



Zaporizhzhya Municipal Energy Plan

Investment projects





Dear friends!

In 2012, Zaporizhzhya City Council made an important decision to change the energy policy of the city, to begin development and implementation of the municipal energy plan for the period until 2030. This plan is designed for a complete thermal and architectural renewal of city public and residential buildings, for a renewal of the city energy supply systems, for a reduction of the ever-increasing burden on the people budgets and Zaporizhzhya municipal budget.

This step was not accidental - we carefully studied practices of European cities. Over the last 2 years, many European experts, diplomats and bankers from Great Britain, Germany, Sweden and other EU countries visited our city. We have carefully examined international experience of residential and public buildings modernization, modern municipal energy, and modern municipal services management experience. Longtime city partner European Bank for Reconstruction and Development gave us and gives great support on this way.

The European Union in 2002 began a significant and far-reaching modernization of its cities and buildings. Green energy and energy efficiency for all European countries and cities became the main vector in the new plan. The plan was called - 20-20-20 plan. For the first time in modern history, keeping development rate, the EU has set a goal up to 2020 not to increase, but to reduce total cities energy consumption by 20%, to reduce greenhouse gas emissions by 20 % and to replace fossil fuels by renewable sources and renewable energy by 20%. Energy, climatic and environmental planning is the main instrument of this great plan. Cities of Europe have created a vast association of more than 4067 cities for mutual assistance in the implementation of this plan. This movement was called worldwide the Covenant of Mayors.

Zaporizhzhya in 2013 join the Covenant of Mayors, our Municipal energy plan will become a part of Europe-wide Plan 20-20-20. We plan to thermally-modify our residential and public buildings as a result of a 15-year program - it will enable to reduce heat demand by 3-4 times from current consumption levels and to reduce energy supply payments while increasing the comfort of life in houses and hotels. The important thing is that all buildings will be architecturally renewed, their useful lives will be extended for 50 years.

Total industry and city's population payments for electricity and gas in 2012 reached a billion USD and will grow. City's population payments for heat, hot water, gas and electricity from 267 million UAH in 2005 increased to 894 million UAH. Additionally, state budget allocates annually investment support for the city's population for more than 877 million UAH only according to the difference in natural gas prices. The overall goal of the Municipal energy plan is to stop pecuniary city's load.

An increase in energy prices has sharply increased city's budget charges for schools, kindergartens and hospitals energy supply - from 32 million UAH in 2000 to 280 million UAH in 2012. Further increase in the natural gas and thermal energy cost jeopardize wages for teachers and doctors, for all public employees. There is a goal in the Municipal energy plan to transfer fully heat connection of more than 500 public buildings from natural gas to local sources of fuel and energy by 2022.

The second big goal of the Municipal Energy Plan is to reduce natural gas requirement for residential buildings heating in the city by means of thermal modernization by 4-5 times, with its partial substitution by local sources of fuel and energy. In order to achieve this goal 20 years and lots of money we are paying for natural gas that always rises in price are necessary.

The third great goal of Zaporizhzhya Municipal Energy Plan is to reduce by 3-4 times the cost of hot water for urban population and public institutions of the city by abandoning of natural gas and switching to renewable and local fuel and energy sources.

Another goal of the Municipal energy plan is to involve local business in its fulfillment. Restructuring of more than 3,000 residential and public buildings, and city's power engineers will provide new jobs for the next 20 years. Money that we pay annually for energy consumption, now supplement budgets of energy companies far beyond the borders of Ukraine. It will be rather nicely if we switch forever a larger share of this money to city's internal business volume, to its modernization.

Nine investment projects that are presented on the pages of this booklet form the basis of Zaporizhzhya Municipal Energy Plan for the period until 2030. These are the first system projects created in four project streams:

Thermal modernization of Zaporizhzhya public and residential buildings

- Investment project “Thermal modernization of 361 public buildings”
- Investment project “Thermal modernization of 2418 multi-storey residential buildings”
- Investment project “Modernization of heat connections of 579 multi-storey residential buildings and 66 public buildings on the basis of district heating substations”

Substitution of natural gas by local fuel and energy in Zaporizhzhya hot water supply system

- Investment project “Transfer of Kommunarshchy District hot water supply to the waste heat from wastewater treatment plant (WWTP-1)”
- Investment project “Transfer of Shevchenkivskyi District hot water supply to pelletized biofuel”
- Investment project “Substitution of natural gas in hot water supply systems of multi-storey residential buildings due to the potential of ventilation systems waste heat and solar energy”

Renewable energy in Zaporizhzhya housing and communal sector

- Investment project “Modernization of Zaporizhzhya street lighting system on the base of LED lamps and solar plants”
- Investment project “Transfer of 275 public buildings heating to the pelletized biofuel and heat pumps”

Power consumption reduction at Zaporizhzhya utilities

- Investment project “Power consumption reduction at the municipal enterprise “Vodokanal”

Municipal Energy Plan includes three phases:

- **Phase 1 (2014)** - transfer to the control model based on utility holding company (Germany), increase of the investment attractiveness of Zaporizhzhya utilities, attraction of extrabudgetary funding, financial and technical partners.
- **Phase 2 (2015-2017)** – establishment of the first investment projects and thermal modernization programs 214 residential multi-storey buildings, 22 public buildings. Formation of utilities modernization local businesses on the basis of public-private partnership. Creating of a single Zaporizhzhya utilities modernization operator.
- **Phase 3 (2017-2030)** - implementation of projects and thermal modernization programs 2204 residential multi-storey buildings, 339 public institutions and projects in the sectors of energy supply (natural gas substitution projects), street lighting.

I welcome managers and specialists of Zaporizhzhya who has been working at the Municipal energy plan development, all those who build persistently and consistently future of our city.

Respectfully yours,

Mayor Oleksandr Sin

The full version of the materials of the Municipal Energy Plan can be found on the website:

<http://mep.ecosys.com.ua/>

Project stream

“Thermal modernization of Zaporizhzhya public and residential buildings”

- Investment project “Thermal modernization of 361 public buildings”
- Investment project “Thermal modernization of 2418 multi-storey residential buildings”
- Investment project “Modernization of heat connections of 579 multi-storey residential buildings and 66 public buildings on the basis of district heating substations”



Investment project

“Thermal modernization of 361 public buildings”

Investment project “Thermal modernization of 361 public buildings” is developed by ESCO “Ecological Systems” within Zaporizhzhya Municipal Energy Plan by order of the utility “Zaporizhzhya City Investment Agency”.

