In a tense state there are stocks of gobies and pilengas. All types of sturgeon, as well as stems, Black Sea salmon, Headballs, pipe fish and some others are listed in the Red Book of Ukraine.
Today it is possible to state the fact of the complete disappearance of species from the Azov basin such as a spike, hunchback, hambrinum, virezub, robin, seahorse, and moroz Nosar, which were previously considered rare species. Sharply reducing the industrial stocks of valuable fish species, reducing the number of rare and endangered species of hydrobionts emphasize the need for vigorous measures to reduce the human impact on the ecosystem of the sea and its recovery.

The influence on flora and fauna during the reconstruction of external lighting systems

The construction work during the modernization of the external lighting systems of Mariupol city will involve the construction of related works for:

- excavation of foundation pits for supports;

Construction work involves the use of a range of special vehicles. But, since the work will be performed by the contractor, the contractor will be selected based on the results of the competitive bidding. Thus, the final quantitative and qualitative composition of equipment and tools of the contractor is not known at present. It is known that the use of large-scale equipment is foreseen. This, in turn, implies:

- mechanical influence at the expense of anthropogenic exhaustion;
- This type of impact will be minimized by fencing the site with repair work in accordance with rules and regulations.
- mechanical impact due to the compression of heavy machinery, which will work outside the surfaces with asphalt-concrete coating, which will disrupt the plant cover of the area.

The impact will be minimal due to a small area of construction work. In addition, before the start of construction work, which involves drilling operations and excavation of pits under the foundation of the supports, it is supposed to remove the upper layer of soil with the help of special equipment and its storage in the designated places, which will minimize the loss of soil of such quality as fertility and in the future restoration of grass cover.

- chemical influence through the development of harmful substances contained in the exhaust gases and negatively affect the physical state and photosynthetic properties of the vegetation cover.
- chemical influence due to pollution by spent fuel and lubricants, formed because of the internal combustion engines technology used in the process of work;
- chemical influence at the expense of emergency spilling of fuel and lubricants;
- Chemical influence by increasing the concentration of harmful substances in the surface layer of the atmosphere because of increasing the density of traffic, and hence the speed of vehicles as a result of reducing the lanes of roads in the location of repair equipment.

Minimization of this influence will be achieved due to the placement of equipment only on surfaces with asphalt concrete coating and control of the technical condition of used vehicles in order to avoid their breakage with subsequent increase in the number of selected fuel and lubricants. In addition, storage of oil, other harmful materials spent from removed external lighting structures to replace the lamps of MAL and HPSL type at the appropriate places, with appropriate markings and conducting preliminary briefing of the designated persons responsible for minimizing pollution.

Regarding works related to constructions within the boundaries of a preserved area (for example, in a botanical garden), all work will only take place after a plan of work has been prepared with a clear schedule for their implementation, with subsequent approval by the relevant departments of local government. In this case, it is

also envisaged to conduct a briefing with the direct executors to minimize the impact on the objects of the preserved area.

With regard to the wildlife, the main threat to the existence of urban biota the use of construction equipment will also be, since it will affect the sedentary organisms. Due to changes in the density of the soil, the probability of survival of the soil biota will decrease. Measures to remove the soil layer allow to preserve a part of the mesophane, whose representatives can migrate to the undisturbed soil after storing.

Also, during construction, there are such factors of excitement as noise and vibration, which adversely affect rodents and certain species of birds whose habitats are urban. As a result, their life cycle, associated with breeding and nesting and the birds laying of eggs, may be affected.
The influence of these factors is inevitable, but due to a short duration of work it will be minimized.

Regarding the inhabitants of the basins - the negative impact on them may be related to the getting of spent fuel and lubricants and household waste to the basins. However, this type of influence will be reduced to a minimum, if not completely absent, due to storage of oil, other harmful materials, in particular, spent exhaust from external lighting structures to replace lamps of MAL and HPSL types at the appropriate places, with appropriate markings and conducting preliminary instruction intended responsible persons to minimize pollution.

The influence on flora and fauna during the operation of external lighting systems

The influence is related to the operation of the heavy equipment:

- Noise influence;
- Vibration influence;

Will be minimal due to the long operational life, and accordingly the low frequency of replacement of LED lamps. In addition, the location of heavy equipment will be conducted on the surfaces covered with asphalt, which will not adversely affect the soil biota and flora.

Figure 4.3 A bat at night time

However, one of the characteristics of ordinary gas-discharge lamps, which will be used up to modernization, is a wide spectrum of wavelengths, including the ultraviolet range. This causes the accumulation of insects near sources of lighting. As a result, the life of bats is maintained (insects are their main source of nutrition).

New LED technologies do not radiate ultraviolet waves, which can significantly affect the livelihoods of urban light-loving bat species. Thus, the operation of this type of lamps will change the activity of bats and will affect the number of insect populations - their increase in urban environments.

To reduce the risk of birds being exposed to electric currents, the project foresees the installation of special adaptations, which are wire twists, which are mounted on the support above the garlands of the insulators and prevent the birds from landing on the construction of the supports.

3.4.4 Land usage

The lands usage state analysis in Mariupol city

The total area of the city is 24.4 thousand hectares. The city is divided into four administrative districts:

- Kalmiusky district - in the north part of the city, the largest by area and by the development of industry district. Old name: Illichivsky district.
- Livoberezhny district - in the east of the city, on the left bank of Kalmius. The old name: Ordzhonikidzevsky district.
- Primorsky District - in the south of the city, on the Azov Sea. Central region - the central district of the city. Old name: Zhovtnevy district.
- In addition urban settlements are subordinated to the Mariupol city council: Sartana, the Stary Crym and Talakovka, are 8, 10 and 22 km distant from the city respectively.

In accordance with the "Land Reform Program, preservation, reproduction, ensuring the rational use of land resources and the development of topographic and geodetic activities in Mariupol in 2016-2020" 9 919.7 hectares of land were inventoried in the territory of Mariupol city, of which:

- lands of residential and public buildings - 5775.2 hectares.
- lands for recreational purposes (parks, squares) - 132.5 ha.
- lands of industry - 3 985,00 hectares.
- lands of historical and cultural destination - 27ha.

According to the Verkhovna Rada of Ukraine Decree of December 20, 2011 #4179-IV "On the Change and Establishment of the Limits of Mariupol City, Volodarsky, Novoazovsky, and Pershotravnevy Districts of the Donetsk Region", the territory of Mariupol city increased to 166 km^2

Establishment of boundaries of settlements Sartana, Talakovka, Stary Crym of Mariupol city council is carried out with the purpose of establishing the location of objects of land management, their sizes and boundaries. The reliability of establishment in the nature (on the ground) of the administrative-territorial entities will improve the rational system of land use. Determining the boundaries of the adjacent territories contributes to the additional income to the local budget in the form of payment for land.

In 2015, the Mariupol City Council has privatized 640 land plots covering an area of 43.94 hectares. of them:

- for the construction and maintenance of a residential house and commercial buildings, constructions - 469 plots with an area of 29.94 hectares;
- for introduction of gardening - 167 plots with an area of 10.60 hectares;
- for the maintenance of a personal farming - 4 plots with an area of 3.40.

Impact on land use in the process of reconstruction of external lighting networks

All suggested components of the project will be carried out in accordance with the existing land use plan. There will be no impact on the existing land use regime associated with the proposed project.

Most elements of external lighting networks are used to maintain a sufficient level of illumination of the motorways. Due to this, the external lighting supports are in most cases located in the boundaries of road ways and are in the municipal property of the territorial community of the Dnipro city.

Work on the reconstruction of external lighting does not involve the seizure of land plots.

However, in the case of the placement of light supports, which is on the balance sheet of the ME "Mysksvitlo" on the territory of the land that is part of the nature reserve fund, the works will be carried out only after the completion of a plan of work with a clear schedule for their implementation, with the subsequent approval of the relevant departments of local self-government. The work plan will include a scheme indicating places for the temporary storage of waste, new and dismantled external lighting supports and other structural elements.

In the case of the placement of external lighting elements located on the balance of ME "Mysksvitlo" on the facades of buildings, it is necessary to prepare a preliminary plan of work with a detailed schedule for their execution, with the following agreement with the balance holder and the owner of the building. The work plan will include a scheme indicating places for the temporary storage of waste, new and dismantled external lighting supports and other structural elements.

A similar situation is with works that take place on the territory of bridge crossings.

According to clause 1.3 of the State building codes "Determination of the sizes of land plots for objects of electric networks" (SBC B.2.5-16-99) for the period of construction of the developer of the object of electric networks, provision of land for temporary use for the construction and erection works (lanes along the axis of the route of the electric power transmission line for the passage of personnel and the passage of vehicles and mechanisms with a width of 17 m, as well as transportation of construction and other materials through foreign land for construction and operation of external lighting networks, construction sites for the storage of materials and installation of structures of supporting structures - supports of external lighting networks).

However, the details of the construction program, including the selection of access routes to the construction sites, the number of working fronts, the selection of places, storage of materials and parking for cars/equipment and maintenance points will be determined only after the signing of the contract for the construction works and the preparation of a detailed construction plan.
In general, the negative impact on land use because of modernization of the external lighting network is not provided.

Influence on land use during the operation of the external lighting networks
The influence on land use during the operation of external lighting networks will be absent.

There is only a temporary effect associated with obtaining the right to work on the territory of the nature reserve fund, bridge crossings (if necessary) for carrying out repairs and scheduled maintenance works. However, its impact will be short-term and minimized by agreeing with the balance-holders of the structures and the relevant structural units of the local self-government body, drawing up a plan of work with a detailed schedule of execution of works. The plan will include the selection of access routes to construction sites, the number of working fronts, places selection, storage of materials and parking spaces for cars/equipment and temporary servicing points.

3.4.5 Protected territories

The protected territories state analysis of Mariupol city
Mariupol, located in the steppe zone without trees and forests, thanks to the efforts of agronomists and gardeners, has received trees from various climatic zones and even other continents, including wild and decorative, as well as many new and garden forms, embedded in nurseries and botanical gardens.

List of parks, public gardens and gardens of Mariupol

- City public garden ("Theater Square"),
- Extreme-Park (Mariupol) (new attractions near the largest in the city of the Palace of Culture of Metallurgists). Founded in 2003
- meadow park named after Gurov (formerly named after the 200th anniversary of Mariupol), a meadow park in the valley of the Kalchik river
- Zoo (Mariupol) Metallurgists avenue, park named after Gurov
- City Garden ("Gorzad", "Children's CPCaR"),
- Park "Rainbow", Ordzhonikidzevsky district
- Park named after Leporsky, Ordzhonikidzevsky district,
- Petrovsky Park (near the modern Illichivets stadium and Azovmash basketball clubs) - in Ilichevsk region,
- Prymorsky Park - in the Prymorsky District of the city on the highlands by the sea. Founded in 1977
- Children's Public Garden of the Aerodrome settlement. The Public Garden arose in the settlement of the Aerodrome of 1953 in a complex with the Soviet housing stock[7]. The residential area was built with three-story buildings, the border of which was on the street Karpinsky. Only two four-story buildings will play the role of architectural accent of the district. The area for children and residential area was among the first, built in Illichivsky district 10 years after the liberation of Mariupol from the German invaders [8].

Influence on protected areas in the process of modernization of external lighting networks

The part of the external lighting network of Mariupol city located on the balance of the ME "Mysksvitlo" is on the territory of protected areas, the special status of which is determined by the resolutions of the central body of executive power on issues of environmental protection, relevant decisions of the local self-government body. In this regard, all actions related to the implementation of a range of works on the modernization of street lighting networks provide coordination with the relevant state authorities.

Influence on protected areas during the operation of modernized external lighting networks

Possible negative impact on the protected areas is the impact on certain species of flora and fauna, species of biogeocoenoses, etc., located on the territory of objects with a special nature preservation status. This explains the need for a detailed plan with a clear definition of terms and scope of work.

The main types of possible negative influence will be:

- violation of the soil-vegetation layer;
- pollution of the working area with fuel and lubricants;
- Noise and vibration contamination will cause disturbance of the fauna calm of the protected areas;
- possible contamination by household wastes;
- Possible contamination with hazardous wastes;
- Anthropogenic impact, which is seen in the form of trampling of territories adjacent to the area of work;
- disturbance of the rest of animals and birds living on the territory of objects with a special nature reservation status, which may lead to their forced relocation from the places where the breeding process has been breached.

Possible negative impact on protected areas is the impact on certain species of flora and fauna, species of biogeocoenoses, etc. This explains the need for a detailed plan with a clear definition of terms and scope of maintenance work.

The main types of possible negative impact on protected areas in the maintenance process will be:

- violation of the soil-vegetation layer;
- pollution of the working area with fuel and lubricants;
- Noise and vibration contamination will cause disturbance of the fauna calm of the protected areas;
- possible contamination by household wastes;
- Possible contamination with hazardous wastes;

However, the impact will be minimal. This is because the LED lamps have a much longer operational life, which does not require frequent replacement, and hence the use of special equipment and personnel presence.

3.4.6 Cultural Heritage

The cultural heritage state analysis of Mariupol city

Today Mariupol is the second most important city in the Donetsk region (after Donetsk), the tenth in terms of population in Ukraine. It has a long history (Mariupol is the first settlement on the territory of the Donetsk region, which received the status of the city in 1779), is the "metallurgical capital" of Ukraine, a regional resort, has repeatedly received higher places in Ukrainian rankings for improvements, etc.

In a relatively young city (just over 200 years old), there were no conditions for the development of great architectural styles. The destroyed city cathedral had signs of provincial classicism. The average building of the late 19th and early 20th centuries has all signs of the decorative style of capitalism modern (ar nouveau) - the support of the veterans of the First World War (museum of local lore), the choral synagogue of 1882, destroyed), the former Religious College (1880), the former Alexander Men's Gymnasium (architect M. K. Tolvinsky), the mansion of Dc. Gamper S.V. 1897), Hotel "Kontinental" (SC "Azovstal"). Until 1917, Mariupol had nine Orthodox churches, the Catholic Church of St. Catherine (1860), several synagogues. The best according to the architectural qualities was the Church of Mary Magdalene of Pseudo-Byzantine style (consecrated in 1897, destroyed, built by a drama theater). The largest among the modern temples is St. Nicholas the Wonderworker Cathedral (architect A. D. Klyuev and N. Y. Ehrenburg, 1992). Muslims built a Suleyman the Great and Roksolana Mosque at the expense of money of the Azerbaijan community.

The greatest value for the artistic life of the city was the work of the sculptor Georgy Korotkov (museum of G. Y. Korotkov, moved to the premises of the Priazovsky State Technical University, and the celebrated medalist Yuhim Harabet (1929-2004) - a museum collection at the Center for Contemporary Art and Exhibition Hall (Metallurgists avenue, 25.) Harabet made a lot of useful for the medallion art of Ukraine.

Theaters, music and cinema

Cinema "Savona"

In 2003 Donetsk Academic Regional Drama Theater celebrated its 125th anniversary. The theater has a talented group of actors, including 2 folk and 2 honored artists of Ukraine. For the contribution to the spiritual education of the region, in 2000 the drama theater became the winner of the "Golden Skiff" Prize.

Puppet Theater (created in 1999).
Cinemas: "Burevisnyk", named after Lukov, "Komsomolets", "Victory" ("Peremoha"), "Savona", "Soyuz". Currently, "Yuvileiny", "Mariupol", "Rodyna", the name of Lenin are not operating.
Palaces of Culture (together with so-called clubs - only 16 units): Palace of Culture "Youth", Palace of Culture "Iskra", Illich Avenue, Markokhim, etc.

Museums
Mariupol Museum of Local Lore was found on February 6, 1920, by the city department of public education of the Mariupol Revolutionary Committee. The first exposition was created in 1920 and is open to visitors. The research of the museum's scientists contributed to the creation of nature reserves in the Priazovye. The museum has seven exposition halls, a scientific library the fund of which is 17 thousand books. The museum has a permanent exposition that covers the natural conditions of the southern part of the Donetsk region and the history of the region, from the beginning to the present day. At the museum's exposition you can simultaneously see all the diversity of flora, fauna of this region, which has undergone significant changes under the influence of human factors of civilization.

Kuninji Art Museum was opened in 2010. A part of his works of the museum was handed over to artist Arnautov Victor Mikhailovich (1896-1979), who worked for a long time in the USA and was a co-worker of the Mexican artist Diego Rivera for some time. The funds of the museum are works of masters of Russia and Ukraine of the 20th century. A.I. Kuindzhi Exhibition Hall is an exhibition space and art collections containing more than 2 thousand works. Each year the exhibition hall of the center takes up fifty art exhibitions in different fields of art.

There is also a museum of ethnography (in the past the museum named after A.O. Zhdanov), the museum of medallist Efim Harabeta, Harbarbond, Azov Sea Museum named after V.A. Paliy, Museum of History of the Ilyich Plant; Museum of the Mariupol Sea Commercial Port, The People's History Museum of the Mariupol Azovstal Iron and Steel Works.

The city is decorated with St. Nicholas Cathedral (Central district, Novoselivka) - in 1989, a new church building was found in the traditional style of Russian Orthodox churches. It was built on the funds of parishioners. It was sanctified in 1991. In the temple there are two great sacraments - a copy of the miraculous icon of the Mother of God "Mariupol"; and the sanctifier's hollies of Ignatius of Mariupol. Every Monday (except holidays) there is a rite of blessing the water in front of the icon of the Blessed Virgin "Vsetsarytsia", which helps with cancer. At the temple there is also a Sunday School for children. Throne day is on December 19th.
Monument to T. Shevchenko

Other temples of the city are St. Nicholas Portsovsky (Primorsky District), Svyato-Preobrazhensky ("Spassky", Primorsky District, Cheryomushki), St. Ilyinsky ("Prophet Elijah" Kalmiu District), Svyato-Uspensky (Livoberezhny district), Boris and Gleb (Primorsky district, settlement of Mariners, being built), and others.

Also there is a mosque in honor of Sultan Suleiman the Great and Roksolana in the city.
There is an open monument of archeology is a late-neolitic tribal burial ground of the third millennium BC in the suburbs of the city on the shore of the Azov Sea. Over 120 skeletons were found here during excavations. Along with them the stone and bone tools, necklaces, ornaments from shells of mollusks, animal teeth were found.

The city has monuments to Taras Shevchenko, Vysotsky, Kuindzhi, Makar Mazay, Grigory Gorban, Kuzma Apatov, Crocodile Godzila, Prince Svyatoslav. There are memorable signs of the liberation of Donbass, metallurgists and others.

The old Mariupol (an area separated in the south by the coast of the Azov Sea, in the east by the Kalmius River, in the north by Boulevard Shevchenko, in the west by the Metallurgists Avenue) was built mainly by low-rise buildings, preserved its pre-revolutionary architecture. Only Artem Street and Mira Avenue (then - Lenin) were built after the German-Soviet war by modern buildings of the so-called "Stalinist" architecture, for example, two buildings with a spire on Theater Square, the house of the Drama Theater, DOSAAF on the site of the destroyed cathedral, the House of the Child's World (modern building of the Bank PUMB), department store "Ukraine" (in

the former CDS). The building of a part of the left bank of the city with a low-rise housing estate of the 1950s with cozy courtyards is interesting. The high-rise buildings of 9-12 floors appeared in the city.

The central district of Mariupol (from the Metallurgists Avenue to Budivelnyk Avenue) is almost exclusively administrative and commercial development (the city council building, post office, the cinema named after Lukov, the Mariupol State University - MSU, Priazovsky State Technical University - PSTU, the central city library named after Korolenko, large shops (shopping and entertainment complexes "Obzhora", "Absolute", "Thousands of trifles", etc.)

Architecture of the remaining residential areas ("Western", "Eastern", "Kirov", "Cheryomushki", 5th, 17th micro districts, etc.) are not especially original and are represented by standard 5- and 9-storey houses. The city's housing stock is 9.82 million m² of total area, housing provision is 19.3 m² per 1 inhabitant, the share of privatized housing is 76.3%. A sketch of the general plan of the city is developed.

The influence on the cultural heritage objects during the modernization of the external lighting network

Historical area (territory of historical and cultural significance with approved boundaries) should be recorded in all land management and urban planning documents and considered as a specific object of urban planning. Each project work within the boundaries of historic areas should be necessarily preceded by the development of historical and town planning justifications in accordance with the current legislation of Ukraine.

The main types of possible negative influence will be:

- Vibrational influence during the construction work, which can lead to mechanical damage of the object of cultural heritage;
- pollution of the working area with fuel and lubricants;
- mechanical damage to the object of cultural heritage (for example, provided that the object of external lighting is attached directly to the facade of the building, which is a cultural heritage);
- possible contamination by household wastes;
- mechanical influence in the form of settling of particles of dust or particles of asphalt during its dismantling along with the object of cultural heritage.
- Possible contamination with hazardous wastes;
- anthropogenic impact, which is presented in the form of trampling of the territories adjacent to the zone of work.
- during work on territories with pavement there may be a violation of its appearance.

The influence on the cultural heritage objects during the operation of the external lighting network

Possible influence on the objects of cultural heritage of Mariupol city may occur during the work of scheduled repairs or technical inspection.

The main types of possible negative impact on protected areas during the maintenance process will be:

- Vibrational influence in the process of carrying out of construction works, which may lead to the destruction of the object of cultural heritage;
- pollution of the working area with fuel and lubricants;
- mechanical damage to the object of cultural heritage (for example, provided that the object of external lighting is attached directly to the facade of the building, which is a cultural monument);
- possible contamination by household waste;
- mechanical influence in the form of settling of particles of dust or particles of asphalt during its dismantling along with the object of cultural heritage.

However, the impact will be minimal. This is because the LED lamps have a much longer operational life, which does not require frequent replacement, and hence the use of specialist equipment and personnel presence.

3.4.7 Treatment of wastes

The wastes treatment state in Mariupol city analysis.

Despite the annual decline of industrial production, and, accordingly, the reduction of atmospheric air emissions, water resources, and the accumulation of toxic waste generated at the city enterprises remain high. All industrial waste is divided into four classes of toxicity depending on their impact on soils, underground soils waters, atmosphere and human health: extremely hazardous, highly dangerous, moderately dangerous, slightly dangerous. The concentration of raw material and energy complex enterprises and the low technical level led to significant amounts of waste generation and accumulation. The main source of waste generation in the region is metallurgy.