The purpose of this investment project is to reduce heat energy consumption by public buildings by 3 times, and therefore expenses from the city budget for the energy supply of public buildings by means of their thermal modernization. The project is planned at the expense of investors and international financial institutions.

As part of investment project all public institutions of the city (361 buildings), including schools and preschools, hospitals, office buildings and others were selected for thermal modernization.



Initial condition assessment

In 2012, energy audit of 23 pilot public buildings for the preparation of investment project was carried out. Almost 35 years there were not overhauls of public buildings in the city. Specific heat consumption for Zaporizhzhya public buildings heating is on the average of 180 - 220 kW·h/m². Deep thermal modernization of public buildings with heat energy demand reduction on the average by 3 times is necessary to meet modern standards of energy efficiency.

During the period of 2004 - 2013 Zaporizhzhya budget payments for the public buildings energy consumption increased by 545% - from 32 million UAH to 176 million UAH. Further price increase of public buildings energy consumption leads to a crisis of the most essential utility infrastructure of the city.

Investment project concise description

It is planned for next 12 years to fulfill a deep thermal modernization of all 361 city's public buildings that would permit to reduce budget payments by about 3.5 times. An additional positive outcome will be occurred in the form of increase of comfort in housing units and buildings architectural decoration. Buildings thermal modernization will permit to extend their useful life for 40-50 years.

This project implementation is planned in two phases:

- Phase 1. Thermal modernization of 22 pilot buildings (2015-2017). To attract EBRD assets it is necessary to perform a feasibility study of the thermal modernization of 22 pilot public buildings, including: schools, kindergartens, clinics, and social infrastructure buildings;
- Phase 2. Thermal modernization of 339 public buildings (2017-2023). To attract Eurobanks assets it is necessary to perform a feasibility analysis of mass public buildings thermal modernization.

As part of this investment project deep modernization of buildings engineering systems - an integrative modernization of heating units, heat consumption systems, ventilation and lighting, windows replacement for energy efficient metal-plastic windows, exterior building envelopes heat insulation (walls, floor of roof, floor of basement) – is provided.

While carrying out indicated energy efficiency measures complex, decrease of the specific heat loss for buildings heating to the average of 45-50 kW·h/m² during the heating period is expected. In general, the city is projected reduction of heat consumption in public buildings by an average of 65%.

Investment project technical-and-economic parameters

Main technical-and-economic parameters of public buildings thermal modernization are described in the following table.

| No | Name | Measuring unit | Value (22 pilot buildings) | Value (Mass thermal modernization) |
|-----|--|----------------------------|----------------------------|------------------------------------|
| 1 | <i>Economic parameters of the project</i> | | | |
| 1.1 | Life of project | years | 20 | 20 |
| 1.2 | Project implementation period | years | 2015-2017 | 2018-2023 |
| 1.3 | Capital expenses | thous. UAH | 40 235 | 940 356 |
| 2 | <i>Technical parameters of the project</i> | | | |
| 2.1 | Quantity of modernization objects | pcs | 23 | 389 |
| 3 | <i>Operational parameters of the project</i> | | | |
| 3.1 | The consumption of heating energy per year | thous. kW·h | 10 765 | 173 936 |
| 3.2 | Thermal energy savings after implementation of thermal modernization | thous. kW·h | 6 935 | 116 423 |
| 3.3 | Gas savings for the production of thermal energy for heating | thous. m ³ /yr | 955 | 16 027 |
| 3.4 | Price for natural gas for public buildings (2012, VAT is not included) | UAH/ thous. m ³ | 3 913 | 3 913 |
| 4 | <i>Efficiency indicators</i> | | | |
| 4.1 | Net present value (NPV) | thous. UAH | 62 679 | 959 007 |
| 4.2 | Discounted Payback Period (DPP) | years | 7,6 | 9,6 |

Indicated calculations are intended for the banks, potential investors and Zaporizhzhya municipal government management, and they will be also used for Zaporizhzhya energy plan development.

Investment project implementation will contribute significantly to Zaporizhzhya budget expenses reduction for the public buildings energy supply.

As part of the MEP preparation for the investment project “Transfer of Zaporizhzhya public buildings heating to the biofuel and heat pumps” that will reduce expenses by 6-7 times is also planned.

Investment project

“Thermal modernization of 2418 multi-storey residential buildings”

Investment project “Thermal modernization of 2418 multi-storey residential buildings” is developed by ESCO “Ecological Systems” within Zaporizhzhya Municipal Energy Plan by order of the utility “Zaporizhzhya City Investment Agency”.

The purpose of this investment project is to reduce heat energy consumption by residential buildings by 3 times, and therefore private consumption for flat ownership by means of buildings thermal modernization. The project is planned at the expense of residents, domestic and international financial institutions. This project is the largest on a scale and employment of funds throughout the history of Zaporizhzhya. The project is intended to the natural gas demand reduction by 260 million cubic meters. The project corresponds to the EU Directive 2010/31/EC in the buildings energy performance.

Initial condition assessment

In 2012, energy audit of 5 pilot residential buildings for the preparation of investment project was carried out. Almost 40 years there were not overhauls of residential buildings in the city. Specific heat consumption for Zaporizhzhya residential buildings heating is on the average of 150 – 220 kW·h/m² that considerably exceeds the passive house standard, which is massively implemented in the EU. Deep thermal modernization of residential buildings with heat energy demand reduction on the average by 3 times is necessary to meet modern standards of energy efficiency.

During the period of 2004 - 2013 Zaporizhzhya budget payments for the residential buildings energy consumption increased by 275%. Further price increase of residential buildings energy consumption leads to a non-payments crisis among Zaporizhzhya population.



Investment project concise description

It is planned for 16 years (beginning 2015) to fulfill mass deep thermal modernization of 2418 city's multi-storey residential buildings that would permit to reduce population payments by about 3 times. An additional positive outcome will be occurred in the form of increase of comfort in housing units and buildings architectural decoration and buildings surrounding grounds. Residential buildings thermal modernization will permit to extend their useful life for 40-50 years.