Wastes from metallurgical production are low-toxic and have the fourth grade of hazard.

The volume of highly toxic waste generation in the city is small, and most of them are currently being disinfected or disposed of. The wastes containing mercury and its compounds are included to the 1 class of toxicity.

The second class of toxicity include petroleum products, petroleum jams, spent batteries, oiled filters, and so on.

Third class toxic wastes include wastes containing copper and its compounds, waste mineral wool, dirty trichlorene ethylene, waste plastics and rubber, and so on.

The fourth-class toxicity of wastes include agglomeration, blast furnace, steelmaking, limestone sludge, blast furnace, steelmaking, welding slag, dust, construction waste, coke, scrap.

Waste classes 3 and 4 due to the lack of facilities for their disposal in the city or special burial grounds are stored on the territory of the plant in special containers. Waste class 2 was not disposed of for a long time and was exported to dumps. At present, the disposal is conducted at the metallurgical plant with the permission of the environmental authorities.

Impact on the waste treatment system in the process of modernization of external lighting networks.

While measures of the modernization of external lighting networks, the following types of waste are produced:

- Construction wastes, which in most cases relate to a slightly hazardous waste class,
- The impacts associated with the generation of this type of waste will be minimal, as they are stored in specially designated areas located near the immediate works. The storage time is insignificant due to the large localization of the work. After that, the company responsible for the export of waste transport them to the appropriate polygons, with which it has concluded business contracts (in the absence of own).
- During the operation of the substation, the use of hazardous materials such as lubricants, gases is provided. The active use of automotive equipment does not require repairs directly at the construction site, therefore, spent fuel and lubricants and worn tires on the construction site are not stored for temporary storage.
- Asphalt wastes, which are not suitable after dismantling for re-storage, are exported to asphalt concrete plants for recycling and to dumps.
- Dangerous wastes such as oily rags
- Household wastes of anthropogenic origin.
- Spent lamps of gas-discharge MAL and HPSL types.

The impact of these factors will be minimal because the obligatory requirement for the start of construction work is the preparation of a detailed construction plan with a clear schedule of construction work and the application of temporary storage sites with a comprehensive list of requirements to them in accordance with the type and class of wastes (demercurization of mercury wastes).

All works related to transportation, utilization and storage of waste will be carried out by a contracting organization that has a set of permitting documents for the implementation of this type of activity. The company will be selected as a result of the public procurement procedure. Therefore, all documentation requirements, level of training of responsible persons and availability of own or leased sites for permanent/temporary storage of hazardous wastes or contracts with dumps entitled to accept such a waste class will be clearly specified in the tender documentation.

The construction is supposed to appoint a person responsible for dealing with hazardous and solid household waste, which controls and provides briefing of workers on all issues related to the range of his responsibilities.

Placing of temporary storage sites of wastes will be carried out in accordance with national sanitary and hygienic norms and rules in order to avoid negative impact on the population.

Influence on the waste treatment system in the process of operation of external lighting networks

During operation it is planned to carry out scheduled technical works, which will mainly involve the replacement of spent LED lamps.

However, this type of effect will be minimal, if at all tangible, because the life of the lamps is significant, which explains the low frequency of their replacement, and hence the number. This, in turn, does not provide the creation of temporary storage sites for lamps on the territories. The spent lamps based on contracts with contractors, concluded as a result of the procedure of public bidding in accordance with the procedure established by law, will be collected and exported to the premises for the purpose of disposal.

Closing and decommissioning

Construction work in this project consists of common components. The closure and decommissioning of the elements of external lighting network has not been reported about to date.

In any case, decommissioning will include:

- Removal of all external and underground equipment and installations
- Restoration of sites and all project areas prior to construction

It is expected that the components of the decommissioning elements will behave in accordance with procedures such as reuse, re-utilization or landfills storage.

3.4.8 Noise

General characteristics of the noise level in Mariupol city

The main sources of noise pollution in Mariupol city, with the representation of planning restrictions, are:

- street network with transit traffic;
- railway;
- system of main transformer substations;
- aerodrome.

The main source of acoustic influence in the city is the noise from urban transport: buses, trams, trolleybuses, trucks and cars, as well as rail transport. Levels of traffic noise are 80% of all external noise of the city. According to the results of measurements, the level of equivalent noise at separate sites 1.2-3.6 times exceeded the MAL (MAL = 65 dBA).

In recent years, the intensity of transport and the density of traffic flow of freight and passenger cars through residential areas has increased, respectively, noise indicators has appropriately deteriorated.

In general, there is no noise map in the city (taking into account the noise from transport and enterprises).

The electromagnetic environment in the city is satisfactory.

Control of compliance with sanitary legislation in the city is conducted, RTS certification in accordance with laboratory-instrumental studies of electric field strengths is carried out.

The largest objects with the possible unfavorable influence of the EMR on the city's housing development are the Donetsk regional radio transmitting center of Mariupol, radio stations of the city, the coastal radar station of the Mariupol port, transmitting devices of cellular communication.

According to the measurements, the excess of the permissible indicators of the intensity of the electromagnetic field is not observed.

Influence of upgraded external lighting networks on noise level during operation

Noise pollution resulting from the operation of external lighting networks will be absent. Measures to mitigate noise pollution are not required.

3.4.9 Economic state of Mariupol city

The general economic state of Mariupol city analysis.

industrial production index of Donetsk region compared to the corresponding period of 2015 was 106.9%.

Total volume of sales of industrial products (goods, services) at retail prices of enterprises for January-July 2016. was 39391.6 million UAH in Mariupol. The enterprises of the city provided shipment of 35.9% of the industrial products of the region.

Agriculture

Presence of grain crops and sunflower seeds. As of September 1, 2016 14,6461.1 tons of grain was available in agricultural enterprises (except for small ones) and enterprises that store, process grain crops, which was 83.8% by September 1, 2015, the stocks of sunflower seeds amounted 3176.6 tons, which was 22.5% by September 1, 2015

Production of grain and leguminous crops. As of September 1, 2016, agricultural enterprises produced 74.5 thousand hwt of grain and leguminous crops (initially earned weight), which was 145.8% by September 1, 2015. The yield from 1 hectare of gathered area was 41.1 hwt, an increase from 1 hectare of the gathered area relative to September 1, 2015 was 10.3 hwt.

Construction and investment activity

Construction companies, worked under contractor's agreement, as well as enterprises that carried out construction works by economic means, for January-August 2016 performed construction works on their own for 328.9 million UAH.

The share of completed construction works in Mariupol city in the regional scale was 23.6%.

For January-June 2016 4077 m² of total housing area is commissioned in Mariupol, which is 2 times more than in January-June 2015.

For January-June 2016 1301.7 million UAH of capital investment[2] were invested to the development of the city's economy at the expense of all sources of financing. The total regional share of capital investments was 31.6% in Mariupol city.

Motor transport[2] of enterprises and private entrepreneurs who carry out transportation on a commercial basis in January-August 2016 353.3 thousand tons of cargo were transported, which is 36.6% more compared to the corresponding period of 2015. The cargo turnover amounted 35.1 million tkm. 12.4 million passengers used the road transport services, which is 26.2% less than in January-August 2015.

Foreign economic activity[2]

During January-July 2016 the export of goods in Donetsk region amounted $1805 million, having 19.8% decreased regarding the same indicator for January-July 2015. Import volume of the region amounted $553.5 million for January-July 2016, which is 24.5% less of import commodity operations in January-July 2015. The positive external economic balance amounted $1251.4 million.

Labor market

The average number of full-time employees in Mariupol city (by enterprises, institutions, organizations and their separate units with the number of employees of 10 or more persons) was 118.7 thousand people in January-June 2016.

During January-June 2016 11.2 thousand people were hired to enterprises, 16.4 thousand people were fired (respectively 9.4% and 13.8% of the average number of full-time employees).

According to the State Employment Service, the number of registered unemployed was 4623 persons at the end of August 2016, which is 5.2% less than at the end of July 2016. The overwhelming majority (57.6%) of the total number of unemployed were women.
The structure of the registered unemployed by individual social groups is provided in the table.

The number of vacancies declared by employers to the state employment service 166 units increased, compared with the end of July 2016, or 65.6%, and by the end of August 2016 was 419 units.

The load factor of registered unemployed at one vacant post decreased from 19 at the end of July 2016 to 11 people at the end of August 2016.

Population income
Average monthly nominal wages per one staff member of Mariupol city (by enterprises, institutions, organizations and their separate units with the number of employees of 10 or more persons) was 5437 UAH for January-June 2016, which is 5.3% less than the average indicator in the region (5743 UAH).

As of August 1, 2016, the total amount of wages debt to be paid to employees of enterprises, institutions and organizations amounted to 168.4 million UAH. (15 enterprises), which is 43,7% more than on January 1, 2016 (117.2 million UAH - 17 enterprises) and 3.3% - as of July 1, 2016. (163 million UAH).

At economically active enterprises, the amount of unpaid wages 42.5% increased as compared to January 1, 2016, (116.7 million UAH) and amounted 166.4 million UAH on August 1, 2016.

The number of employees of economically active enterprises, who did not receive salaries in time was 13580 persons on August 1, 2016, which is 427 persons less than on January 1, 2016 (14007 people).

Retail trade[8]

The volume of retail trade turnover of enterprises engaged in retail trade amounted 2677 million UAH (excluding turnover of individuals-entrepreneurs) in January-June 2016.

Prices[1]
Consumer price index in the region amounted 99.6% in August 2016, since the beginning of 2016 - 102.9%, in Ukraine (excluding the occupied territory of the Autonomous Republic of Crimea and Sevastopol city and part of the zone of the anti-terrorist operation) - 99.7% and 104.5% respectively.

Services
In January-July 2016 29099 families subsidies were assigned for reimbursement of expenses for payment of housing and communal services and electricity, which is 1.7 times more than in the corresponding period of 2015. The total amount of assigned subsidies amounted to 15130 thousand UAH in January-July 2016. The average size of the targeted subsidy per family in July 2016. amounted to UAH 163.7 The total number of families receiving subsidies in July 2016 was 40,379, which is 3.4 times more than in July 2015. The total amount of subsidies received for the reimbursement of expenses for the payment of housing and communal services amounted 217367.2 thousand UAH in January-July 2016.

The funds were transferred to organizations providing housing and communal services to the population, including repayment of debts of previous periods in the amount of 182852.4 ths UAH. By the end of July, 2016, the total amount of debts of local budgets before these organizations amounted 98541.5 ths UAH.

In January-July 2016 1158 families applied for subsidies in cash for the reimbursement of expenses for the purchase of liquefied gas and solid fuel, which is 3.2 times more than in January-July 2015. Subsidies were granted for 1125 families, which is 5.2 times more than in the corresponding period of 2015. The total amount of assigned subsidies was 1998.6 thousand UAH in January-July 2016. The debts of local budgets on the payment of cash subsidies to the population for the reimbursement of costs for the purchase of liquefied gas and solid fuels amounted 1166.8 thousand UAH by the end of July 2016.

[8] Excluding zone of anti-terrorism operation. The data can be ascertained.

Influence on the economy of Mariupol city during the reconstruction of external lighting networks in Mariupol city.

Implementation of this project will lead to a general improvement of the economic situation in Mariupol city. This is due to the reconstruction of external lighting networks, which will reduce the costs associated with repairs arising from their unsatisfactory state.

In case of situations involving construction works in the immediate vicinity of the place of private business, the construction plan and schedule of works will be preliminarily agreed with owners or representatives of owners of private business to minimize this type of negative influence. In addition, to prevent overlapping access, if it does not contradict the requirements of safety rules in construction, to provide and improve access due to inconvenience caused by construction work, special mobile crossings will be arranged for citizens.

Implementation of this project will lead to a general improvement of the economic situation in Mariupol city. This is due to the replacement of existing lamps with LED lamps, which are characterized by lower power consumption. This, in turn, will lead to savings in the local budget and will not lead to an increase in utility bills (at least due to the need to provide street lighting against the background of a general increase in the cost of electricity).

However, among the possible negative influences there can be considered:

- Damage to other infrastructure objects, such as roads, energy communications, etc.
- temporary suspension of commercial activity.
- violation of the schedule of public transport.
- a reduction in the incomes of the population whose source of economic income is a private business, physically located in the immediate proximity to the site of construction work, the interruption of the electricity supply or with the access of consumers of goods/services can be is possible.

The occurrence of such negative effects is minimal and will have a short-term nature due to the short term of installation work (if required). The time and place of construction works will be reported by giving information to mass media, in particular on the site of the Dnipro City Council.

In case of situations involving construction works in the immediate vicinity of the place of private business, the construction plan and schedule of works will be preliminarily agreed with owners or representatives of owners of private business to minimize this type of negative influence. This is conditioned by the right to access to environmental information. Public discussion in Ukraine is a widespread form of public opinion for decision-making on matters that cause or may have a negative impact on the state of the environment and may be initiated by public discussion subjects.

In order to ensure the rights of the public to participation in environmental decision-making, preventing the emergence of environmental and social risks and timely informing the population of Ukraine, regulation of legal relations concerning the realization of the rights of the public to participate in decision-making, in particular, in the field of environmental protection, has been introduced in accordance with :

- The Convention “on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention)”;
- Law of Ukraine "On access to public information";
- "Regulations on public participation in environmental decision-making" (approved by the Decree of the Ministry of Environmental Protection of Ukraine dated 18.12.2003, No.168).

Influence of the operation of the modernized external lighting system on the Mariupol city economy, Donetsk region.

Data from the State Statistics Service of Ukraine show that in 2016, the level of employment in Donetsk region aged 15-70 years was half of the population of the corresponding age group - 50.0%. That is, in fact, only every second of the given age group is employed. At the same time, the dynamics of wages in the last three years shows that the average wage 29.08% increased in 2015 compared to 2014, while the cost of electricity 25.4% increased only in 2015. Along with the general rise in the price of electricity for households, we can observe the dynamics of the increase in the share of electricity costs in the total household expenditures - in December 2014,

the cost of covering of communal expenses in the total population expenditure of Donetsk region amounted 9.9%, along with the same indicator for December, 2013 - 9.8%. (based on data from the State Statistics Service of Ukraine).

Thus, the general increase in the cost of electricity for utilities would be due to the increase in local budget expenditures for covering communal needs, which in turn would affect the tariffs and the level of local population charges.

However, the modernization of the external lighting system by replacing the lamps on the LED will save energy consumption for the needs of the external lighting network of Mariupol city, accordingly, will not negatively affect the economic situation of the population of Mariupol city and Donetsk region during the operation of the modernized external lighting network.

Table 4.9 the population economic activity by gender and residence in 2015

Units	Total population	Female	Male	Urban population	Rural population
Economically active population	Thous. of people				
In the age of 15-70 years		872.9	400.2	472.7	739.5
Working age		851.4	388.1	463.3	720.1
The level of population economic activity	In % of population of the appropriate age group				
In the age of 15-70 years		58.4	50.6	67.0	58.2
Working age		69.0	61.4	76.9	68.7
Employed population	Thous. of people				
In the age of 15-70 years		743.7	364.0	379.7	639.4
Working age		722.2	351.9	370.3	620.0
Occupational level	In % of population of the appropriate age group				
In the age of 15-70 years		49.7	46.1	53.8	50.3
Working age		58.5	55.7	61.4	59.1
Unemployed population	Thous. of people				
In the age of 15-70 years		129.2	36.2	93.0	100.1
Working age		129.2	36.2	93.0	100.1
Population unemployment level (by the methodology of PAM)	In % of population of the appropriate age group				

In the age of 15-70 years		14.8	9.0	19.7	13.5
Working age		15.2	9.3	20.1	13.9
Economically inactive population	Thous. of people				

Continuation of table 4.9

Units	Total population	Female	Male	Urban population	Rural population
In the age of 15-70 years		622.6	390.0	232.6	531.4
Working age		383.0	243.6	139.4	328.8

Table 4.10 the total costs structure in Donetsk region in 2014

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total costs on average per month per household, UAH	384.2	500.49	595.40	616.59	711.44	896.69	1208.58	1375.12	1693.78	2543.16	2703.43	3038.03	3421.94	3606.89	3901.54	3627.75
Households' total costs structure																
Total consumer costs	97.4	94.8	95.6	96.0	95.5	94.4	39.2	93.9	93.7	89.7	87.5	89.9	91.3	92.7	92.5	91.9
Food and non-alcohol drinks	66.2	65.7	64.5	63.1	62.2	58.4	57.0	54.4	52.8	50.7	51.6	52.3	52.7	51.1	50.4	55.7
Alcohol drinks, tobacco products	3.4	3.8	3.3	2.9	3.4	3.4	3.4	2.9	3.1	2.5	4.1	4.0	4.2	3.9	4.0	4.5
Non-food goods and services	27.8	25.3	27.8	30.0	29.9	32.6	32.8	36.6	37.8	36.5	31.8	33.6	34.4	37.7	38.1	31.7
including																
Clothes and shoes	x	x	X	5.0	4.7	5.8	5.3	5.6	5.4	4.8	4.6	5.3	4.9	5.7	5.2	3.8
Housing, water, electric energy, gas and other fuel types	x	x	x	10.7	10.3	10.2	9.8	12.3	13.3	11.9	10.7	9.8	10.0	10.4	9.8	9.9

Householdware, consumer electronics and current housing	x	x	x	1.7	2.1	2.3	2.9	2.6	2.9	2.6	1.9	1.9	2.2	2.7	2.6	2.0
Healthcare	x	x	x	2.5	2.1	2.3	1.8	2.2	1.9	2.2	2.9	2.9	3.1	3.4	3.9	2.6
Transport	x	x	X	2.7	2.4	2.6	2.8	2.6	2.9	2.9	2.8	3.3	3.3	3.8	5.0	3.9
Communication	x	x	X	0.9	1.0	1.4	1.8	2.5	2.5	2.2	2.3	2.6	2.6	2.7	2.8	2.6
Recreation and culture	x	x	X	2.4	3.2	3.1	3.6	3.2	3.0	3.4	1.6	1.9	2.5	2.4	2.2	1.5
Education	x	x	X	1.0	0.8	1.2	1.0	1.2	1.2	1.6	0.7	1.1	0.9	0.9	0.8	0.8
Restaurants and hotels	x	x	x	1.0	1.4	1.9	1.9	2.4	3.0	2.9	2.0	2.4	2.6	3.0	2.8	1.7

Table 4.11 Average salary on Donetsk region per month in 2015 per one regular employee, UAH

	Nominal salary of one regular employee	
	Per month	For the period since the beginning of the year
January	5142	5142
February	5265	5173
March	6088	5498
April	6121	5656
May	5976	5717
June	5999	5743
July	6002	5779
August	5897	5786
September	6017	5716
October	6733	5970
November	6106	5900
December	7111	5989

4.4.11. Working conditions

An analysis of the general state of working conditions in Mariupol city

The working conditions in Mariupol city are within the national legal field. The legislation of Ukraine on labor protection consists of:

- The Law "On Occupational Safety";
- "Code of Labor Laws of Ukraine";
- Law "On ensuring the sanitary and epidemiological well-being of the population";
- Law of Ukraine "On Fire Safety", "Norms of Radiation Safety of Ukraine (NRSU-97)" and other legal acts regulating the relations between different subjects of law in the field of labor protection.

International labor protection legislation is a system of international legal acts aimed at protecting employees against occupational risks. The Law of Ukraine "On Occupational Safety" provides the advantage of the norms of international treaties and agreements in which Ukraine participates over the legal norms of Ukrainian legislation.

Conventions of the International Labor Organization, under which Ukraine has international cooperation in the field of improving of working conditions: No. 115 - on the protection of employees from ionizing radiation, №155 - on occupational safety and health and the working environment, No. 148 - on the protection of workers from occupational risk, No. 174 - about equipment of machines with protective devices.

Influence on working conditions during the modernization of the external lighting network.

During the modernization of the external lighting network, it is necessary to consider the impact on the working conditions of the two categories of workers:

- construction workers directly involved in the reconstruction of an external lighting network;
- employees of enterprises of social sphere (medicine, education), budget sphere, self-supporting sphere, located in areas of construction work.

At the enterprises of the municipal enterprise "Mysksvitlo" (the customer of the project) labor relations are built in accordance with the requirements of labor legislation of Ukraine.

When hiring, new employees are familiarized with the documents regulating labor relations, in particular:

- Collective agreement;
- Code of conduct;
- working conditions at the workplace.

Moreover, all employees are informed about compulsory instruction on occupational safety and health, safety during work with equipment and special equipment, sanitation. The company identifies jobs, equipment and technological processes that can affect the health and safety of workers, as well as measures developed and proposed remedies to minimize risks.

The main type of work during the modernization of the external lighting network is:

- direct replacement of lamps;
- excavation work related to the excavation of ditches;
- construction/dismantling works;
- replacement of cable networks.

The conditions of work during the building type works are influenced by:

- occupational safety measures;
- sanitary and technical measures;
- fire safety;
- control over compliance with the rules and regulations on occupational safety.

These works in accordance with the "Hygienic classification of the production environment, the difficulty and intensity of the labor process" are:

- 2nd class - acceptable working conditions;
- 3d class - Harmful working conditions;
- 4th class - dangerous working conditions.

The work of builders is approaching the work of highly mechanized manufacturing enterprises. The peculiarities of the work include:

- open-air work (uncontrolled meteorological conditions at workplaces);
- permanent movement of workplaces and tools (labor safety issues are needed to be solved);
- significant physical expenses (increased attention to a constantly changing production situation);
- a combination of professions, the need to use the work of various construction departments.

Peculiarities of working conditions of builders determine the specifics and role of sanitary and occupational safety in construction.

All dangerous and harmful production factors that are eliminated in construction can be combined into a single system (dangerous, as a rule, lead to injuries, that is, the damage of the integrity of the body tissues, harmful - to occupational diseases and poisonings, and sometimes to injuries):

- violation of normal meteorological conditions (thermal shock, overcooling);
- noise (noise disease);
- vibration (vibrational illness, neurosis);
- dust (pneumonia, silicatosis);
- systematic strain of individual muscle groups in heavy manual work (widening of veins, neuritis, arthritis, hernia);
- machines, moving mechanisms; products, moving structures;
- ruining of buildings;

Table 4.12 Main sources of the harmful production conditions, influencing the specialists of the construction industry

Occupation	Source of harmful production conditions
Welders	Toxic emissions during welding (iron oxides)
Graders, bulldozers operators	Fine dust, body vibration, high body temperature, noise, exhaust gases of working internal combustion engines
Road workers	Asphalt vapors (hydrocarbon compounds), exhausted gases of working internal combustion engines
Assemblers	Work at height, danger of injuries and electric shock

Employees involved in construction work are subjected to the following four types of danger:

- chemical impact;
- physical impact;
- social impact;
- biological impact.