As part of this investment project integrated modernization of heating and ventilation system, beyond radiator screens installation, windows replacement for energy efficient metal-plastic windows, shell works heat insulation, roofs and basement housing units heat insulation etc is provided.

Implementation of investment project because of a large number of modernization objects and large capital expenses is stipulated in several stages, beginning 2015:

- Stage 1. Thermal modernization of 7 pilot residential buildings (2015);
- Stage 2. Thermal modernization of 214 multi-storey residential buildings (2016-2019);
- Stage 3. Thermal modernization of 2197 multi-storey residential buildings (2020-2030);

Requirement for attraction of bank funds for the financing of residential buildings thermal modernization projects is creation of housing cooperatives.

Investment project technical-and-economic parameters

Main technical-and-economic parameters of investment project are described in the following table.

| No | Name | Measuring unit | Value (stage 1) | Value (stage 2) | Value (stage 3) | In all |
|-----|--|----------------------------|-----------------|-----------------|------------------|------------------|
| 1 | <i>Economic parameters of the project</i> | | | | | |
| 1.1 | Life of project | years | 20 | 20 | 20 | 20 |
| 1.2 | Project implementation period | years | 2015 | 2016-2019 | 2020-2030 | 2015-2030 |
| 1.3 | Capital expenses | thous. UAH | 37 030 | 1 416 950 | 9 671 910 | 11 125 880 |
| 2 | <i>Technical parameters of the project</i> | | | | | |
| 2.1 | Quantity of modernization objects | pcs | 7 | 214 | 2 197 | 2 418 |
| 3 | <i>Operational parameters of the project</i> | | | | | |
| 3.1 | The consumption of heating energy per year | thous. kW·h | 6 510 | 259 291 | 1 631 282 | 1 897 083 |
| 3.2 | Thermal energy savings after implementation of thermal modernization | thous. kW·h | 4 671 | 194 468 | 1 223 461 | 1 422 600 |
| 3.3 | Gas savings for the production of thermal energy for heating | thous. m ³ /yr | 643 | 27 336 | 171 977 | 199 956 |
| 3.4 | Price for natural gas for public buildings (2012, VAT is not included) | UAH/ thous. m ³ | 712 | 712 | 712 | 712 |
| 4 | <i>Efficiency indicators</i> | | | | | |
| 4.1 | Net present value (NPV) | thous. UAH | | 1 306 130 | 9 362 790 | 10 668 920 |
| 4.2 | Discounted Payback Period (DPP) | years | | 10,5 | 10,2 | 10,4 |

The economic effect of the project is directly proportion to tariffs of natural gas for households. The predicted natural gas prices rise and the state's refusal to cross-subsidize of tariffs for population will have a positive impact on project performance indicators (the payback period will decrease up to 6 years).

Indicated calculations are intended for population, banks, potential investors and Zaporizhzhya municipal government management, and they will be also used for Zaporizhzhya energy plan development.

Investment project implementation will contribute significantly to the reduction of the cost of services for the residential buildings energy supply until 2050.

As part of the MEP preparation for the investment project "Modernization of heat connections of 579 multi-storey residential buildings and 66 public buildings on the basis of district heating substations" and 3 investment projects to reduce hot water preparation cost price that in cooperation with buildings thermal modernization project will reduce energy supply expenses by 4-5 times are also planned.

Investment project

“Modernization of heat connections of 579 multi-storey residential buildings and 66 public buildings on the basis of district heating substations”

Investment project “Modernization of heat connections of 579 multi-storey residential buildings and 66 public buildings on the basis of district heating substations” is developed (feasibility study stage) by ESCO “Ecological Systems” within Zaporizhzhya Municipal Energy Plan by order of the utility “Zaporizhzhya City Investment Agency”.

The goal of investment project is to reduce (by an average of 10%) existing losses of heat energy and fuel for heating in Zaporizhzhya district heating system by means of equipping 645 residual buildings with automatic district heating substations.

This project is typical with the basis of the successful implementation of over 2,000 European cities which is the best recommendation for investors and international financial institutions.

Initial condition assessment

By connecting the heating system of the vast majority of Zaporizhzhya buildings to the district heating network at the consumer connections noncontrolled hydraulic elevator is applied. This lack of district heating systems provokes mass phenomena of so called “overheating” in multi-storey buildings, this leads to annual losses of natural gas in the city of more than 15-25 million cubic meters.

Experience of many countries and cities around the world points at the effectiveness of consumer connections of the residential buildings heating system by installing automatic weather heat flow regulators and heat meters. Equipment of residential buildings with metering systems and weather heat flow regulation is the main objective of the project.

Investment project concise description

As part of this investment project modernization of consumer connections of 645 residential buildings heating system by automatic district heating substations installation is proposed.



Measure for automatic district heating substations installation includes the following operations:

- installation of 645 automated regulating / adulterating units using pumps and heat flow regulators with weather adjustment for local heating systems;

- installation of 645 commercial heat energy metering devices at heat connections of consumers (if they are absent).

The main advantage that will be received from this project implementation will be formed by reduction of untenable heat energy losses for customers heating needs, and therefore of the fuel and energy resources required for this energy production. An additional economic benefit is the reduction of power consumption by district heating pumps at heat boiler stations and central heat distribution stations during heat carrier transportation. Installation of automatic regulation devices will permit to reduce heat energy consumption in transient intervals (beginning and end of the heating season) by an average of 15%, and during the heating season by an average of 5%. These data are derived from the main statistics of the regulators maintenance at connections of 34 multi-storey buildings in Zaporizhzhya.

Previous project technical-and-economic parameters

Integrated data of the previous calculation of project efficiency are described in the following table.

| No | Name | Measuring unit | Value |
|------------|---|---------------------------|---------------|
| 1 | <i>Economic parameters of the project</i> | | |
| 1.1 | Life of project | years | 20 |
| 1.2 | Project implementation period | years | 2015 - 2020 |
| 1.3 | Capital expenses | thous. UAH | 60 703 |
| 2 | <i>Technical parameters of the project</i> | | |
| 2.1 | Quantity of modernization objects | pcs | 645 |
| 2.2 | Required quantity of heat flow regulators | pcs | 645 |
| 2.3 | Required quantity of heat meters | pcs | 645 |
| 3 | <i>Operational parameters of the project</i> | | |
| 3.1 | Calculated annual consumption of thermal energy for heating | Gcal | 389 685 |
| 3.2 | Thermal energy savings for heating (mean value) | % | 10 |
| 3.3 | Thermal energy savings for heating | Gcal | 39 839 |
| 3.4 | The volume of natural gas savings | thous. m ³ /yr | 6 378 |
| 4 | <i>Efficiency indicators</i> | | |
| 4.1 | Net present value (NPV) | thous. UAH | 160 866 |
| 4.2 | Discounted Payback Period (DPP) | year | 4,8 |

Multi-storey buildings, heat connections of which are subject to modernize, consist of 645 buildings of Zhovtnevyi, Ordzhonikidzevskiyi, Kommunariskiyi and Leninskyyi Districts of the city.

It is expected that financial and organizational and technical scheme of the project, tested on 250 pilot buildings (which will be funded by a grant of EBRD) will permit to disseminate experience at 395 buildings with the credit resources volume of about 3.2 million EUR.

Project stream

“Substitution of natural gas by local fuel and energy in Zaporizhzhya hot water supply system”

- Investment project “Transfer of Kommunarskyi District hot water supply to the waste heat from WWTP-1”
- Investment project “Transfer of Shevchenkivskyiskyi District hot water supply to pelletized biofuel”
- Investment project “Substitution of natural gas in hot water supply systems of multi-storey residential buildings due to the potential of ventilation systems waste heat and solar energy”



Investment project

“Transfer of Kommunarskyi District hot water supply to the waste heat from WWTP-1”



Investment project “Transfer of Kommunarskyi District hot water supply to the waste heat from WWTP-1” is developed (feasibility study stage) by ESCO “Ecological Systems” within Zaporizhzhya Municipal Energy Plan by order of the utility “Zaporizhzhya City Investment Agency”.

The goal of the project is significant (by 2 times) reduction of the cost price of hot water supply for the inhabitants of Kommunarskyi District of Zaporizhzhya city by system modernization and employment of investors and international financial institutions funds.

Initial condition assessment

Since 2005 the city's population began to reject on a massive scale from the district water heating and to install individual electric or gas water heaters. Concern “Miski Teplovi Merezhi” (district heating supply utility) in 2013 lost more than 50% of consumers in hot water supply sector. This phenomenon is explained by lower prices (gas and electricity) for population than for district heating system, due to cross-subsidization of population by national budget. Further hot water cost increase with natural gas cost increase creates crisis phenomena for the city as a whole

in case of renunciation of the state of cross-subsidization during 2017-2019. By composition of Municipal Energy Plan projects it is planned to reduce natural gas demand in heating systems by 3 times (buildings thermal modernization) and to reduce by 2 times the cost price of hot water (substitution of natural gas by local fuel and energy) in order to reduce crisis phenomena.

Experience of many countries and cities of the world shows the efficiency of hot water supply systems modernization involving renewable energy, including wastewaters waste heat potential. Total annual volume of domestic sewage at wastewater treatment plant of the left-bank Zaporizhzhya (WWTP-1) accounts for more than 50 million m³. Wastewater temperature is +16...+24 °C depending on the season. WWTP-1 is located on the left bank of the Old Dnieper within the area of Kommunarskyi District of Zaporizhzhya city.

Economically effective substitution of natural gas in hot water supply system of Kommunarskyi District of Zaporizhzhya city by means of wastewaters waste heat utilization at WWTP-1 is the main objective of the project.

Investment project concise description

As a part of investment project heat pump station construction at central treatment facilities of the left-bank Zaporizhzhya (heat pump station at WWTP-1), which will supply with hot water production by means of wastewaters waste heat potential use, is provided.

Heat pump station at WWTP-1 with high-temperature cycle on basis of modern high-performance “water-water” type heat pumps uses lower-grade heat of wastewaters to heat leaving water up to a temperature of +80...+85°C. In order to reduce cost of electric energy that is consumed by heat pump station, use of cogeneration gas reciprocating unit, high-grade heat of which is also used in order to produce hot water, is provided.

The main advantage that will be received from this project implementation will be formed by low-cost of hot water production using heat pumps with high conversion efficiency. Furthermore, an additional effect is a reduction of the ecological load on the external environment by reducing emissions of greenhouse gases in the atmosphere and thermal pollution of the water areas of the Dnieper River.

Previous project technical-and-economic parameters

Integrated data of the previous calculation of project efficiency are described in the following table.

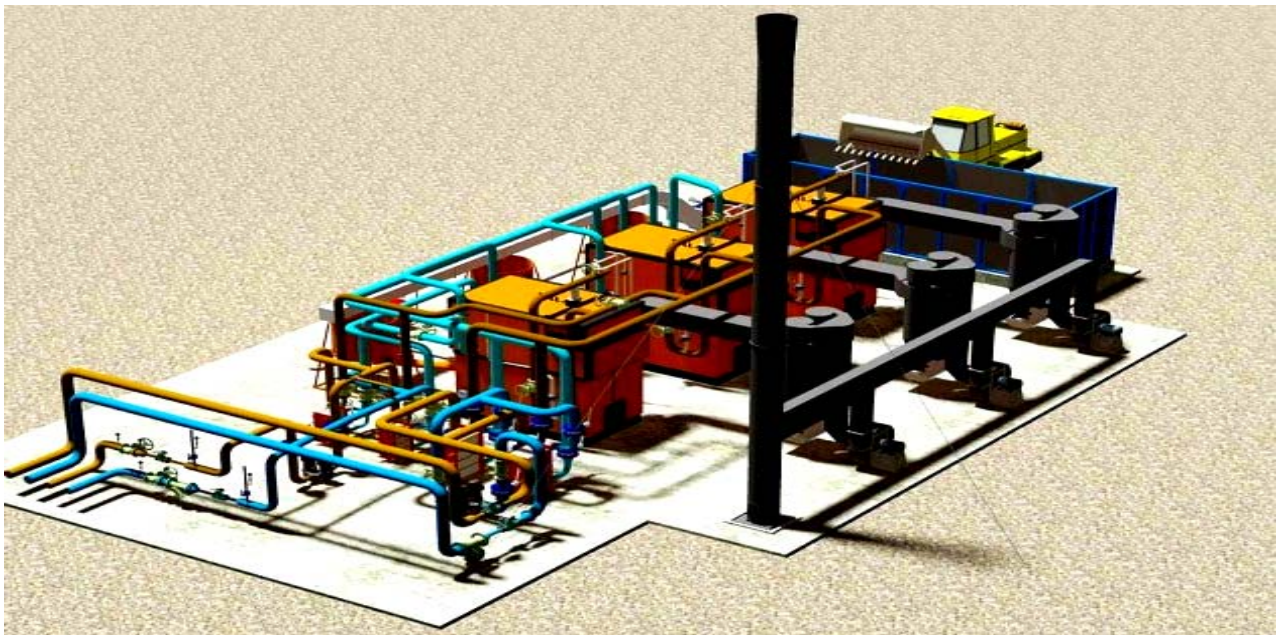
| № | Name | Measuring unit | Value |
|----------|---|--------------------------|----------------|
| 1 | <i>Economic parameters of the project</i> | | |
| 1.1 | Life of project | years | 20 |
| 1.2 | Project implementation period | years | 2018 - 2020 |
| 1.3 | Capital expenses | thous. UAH | 164 860 |
| 2 | <i>Technical parameters of the project</i> | | |
| 2.1 | Defined thermal capacity of the heat pump station | kW | 12 000 |
| 2.2 | Production of thermal energy per year | Gcal | 86 771 |
| 2.3 | Electric power consumption | thous. kW·h | 17 160 |
| 2.4 | Volumes of natural gas consumption | thous.m ³ /yr | 4 083 |
| 2.5 | The volume of natural gas substitution | thous.m ³ /yr | 6 732 |
| 3 | <i>Efficiency indicators</i> | | |
| 3.1 | Net present value (NPV) | thous. UAH | 269 809 |
| 3.2 | Discounted Payback Period (DPP) | year | 8,1 |