Chemical impact is most often due to contact with air through dust, smoke, fog, vapors or gases. Thus, the effect on the worker can be provided by inhalation, although some particles carried by airborne transmissions can deposit on healthy skin. Chemical hazards also occur because of contact with liquid or semi-liquid substances (e.g., glues or resins) or powders (e.g., dry cement).

Physical effects will include:

- noises
- elevated and reduced environment temperature,

- radiation, vibration.

The social (psycho-physiological) impact associated with the peculiarities of work during construction, such as heavy production loading, limited control of social phenomena, and limited social support are stress factors.

Biological danger is associated with the possible influence of infectious microorganisms, toxic substances of biological origin and animal bites.

It is assumed that the execution of work in accordance with this project will be carried out in accordance with the norms of the labor legislation of Ukraine, with the compliance of all life safety requirements, in particular with the use of special equipment and special protection means (clothing, respirator masks, protective masks), fire safety, sanitary and hygienic requirements. In addition, the proposed project will have a general positive impact on working conditions regarding the installation of modern and safe technologies and the appearance of new jobs.

Construction work using special construction equipment will be carried out by a contracting organization that will be selected as a result of the public procurement procedure. The technical documentation will provide confirmation of satisfactory working condition of all operational equipment, which will be used in accordance with the construction plan, confirmation of qualification and practical experience of workers involved in construction work.

Since the final plan of construction works will be compiled after the contractor organization has been identified, the final technical structure is unknown to date.

Regarding the impact of construction works on employees of enterprises of the social sphere (medicine, education), the budget sphere, the self-supporting sphere located in the areas of construction work, according to the current legislation of Ukraine, the intentions of construction work will be pre-announced through public hearings, where all proposals and comments regarding future work will be accepted as well as information on time, place and duration of the previous publication in the mass media and on the site of the city council. alias of carrying out of works.

If all permitting documents are approved, the start of work, the plan of construction, the schedule of works with the indication of the time and place of work will be reported through the media, in particular, on the website of the city state administration, and will be agreed upon mechanism for receiving complaints and responses to them.

Concerning the very works, there are risks of:

- Noise pollution;
- vibration;
- pollution of the surface layers of the atmosphere by fine particles because of excavation works;
- violation of the working regime due to failures in public transport operation;
- possible increase of traffic loads (if necessary);
- temporary switching off of the external lighting.

With regard to physical effects expressed by noise and vibration pollution - the impact will be temporary, at the time of execution of works, work will be carried out in accordance with the previously announced plan of construction with a schedule of work, indicating the time and place of work. It is assumed that noise and vibration levels will be allowable and comply with sanitary and hygiene standards. Construction will take place during working hours (without a violation of the sleep regime of patients in hospitals, as an example).

Contamination of the surface layers of the atmosphere with fine dust as a result of excavation works - during the excavation, it is provided the usage of dust covering materials to reduce the scattering of excavated mines. It will have a minimal impact and a temporary nature.

The loading of traffic roads will be provided at the expense of the possible placement of construction equipment on roads/road-sidess, carrying out earthworks, which will lead to temporary crashes in public transport. It is

anticipated that the work will be carried out in accordance with a previously announced plan of construction with a schedule of work specifying the time and place of work to minimize the impact.

Emergency shutdown of Light (minimal risk) will also have a temporary impact - work will be carried out in accordance with a previously announced construction plan with a schedule of work specifying the time and place of work to minimize the impact, shutdowns will occur in accordance with the schedule.

Influence on the work conditions as a result of the modernized external lighting systems operation

As a result of the modernized external lighting systems operation the occurrence of the negative factors is not expected.

4.4.12 Population movement

The migration state in Mariupol city analysis

The number of the current population of Mariupol city council was 472700 people, as of August 1, 2016, including:

- urban settlements - 471819 people;
- rural area (village Gnutovo, village Lemakine) - 881 persons;
- Mariupol city - 451173 people;
- Sartan urban settlement- 10605 persons;
- Stary Crym urban settlement - 5972 persons;
- Talakivka urban settlement - 4069 persons.

The number of permanent residents of Mariupol city council made up 469284 people as of August 1, 2016, including:

- Urban settlements - 468,405 people;
- rural area (village Gnutovo, village Lemakine) - 879 people;
- Mariupol city - 447778 people;
- Sartan urban settlement - 10590 people;
- Stary Crym urban settlement - 5964 people;
- Talakivka urban settlement - 4073 people.

During January-July 2016 the population has decreased by 2533 people.

The decrease in the population was due to the natural decrease - 2519 people with a migration reduction of 14 people.

In January-July 2016 there are 4254 deaths registered, 2.5 times more than births. The number of births was 1735 persons.

In January-July 2016 25 babies under the age of 1 died, which is 1 infant more than in the same period of 2015.

During January-July 2016 464 people arrived on the territory of the city council, and 478 people left, which led to a migration decrease of the population. Compared to January-July 2015 the number of arrivals and departures 68.8% and 56.8% decreased respectively.

In January-July 2016 1230 marriages were registered, which is 13% less than the same period of the previous year.

Influence of modernization of the external lighting network on the forced movement of the population

This project will be implemented on the lands belonging to the territorial community of Mariupol city.

In the case of setting of sources of street lighting in the territory of private plots - all work will be carried out with prior agreement with the owners of these sites. Because of the work, there will be no acquisition of land, property or economic assets as a result of the proposed project. The proposed project will not lead to forced movement of the population. All social and civil rights of the city's population in accordance with national and

international human rights law during the implementation of the construction phase of the project will be maintained.

Influence of the operation of the external lighting network on the forced movement of the population

Negative consequences during the operation of the external lighting network expressed in the forced movement of the population are not expected.

4.4.13 Health protection, security and safety

The analysis of state of population health protection, security and safety

The legislation of Ukraine on labor protection in Mariupol city is within the national legal field and is represented by:

- Law of Ukraine "On Occupational Safety";
- "The Code of Labor Laws of Ukraine", the Law "On ensuring the sanitary and epidemiological well-being of the population";
- Law of Ukraine "On Fire Safety";
- "Radiation Safety Standards of Ukraine (RSSU-97)"
- other regulatory legal acts that regulate

Influence of modernization of the external lighting network on the local community in terms of health, safety and security

The modernization will play a major potential impact on the local community. Such impacts may include:

- Failures in traffic, resulting in inconvenience and interruption of commercial activity.
- Security issues that may be caused to the general public by possible excavations during the installation of supports.
- Perturbations and inconvenience to the population due to dust formed on installation/dismantling sites (if necessary).
- Discomfort for residents due to noise from construction activities.

The designs of external lighting networks are mostly located in the road strip of roads. Thus, any mounting/dismantling work will be related to the delineation of the site and can temporarily reduce the number of lanes in the driveway. This effect can be reduced by changing the movement and carrying out work in a short period, but the changes will lead to disruption in the movement and in business, if they are located along the roads. This can lead to an increase in transportation time and likely periods in which movement will be difficult in some areas.

The work will be carried out at the light daytime, so the conditions of movement during the dark season will not be deteriorated in any way, due to short work period.

Influence of the operation of the external lighting network on the local community in terms of health, safety and security

Most of the maintenance works involve scheduled or unscheduled replacement of spent LED lamps. The operating noise of motor vehicles (including lifts) may have some negative effects, but, since their operational life is several times greater than the operational life of gas-discharge lamps, the frequency of their replacement is also extremely low. Therefore, the impact will be minimal.

4.4.14. Gender issues

The gender state analysis of Donetsk region for 2012

Table 4.13. Specific weight of women and men of the general population number

(at the beginning of the year, %)

	Quantity of the permanent population, Thousand of persons	Specific weight, %	
		women	men
2010	4453.9	2020.3	2433.6
2011	4420.1	2004.8	2415.3
2012	4390.3	1991.4	2398.9
2013	4362.6	1979.9	2382.7
2014	4331.0	1965.3	2365.7
2015	4284.4	1943.7	2340.7
2016	4252.3	1929.3	2323.0

As of December 1, 2012, the population of Mariupol city from the beginning of the year has 2365 people decreased and amounted 483955 people. The reason was the natural decrease in the population and the negative balance of migration. A natural reduction was due to exceeding the number of deaths over births by 1.5 times.

For the first time in the past 10 years, the migration population was 212 people. Compared to January-November 2011, the number of arrivals for permanent residence in the city 6.0% decreased, while the number of those who left was 17.0% increased.

4.4.15 Influence of modernization and further operation of external lighting networks of Mariupol city on the gender composition of the population

No negative gender effects are expected. The proposed project will not have any adverse effect on the social and economic roles of men and women, in any case, will not interfere the equal opportunities of both sexes.

4.5. Environmental protection measures

Environmental protection in the process of implementing an investment project involves a single complex of the following components:

- protection of atmospheric air;
- protection of basins;
- protection of soils and landscapes;
- protection of flora and fauna;
- protection of protected areas;
- protection of cultural heritage;
- measures to prevent the occurrence of negative waste management situations;
- medical and social aspects, and so on.

The potential impact of the planned activity should be considered on components of the environmental protection both at the stage of construction and at the operational stage of the project.

The project documentation of the investment project will provide a list and justification of the required amount of equipment that will be used during the construction and operation phases.

When carrying out environmental protection works, compliance with the Law of Ukraine "On Environmental Protection of 25.06.1991, No. 1264-XII", is mandatory. According to Article 51, during the design, placement, construction, commissioning of new and reconstruction of existing enterprises, structures and other objects, improvement of existing and introduction of new technological processes and equipment, as well as in the process of operation of these objects, the ecological safety of people is ensured, rational use of natural resources, compliance with norms of harmful effects on the environment. This should include the capture, disposal, detoxification of harmful substances and wastes or their complete elimination, fulfillment of other requirements for the protection of the environment and human health.

The future project should have materials to assess the impact of the planned activities on the environment and human health.

The assessment should be made considering the requirements of the national environmental protection legislation and the requirements of the EIB, the environmental capacity of the territory, the state of the environment in the place where the site is located, environmental forecasts, prospects for social and economic development of the region, capacity and species the combined effect of harmful factors and objects on the environment.

Any enterprise that plans to implement an investment project that may have an impact on the environment should inform the relevant local authorities, whose lands will be the projected objects of the facility (the so-called "Statement of Intent"). Pre-project development organizations are required to collect relevant information on the state of the environment and prepare EIA materials in the investment project documentation package.

It should be noted that a full-scale EIA is provided only for objects included in the "List of types of activities and objects that have an increased environmental hazard" (approved by the Cabinet of Ministers of Ukraine Resolution 808 dated August 28, 2013). As for other investment projects, their preparation requires a limited EIA, in volumes that are necessary for the needs of approval and expertise. Similar requirements are set out in the Environmental and Environmental Practices Guide for Category A projects.

4.6. Summary information on the results of the planned activities and measures on their mitigation

The table provides the summary information on the key results of the planned activities and their mitigation methods.

Table 4.14 The summary information on the possible results of the planned activities and their mitigation methods

Project stage	Results for the environment	Mitigation measures	After-effect
Air quality			
Building	Dust and other emissions (undifferentiated) because of construction work	-Spraying with water of a soil surface without living cover to minimize the suspended dust during excavation, before clearing, excavation, filling, consolidation and leveling of soil. - If possible, turning off the vehicles and equipment at idle. - Usage of dustless materials for the prevention of air pollution through the use of cover materials. -Development of a traffic management plan to ensure uninterrupted traffic flow and safety of workers and passing vehicles. - Regular check of the state of vehicles to check the correctness of their operation and maintenance in the working condition. - If possible, prevent the operation of vehicles outside areas without asphalt covering.	Slight
	Air pollution: emissions of equipment, dust during the earthworks, other	Ensure switching off of vehicles and preventing idling.	slight

	wastes	- Whenever possible, minimize the use of diesel or gasoline generators and use of equipment powered by the electricity. - Develop a project for construction organization to manage the rational delivery of materials, etc.	
	Greenhouse gases emissions	Development of a traffic management plan to ensure uninterrupted traffic flow - Provision of regular check of the state of vehicles and other mechanisms. -Use of vehicles with an effective system of exhaust silencer systems. - Briefing on the treatment of spent lamps of MAL and HPSL types. - Develop a project for the organization of construction for the organization of temporary storage of waste places. - The conclusion of contracts for the disposal of lamps with enterprises having a complete package of permits for handling the corresponding class of hazardous waste in accordance with the current legislation of Ukraine.	slight

		- Ensure switching off of vehicles and preventing idling. - Use of effective equipment operation schedule.	
Operation	Transport vehicles emissions	-Ensure switching off of vehicles and preventing idling. - Development of a traffic management plan to ensure uninterrupted traffic flow - Provision of regular check of the state of vehicles and other mechanisms. -Use of vehicles with an effective system of exhaust silencer systems.	slight
	Greenhouse gases emissions	- Development of a traffic management plan to ensure uninterrupted traffic flow - Provision of regular check of the state of vehicles and other mechanisms. -Use of vehicles with an effective system of exhaust silencer systems. -Effective lighting equipment operation (switching off when necessary)	positive
Noise pollution			
Construction	Noise from the transport vehicles	- Limit noisy types of operation by the least sensitive to noise time	slight

	operation	of the day (weekdays between 8:00 a.m. and 22:00 p.m.). - All used equipment and tools must have means of reducing noise, not less effective than those provided in the original equipment/techniques. – Provision of regular checking of technical condition of vehicles and other used mechanisms.	
Landscape			
Construction	Construction influence on the landscape	-If necessary, during the construction phase, the installation of fencing structures is required to protect sensitive recipients. - Restoration of the landscape after the completion of construction work by cleaning the land dumps.	The influence will be temporary and is characterized as slight
Soils			
Construction	Losses/pollution of soils during excavation for construction	-Determination of dispersion characteristics with respect to potential erosion. - Removing of the top layer of soil and its storage in special dumps for preservation. - Proper storage of the excavated soil to simplify the process of future recovery and its cover to prevent	slight

		scattering. - At the end of the construction work on the restoration of the fertile soil layer, including the use of a suitable top layer of soil, soil fracturing, sowing of the corresponding seeds, the use of appropriate fertilizers as necessary. - Development of a plan of construction with briefing the responsible persons on the issues of handling of the upper layer of soil. - Prohibition of heavy machinery outside areas with asphalt covering, if possible, to prevent negative compressive effects on the upper layers of the soil.	
	Soils pollution by the construction and housing wastes	Briefing and ensuring the compliance of regulations of employees' safety during operation with hazardous and toxic materials. - Development of the construction plan with indication of places of temporary storage of waste and building materials. - Compliance by workers with the rules of handling and storage of building materials, fuel, petroleum products, chemicals.	slight

		- Briefing on behaving during emergencies involving spillages of fuel and lubricants.	
Operation	Losses/pollution of soils during excavation for construction/ (during repair works)	- Removing of the top layer of soil and its storage in special dumps for preservation. - Proper storage of the excavated soil to simplify the process of future recovery and its cover to prevent scattering. - At the end of the construction work on the restoration of the fertile soil layer, including the use of a suitable top layer of soil, soil fracturing, sowing of the corresponding seeds, the use of appropriate fertilizers as necessary. -Briefing the responsible persons on the issues of handling of the upper layer of soil. - Prohibition of heavy machinery outside areas with asphalt covering, if possible, to prevent negative compressive effects on the upper layers of the soil. -Regular inspection of the external lighting networks, preventive works in order to prevent breakdowns and emergency situations in equipment	slight

		operation.	
	Soils pollution by the construction and housing wastes	Following the rules of handling of hazardous and domestic wastes by employees. - Provision of places for temporary storage of waste organization. - Briefing on behaving during emergencies involving spillages of fuel and lubricants.	slight
Water medium			
Construction	Contamination of surface and groundwater through spills of fuel and lubricants and other hazardous substances	Provision of regular check of technical condition of vehicles and other used mechanisms. In the event of any leakage of the oil/fuel the vehicle/equipment must be moved to a specially designated space for immediate repair. - Organization of proper storage of waste (in closed containers in order to minimize the formation of filtrate as a result of rainfall). - Compliance by workers with the rules for dealing with hazardous and domestic waste.	slight
Operation	Contamination of surface and groundwater through spills of fuel and lubricants and other hazardous substances	Provision of regular check of technical condition of vehicles and other used mechanisms. In the event of any leakage of the oil/fuel the vehicle/equipment must be moved to a	slight

		specially designated space for immediate repair. - Organization of proper storage of waste (in closed containers in order to minimize the formation of filtrate as a result of rainfall). - Compliance by workers with the rules for dealing with hazardous and domestic waste.	
Flora and Fauna			
Construction	Biodiversity	-Maintaining of key features of the life environment: removing the top layer of the soil with the existing grass cover in order to keep its condition as good as possible. - Carrying out restoration works at the end of the construction stage in order to restore vegetation cover. - Taking measures to prevent pollution. - Operation only at specified hours and prevent the idle work of the equipment to reduce the noise load on the local flora.	slight
Operation	Biodiversity	-Taking measures of the pollution preventing - Operation only at specified hours and prevent the idle work of the equipment to	

		reduce the noise load on the local flora. -If possible, operation only at the areas with the asphalt coverage.	
Waste treatment			
Construction	Construction wastes influence	Taking measures and recommendations of best practices for minimization and disposal of wastes and their inclusion to the Environmental Protection Plan	slight
	The impact of waste generated during the construction phase on the waste disposal infrastructure	Development and implementation of a waste recycling strategy for their proper temporary storage and disposal (due to the large number of lamps waste of MAL and HPSL types that require special recycling techniques - demercurization). - Materials that are considered suitable for re-use in construction work must be properly stored and constructed. If it is impossible to reuse materials on site, the feasibility of using them will be determined	Slight
Operation	The impact of waste generated during the construction phase on the waste disposal infrastructure	Compliance by workers with the rules for dealing with hazardous and domestic waste. Briefing of responsible persons concerning the handling of hazardous substances associated	slight

		with the leakage of harmful substances.	
Cultural heritage			
Construction **Operation**	Construction and operation consequences	Briefing of employees regarding the rules of handling of objects of cultural heritage. - Development of the order of work and proper treatment of objects of cultural heritage.	Slight slight
Employment			
Construction	Direct employment	-Measures on mitigation are not required	slight
	Indirect employment	-Measures on mitigation are not required	slight
	Local business possibilities	Support for communication and operational exchange of information with state authorities on the plans and progress of the project implementation, operational coverage of the project's needs in the workforce. - Timely coverage of the needs of employees of the relevant qualification through the mass media / on the site / website of the local government / employment service in order to attract, first and foremost, local staff of the appropriate qualification level.	slight
Operation		- Provision the necessary briefing /	slight

		specialized training to improve the quality of work and services. - Maintaining and improving relationships and feedback between executives and employees. - Compliance with national labor legislation. - Protection of vulnerable workers. - Promoting safe and hygienic working conditions. - Prevention of forced and overtime work. - Preparation and familiarization with detailed job descriptions. - Active and timely cooperation with trade unions and professional associations in order to respond in advance to their demands and proposals. - Timely coverage of the needs of employees of the relevant qualification through the mass media / on the site / website of the local government / employment service in order to attract, first and foremost, local staff of the appropriate qualification level.	
Land usage			

Construction **Operation**	Deprivation of Sustainable Economic Development	Implementation of the land withdrawal program (on a volatile basis) and the restoration of livelihood sources, as appropriate, by the EIB, considering official and unofficial livelihoods that may be subject to the negative impact of the project. The plan should include identifying vulnerable groups and developing activities to prevent situations where they could be negatively affected or would be in a disadvantaged position in terms of opportunities for development / existence. - Implement the procedure for filing complaints and proposals for full stakeholder engagement.	slight
Social sphere			
Construction		- Development and implementation of a stakeholder engagement plan, a regular evaluation and review during project implementation. - Implement the procedure for filing complaints and proposals for full stakeholder engagement. - Development of social indicators in the part of monitoring,	slight

		which will allow to identify in advance social demographic problems, the emergence of which is associated with the implementation of the project. - Possible cooperation with local social protection bodies, work with socially vulnerable layers of the local population for the purpose of promoting a healthy lifestyle, and so on.	
Operation		Development and implementation of a stakeholder engagement plan, a regular evaluation and review during project implementation. - Implement the procedure for filing complaints and proposals for full stakeholder engagement. - Development of social indicators in the part of monitoring, which will allow to identify in advance social demographic problems, the emergence of which is associated with the implementation of the project. - Possible cooperation with local social protection bodies, work with socially vulnerable layers of the local population for the purpose of promoting a	slight

		healthy lifestyle, and so on. - Interaction with local educational institutions for the organization and creation of opportunities for studying and passing professional practice.	
Healthcare			
Construction	Medical services provision by the local healthcare authorities	Establishing communication with local health care facilities. - Developing a plan for dealing during emergencies and familiarizing of employees with them. - Compulsory medical examination. - Provision of educational measures for the prevention of diseases. - Monitoring of workers' diseases. - Labor health monitoring. - Implementation of the management system of labor protection in accordance with the requirements established by the EIB.	Slight
Operation		Establishing communication with local health care facilities. - Developing a plan for dealing during emergencies and	

		familiarizing employees with them. - Compulsory medical examination. - Provision of educational measures for the prevention of diseases. - Monitoring of employees' diseases. - Labor health monitoring. - Implementation of the management system of labor protection in accordance with the requirements established by the EIB	

5. Basic approaches to attracting stakeholders

This section describes the main approaches to interaction with the public and stakeholders that can be used during the implementation of the project on the reconstruction of the external lighting network in Mariupol city, which includes measures aimed at increasing the efficiency of equipment and networks, as well as reducing the cost of services by reducing energy consumption, trouble-free operation, and environmental protection.

The process of stakeholder engagement involves the establishment of a detailed Stakeholder Engagement Plan (SEP). It will provide:

- the process of access and timely provision to stakeholders of comprehensive information on potential environmental and social impacts in an acceptable and comprehensible form;
- A mechanism for stakeholder consultation to consider their comments and provide the necessary clarifications on the benefits and potential inconveniences and probable risks that may arise during the project implementation, the measures that are planned to be implemented to reduce risks and potential impacts.