Investment project

“Transfer of Shevchenkivskyi District hot water supply to pelletized biofuel”

Investment project “Transfer of Shevchenkivskyi District hot water supply to pelletized biofuel” is developed (feasibility study stage) by ESCO “Ecological Systems” within Zaporizhzhya Municipal Energy Plan by order of the utility “Zaporizhzhya City Investment Agency”.

The goal of the project is significant (by 2 times) reduction of the cost price of hot water supply for the inhabitants of Shevchenkivskyi District of Zaporizhzhya city by modernization of heat boiler station at 9 Tsytrusova st. (substitution of natural gas by regional origin biofuel) by employment of employment of investors and international financial institutions funds.



Initial condition assessment

Since 2005 the city's population began to reject on a massive scale from the district water heating and to install individual electric or gas water heaters. Concern “Miski Teplovi Merezhi” (district heating supply utility) in 2013 lost more than 50% of consumers in hot water supply sector. This phenomenon is explained by lower prices (gas and electricity) for population than for district heating system, due to cross-subsidization. Further hot water cost increase with natural gas cost increase creates crisis phenomena for the city as a whole in case of renunciation of the state of cross-subsidization during 2017-2019. By composition of Municipal Energy Plan projects it is planned to reduce natural gas demand in heating systems by 3 times (buildings thermal modernization) and to reduce by 2 times the cost price of hot water (substitution of natural gas by local fuel and energy) in order to reduce crisis phenomena.

Experience of many countries and cities of the world shows the efficiency of hot water supply systems modernization involving renewable energy, also by use of wood and agricultural waste. Use of pelletized biofuel will permit to produce annually 56 000 – 72 000 Gcal of heat energy. It is equivalent to the substitution of natural gas in the amount of 8.0 - 10.0 million m³ per year.

Economically effective substitution of natural gas in hot water supply systems of Shevchenkivskyi District of Zaporizhzhya city by solid pelletized biofuel, produced from wood and agricultural waste, is the main objective of the project.

Investment project concise description

As a part of investment project substitution of existing gas boilers that supply with hot water production at heat boiler station at 9 Tsytrusova st. for modern solid pelletized biofuel boilers with fuel automatic feed system is provided. An automated storage of pellets to supply fuel storage for 15 days is also provided.

Implementation of the project involves following operations:

- installation of two solid fuel boilers and flue gas treatment plant;
- accessing of the boilers to the water supply network in the heat exchangers;
- accessing of the boilers to flue gas venting system;
- installation of fuel feeding and metering device, ash removal system, flue gas cleaning devices;
- installation of automatic fuel storage of "Alive bottom" type and silo for fuel conservation.

The main advantage that will be received from this project implementation will be formed by low-cost of hot water production by means of cheap biofuel burning in modern solid fuel boilers with high efficiency. Furthermore, an additional effect is a reduction of the ecological load on the external environment by reducing emissions of greenhouse gases in the atmosphere.

Previous project technical-and-economic parameters

Integrated data of the previous calculation of project efficiency are described in the following table.

| No | Name | Measuring unit | Value |
|-----|---|--------------------------|---------------|
| 1 | <i>Economic parameters of the project</i> | | |
| 1.1 | Life of project | years | 20 |
| 1.2 | Project implementation period | years | 2018 - 2020 |
| 1.3 | Capital expenses | thous. UAH | 41 739 |
| 2 | <i>Technical parameters of the project</i> | | |
| 2.1 | Defined thermal capacity of biofuel boilers | kW | 5 000 |
| 2.2 | Production of thermal energy per year | thous. kW-h | 37 214 |
| 2.3 | The consumption of biofuel | tn./yr | 9 303 |
| 2.4 | The volume of natural gas substitution | thous.m ³ /yr | 4 345 |
| 3 | <i>Efficiency indicators</i> | | |
| 3.1 | Net present value (NPV) | thous. UAH | 37 967 |
| 3.2 | Discounted Payback Period (DPP) | year | 11,6 |

Heat boiler stations which pertain analogous modernization consists of big heat boiler stations of Khortytskyi and Leninskyi Districts.

It is expected that financial and organizational and technical scheme of the project, tested on heat boiler station at 9 Tsytrusova st. will permit to disseminate experience at heat boiler stations of Khortytskyi and Leninskyi Districts with the credit resources employment volume of about 50-60 million UAH.