The process of stakeholder engagement is an integral part of the assessment, management and oversight of the environmental and social processes associated with this investment project. The main purpose of this process is:

- Disclosure by the Initiator of the project of the necessary information for providing meaningful consultations with the interested parties;
- Conduction of meaningful consultations with the parties of potential impact
- A "feedback" procedure or strategy, according to which citizens can express comments or complaints. The Stakeholder Engagement Plan refers to the establishment and maintenance of constructive long-term relationships with individuals both inside and outside the country, interested in the Program or in which the Program will be affected;
- ensuring that all interested parties are properly informed about the progress of the implementation or the change in the project. SEP;
- development of recommendations on the composition and sequence of actions aimed at solving existing and preventing potentially possible conflict situations related to the implementation of the Project.

5.1. National legislation on public consultation and information disclosure

The requirements for consultation with interested parties and for disclosure of information should be in line with the requirements of national Ukrainian legislation and best international practices that are used by international financial organizations, in particular the EIB.

The fundamental rights of citizens are defined by the Constitution of Ukraine. Thus, Article 50 of the Constitution of Ukraine guarantees to everyone the right to free access to information about the state of the environment, as well as the right to its dissemination; such information cannot be classified by anyone.

A number of laws and other normative legal acts have been adopted in Ukraine on public participation in environmental decision-making, public deliberation of planned activities that could potentially have a negative impact on the state of the environment and disclosure of information on such projects. Citizens of Ukraine have the right:

- access to relevant information (Law of Ukraine "On Information", Law of Ukraine "On Access to Public Information");

- Submit complaints to the authorities (Law of Ukraine "On Citizens' Appeal"). The Law of Ukraine "On Environmental Protection" defines the role and procedure for the promulgation of environmental information and public participation in the discussion and decision-making on environmental protection.

The requirements for public consultation and disclosure are mandatory for compliance with the implementation of national and regional programs for economic, social and cultural development. Such consultations are regulated, in particular, by the Decree of the Ministry for Environmental Protection of Ukraine dated December

18, 2003 No. 168 "On Approval of the Regulation on Public Participation in Decision-making in the Field of Environmental Protection". In addition, informing the population about the planned activity, determining the place and procedure for holding public hearings, open meetings, collecting appeals from citizens, reviewing and taking into account comments and suggestions is an essential part of preparing an EIA report that meets national regulatory requirements (DBN A.2.2-1 -2003) By the Resolution of the Cabinet of Ministers of Ukraine # 771 of June 29, 2011 "On Approval of the Procedure for Involving the Public in Consideration of Issues Regarding the Making of Decisions That May Affect the State of the Environment", which stipulates that conducting of public hearings is obligatory in the case of making decisions on objects and activities that constitute an increased ecological danger .

The project will have not only ecological, but also social focus and accordingly will expand the range of aspects that will be included in the report. The project will take into account the interests of the local population, which may be affected by the project implementation. To this end, the project approval process will include two rounds of discussion on potential environmental and social impacts, informing and engaging all stakeholders in the discussion, broad dissemination of information about EIA, providing the public with the opportunity to comment on the final revision of the project, provide appropriate information on mechanisms that will provide feedback and communication at the stages of processing, approval and implementation of the project.

5.2. International requirements in the field of public consultations and disclosure of information

The process of public discussion of project materials that may have potential environmental and social impacts is carried out under the condition of full compliance with all requirements of the relevant international agreements ratified by Ukraine:

- UNECE Aarhus Convention - "Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters ", signed by Ukraine on 25.06.1998, ratified by the Law No. 832-XIV of July 6, 1999. The Convention defines the right of everyone to access environmental information, the right of the public concerned to participate in decision-making and access to justice in environmental matters. The Convention obliges States parties to adequately, timely and efficiently inform the public concerned in the early stages of decision-making and ensure that the results of public participation are adequately reflected in the relevant decision (Article 6). In the event of a breach of the right to information or participation in decision-making, any person has the right to appeal against a decision taken by a court or another unbiased body.
- Espo Convention - "Convention on Environmental Impact Assessment in a Transboundary Context" (ratified by the Law of Ukraine No. 534-XIV of 19.03.1999). The Espoo Convention defines the responsibilities of countries for assessing the impacts of planned activities on the environment. It also defines the main responsibilities of countries for informing and discussing other important projects with other parties to the Convention, provided that such projects have a significant impact on the environment abroad. An important point to be addressed is the consideration of the issue of the possibility of the existence of transboundary impact as a result of the implementation of the planned project.
- Best international practice (including, in particular, EU environmental law, EIB Environmental Protection and Social Policy). All these standards and recommendations provide a similar approach to interacting with stakeholders, emphasizing its importance for building constructive relationships essential for the successful resolution of environmental and social issues. In accordance with the requirements for project implementation (EIB policy, 2008), disclosure of information and stakeholder involvement is required to:
    - identify individuals, communities or other stakeholders who are or might be harmed by the project
    - involving all stakeholders in the discussion of environmental and social issues and ensuring the potential for influencing them through representative consultation and disclosure;
    - Continuously maintain constructive relationships with all stakeholders through a representative engagement of them in the dialogue, throughout the duration of the project.

5.3. Identification of project stakeholders

The following groups of stakeholders can be identified in the investment project:

- Group A - Individuals or social groups that directly or indirectly suffer damage from the project or are interested in the project.
- Group B - Individuals or social groups that will take part in the project implementation.
- Group C - Individuals and social groups that have an opportunity to influence decision-making on project implementation.

Table 5.1 Stakeholders groups

Item	Stakeholders group	The characteristics of stakeholders' groups
1	**Group A - directly or indirectly suffer damage**	• Harmful communities: city dwellers located in the vicinity of the sites for the modernization of external lighting networks. • Enterprises and small businesses located along construction sites. • Subscribers, permanent residents of the city; • Subscribers, guests of the city. • National and local non-governmental organizations concerned with environmental or other risks • National and regional media. • Owners and operators of infrastructure objects along territories with engineering communications (power transmission lines, railways, sewage systems, gas pipelines and plumbing, heat networks, telecommunications).
2	**Group B – take part in the project implementation**	• Employees of ME and related enterprises, including those who carry out maintenance and maintenance. • Hired employees of construction companies or subcontractors who take part in the reconstruction. • Manufacturers and suppliers of raw materials.
3	**Group C - have an opportunity**	• National government agencies

	to influence decision-making	and legislatures • Central bodies of executive power • State administrations • Representatives of regional and district authorities • Professional organizations • Inspection institutions • International institutions

Group A1 Residents of territories located along the sites that will be modernized are characterized by multi-directional employment.

Disadvantages for local residents due to repairs and construction work: possible temporary inconveniences for road transport, which may create obstacles to the main stream, destruction, dust, noise, smell of bitumen, air pollution, gas emissions, vibration, temporary obstacles in movement of citizens.

Upon completion of the project, the standard of living, the sanitary and hygienic conditions of the local population will improve. Carrying out repairs and construction works is also a potential opportunity for temporary or permanent employment, people living in the area.

Group A2 Enterprises and small businesses located along construction sites are represented by various segments of economic activity and require an exhaustive list to avoid negative attitudes and dissatisfaction.

In addition to the above inconveniences for the residents, one should note another - the decline in the level of economic activity due to the construction works in the immediate vicinity of their places of economic activity.

Group A3, Group A4 To date, the network of external lighting in Mariupol city has a number of shortcomings.

Through the repair work, users will have some inconveniences associated with the temporary disconnection of external lighting networks.

One of the main economic results of the restoration work will be the stabilization of the population's expenses for the payment of utilities. Implementation of this project will also improve the working conditions for employees of ME "Mysksvitlo".

Group A5 It is necessary to create an exhaustive list of non-governmental organizations of national and local level in order to familiarize themselves with the investment project.

Group A6 Media plays an important role in the dissemination and dissemination of project information and its implementation, and is an important means of conducting public consultations. It is necessary to create an exhaustive list of local mass media that may be potentially interested in the project and disseminate project information with the following information: addresses of newspapers, radio and television editions, including name, address, telephone and fax numbers, web page addresses and electronic addresses.

Group B1 Municipal Distribution Company "Mysksvitlo" is based on the communal property of the territorial community of Mariupol and subordinated to the Mariupol City Council. As of 01.08.2016, the company employed 177 people.

For the Municipal Enterprise, the preparation and implementation of the project is a priority. The organization is interested in the proper and effective implementation of the project, minimizing costs and avoiding delays, and building good relationships with local authorities and the community.

Group B2, Group B3. Workers involved in modernization, construction and maintenance are interested in obtaining work, wages, at the appropriate level of occupational safety and security, living conditions during work and / or transportation to the workplace.

The list of stakeholders involved in the project will be clarified after the design documentation has been prepared and a detailed construction plan has been drawn up.

Group C The state-run administrations, regional and local authorities, while in control of the services, are legally involved in the draft law. Stakeholder involvement of this group will consist in organizing consultative information meetings, exchange of letters and documents related to the project. This is an ongoing process within the Ukrainian administrative procedure.

5.4. The main methods of stakeholder engagement

The methods are selected based on the requirements of Ukrainian legislation and international best practices. In the process of interaction with the interested parties, it is envisaged to use different methods and means of disclosure of information about the project. Information will be provided on the Internet and on its various carriers, in printed form, by presentations at public hearings and other meetings, by means of television and radio means, by correspondence, in oral and written answers to questions and in direct conversations with direct contacts. the project implementation process, based on recommendations and stakeholder selection, will introduce additional forms and methods for engaging the public.

- General Meetings and Public Hearings.

The general meeting is considered as the key stages of the stakeholder consultation process and the disclosure of information; As a rule, all key stakeholder groups are invited to participate. Such meetings are necessary for the wide dissemination of information and feedback from interested parties.

All discussions, offers are recorded in the minutes of the meetings and distributed. The frequency of general meetings and public meetings will be determined depending on the need to discuss a number of issues.

In accordance with the current legislative and regulatory requirements, information about the planned public hearings, the date, place and time of each of them should be made public not later than 30 days before their beginning.

The timely inclusion of public hearings into the overall plan of the consultation process and the wide dissemination of information about them will help to broaden the interest of the audience at such hearings.

To support public hearings by the Project Initiator and Consultant, it is envisaged:

- Providing for registration of each source of information to each participant in public hearings
- Presentation of the project by representatives of the Initiator.
- Answers to public questions orally during public hearings or in writing after their completion.
- Audio recording for further reproduction of the transcripts of the discussion parts of the hearings for the purpose of collecting and processing the questions, comments and suggestions of the Consultant's representatives. Decisions of public hearings will be made public on the website of local authorities and will be included, together with transcripts of their discussion parts, in the materials of the final report on the results of the consultation process.
- Information Service of the ME. A number of employees from the total number of employees are empowered to provide information on the implementation of this project.
- Meetings with specific stakeholder groups. This method is used to prevent the occurrence of negative situations, which may result in inhibition of design and construction work, respectively. Residents who will live in the area of construction work require special attention. Meetings with this group should be

held regularly and not stop during the entire course of the project. It is recommended to determine the format of such meetings at an early stage, taking into account the proposals of residents.