The investment project

“Substitution of natural gas in hot water supply systems of multi-storey residential buildings due to the potential of ventilation systems waste heat and solar energy”



Investment project "Substitution of natural gas in hot water supply systems of multi-storey residential buildings due to the potential of ventilation systems waste heat and solar energy" is developing (feasibility study stage) ESCO "Environmental Systems" within the Zaporizhzhya Municipal Energy Plan by order of communal enterprise "Zaporizhzhya City Investment Agency."

The aim of the project is significant (in 2 times) reduction in the cost of hot water supply (DHW) for inhabitants of the city through modernization of the system and involvement of investors and international financial institutions.

Initial condition assessment

Since 2005 the city inhabitants began rejecting the district water heating and installing individual electric or gas water heaters. Concern "Miski Teplovi Merezhi" (district heating supply utility) in 2013 lost more than 50% of the consumers in the hot water supply sector (DHW). Further increase of the hot water cost with the rising cost of natural gas creates a crisis phenomena for the city in general.

Many countries and cities experience around the world demonstrates the effectiveness of DHW modernization involving renewable energy, even through the use of solar energy and waste heat ventilation

system. Cost-effective replacement of natural gas hot water systems of apartment buildings Zaporizhzhya waste heat ventilation systems and solar energy is the main objective of the project.

Short description of project

As part of the project the modernization of residential buildings DHW system is proposed by installing heliocollectors and roof heat pump points that provide hot water using the advantages of climatic zones of the city.

Using heliocollectors and heat pumps type "air-water" is characterized by minimal operating costs, ecological compatibility, requires 4 times less energy than each apartment, electric water-heating devices (boilers).

The total demand for heat is provided by heliocollectors and heat pumps operating in bivalent-parall mode. In the scheme proposed by solar energy covered up to 50% of the heat energy in the hot water supply. The existing system of centralized hot water supply is proposed to save as a backup source of peak power.

The main advantage that aimed by the project is formed by low-cost hot water creation by independent sources using solar energy and heat pumps. In addition, more attractive is the low power consumption and no heat losses during transportation carrier.

To the list of pilot objects to be upgrade included 211 apartment buildings of Lenin and Khortytskyi districts.

It is expected that the financial, organizational and technical scheme of the project tested on 211 buildings will extend the experience for 379 residential buildings in the city in 2 districts of Zaporizhzhya (Khortitskiy, Lenin).

Preliminary technical and economic characteristics of the project

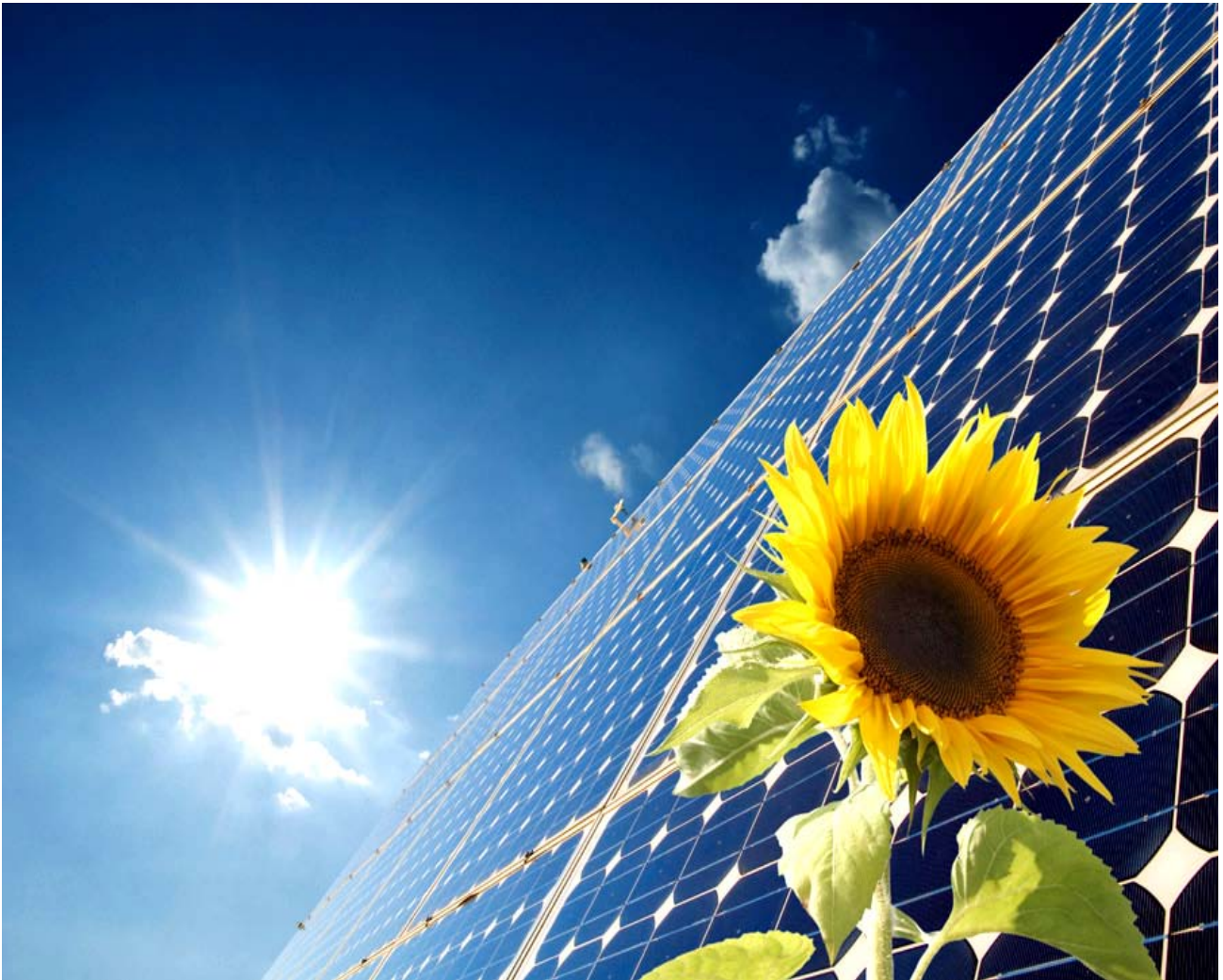
Summary preliminary calculation of the project are listed in the table below.

| № | Name | Units | Value |
|----------|--|----------------------------|----------------|
| 1 | <i>Economic Characteristics of Project</i> | | |
| 1.1 | Life period of the project | years | 20 |
| 1.2 | Project realization terms | year | 2016 - 2030 |
| 1.3 | Capital expenditure | Ths UAH | 621 950 |
| 2 | <i>Technical specifications of the project</i> | | |
| 2.1 | Number of facilities to upgrade | units | 590 |
| 2.2 | The installed thermal capacity of heat pumps | kW | 30 527 |
| 3 | <i>Performance Specifications</i> | | |
| 3.1 | The required amount of thermal energy for hot water supply per year | Gcal / year | 165 471 |
| 3.2 | Cover percent needed heat energy to DHW from heliocollectors (average) | % | 49% |
| 3.3 | Heat production from heliocollectors | Gcal / year | 82 359 |
| 3.4 | Heat energy produce from heat pumps | Gcal / year | 83 112 |
| 3.5 | Replacement of gas volume | ths. m ³ / year | 27 050 |
| 3.6 | Power consumption | thousand kW·h / year | 30 884 |
| 4 | <i>Efficiency indicators of the project</i> | | |
| 4.1 | Net present value (NPV) | Ths.UAH | 780 088 |
| 4.2 | Discounted Payback Period (DPP) | year | 8,6 |

Project stream

“Renewable energy in Zaporizhzhya housing and communal sector”

- Investment project "Modernization of Zaporizhzhya street lighting system on the base of LED lamps and solar plants"
- Investment project "Transfer of public buildings heating to the pelletized biofuel, heat pumps and solar thermal collectors"



Investment project

"Modernization of Zaporizhzhya street lighting system on the base of LED lamps and solar plants"

Investment project "Modernization of Zaporizhzhya street lighting system on the base of LED lamps and solar plants" is developing (feasibility study stage) ESCO "Environmental Systems" within the Municipal Energy Plan Zaporizhzhya on orders communal enterprise "Zaporizhzhya City Investment Agency."

The aim of the project is to reduce (on average 1,6 times) spending from the city budget Zaporizhzhya on the electricity consumed by the needs of street lighting. Moreover it is planned to significantly reduce operating costs by increasing the life of the lamps up to 9 times.



Initial condition assessment

The system of street lighting is an integral part of the urban economy. As of 01/01/2013 Zaporizhzhya has over 40 thousand working and nearly 2 thousand broken street lamps. The vast majority of streetlights equipped with lamps with high energy consumption and insignificant life. The average annual electricity consumption of street lighting system in Zaporizhzhya is more than 13 million kW·h. Over the last 5 years of budget expenditures for street lighting increased by 3 times (which is associated with an increase in electricity tariffs), and in 2012 these were 5.3 million UAH, including VAT.

Further increase in electricity prices under the current technical equipment of Zaporizhzhya street lights creates an objective threat of underfunding.

Experience of a large number of European cities shows that the introduction of energy efficient street lighting system, which is based on the use of LED lamps can reduce energy consumption by an average of 50-80%. Implementation of these projects have high investment attractiveness and actively supported by international financial institutions.

Short description of project

As part of the project proposed modernization of street lighting by replacing 40 170 existing fixtures with energy-efficient LED with modernization of systems and supervisory control.

In addition the project provides installation of solar plants on rooftops of buildings to provide electricity to power street lighting using the benefits of "green tariff".

The main advantage that aimed by the project is formed by reducing the electricity consumption of lighting needs.

The street lights modernization project will result in annual savings of about 4 million budget by reducing power consumption and an additional annual income of more than 28 million by selling on the "green tariff" of electricity generated by solar power plants on the roofs of buildings.

Furthermore, an additional effect is reducing the environmental burden on the environment by reducing emissions of greenhouse gases in the atmosphere and improve the quality and safety of street lights.

Preliminary technical and economic characteristics of the project

In order to choose the optimal variant of the project are shown in Table preliminary calculations for 2 options:

- 1) modernization of street lighting based on LED lights;
- 2) modernization of street lighting based on LED lamps and solar plants on the roofs of buildings.

| № | Name | Units | Option 1 Lamps replacement | Option 2 lamps + solar stations |
|----------|--|----------------------------|---|--|
| 1 | <i>Economic Characteristics of Project</i> | | | |
| 1.1 | Project life term | Years | 15 | 15 |
| 1.2 | Project implementation period | Year | 2017 - 2020 | 2017 - 2020 |
| 1.3 | Capital expenditure | Ths.UAH | 177 159 | 233 269 |
| 2 | <i>Project Specifications</i> | | | |
| 2.1 | Number of lamps | units | 40 170 | 40 170 |
| 2.2 | The service life of existing lamps | thousand hours. (years) | 11 (5,0) | 11 (5,0) |
| 2.3 | The service life of LED lights | thousand hours. (years) | 100 (45) | 100 (45) |
| 2.4 | Required solar plants power | kW | – | 6 046 |
| 3 | <i>Performance specifications</i> | | | |
| 3.1 | Average annual electricity consumption by existing lamps | thousand kW·h | 13 731 | 13 731 |
| 3.2 | Average annual LED lights electricity consumption | thousand kW·h | 8 423 | 8 423 |
| 3.3 | Annual production of solar power stations | thousand kW·h | – | 8 423 |
| 3.4 | Annual electricity savings | thousand kW·h | 5 309 | 5 309 |
| 3.5 | Annual reduction of the cost of replacing lamps (life time of the project) | Thousand UAH | 1 566 | 1 566 |
| 4 | <i>Project Efficiency indicators</i> | | | |
| 4.1 | Net present value (NPV) | Thousand UAH | | 36 642 |
| 4.2 | Discounted Payback Period (DPP) | Year | | 13 |

Given the much greater annual savings (1,6 times) expenditures for the needs of street lights and less capital investment payback period (3 times), option 2 is more appropriate for implementation through the involvement of investors and international financial institutions.

Investment project

"Transfer of 275 public buildings heating to the pelletized biofuel and heat pumps"

Investment project "Transfer of 275 public buildings heating to the pelletized biofuel and heat pumps" is developing (feasibility study stage) ESCO "Environmental Systems" within the Municipal Energy Plan Zaporizhzhya by orders communal enterprise "Zaporizhzhya City Investment Agency."

The aim of the project is significant (on average 3 times) reduction in payments from the municipal budget for heating public buildings Zaporizhzhya (schools, kindergartens, clinics, etc.) by putting buildings into modern self-contained boilers renewable fuels and energy by involving investors funds and international financial institutions.



Initial condition assessment

Natural gas is the primary fuel used in the boilers of Zaporizhzhya for electric power generation for public buildings.

Each year the cost of the municipal budget to pay for heating public buildings are increasing and reached almost 200 million a year. Further increase in the cost of heating with the rising cost of natural gas provokes the budget crisis the city as a whole.

Experience in many countries and cities of the world shows the economic efficiency upgrading heating systems involving renewable energy, including through the use of solid granular biofuels, solar energy and low potential energy of the outside air. Cost-effective replacement of natural gas by local fuels and energy in heating public buildings Zaporizhzhya is the main objective of the project.

Short description of project

As part of the project is expected to do the following:

- provide heating of thermo modernized public buildings, right bank of Leninskiy, Zavodskuy, Khortytzkiy, Kommunarskiy and Shevchenko district of Zaporizhzhya mainly due to the establishment of autonomous modular boilers with modern solid fuel boilers and heliocollectors;
- provide heat thermo modernized public buildings in Ordzhonikidze, left bank of Lenin district, and the Zhovtnevyi district of Zaporizhzhya mainly due to heat pump installation points and heliosystems.

The above equipment operates automatically and produces heat according to the outside temperature.

The main advantage that aimed by the project is formed by the low cost of thermal energy independent sources using cheap fuels and energy. In addition, more attractive project is the lack of heat losses during transportation carrier.

The structure of the sites to be upgrading included 275 public buildings.

Preliminary technical and economic characteristics of the project

Summary of the previous project calculations are listed in the table below

| № | Name | Units | Summary |
|----------|--|--------------------------------|----------------|
| 1 | <i>Economical project specifications</i> | | |
| 1.1 | Project period | years | 20 |
| 1.2 | Period project implementation | years | 2015-2023 |
| 1.3 | Capital costs | Ths. UAH | 154 403 |
| 2 | <i>Technical project specifications</i> | | |
| 2.1 | Number of objects | units | 275 |
| 2.2 | Thermal load attached | Gcal / h | 35,7 |
| 3 | <i>Performance Specifications</i> | | |
| 3.1 | Autonomous boiler heat production | Gcal | 67 482 |
| 3.2 | Centralized boiler gas consumption | thousand m ³ /year | 11 015 |
| 3.3 | Consumption of bio fuel pellet boilers | tn./year | 3 973 |
| 3.4 | Heat pump power consumption | Ths.kW·h / year | 19 481 |
| 3.5 | Natural gas volume replacement of natural gas | thousand m ³ / year | 11 015 |
| 4 | <i>Efficiency indicators of the project</i> | | |
| 4.1 | Net present value (NPV) | Ths. UAH | 137 952 |
| 4.2 | Discounted Payback Period (DPP) | years | 9,9 |

It is expected that the financial, organizational and technical project design, tested on 22 buildings will spread the experience on 389 public buildings with the volume of credit resources about 250 million UAH.

Project stream

"Power consumption reduction at Zaporizhzhya utilities"

- Investment project "Power consumption reduction at the municipal enterprise "Vodokanal"



Investment project

"Power consumption reduction at the municipal enterprise "Vodokanal"

Investment project "Power consumption reduction at the municipal enterprise "Vodokanal" developed (feasibility study stage) ESCO "Environmental Systems" within the Municipal Energy Plan Zaporizhzhya on orders communal enterprise" Zaporizhzhya City Investment Agency".

The aim of the project is to reduce the cost of Zaporizhzhya municipal enterprise "Vodokanal" (district water and wastewater utility, hereinafter – ME "Vodokanal",) for electricity consumed by the needs of the pumps.

Initial condition assessment

Water supply and sanitation in Zaporizhzhya is ME "Vodokanal". The installed production capacity municipal water Zaporizhzhya is 510 m³/day. The basis of production capacity in the structure of the company is pumping industry, which includes more than 250 pumping units. In previous years are set frequency inverters and soft starters on the 96-electric drives of different capacities. Average annual energy consumption pump drive is more than 80 million kW·h. Over the past 10 years, consumption ME "Vodokanal" for the consumption of electricity increased by 3 times (while reducing power consumption by 2 times) and in 2012 accounted for UAH 91 million, including VAT.



The upward trend in electricity prices threatens the proper functioning of ME "Vodokanal".

Experience of Ukrainian utilities shows that the introduction of regulation of electric drives, which is based on the use of variable speed drives and soft start devices, can reduce energy consumption by 15% to 45%. Implementation of these projects have high investment attractiveness and supported by international financial institutions.

Short description of project

As part of the project proposed modernization of the economy pumping ME "Vodokanal" by replacing the old pumps to modern efficient pumps and rigging electric drives with frequency converters and soft start devices.

The main advantage that refrain from the project, formed by reducing the consumption of electricity by utilities of Zaporizhzya city.

Furthermore, an additional effect is to increase the service life of pumps and devices of draft and providing operational management and control of flow processes.

Preliminary technical and economic characteristics of the project

Summary preliminary calculation of the project are listed in the table below

| № | Name | Units | ME «Vodokanal» |
|----------|---|----------------------|---------------------------|
| 1 | <i>Economic Characteristics of the project</i> | | |
| 1.1 | Project period | Years | 10 |
| 1.2 | Period project implementation | Year | 2015 |
| 1.3 | Capital costs | Thousands UAH | 7 096 |
| 2 | <i>Technical project specifications</i> | | |
| 2.1 | Number of facilities | units. | 11 |
| 3 | <i>Performance Specifications</i> | | |
| 3.1 | Average annual electricity consumption of pumping the economy | thousand kW·h | 9 036 |
| 3.2 | Annual electricity savings | thousand kW·h | 1 216 |
| 4 | <i>Project Efficiency indicators</i> | | |
| 4.1 | Net present value (NPV) | Thousands UAH | 6 911 |
| 4.2 | Discounted Payback Period (DPP) | Year | 5,5 |

Given that the simple payback period of capital investment is from 5 to 6 years, the investment project is acceptable to implement and involving investors funds and international financial institutions.