- Publications in the media. Mass media provide the most effective way of delivering an opinion to a wider audience. In this case, it is recommended to rely on existing periodicals.
- Focus groups. Focus groups that involve groups of specially selected individuals are used to define public opinion on a predefined topic. Focus groups help to identify the views of stakeholder groups that may remain unpublished at large general meetings (for example, pensioners, young people or disabled persons). Such meetings are also a useful way of pushing people with common anxieties to discuss these anxieties with each other (for example, residents of a particular area or small business).
- Internet network. The Internet can provide wide dissemination of information both on a regional and national scale and abroad. In particular, on the site of city authorities and other Internet-images of the public life of the city (the municipal enterprise does not have its own web-site) it is necessary to place information on the progress of work, information on possible temporary difficulties that may arise as a result of the work performed, etc. At the same time, many key stakeholders have limited access to the Internet. Therefore, such a communication channel should be used in conjunction with other methods of disclosure.
- Booklets and leaflets, ads

The distribution of booklets and leaflets is an effective way of communicating information to the public and the interest groups concerned. Documentation will be available at the office of the Company and local authorities. In particular, the following information is highlighted:

1.About the project

- Brief information about the project, indicating the purpose, legal status, information about the organization providing the loan, the expected results
- Schedule of work on the project, volumes of works, place of work on modernization, stages.

2.About the inconvenience

- Where, and what kind of inconvenience can be expected.
- Road traffic organization while upgrading.
- By-passes schemes

3.Where more information can be got

- Address of the Contractor, telephone numbers, responsible for the person's project.
- Web page addresses and phone numbers.
- Addresses, telephone numbers, working hours of information points.
- Where and what documents can be obtained.
- Information on the mechanism for filing complaints and places where it is possible to file a complaint.
- Personal Letters. Personal Letters can be used to better inform stakeholders. They may contain key information about subsequent meetings and other events, important indicators of environmental and social efficiency, and other information that the Company deems appropriate. Such letters are usually sent to all individuals and organizations that have expressed a significant interest in the process.
- Bulletins. Bulletins can be used to provide exhaustive information about the project, including the images associated with it to provide a practical understanding of what is proposed. Such bulletins may be distributed to local communities or provided to interested parties who have expressed a desire to receive regular updates on the progress of the project.
- Questionnaires. Questionnaires are used as a feedback form for stakeholders and help collect information about wishes and moments that, from the point of view of stakeholders, require correction / revision. An important point is that questionnaires may need to be considered even in the absence of the contact details and author's name.

5.5 The mechanism for filing complaints

As a result of interaction with the stakeholders of the investment project, it is possible that the project would run counter to the interests of certain groups and / or individuals. The EIB policy also requires the introduction of a mechanism, process or procedure for filing and reviewing complaints to obtain and accelerate the resolution of alerts and complaints of interested parties. on the environmental and social performance of the Company. An important element in managing the environmental and social aspects of the implementation of an investment project is the adoption and processing of applications and complaints from individuals and legal entities.

Therefore, it is necessary to develop an effective system for receiving and processing requests and complaints. A special complaint handling mechanism, starting from the level of the Contractor, including subcontractors, and the Client for the entire period of the Project implementation, is required. Non-commercial complaints or non-contractual or commercial treaties from local contractors will be processed under this appeal mechanism, such as those relating to the community affected by the Project.

In the event of any complaints about the project implementation process, a special, separate procedure will be applied. The procedure will be developed after the development of design decisions for the implementation of this investment project. The fact of receipt of each complaint will be confirmed by the sender within the specified number of working days, the response will be given within no more than 30 days. The procedure for filing a complaint will be made public on the website of the local state administration, the corresponding reference in information booklets is indicated and information is provided to the relevant information services of the city, the list of which will be specified after the development of the project documentation.

Under this mechanism, the acceptance and processing of complaints and proposals involves the assignment of a number of responsibilities by each Artist. In particular:

Responsibilities of the Customer of the Investment Project
The Customer has overall responsibility for managing the complaints and the appeal mechanism. All complaints relating to any aspect of the Project will be resolved through negotiations aimed at reaching a compromise solution.

Among the responsibilities are the following:
- appointment of the person / persons who will process the appeal in accordance with the developed mechanism and prepare social plans and programs;
-receive, organize and document feedback from interested parties on a regular basis (in accordance with the deadline);
-manage all aspects of the implementation of the complaints mechanism, control and resolution of complaints, including providing the necessary information and reporting;
-Monitor the effectiveness of using a foreclosure mechanism by contractors. Obligations of contractors and subcontractors. A list of responsibilities of subcontractors and subcontractors in the area of handling complaints and managing the mechanism of appeal is needed, including:
-appointment of the person / persons who will process the appeal process in accordance with the developed and agreed mechanism;
-ensuring familiarization of all subcontracting organizations with the mechanism of appeal and related processes;
-Ensuring proper adoption and processing / registration in accordance with the established mechanism for appealing all complaints received from members of the community and employees or through subcontractors;
-Participation in the reporting process in response to complaints received and assistance in developing and implementing a mitigation strategy, including strategies to mitigate the impact of stakeholder-related activities;
-regularly (according to the specified term) or immediately (after an emergency) inform about social and environmental problems or problems of a public nature that arose as a result of such an emergency.

In order to ensure the prevention and resolution of conflicts, the following measures should be implemented:

- The company's responsible persons were identified for communicating with stakeholders on environmental and social issues.
- created at the reception hall of local authorities (or elsewhere acceptable to the Company, local authorities and interested people) a central point (visitor center) for disseminating information related to the project, collecting comments and proposals and filling out complaints. Stakeholders will be informed about the establishment of such a central point using one of the methods mentioned above;
- development and publication of the written form of the request of the interested party; In addition, the necessary moment to prevent the occurrence of negative situations is the periodic conduct of questionnaires in order to identify issues that concern the representatives of interested parties and their proposals. The questionnaire is carried out by the side of the Company-customer of works.
- Develop and establish a mechanism for filing complaints through three alternative channels: through the receiving company through a specialized website and a visitor center / by telephone. The receipt of each

complaint must be confirmed in writing within a specified period, and a written reply must be given within 30 days;

- Redirection of all received requests and comments to the companies involved in the project: each request or comments must be reviewed by the responsible person giving a written reply, and the decision on each complaint is taken within 30 days and communicated to all parties to whom it relates;
- If necessary, a reconciliation commission is created to achieve consensus. The commission includes representatives of all parties involved, and is usually headed by a representative of the local government or regional state administration as an independent third party; If the parties cannot reach consensus by negotiation, they have the right to resolve the dispute by administrative or judicial procedure;
- information on the results of the consultation process with the public, including data on the results of the analysis of complaints, as well as any outstanding issues should be published on a regular basis; All complaints and responses to them must be registered, stored and provided to interested parties upon request.

The appeal procedure should be submitted at the local level during public hearings.

6. Environmental and social monitoring and planning

Environmental and social monitoring of areas under the influence of factors associated with the implementation of projects is a system for assessing the state of components of the natural and social environment, analysis of trends and forecast their state.

An important component of ecological and socio-economic monitoring of territories is the analysis of possible risks - environmental, economic, social, etc. - that calculation of possible losses. Carrying out such studies allows to fully assess the situation or predicted situation, develop action plans and propose possible managerial decisions.

In the process of preliminary environmental and social assessment and monitoring, international financial institutions seek to ensure that projects financed by them:

- Were socially and environmentally sustainable;
- ensure respect for the rights of workers and the local population, and
- Developed and implemented in accordance with applicable regulatory requirements and best international practice.

The Contractor will be fully responsible for monitoring the project. Such monitoring will include careful monitoring of construction work, a process to enhance road safety, measures for institutional and human resources development, audit of financial statements, and monitoring of project performance indicators throughout the entire project implementation cycle.

Such monitoring will be carried out on the basis of agreed indicators. The achievement of these indicators is critical to ensuring the effectiveness of the project, its timely completion and avoiding any delays. Defined metrics should not cause data collection problems.

In order to ensure the effective implementation of the proposed mitigation measures, including the fulfillment of environmental protection obligations during the project implementation (construction stages, demolition of existing facilities and the operation phase), an appropriate Monitoring Plan will be developed as part of the Management Plan environmental and social damages.

The monitoring plan should have the following objectives:

- confirmation of proper implementation of mitigation measures;
- ensuring compliance with the requirements of the national permit system;
- ensuring that the stages of construction and operation do not result in unforeseen impacts in advance;
- Ensuring that the construction and operation stages do not entail predetermined impacts on a larger scale than was foreseen in advance;

- Identification in the early stages of unforeseen pre-dangers and taking appropriate measures to eliminate them;
- control of the implementation of environmental restoration work after the completion of the construction phase.
- The plan for monitoring social issues is aimed at achieving the following goals:
- building positive relationships between the project developer and local communities;
- mitigation (or minimization) of negative social impacts caused by the project in accordance with the developed mitigation plan;
- optimization of potential positive effects of project implementation.

ME "Mysksvitlo", contractors and project developer will conduct regular local monitoring at the project operation stage. Local authorities responsible for protecting the environment will also conduct regular inspections of external lighting during construction and operation.

In order to ensure the effective implementation of projects, minimization of risks associated with implementation and avoidance or mitigation of potential negative impacts of project activities, as well as enhancement of the positive effects of the project, it is necessary to ensure the involvement of stakeholders in the discussion of project activities. Stakeholder participation will be ensured through publication with subsequent public hearings. Publication will be made by placing an electronic publication on the website of the Ministry of Regional Development, the city administration and utilities (if available) and the paper form in an accessible and convenient place (city administration, office of the communal enterprise, etc.).

The monitoring program should be set up both for construction and for operation, and should cover the following aspects:

- local inspection to detect any malfunctions or damage;
- Emissions of pollutants (parameters, sampling points, sampling frequency);
- waste (types, quantities);
- the format and periodicity of reporting in accordance with the requirements of the RIS and EIB;
- working conditions;
- Stakeholder engagement and public consultation;
- institutional capacity of the company to implement the monitoring program;

Monitoring can be divided into three categories:

- Construction - to ensure the success of the proposed mitigation measures and careful monitoring and management of potential impacts;
- exploitation - to constantly monitor the success of the proposed mitigation measures, identifying possible problems that are taken into account in the evaluation and planning phase;
- compliance - monitoring and reporting of the regimes provided by national and international laws and regulations, licenses and permits.

6.1. Construction stage of the project

A schedule will be provided for measures to reduce or mitigate environmental impacts.

The proposed monitoring program at the construction stage is generally limited to air quality and noise levels at workplaces and control over the amount of waste. This will be of particular importance for upgrading the network, as this is the largest building component of the proposed project.

6.2. Operation of external lighting networks

Operation monitoring should be carried out at all sites of the company. However, as far as this proposed project is concerned, the focus should be periodic in order to prevent unforeseen situations and control over the operation of equipment.

It is important to note that, as well as procedures and guidelines, actual equipment and training in such equipment for staff will be required. Monitoring will also be conducted in relation to the general observance of

working conditions, long-term involvement of stakeholders and public consultations, as well as all additional requirements set out in the PPSM to ensure social as well as environmental requirements.

6.3. Compliance with requirements and environmental monitoring

Compliance with requirements is directly related to both construction and operation, but it is important to mention separately that certain permits and licenses may require monitoring not specified above.

Compliance monitoring may include the following: