JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
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"Rehabilitation of the district heating system of Crimea"

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SECTION A.   General description of the **project**

A.1.   **Title of the project:**

"Rehabilitation of the district heating system of Crimea"
PDD Version: 04, dated April 23, 2008

A.2.   **Description of the project:**

The project main goal is fuel consumption reduction, in particular reduction of natural gas (which is imported to Ukraine) and fuel oil consumption, by means of district heating system rehabilitation in the Autonomous Republic of Crimea (excluding the city of Sevastopol), including boiler and distribution network equipment replacement and rehabilitation, switching inefficient oil-fired boilers to gas, installation of combined heat and power production plants, heat exchangers replacement, frequency controllers installation and landfill gas recovery and utilization at chosen boiler house. Such reduction of fuel consumption will result in decrease of greenhouse gas emissions (CO_2 and N_2O). The purpose of the project is sustainable development of the region through implementation of energy saving technologies.

Crimea region's district heating (DH) utility (system of heat supply enterprises) supplies and sells heat energy in forms of heat, hot water and steam, to local consumers, namely households, municipal consumers and state-owned organizations. It is a natural monopolist of heat production in the region. Heat supply market in the region is stable for years.

The project "Rehabilitation of the District Heating System of Crimea" was initiated in 2004 to rehabilitate Crimea region's district heating system. It consists of two parts:
- rehabilitation of the district heating system of Crimea, which includes boiler and distribution network equipment replacement and rehabilitation with installation of combined heat and power production plants (CHP) at the boiler houses, heat exchangers at the central heating points replacement and frequency controllers installation;
- landfill gas extraction at Simferopol city landfill, which will allow to reduce methane emissions, and its further utilization at closest to the landfill boiler house.

Rehabilitation of the district heating system includes 188 boiler-houses with 709 boilers, 634 of which are in operation, and 516 km of heat distributing networks that belong to LE "Krymteplocomunenergo". This is the large part of Crimea regional DH system, and project may be expanded by including the other DH objects in the region. Project provide replacement of 398 boilers and rehabilitation of 91 boilers, installation of cogeneration units at 5 boiler houses (6 gas engines, 0.5 MW each) with total installed capacity 3 MW. Deutz TBG 616 V12 K machines are considered as potential candidate for installation. Landfill gas extraction at Simferopol city landfill will allow to capture 3700 ths. m^3 of methane annually.

The project employs the increase in fuel consumption efficiency to reduce greenhouse gas emissions relative to current practice. Over 21 million Nm^3 of natural gas and 15 thousand ton of fuel oil will be saved annually starting from 2010. Such reduction of fuel consumption is based on increase of the boiler efficiencies, reduction of heat losses in networks, installation of CHP units and replacement of natural gas consumption by landfill gas.

The following activities will ensure fuel saving:
- Replacement of old boilers by the new highly efficient boilers;
- Upgrading of boilers' burners for the combustion improvement;
- Switching of boiler-houses from fuel oil to natural gas;
- Improving of the network organization, application of the new insulation and the pre-insulated pipes;
- Installation of niche-flow burners;
- Installation of combined heat and power plants;

- Installation of heat-utilizers (contact heat-recovery gas-cleaning apparatuses) that provide utilization and recovery of flue gas heat as well as additional heat from steam condensation when temperature of flue gas falls below dew point;
- Replacement of heat exchangers at Central Heating Points;
- Installation of frequency controllers to electric drives of smoke exhausters, ventilators and network pumps;
- Landfill gas extraction at Simferopol city landfill and its further utilization at closest to the landfill boiler house at the address: 66th Glinki Street.

Estimated project annual reductions of GHG emissions, in particular CO_2, are from 5.8 thousand tons to 100.5 thousand tons in 2005 – 2009, and are over 150.5 thousand tons per year starting from 2010 comparing to business-as-usual or baseline scenario.

Implementation of the project will provide substantial economic, environmental, and social benefits to the Crimea peninsula. Social impact of the project is positive since after project implementation heat supply service will be improved and tariffs for heat energy will not be raised to cover construction costs. Environmental impact of the project is expected to be very positive as an emission of the exhaust gases such as CO_2, NO_x, SO_x and CO will be reduced. Also due to better after-implementation service, some part of population will cease to use electric heaters thus reducing electricity consumption, which is related to power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

LE "Krymteplocomunenergo" fulfils annual minimal repairing of the DH system to keep it working. Particularly it executes repairing of network's parts and boilers that might cause accidents. More economically feasible and realistic scenario without carbon credits sales is a baseline scenario with very slow reconstruction activities than to make a major overhaul of the heating system. Tariffs for heat do not include the resources for prospective reconstruction of the district heating system, only the resources for probable necessary repairing after possible accidents. Minimal annual repairing doesn't lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the same level. This scenario is less environmentally favorable for the near future (including first commitment period 2008-2012), since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is more attractive

Estimated project risks are limited and minimized. Ukraine has claimed district heating and municipal energy sector as a priority of the national energy-saving development.

A.3.	**Project participants:**

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host Party)	LE "Krymteplocomunenergo" Institute of Engineering Ecology, Ltd	No
The Netherlands	"E – energy B.V."	No

The project is initiated by three partners that distribute their functions in the project as follows:

- *LE "Krymteplocomunenergo":* is a project implementation agency (**Supplier**), which represents heat supply enterprises in the Autonomous Republic of Crimea. It operates equipment for heat production and distribution, and renders the heat supply services. As far as this organization purchases all the necessary inputs, including fuel, electricity, water, etc., it has the primary interest in the reduction of specific fuel consumption that can be achieved by the implementation of the project. Besides, this enterprise has all licenses and permissions, required under Ukrainian legislation, to perform designing and rehabilitating of the equipment. It is responsible for designing, engineering and installation works execution by its own personnel or with the aid of subcontractors. It finances this project and receives profits.

  Historical details:

Leasing Association "Krymteplocomunenergo" was founded in 1994. As a result of reorganization it was reformed in Leasing Enterprise "Krymteplocomunenergo" in 2002.

At present, the members of LE "Krymteplocomunenergo" are 8 district heating productive units: Simferopol city, Alushta district, Dzhankoj district, Evpatoria district, Kerch district, Rozdolne district, Feodosia district, Yalta district.

The main activity of this district heating utility is to supply and sell the heat energy in forms of heat, hot water and steam, to local consumers, namely households, municipal consumers and state-owned organizations. The LE "Krymteplocomunenergo" is a natural monopolist of heat production in the region.

One of the jther important directions of "Krymteplocomunenergo" activity is assistance to heat supply enterprises in implementation of the energy saving technologies. For this purpose LE "Krymteplocomunenergo", in collaboration with Institute of Engineering Ecology, has developed, tested and put into production the new hot water boiler KVV-2,0Gn with capacity 2.0 MW and efficiency over 92%. This work was awarded with the State Premium of Ukraine.

- ***Institute of Engineering Ecology, Ltd:*** is a research and engineering organization. It is responsible for development of project feasibility study, development of the Joint Implementation project, development and choice of appropriate technologies, and further selection of necessary equipment. It will also take part in environmental monitoring and verification processes.

Historical details:

Institute of Engineering Ecology (IEE), Ltd., is the independent nongovernmental professional organization, created in February, 1992. It deals mainly with the engineering ecological problems in industrial sphere. Its activity is aimed at development, production and application of the new ecologically pure technologies and various equipment for fuel and energy saving and environmental protection, as well as at carrying out ecological and energetic investigations and examinations, development of Joint Implementation projects on GHG emissions reduction in industry and district heating systems according to the Kyoto Protocol mechanisms.

Institute's activity is being executed by well-qualified and experienced specialists, including possessing DrSci and PhD degrees, in fields of heat power engineering, industrial and municipal heat supply, district heating, gas cleaning, toxic substances formation and decomposition in burning processes, waste utilization, etc.

Among the Institute's developments there are such new technologies and equipment as hot water boilers (with heat capacity of 0.63 and 2.0 MW), heat utilizers (condensation, contact, contact-surface), air-heaters, modernized hearth radiation burners, intensification of furnace heat-exchange, increasing of dust and gas-cleaning efficiency, etc.

IEE has accomplished a number of projects on development and application of the technologies for energy saving in the processes of heat generation and reduction of toxic and greenhouse gas emissions. Such projects are applied, in particular, in the municipal district heating systems of the cities of Kyiv, Zhytomyr, Vinnytsia, Sumy, Luhansk, Yalta, Khmelnytsky, Odesa, Sevastopol, Simferopol, etc., as well as at industrial enterprises in Kharkiv, Lviv, Kyiv, Donetsk and Khmelnytsky regions, and also in Moscow and Moscow region.

IEE deals with questions related to the global climate change, greenhouse gas mitigation and Kyoto protocol, since 1998.

IEE is the main scientific and engineering organization of the Ministry of Housing and Municipal Economy of Ukraine (under the management of which there are all district heating enterprises of the country, that consume over 30% of total fuel consumption by the country) in field of control and reduction of CO_2 emission, and by the order of this Ministry (previously the State Committee) has executed the expert estimation of potential and possibilities for reduction of CO_2 emission into atmosphere from the municipal district heating utilities of Ukraine.

To date, IEE has prepared the Project Idea Notes (PINs) for the JI projects on the rehabilitation of the district heating systems for several cities (Vinnitsa, Khmelnytsky, Luhansk, Chernihiv, Donetsk, Rivne, Kharkiv, etc) and regions (Chernihiv and Donetsk regions, Autonomous Republic of Crimea) of Ukraine, under preparation there are the Project Design Documents (PDDs) for some of these projects and PINs for cities Dnipropetrovsk, Zhytomyr, Odesa and several industrial enterprises. The complete PDDs developed for Chernihiv region (the first in Ukraine JI project), Donetsk region and AR Crimea, already successfully passed the international validation process and received the Letters of Approval from Ukrainian government.

Questions of energy saving and reduction of GHG traditionally take the considerable part of reports at International conferences «Problems of ecology and exploitation of energy objects», annually held by IEE in Crimea.

IEE was the co-organizer of the First (October 3-5, 2005, Kyiv, Ukraine) and the Second (October 23-25, 2006, Kyiv, Ukraine) International Conferences on JI Projects in Ukraine "Climate Change and Business".

- *E-Energy B.V.:* is the purchaser of emission reduction units generated from this project. It is a company registered in the Netherlands, and is one of subsidiaries belonging to the E energija group.

Having started its activity in 1994, E energija group has expanded from its first established company Energijos taupymo centras (Energy saving center).

The rising work range and economical-social conditions caused the creation of vertically integrated company's structure, with the separation of group's operation fields. For this purpose, the company E energija UAB, which now is the management company of the whole E energija group, was established.

E energija, UAB is an energy planning and management company, which implements turnkey projects from conceptual development and owns companies generating and supplying energy for industries and residents of the cities.

One of key aims of E energija specialists is to prepare energy plans to meet energy needs for subsistence and development of alternate energy sources and the increase of energy efficiency at least cost to the economy and environment.

Since 2005 E energija group, one of the first companies in the Baltic countries has been involved in the project development under Kyoto Protocol flexible mechanisms and started trading activities with EU allowances as specified by EU Emission Trading Scheme.

E-Energy B.V. is a company responsible for E energija group carbon credit procurement for its own purposes and all business related with carbon credit trade. E-Energy B.V. is active investor in the market of Eastern European countries in a number of JI projects.

A.4.   **Technical description of the <u>project</u>:**

A.4.1.   Location of the <u>project</u>:

The Project is located in Autonomous Republic of Crimea in the South part of Ukraine (**Fig.1**).

Fig. 1. The map of Ukraine with neighboring countries

A.4.1.1. Host Party(ies):

Ukraine.

Ukraine is an Eastern European country that ratified the Kyoto Protocol to UN FCCC on February 4th, 2004, and is eligible for the Joint Implementation projects.

A.4.1.2. Region/State/Province etc.:

The Project is located in Autonomous Republic of Crimea in the South part of Ukraine. Its territory is 26000 km^2 (about 4.3% of the total area of Ukraine). The capital of Autonomous Republic of Crimea is Simferopol city. South coast from cape Aya to Karadag mountain has subtropical climate, northern part – soft continental climate. The average temperatures are: +4 ^{0}C in January, and +24 ^{0}C in July, with average annual rainfall of 300-500 mm.

A.4.1.3. City/Town/Community etc.:

Cities, towns and villages of the Autonomous Republic of Crimea with exception of Sevastopol city (see the next issue).

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

Autonomous Republic of Crimea borders in the north with Kherson region, on the west and south – Crimea is washed by Black sea. On the north-west – by Azov Sea. Autonomous Republic of Crimea has the sea borders with Zaporizhzhya region and Krasnodarsk region of Russian Federation. There are 16 cities in Crimea. It's territory divided into 19 regions: Alushta, Belogorodsk, Bahchisaray, Dzhankoj, Kirovskiy, Krasnoperekopskiy, Leninskiy, Nyzhnogirskiy, Pershotravneviy, Razdolne, Sakskiy, Simferopolskiy, Sudak, Radyanskiy, Feodosiya, Chornomorskiy, Yalta districts.

On the 01 of January 2004 there were 23,7 million square meters of houses, 514 boiler houses and 2000 km of heat network that belong to municipal property. There are other heat supply enterprises in Crimea beside LE "Krymteplocomunenergo", but their network systems are separate. The population of Autonomous Republic of Crimea is 2.024 million.

The average temperatures of heating period are: -1,7 ^{0}C, and it's duration is 187 days.

District Heating systems of major cities and towns (with exception of Sevastopol city) are included in this project. Places involved in project are marked on the map (**Fig. 2**).
By the organizing structure, 8 district heating productive units are the members of LE "Krymteplocomunenergo": Simferopol city, Alushta district, Dzhankoj district, Evpatoria district, Kerch district, Rozdolne district, Feodosia district, Yalta district.

Fig. 2. Location of Autonomous Republic of Crimea major cities and towns where project will be implemented.

> **A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:**

Sectoral scope related to approved CDM methodologies and DOEs (version 18 Jan 08) are:

- Energy industries (renewable - / non-renewable sources);
- Energy distribution;
- Energy demand.
- Waste handling and disposal

Measures that will be used to improve the efficiency of Autonomous Republic of Crimea DH utility are as follows:

- Old operating but low efficient boilers will be replaced by the new highly efficient ones that will result in efficiency increase from 62-72% до 90-93%;

- Old operating low efficient fuel oil-fired boilers will be partially switched to or replaced by the new gas-fired boilers.

- Rehabilitation of obsolete boilers through replacement of existing burners by upgraded ones with better intensity of furnace heat exchange and heat transfer due to increased radiant component, according to technologies, developed and patented by Institute of Engineering Ecology (project partner). Application of these technologies will add 8-10% to the efficiency (with total 90%) and enable reducing CO and NO_x emissions.

- Installation of contact heat-recovery gas-cleaning apparatuses, developed and patented by Institute of Engineering Ecology, will allow utilizing and recovering the flue gas heat as well as additional heat of steam condensation, occurring when the flue gas temperature falls below dew point. Application of this technology will result in fuel consumption efficiency increase by 7-8%. The efficiency of boiler units with condensation heat-recovery systems reaches 100% and even more.

- Rehabilitation of distribution network system will enable to reduce heat energy losses from existing 10-16% to 6-13% for a pipeline:
  o replacement of high heat loss sections of the major heat-network pipes with diameter 108 mm and larger by the pipes with new insulation and pre-insulated pipes;
  o improvement of network organization.

- Replacement of obsolete heat-exchangers at the Central Heating Points.

- Installation of frequency controllers at smoke exhauster and hot water pumps engines will result in energy saving. Power consumption of boiler houses will be decreased at least by 10-20% from total annual boiler house power consumption.

These technologies have been already approved but not widely applied due to financial limitations. Therefore, some bottlenecks may occur, which is typical during implementation of new technologies and installation of new equipment.

Installation of cogeneration units (6 gas engines, 0.5 MWe each) with total installed capacity 3 MWe will be incorporated into the project. German Deutz engine TBG 616 V12 K is a considered candidate for the installation. Installation of cogeneration units will result in increasing the fuel consumption efficiency, decreasing of dependence on the power supply and improvement of operational stability and reliability, decreasing of power consumption from power stations, decreasing of power transfer losses, and decreasing of environmental pollution.

American landfill gas extraction technology will be applied at Simferopol MSW landfill. All captured landfill gas will be utilized at the closest boiler house at the address: 66 Glinky Street, Simferopol.

A.4.3.   Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

The project activities including rehabilitation of boilers, heat distribution networks and installation of combined heat and power coupling plants will increase energy efficiency of Crimea DH system thus enabling it to produce the same amount of heat energy with less fuel consumed. Additionally it will produce electric power with less specific fuel consumption. Reduced fuel consumption will make lower CO_2 emissions.

In the absence of the proposed project, all equipment, including the old low efficient but still workable for a long life period, will operate in as-usual mode, and any emission reductions would not occur.

Ukraine has claimed district heating and municipal energy sector as a priority of the national energy-saving development. This is pointed out in the State Program for Reformation and Development of municipal economy for 2004-2010 (Law of Ukraine from 24.06.2004 № 1869-IV), The Law of Ukraine from 01.07. 1994 № 74/94-VR "On energy saving" and The Law of Ukraine from 22.12.2005 №3260-IV "On changes in The Law of Ukraine "On energy saving". The law of Ukraine "On heat energy supply" (№ 2633-IV from 02.06.2005) regulates all relations in the heat supply market. It does not considerably change the previously existing practices in the market, but stimulates the more rigid energy saving and implementation of energy-efficient technologies.

A.4.3.1.   Estimated amount of emission reductions over the <u>crediting period</u>:

In course of project implementation, the following emission reductions will be achieved, at the stages of project implementation:

Length of the crediting period	Years
2005-2024	20
Year	**Estimate of annual emission reduction in tons CO_2 equivalent**
2005	5839.5
2006	9664.4
2007	13335.7
Subtotal 2004 - 2007	**28839.5**
2008	20076.7
2009	100483.7
2010	150464.2
2011	155141.2
2012	155506.0
Subtotal 2008 - 2012	**581671.8**
2013	152702.9
2014	150036.6
2015	147500.2
2016	145087.6
2017	142792.6
2018	140609.6
2019	138533.0
2020	136557.7
2021	132891.4
2022	129574.0
2023	126572.3
2024	123856.3
Subtotal 2013 - 2024	**1666714.3**
Total estimated emission reduction over the crediting period (tons of CO_2 equivalent)	**2298868.7**
Annual average of estimated emission reduction over the commitment period 2008-2012 (tons of CO_2 equivalent)	**116334.4**

Table 1.Estimated amount of CO_2e Emission Reductions

Thus the estimated amount of emission reductions over the commitment period (2008-2012) is **581671.8** tons of CO_2e, over the crediting period (2005-2024) - is **2298868.7** tons of CO_2e. For more detailed information see **Appendixes 1 – 6**.

Average annual amount of ERUs will be the following:
During commitment period 2008-2012 years – **116334.4** t CO_2e;
After commitment period 2013-2024 years – **138892.9** t CO_2e.

Description of formulae used to estimate emission reductions is represented in paragraph D.1.4.

Selling of the AAUs will be possible in case of approving the corresponding procedure by Ukrainian government. As the alternative, the possible selling of the Voluntary Emission Reductions (VERs) is under discussion.

A.5.	**Project approval by the Parties involved:**

The project is already approved by local authorities, Parliament of Autonomous Republic of Crimea, and Ukrainian government representatives, namely Ministry for Environmental Protection of Ukraine (the Local focal point for Kyoto Protocol in Ukraine) and Ministry of Construction, Architecture, Housing and Municipal Economy of Ukraine (which manages the District heating in Ukraine). It issued the Letter of Endorsement for this JI project in October, 2004. Therefore, organizational risk for this project is minimized.

The project was initiated in 2004.

January, 2004 – Agreement was signed between the LE "Krymteplocomunenergo" and the Institute of Engineering Ecology on development of the Joint Implementation Project on Green House Gas Emissions Reduction through rehabilitation of the district heating system belonging to LE "Krymteplocomunenergo". Starting of Project planning and implementation.

April, 2004 - Agreement was signed between the LE "Krymteplocomunenergo" and the European Institute for safety, security, insurance and environmental technics (SVT e.V.) (Germany), to fulfill the preparation of the project proposal for the JI project for submission to potential buyer.

September, 2004 – Expression of Interest for the Project was submitted to Federal Minister of Agriculture, Forestry, Environment and Water Management represented by Kommunalkredit Public Consulting GmbH (Republic of Austria). EoI and than full project proposal (PDD) successfully passed this program, but due to lack of the Letter of Approval the further process of making ERPA was aborted.

October, 2004 – Letter of Endorsement for this JI project

September, 2005 – Positive Final Determination report (by TÜV Süddeutschland, Germany) for the Project.

July, 2006 – Agreement was signed between the LE "Krymteplocomunenergo" and E-Energy B.V. (Netherlands), potential buyer of the ERUs to be generated from this project.

July, 2007 – Letter of Approval was issued.

SECTION B. <u>Baseline</u>

B.1. **Description and justification of the <u>baseline</u> chosen:**

At the time when this Project was developed, no approved procedures existed. Our own-developed methodology is partly similar to later appeared "Baseline and monitoring methodology AM0044". But the AM0044 was not used because the project "Rehabilitation of the District Heating System of Crimea" has some differences from applicability conditions of this methodology.

The main cause of impossibility of methodology AM0044 using for baseline calculation is no data for thermal energy output, because of thermal energy meters absence on the majority of boiler houses included in the project. That's why "SVT e.V." (Germany) and Institute of Engineering Ecology invented another methodology, that takes into account all measures involved in the project and it's peculiarities. This methodology is presented in section D (monitoring plan). It was already approved by IAE for the similar JI Projects for Chernihiv region and Donetsk Region.

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of monitoring devices for heat and heat-carrier expenditure in the municipal boiler-houses. Only the fuel consumption is registered on a regular basis. It makes practically impossible the application of AM0044 methodology which basic moment is monitoring of the value $EG_{PJ, i, y}$ (thermal energy output of project boiler i in year y) - page 9 of Methodology AM0044, which should be measured every month by flow-meters (the expenditure of heat-carrier) and thermal sensors (temperatures at the input and output of the boiler, etc.).

This also concerns the definition of the average historical value of heat power generation per year $EG_{BL, his, i}$ (average historic thermal energy output from the baseline boiler "i").

Besides, in section "Scope of Application" it is mentioned, that the scope of application of the Methodology AM0044 is limited only to the increase of boilers' efficiency by means of their replacement or modernization, and it does not apply to the fuel type switch. At the same time our project includes also the such kind of modernization as well as some others such as the replacement of burner equipment, installation of cogeneration units, etc.

The developed "Methodology" is the Project specific approach for the district heating sector in Ukraine, and may be applied to the other countries of previous USSR in view of the similarity of the main features of their district heating systems. It takes into consideration all aspects of the district heating system functioning – heat and hot water production and supply, electricity generation by CHP units belonging to this system, fuel and power saving in course of its operation.

The developed "Methodology" is founded on the basis of permanent monitoring of fuel consumption and of the account of various other factors, such as connection or disconnection of the consumers, change of fuel heating value, weather change, ratio of the heat consumption for heating and for hot water supply, etc.

The developed "Methodology" has two important advantages in comparison with the methodology AM0044 (at least for Ukrainian conditions):

· It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95 % of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (CO_2) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the

normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as registration of residents' complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.

· Definition of the fuel consumption in base year (baseline) in view of the fact that in Ukraine at the majority of the municipal heat supply enterprises the natural gas is used as a fuel, which consumption is measured constantly by the counters with the high measurement accuracy, seems to be more exact, than definition of the fuel consumption with use of heat power, boiler efficiency and heat value of the fuel. This especially concerns the efficiency, which changes greatly depending on load of boilers, which also changes essentially, and often not automatically but manually, in the heat supply systems within a day and within a year. Averaging of such values without having of the heat account system is fraught with serious discrepancies. Definition of the fuel consumption in the presence of counters requires only data collection and implementation of arithmetic actions.

Approved Consolidated Methodology ACM0009 "Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas" proposes the dependences for baseline and reporting year emissions quantity definition (see pages 4 and 5), that contain determination of Energy efficiency $\varepsilon_{project,i,y}$ and $\varepsilon_{baseline,i}$ for equipment. In the chapter "Baseline emissions" on the page 6 there is an explanation that: Efficiencies for the project activity ($\varepsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations. Efficiencies for the baseline scenario ($\varepsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations. These requirements are confirmed by tables for monitoring on the pages 13-15.

However, as it was mentioned before in this PDD, the majority of boiler-houses in Ukraine are not equipped with devices for heat-carrier expenditure definition or heat meters. There is only one parameter, that is regularly and with high precision defined in the boiler houses – fuel consumption.

For this reason, the own project specific methodology was developed, that is based on the permanent measuring of the fuel consumption and amendments for possible parameters changes in baseline in comparison with reporting year. The variable parameters may be the changes in lower heating value of fuels, quality of heating service, weather changes, changes in customers number, etc. Taking into account only equipment efficiency does not eliminate the possibilities of undersupply of heat to customers (deterioration of heat supply service), and possible weather warming in reported year, change in fuel quality, disconnection of some consumers, and other factors, and could lead to artificial overestimation of ERUs amount.

In additional, the proposition in ACM0009 to take (by conservatism principle) the baseline efficiency of equipment equal to 100 % is unacceptable in "District Heating" type projects, because not only fuel switch, but mainly namely increasing of equipment (boilers) efficiency are implemented in these projects. Accepting of such calculated baseline would lead to essential underestimation of results of implemented measures. And, anyway, as it was shown before, this would not solve the problem with impossibility of monthly measurements for getting energy efficiency $\varepsilon_{project,i,y}$.

Approved Methodology AM0048 "New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels" already in its title shows the scope of applicability, that is different from the scope of the "District Heating" projects. In our projects, the cogeneration facilities produce hot water and not steam. Beside this, in according to AM0048 (page 22) and its monitoring plan (pages 23-30), it is necessary to realize, among other measurements, monthly measurement of $SC_{PCSG,i,y}$ (Total steam self-generated by project customer 'i' during year 'y' of the crediting period, TJ), measured by the steam meter at the customer 'i' (page 25). Thus Methodology AM0048 couldn't be implemented in original. In principle, it could be modified for conditions of hot water production for heating and hot water supply systems, but this will require modification of monitoring plan with introduction of other parameters that it is necessary to measure and register. But it would be the another methodology, that would require to measure such parameters as heat output, or hot water output with its temperature (in analogy with requirements of Methodology AM0048 to measure steam output, its pressure and temperature.

As it was already mentioned before, the majority of the heat supply enterprises and heat customers in Ukraine are not equipped with heat meters or devices for heat-carrier output (hot water for heating and hot water service) determination. Just for this reason, the methodology was developed that is based on the permanent measuring of the fuel consumption and corrections for possible changes of parameters in reporting year comparing to the baseline. The changeable parameters may be the lower heating value of fuels, quality of heating service (providing of normative temperature value inside apartments), weather features, number of customers, etc. As it was mentioned before, this approach eliminates any possibility of reduction of fuel consumption and correspondingly GHG emission due to incomplete delivery of heat to consumers.

In view of the above mentioned, in contrast to the methodologies AM0044, ACM0009 and AM0048, our Methodology, developed for "District Heating" projects in Ukrainian conditions and used in JI Projects "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System in Chernihiv Region", "Rehabilitation of the District Heating System in Crimea" and others, is the most appropriate, precise, corresponding to the principle of conservatism, and the most closely reflects the aims, goals and spirit of Kyoto Protocol.

The baseline study will be fulfilled every year of the emission reduction purchasing, to correct adjustment factors which have an influence at the baseline. For more detailed information see **paragraph D.1.**

For the landfill gas extraction technology the approved by UNFCCC methodology ACM0001 *"Consolidated baseline methodology for the projects activity from landfill gas"* can be used during the baseline scenario development in which the uncontrolled partial or total landfill gas emissions to the atmosphere exist (business-as usual), but the project foresees the landfill gas capture and combustion or utilization.

According to the methodology ACM0001, in the project scenario the following things will happen:
a) Collected landfill gas will be combusted or;
b) Collected landfill gas should be used for power generation (electric/heat), but emissions reduction from other sources are absent, or
c) Collected landfill gas should be used for power generation (electric/heat). Emissions reduction from the other sources happens.

In the proposed project:

- the total landfill gas emissions are presented in the baseline scenario;
- according to the project scenario it is planned to collect and utilize the landfill gas with emission reduction from other sources.

Therefore, the project corresponds to the criteria of the methodology ACM0001.

There were three different versions of Baseline scenario that were discussed before starting this project.

The first version of Baseline scenario was a business-as-usual scenario with minimum reconstruction works balanced by overall degradation of DH system.

The second version of Baseline scenario was to make reconstruction works without JI mechanism. This alternative baseline scenario was not accepted as feasible because in this case the project is not attractive for investments.

The third version of Baseline scenario was the shortened project activity, without any of the non-key type of activity, for example elimination of frequency controllers, etc., installation from the project. This makes project economically less attractive, with the longer pay back period.

Thus, the first version was chosen for Baseline scenario.

Status and adequacy of the current delivery system

Current supply of Crimea DH systems is primarily based on Ukrainian and Russian made gas, fuel oil and coal fired boilers including DKVR-20/13, DKVR-10/13, DKVR-6.5/13, DKVR-4/13, DKVR-2,5/13, DE-4/14, DE-10/14, DE-25/14, DE-6,5/14, Fakel, BGV-50e, KBNG-2,5, KVG-6,5, KVG-7,56, KVGM-20, KVGM-10, KVGM-30, KVGM-2,5, PTVM-30, TVG-8, TVG-4, Universal, Nadtochiya, NIKA-0,5, MKVK-5, MZK, NIISTU-5, E-1/9G, KSVa-0.63, KSV-2,5, KSVa-1.25, KSVa-3,15 and few other types. Detailed information is presented in **Appendix 1 (Boilers)** Current efficiency of those boilers is in the range of 62-92%.

Current distribution networks are characterized by heat losses from 13-16%. Detailed information is presented in **Appendix 2 (Networks).**

Construction of the Baseline Scenario

Current operation of the Crimea district heating system results in continuous deterioration of the heat-generating and distribution equipment, followed by continuous slight efficiency droop. However, at the same time operative maintenance increases efficiency, which pretty much compensates deterioration, and makes annual total emissions level (the Baseline) about the same for years.

Project also provides electric power production on the new cogeneration units. This power will replace consumption from the national power system, that's why we take into account national standard of power system emissions for Baseline definition.

Calculation of Baseline Carbon Emission Factors

For all fuels we used CO_2 emission factors from the data table provided in Annex C of the Operational Guidelines for Project Design Documents of Joint Implementation Projects (Volume 1: General guidelines; Version 2.2).

Cef (natural gas) = 0.0561 $KtCO_2$/TJ;
Cef (fuel oil) = 0.0774 $KtCO_2$/TJ; (taken as "Residual fuel oil").
Cef (methane) = 0.055 $KtCO_2$/TJ.

We assume that CO_2 emission factors for the fuels will be the same for period 2003-2012. For our calculations we assume that the Lower Heating Value of a fuel (LHV) doesn't change during that time,

however in the Monitoring Plan the LHV factor will be taken into account for the baseline correction for any year until 2012.

LHV of fuels used by LE "Krymteplocomunenergo" changes insignificantly from year to year. Table 2 gives average Lower Heating Values for fuels that are used by the Applicant:

Type of fuel	Average lower heating value of fuel	
	Gcal	MJ/m^3 (MJ/kg)
Natural gas	8403	35.21
Mazut	9800	41.06
Methane	8568	35.9

Table 2. Lower heating value for fuels used by the Applicant

Calculation OF CO_2 Conversion Factor (CF)

CF (Conversion Factor) = LHV (Lower Heating Value)* Cef (Carbon Emission Factor)

1000 m^3 of natural gas input = 35.21 $[MJ/m^3]$*0.561 $[KtCO_2/TJ]$ = 1.975 tCO_2

1t of Mazut input = 41.6 [MJ/kg]*0.0774 $[KtCO_2/TJ]$ = 3.177 tCO_2

1t of Methane input = 35.9 [MJ/kg]*0.055 $[KtCO_2/TJ]$ = 1.975 tCO_2.

Calculation of Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2003 was taken as the Base year. This year is one of the typical years concerning the outside temperature in heating period, as well as concerning the conditions of production and consumption of the heat.

Filial	Baseline Natural Gas Consumption, ths Nm^3/yr	Baseline Heavy Fuel Oil Consumption, t/yr
Simferopol' city	138 975	2 417
Alushta filial	13 673	302
Dzhankoj filial	14 503	1 837
Evpatoria filial	28 981	120
Kerch filial	25 736	6 228
Rozdolne filial	5 151	0
Feodosia filial	9 365	4 546
Yalta filial	18 021	4 060
Total	**254 405**	**19 510**

Table 3. Baseline fuel consumption

Detailed information is presented in **Appendix 1 (Boilers)**.

Calculation of Baseline Carbon Emissions

There are 4 types of GHG emissions involved in the baseline scenario:

1) CO_2 emissions from boilers operated by LE "Krymteplocomunenergo" DH systems. Baseline calculations were based on the assumption that baseline emissions during any report year (2008-2012) remain the same as in the basis year 2003.
2) CO_2 emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units.
3) CO_2 emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed.
4) CH_4 emissions from Simferopol landfill.

Carbon Emission factor (CEF) for 2008-2012 is taken from Table B1 "Baseline carbon emission factors for JI projects generating electricity" of operational Guidelines for PDD's of JI projects (ERUPT 4, Senter, the Netherlands).

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF_g tCO2e/MWh	0.77	0.755	0.74	0.725	0.71	0.695	0.68	0.66	0.651	0.636

Table 4. Carbon Emission factors (CEF) for electricity generation in Ukraine

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF_c tCO2e/MWh	0.94	0.92	0.90	0.88	0.856	0.836	0.816	0.796	0.776	0.756

Table 5. Carbon Emission factors (CEF) for reducing electricity consumption in Ukraine

Calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if Donetsk region DH systems remains unchanged, see in **Appendix 7 (Baseline)**. They consist of an exact amount of total CO_2 emissions that took place during the base (2003) year, and additionally of emissions due to electricity consumption for own needs from the grid in amount that will be replaced after installation of CHP units by the own-produced one, and electricity which will be saved after frequency controllers installation.

> **B.2.   Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:**

The anthropogenic emissions of GHG will be reduced due to complex modernization of heat generating and distributing equipment by application of the technologies proposed in the project activities and described above, which include replacement of old obsolete boilers by new ones with higher efficiency, replacement of obsolete and fuel oil-fired boilers by the modern gas-fired ones, installation of new modern burners, installation of cogeneration units at 5 boiler houses, renovation of degraded heat distribution networks with using the new insulation and the pre-insulated pipes.

For more obvious description of how the anthropogenic emissions of GHG are reduced below those that would have occurred in the absence of the JI project, we have built a dynamic baseline, which is the function of the stage of project implementation (see **Fig. 3**).
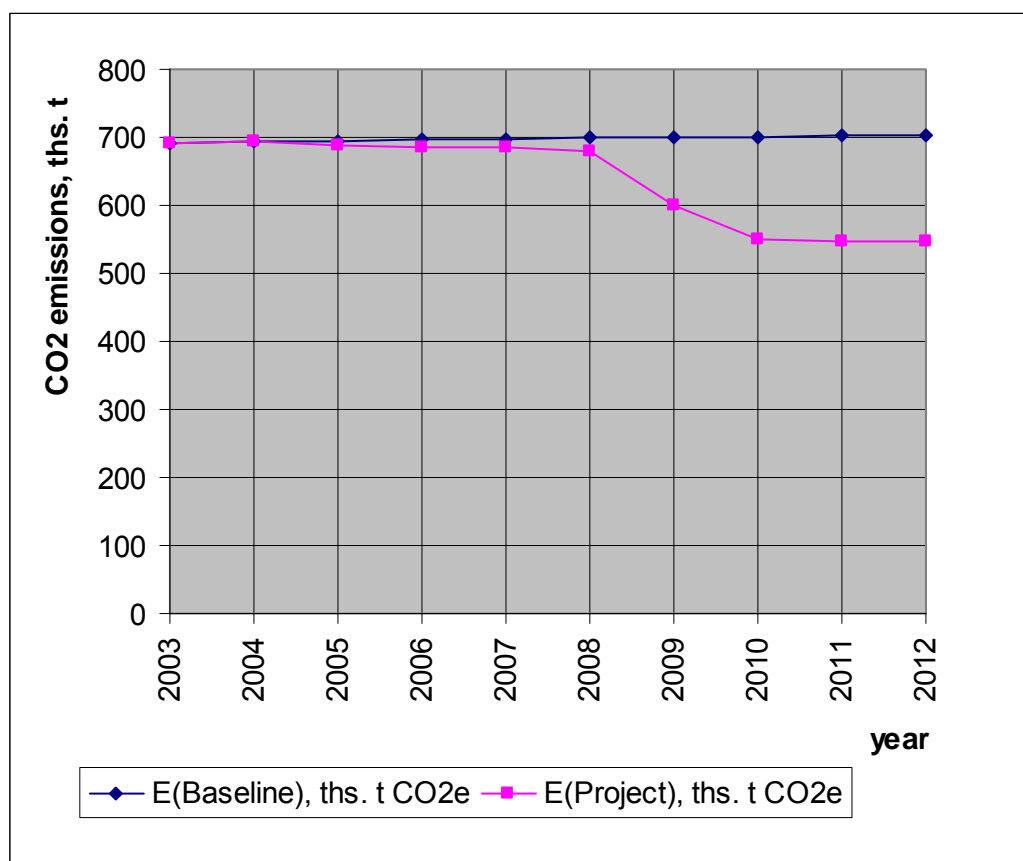

Fig. 3. Dynamic baseline and project emissions of GHG

Additionality of the project

The additionality of the project activity is demonstrated and assessed below with using the latest version of the "Tool for the demonstration and assessment of additionality" (Version 04). This tool was originally developed for CDM projects but may be applied to JI projects as well.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity:

There are three alternatives to this project.

1. The first alternative is business-as-usual scenario with minimum reconstruction works, approximately balanced by overall degradation of the DH system. This is the common practice for DH sector in Ukraine.

It should be noted that there is no local legislation regarding the time of boilers replacement and maximum lifetime permitted for boilers. It is common practice to exploit boilers which was installed in 70 th. and even 50-60 th. and earlier in Ukraine, if they pass the technical examination pass by the authorized body ("Derzhnagliadohoronpratsi").

2. The second alternative is to make reconstruction works without JI mechanism.

3. The third alternative is the shortened project activity, without any of the non-key type of activity, for example elimination of frequency controllers installation, etc., from the project.

There may be noted also several other alternatives, for example, using of the renewable energy sources such as wind power or biomass and biofuel for boiler operation, etc., but these alternatives can not be realized in Ukraine at least at present.

Sub-step 1b. Consistency with mandatory laws and regulations:

According to The Laws of Ukraine "On licensing of the separate types of activity" (№ 1775-III, from June 01, 2000) and "On heat energy supply" (№ 2633-IV from 02.06.2005); Ukrainian Government Regulation "On introduction of changes to the Government Regulations №1698 from 14.11.2000 and №756 from 04.07.2001" №549 from 19.04.2006 and "On approval of the list of licensing bodies" №1698 from 14.11.2000, execution of economic activity in fields of heat energy production, distribution and supply require a license that is issued by Ministry of Housing and Municipal Economy of Ukraine. LE "Krymteplocomunenergo" has such licenses.

The Project "Rehabilitation of the district heating system of Crimea" has been prepared according to The Law of Ukraine from 01.07. 1994 №74/94-VR "On energy saving" and The Law of Ukraine from 22.12.2005 №3260- IV "On changes in The Law of Ukraine "On energy saving".

Also the alternatives, which are: to continue business-as-usual scenario, to make reconstruction works without JI mechanism and to shortened project activity, without any of the non-key type of project activity, are in compliance with the mandatory laws and regulations.

Hence, the Step 1 is satisfied.

Step 2: Investment analysis

According to methodology AM0044, the step 2 - Investment analyses - is mandatory only if the project activity is implemented by a third party as financial analysis is required to confirm additionality of the project activity. In this case, the project is implemented and financed by Supplier.

Step 3: Barrier analysis

Sub-step 3a: Identification of barriers that would prevent the implementation of the proposed project activity

Investment barrier

The financial indicators Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated for two cases of project implementation – with and without the JI mechanism (see **Appendix 9**). The discount rate of 12 % was used for calculations, which is typical to average in Ukrainian banks. Calculations were made with the help of Microsoft office Excel financial functions.

The simple pay back period without JI mechanism will be 9.6 years, with JI mechanism – 9.1 years.

NPV and IRR of the project for 2013 year without using of JI mechanism will be:

NPV: − 5 955.4 ths EUR,
IRR: cannot be calculated.

NPV and IRR of the project for 2013 year with using of JI mechanism will be:

NPV: − 4 438.3 ths EUR,
IRR: − 3.5 %.

In both cases the project is not attractive for investments, even without taking into account that credit percentages of Ukrainian banks are very high.   But using of JI mechanism enables to improve its attractiveness.

All project activities require substantial investment – about 28.5 million EUR (The prices for the new equipment, that is planned to be installed in the project, are represented on the sheets Parameters in the Appendixes 1-2 and Appendixes 3-5 in Excel format, based on the averaged prices of the manufacturers. These prices are used for future calculations of investment costs, and should be corrected in future according to actual manufacturer's prices (changed due to inflation, etc.). The final table with necessary investments for each year is available in the Appendix 7 (Total). Operational and maintenance costs are not included in the project because it is assumed that they will remain at the previous level or even decreased due to less such costs for the new equipment).

Without carbon credits sales the project is not economically favorable for a Supplier, which makes implementation of most activities impossible. More economically feasible and realistic scenario without carbon credits sales is the baseline scenario with very slow reconstruction activities. However, considering degradation of the whole system with efficiency droop at other objects, the overall actual emissions from Supplier's enterprise would remain at the same level.

Technological barrier

1. Not all proposed technologies are widely approved already. Qualification of operational personal for implementation of the new technologies may be not sufficient to provide project implementation in time.
2. Efficiency of installed equipment could be lower than was claimed by producers or equipment may have substantial defects.
3. Available amount of natural gas. Last years Ukraine faced with incomplete delivery of natural gas from Russian Federation. Ukrainian Government realized attempts to decrease dependence from Russian natural gas delivery. Unfortunately it could lead to impossibility of boiler houses fuel switch from coal to natural gas.

Organizational barrier

The management experience in implementation of JI projects is absent, including international collaboration, validation, verification, registration, monitoring of similar projects and so on.

Identified barriers would prevent the implementation of the proposed project activity as well as of the other alternatives - to make reconstruction works without JI mechanism and to shortened project activity, without any of the non-key type of project activity.

Sub-step 3b: Explanation that the identified barriers would not prevent the implementation of at least one of the alternatives

One of the alternatives is to continue business-as-usual scenario. Therefore, as the barriers mentioned above are directly related to investing into upgrading of the Crimea district heating system, there is no impediment for LE "Krymteplocomunenergo" to maintain the district heating system at its present level. Hence, the Step 3 is satisfied.

Step 4: Common practice analysis

Sub-step 4a. Analysis of other activities similar to the proposed project activity.

It should be noted that the district heating systems from almost all territorial districts (excluding city of Sevastopol) of the Autonomous Republic of Crimea are involved in the project. LE "Krymteplocomunenergo" is the main heat supply service enterprise in Crimea. Besides LE "Krymteplocomunenergo" the heat supply service in Crimea is provided by GME "Sevteploenergo" and GME "Sevteploservis (Sevastopol). But the similar projects are not observed in Autonomous Republic of Crimea.

At present there are at least 4 DH Projects with JI in Ukraine beside this project: for Chernihiv and Donetsk regions, Kharkiv and Lugansk cities. But according to the existing rules, the other JI project activities are not to be included in Common practice analysis.

Since the similar projects are not observed in the region, there is no basis for an analysis of similar activities.

Conclusion

The above mentioned approach of JI leads to the conclusion that the project activity is additional.

B.3.   Description of how the definition of the project boundary is applied to the project:

Greenhouse Gas Sources and Project Boundaries:

Project boundaries for Baseline scenario are represented by black rectangle on the graphical picture on the **Fig.4.**
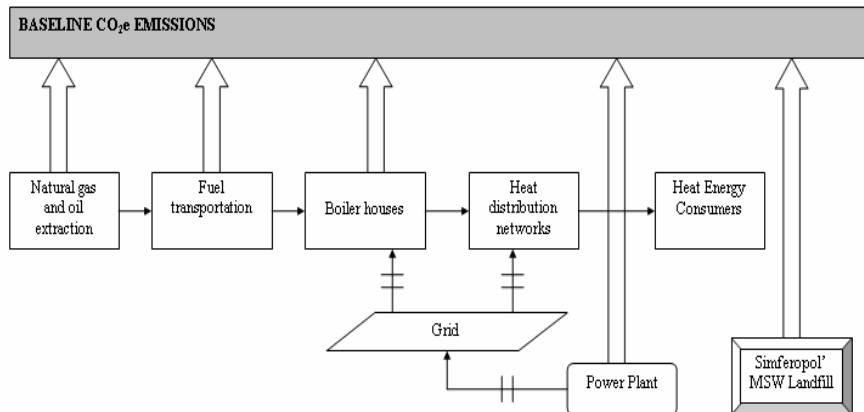

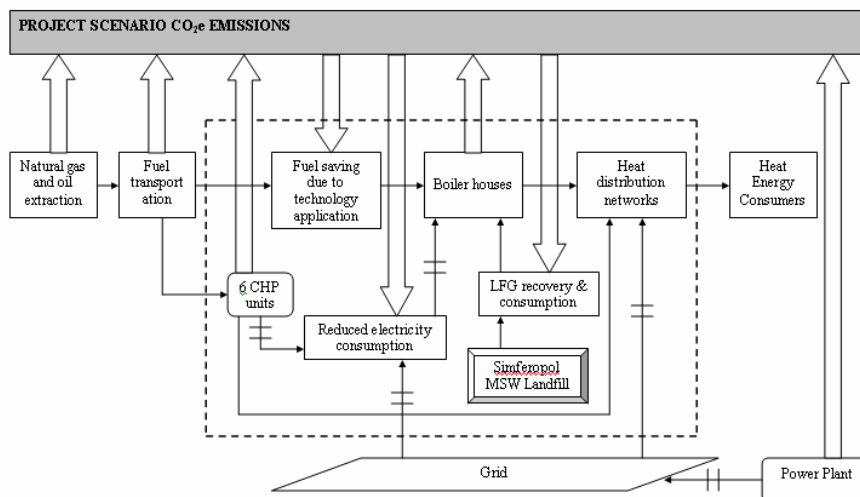*Fig.4. Flowchart of Project boundaries for Baselinet scenario*

Fig.5. Flowchart of the Project boundaries for Project scenario

Project boundary is represented by pointed rectangle on the graphical representation above. Project boundary represents changes that will differentiate baseline scenario from project scenario.

1) Fuel consumption will be reduced due to the technology to be applied, which includes boilers and networks rehabilitation and replacement of heat exchangers. The technology provides producing the same amount of heat with less fuel. Thus project fuel consumption by boilers will be lower than baseline fuel consumption by the amount of saved fuel due to the project technology application.

Correspondingly, the project emissions will be lower than baseline emissions due to higher efficacy of heat production.

2) Another technology to be applied within the project boundary allows saving fuel and curbing GHG emissions is a well known cogeneration technology. 6 CHP units (See Appendix 4) with total installed capacity 3 MWe will be installed for electricity and heat production. Electricity shall be used for own needs reducing electricity consumption from the grid, while heat will be used for hot-water supply.

3) Installation of frequency controllers at smoke exhauster and hot water pumps engines will result in energy saving. Power consumption of boiler houses will be decreased at least by 10-20% from total annual boiler house power consumption. Correspondingly, the project emissions will be lower than baseline emissions.

4) And the last technology to be applied within the project boundary is a fuel switch form natural gas to an alternative energy source – landfill gas for the purpose of hot-water supply. Landfill gas extraction and its utilization for the purpose of heating will save natural gas, prevent methane emissions from MSW decomposition, and improve the environment.

The project boundary was selected taking into account the scope of realistic project activities and effects of applied technologies on the GHG emission sources and GHG emission reductions. Within the project boundaries the project technologies will reduce emissions from boiler houses, from the grid due to CHP technology application and frequency controllers installation, and emissions from the MSW landfill.

Those emissions that are not under control of a project operator were considered the same as in the business-as-usual scenario: fuel extraction and transportation and emissions from power plants.

Direct and Indirect Emissions

Direct on-site emissions: CO_2 from natural gas combustion in boilers (in some cases fuel oil are used as a fuel), NO_x and CO emission from combustion in the existing boilers/ burners, CO_2 emissions from fuel combustion in gas engines on the new CHP units, additional CO_2 emissions from fuel combustion in boilers on the boiler houses due to the too large heat losses in the distribution networks.
Emissions of CH_4 from MSW landfill.

Direct off-site emissions: CO_2 emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units and which consumed by boiler houses and central heating points where frequency controllers will be installed.
CO_2 emissions from power plant(s) due to power production to the grid, used for heating of Crimea customers. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of power heaters is quite typical and widespread.
CO_2 emissions from power plant(s) due to power production to the grid, that consumed by heat networks. It is not efficient due to water leakages, and extended networks' distance.

Indirect on-site emissions: none.

Indirect off-site emissions: CO_2 emissions from fuel extraction and transportation.

On-site emissions			
Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from fuel combustion in boilers	Reduced CO_2 emissions from fuel combustion in boilers due to increased efficiency and fuel saving. Additional CO_2 emissions on the boiler houses where the new CHP units will be installed due to additional fuel consumption for CHP	Direct	Include
NO_x and CO emission from combustion in existing boilers/ burners	Reduced NO_x and CO emissions from fuel combustion after boiler / burners' replacement	Direct	Exclude. NO_x and CO are not GHGs.
CO_2 emissions from fuel combustion in boilers on the boiler houses due to the too large heat losses in the networks	Reduced CO_2 emissions from boiler houses due to decreasing of heat losses in the network's pipes	Direct	Include
Emissions of CH_4 from MSW landfill	Reduced emissions of CH_4 from MSW landfill	Direct	Include
Off-site emissions			
Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units	Reduced CO_2 emissions from power plant(s)	Direct	Include
CO_2 emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed.	Reduced CO_2 emissions from power plant(s)	Direct	Include
CO_2 emissions from power plant(s) due to power production to the grid, used for heating of Crimean customers. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of power heaters is quite typical and widespread.	Reduced CO_2 emissions from power plant(s) due to reduction of power consumption for heating of Crimean customers. This will take place after project implementation when heat supply service will become more efficient. Exploitation of power heaters will decrease substantially.	Direct	Exclude, not under control of project developer
CO_2 emissions from power station(s) due to power production to the grid, that	Reduced CO_2 emissions from power station(s) due to reduction of power	Direct	Exclude, not under control of project developer

consumed by heat networks. It is not efficient due to water leakages, and extended networks' distance.	consumption of rehabilitated heat networks. This will take place due to water leakage decreasing, replacing 4-pipe lines by 2-pipe lines, and reduction of the total network length.		
CO_2 emissions from fuel extraction and transportation.	Reduced CO_2 emissions from fuel extraction and transportation.	Indirect	Exclude, not under control of project developer

Table 6. Project boundaries and sources of emissions

B.4.   Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

Date of baseline setting: 30/04/2004.

The baseline is determined by the Institute of Engineering Ecology (IEE), project developer and project partner, in collaboration with European Institute for safety, security, insurance and environmental techniques (SVT e.V.), project consultant, and LE "Krymteplocomunenergo", project supplier.

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SECTION C. Duration of the <u>project</u> / <u>crediting period</u>

C.1. <u>Starting date of the project</u>:

The starting date of the project is: 01/01/2004

C.2. Expected <u>operational lifetime of the project</u>:

Minimum **-** 20 years (the nominal lifetime of the new boiler and network equipment). The real average lifetime of the new boiler and network equipment is estimated to be up to 30 – 40 years. Thus the expected operational lifetime of the project may be about 30 years. According to conservatism principle for further calculations we assume lifetime and corresponding crediting period for the project equal to 20 years (2005-2024).

C.3. Length of the <u>crediting period</u>:

Earning of the ERUs corresponds to the first commitment period of 5 years (January 1, 2008 – December 31, 2012).

The starting date of the crediting period is set to the date where the first emission reduction units are expected to be generated from the project that is January 1, 2005. The end of the crediting period is the end of the lifetime of the main equipment that is minimal December 31, 2024. Thus the length of the crediting period is 20 years (240 months).

If the post first commitment period under the Kyoto Protocol will be applicable, the crediting period may be expanded up to the end of the expected operational lifetime of the project (20 years 2005-2024).

SECTION D. Monitoring plan

D.1.   Description of monitoring plan chosen:

D.1.1.   Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

Indicator of project performance

The most objective and cumulative factor that will give a clear picture of whether emission reductions really took place – is *fuel saving*. It can be identified as a difference between baseline fuel consumption and fuel consumption after project implementation. If boilers consume fuel at the projected level, than all other relevant indicators such as efficiencies of new boilers and burners, specific gas consumption of CHP units, as well as heat losses in pre-insulated pipes are adequate.

Monitoring methodology for the landfill gas extraction is taken in accordance with approved consolidated baseline methodology ACM0001 "Consolidated baseline methodology for the projects activity from landfill gas" and based on the direct calculation of the collected and utilized landfill gas. Monitoring plan foresees permanent measures of landfill gas quantity and composition (methane content) which would be combusted.

Verification of project performance indicators

LE "Krymteplocomunenergo" collects data on fuel bought for heating in form of fuel bills. Information on saved fuel will be attached to verification reports on a yearly basis (before April 1st for all years of project implementation) with all relevant documentation and historical information on fuel purchasing transactions made by Supplier.

Verification of Emission Reduction Units and Baseline Scenario

For any project year, the baseline scenario may be different due to the influence of external factors such as weather conditions, possible changes of the lower heating value of fuel(s), number of customers, heating area, etc. The Baseline and the amount of ERUs for each project year should be corrected with taking into account these and some other factors.

The following methodology is proposed to be used.

Amount of the Emission Reduction Units (ERUs), t CO_2e:

$$ERUs = \sum[E_i^b - E_i^r]$$

The sum is taken over all boiler-houses which are included into the project.

$E_i^b = E_{1i}^b + E_{gen\,i}^b + E_{cons\,i}^b$,

$E_i^r = E_{1i}^r - E_{gen\,i}^r - E_{cons\,i}^r$,

where:

E_{1i}^b and E_{1i}^r – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the base year and reported year, t CO_2e;

$E_{gen\,i}^b$ and $E_{gen\,i}^r$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year (greed, amount to be substituted in the reported year) and reported year, t CO_2e;

$E_{cons\,i}^b$ and $E_{cons\,i}^r$ – CO_2 emissions due to electric power consumption for an i boiler-house in the base year and reported year, t CO_2e.

$E_1^b = LHV_b * Cef_b * [B_b * a_b * K_1 * K_2 * K_3 * K_4 * K_5 + B_b * (1-a_b) * K_1 * K_6 * K_7 + B_b * (1-a_r) * K_1 * K_8]$

$E_1^r = LHV_r * Cef_r * B_r$

$E_{gen}^b = W_{gb} * CEF_g + Q_{gb} * f_b / 1000 * LHV_r * Cef$

$E_{gen}^r = (W_{gb} - W_{gr}) * CEF_g + [(Q_{gb} - Q_{gr}) * f_b / 1000 + B_g] * LHV_r * Cef$

$E_{cons}^b = P_b * CEF_c$

$E_{cons}^r = P_r * CEF_c$

If any boiler-house consumes more than one type of fuel, the calculations of E are to be made for each type of fuel separately, and results are to be summed.

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, KtCO_2/TJ;

B – amount of fuel consumed by a boiler-house, ths m^3 or tons;

$K_1, K_2, K_3, K_4, K_5, K_6, K_7, K_8$ – adjustment factors;

a – portion of fuel (heat), consumed for heating purposes;

(1-a) – portion of fuel (heat), consumed for hot water supply services;

W_{gb} – scheduled electric power production by the all new CHP units, MWh;

W_{gr} – electric power production by the installed new CHP units in reported year, MWh;

CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;

P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented, MWh;

P_r – electric power consumption by the boiler-houses with energy saving measures implemented, MWh;

CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Q_{gb} – scheduled heat energy production by the all new CHP units, MWh;

Q_{gr} – heat energy production by the installed new CHP units, MWh;

f_b – specific natural gas consumption by the boiler-house, where CHP units are scheduled to be installed, m^3/MW;

B_g – amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;

$[_b]$ index – related to the base year;

$[_r]$ index – related to the reporting year.

$$a_b = L_h^b*q*N^b/ (L_h^b*q*N^b + L_w^b*N_w^b);$$
$$a_r = L_h^r*q*N^r/ (L_h^r*q*N^r + L_w^r*N_w^r)$$

where:

L_h, L_w – maximum connected load required for heating and for hot water supply service, MW;

q – recalculating factor for average load during heating period (usually 0,5-0,8);

N, N_w – duration of heating period and period of hot water supply service, hours.

Adjustment factors

1. K_1 (change in the lower heating value):

$$K_1 = LHV_b/LHV_r$$

2. K (averaged adjustment factor for heating):

Heat losses from the buildings are:

$$Q = F*k*(T_{in} - T_{out})*N,$$
where:

Q – required amount of heat, kWh

k – average heat transfer factor of buildings, (kW/m^2*K);

F – heated area, m^2;

T_{in} – average inside temperature for the heating period, K;

T_{out} – average outside temperature for the heating period, K;
N – duration of the heating period, hours.

$Q_{db} = Q_b*K = Q_r$
where:
Q_{db} – required heat for Dynamic Baseline, is assumed equal to Q_r – required heat in reported year,
Q_b – required heat in base year,
K – averaged adjustment factor for heating,
$K = Q_r/Q_b.$

$K=(F_b*k_b+(F_r - F_b)*k_{r(b)})*(T_{in\,r} - T_{out\,r})*N_r / F_b*k_b*(T_{in\,b} - T_{out\,b})*N_b$
If $F_r > F_b,\, k_{r(b)}=k_r$; if $F_r < F_b,\, k_{r(b)}=k_b$
If the heating area is increased, we will add it with the new heat transfer factor - k_r, if heating area is decreased, we will subtract it with the old heat transfer factor - $k_b.$

Detailed components of K:
$K = K_2* K_3* K_4* K_5$

3. K_2 (temperature change factor):
$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b})$

4. K_3 (heating area change factor):

$K_3=(F_b*k_b+(F_r - F_b)*k_{r(b)}) / F_b*k_b = 1+(F_r - F_b)* k_{r(b)}/ F_b*k_b$
where:
F_b, F_r – heated area in base year and reported year, m^2;
k_b – average heat transfer factor of heated buildings in base year, (kW/m^2*K);
k_r – average heat transfer factor of connected buildings in the reported year, (kW/m^2*K).

5. K_4 (building thermal insulation improvement factor):

$K_4 =((F_b - F_i)*k_b + F_i*k_i)/F_b*k_b = 1 + F_i*(k_i - k_b)/(F_b*k_b)$
where:

F_b and F_i – heating area in base year and heating area of buildings with the new (changed) thermal insulation, m^2;
k_b – average heat transfer factor of heated buildings in base year, (kW/m^2*K);
k_i – heat transfer factor of heated buildings with the new thermal insulation, (kW/m^2*K).
If there is no buildings with improved thermal insulation in reporting year (F_i=0),
K_4=1.

6. K_5 (heating period duration change factor):

$K_5 = N_r/N_b$

7. K_6 (number of customers change factor):

$K_6 = n_r / n_b$
If there was no hot water supply service customers in base year (n_b=0),
K_6=0

8. K_7 (hot water supply period duration change factor):

$K_7 = N_w^r / N_w^b$
If there was no hot water supply service in base year ($N_w^b = 0$),
K_7=0

9. K_8 (hot water supply service quality improvement factor):

If there was no hot water supply service in the base year ($N_w^b = 0$), and it appeared in the reporting year:
$K_8 = N_w^r / 8400$

If hot water supply service was provided in the base year ($N_w^b > 0$):
$K_8 = 0$
In this case, the change in hot water supply service quality is considered by K_7.

The table of parameters included in the process of monitoring and verification for ERUs calculation, is represented in the Section **D.1.1.1** and **D.1.1.3.** Every year the table with foregoing factors will be updated with account for possible change of these factors, and the dynamic baseline will be developed as well as the amount of ERUs will be calculated**.**

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel consumption at boiler houses: (**B$_r$**)	Every Boiler house		m	Every two hours	100%	Registered in the journal (electronic and/or paper)	Fuel consumption at boiler houses is the main data which allows to calculate GHG emissions in the reported year
1.1	Natural Gas		1000 m^3					
1.2	Heavy oil		ton					
1.3	Landfill gas		1000 m^3					
2	Average annual Heating Value of a fuel calculated by Lower Heating Value (**LHV$_r$**)	Fuel Supplier's Report or Chem. Lab Analysis Report, Every town		m, c	Once per month	100%	Registered in the journal (electronic and/or paper)	
2.1	Natural Gas		MJ/m^3					
2.2	Heavy oil		MJ/t					
2.3	Landfill gas		MJ/m^3					
3	Power consumption (**P$_r$**)	Boiler houses and central heating points,	MW*hour	m	Every month	100%	Registered in the journal (electronic	

		where frequency controllers will be installed					and/or paper)	
4	Power production (W_{gr})	New CHP units	MW*hour	m	Every day	100%	Registered in the journal (electronic and/or paper)	
5	Heat energy production (Q_{gr})	New CHP units	MW*hour	m	Every day	100%	Registered in the journal (electronic and/or paper)	
6	Fuel consumption at the CHP units: (B_g)	Every CHP units	1000 m^3	m	Every two hours	100%	Registered in the journal (electronic and/or paper)	
7	Average methane fraction of the landfill gas (w_{CH4})	Landfill	m³ CH4 / m³ LFG	m, c	Every year	100%	Registered in the journal (electronic and/or paper)	

According to valid legislation, all measuring equipment in Ukraine should meet the specified requirements of corresponding standards and is subject to the periodical verifying (usually once per year).

For example, the gas flow meters of the SG type should meet the requirements of the standard TU 4213-001-07513518-02, in particular the measurement error should be not more than ± 2% in the flow range from Qmin to 0,2Qmax; ± 1% - in the range from 0,2Qmax to Qmax.

In case of failure of measurement equipment, it should be replaced or repaired as soon as possible. Such cases should be noted in monitoring reports.

D.1.1.2. Description of formulae used to estimate <u>project</u> emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

$E^r = \sum[E_{1i}{}^r - E_{gen\ i}{}^r - E_{cons\ i}{}^r] + PE_y$,

where:

E^r – CO_2 emissions in the reported year, t CO_2e.

$E_{1i}{}^r$ – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, t CO_2e;

$E_{gen\ i}{}^r$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the reported year, t CO_2e;

$E_{cons\ i}{}^r$ – CO_2 emissions due to electric power consumption for an i boiler-house in the reported year, t CO_2e.

PE_y – Project emissions in year y on the landfill , tCO_2/yr – see below and methodology ACM0001.

The sum is taken over all boiler-houses which are included into the project.

$E_1{}^r = LHV_r * Cef_r * B_r$

$E_{gen}{}^r = (W_{gb} - W_{gr}) * CEF_g + [(Q_{gb} - Q_{gr}) * f_b / 1000 + B_g] * LHV_r * Cef$

$E_{cons}{}^r = P_r * CEF_c$

LHV – lower heating value, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, $KtCO_2$/TJ;

B – amount of fuel consumed by a boiler-house, ths m^3 or tons;

W_{gb} – scheduled electric power production by the all new CHP units, MWh;

W_{gr} – electric power production by the installed new CHP units in reported year, MWh;

CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;

P_r – electric power consumption by the boiler-houses with energy saving measures implemented, MWh;

CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Q_{gb} – scheduled heat energy production by the all new CHP units, MWh;

Q_{gr} – heat energy production by the installed new CHP units, MWh;

f_b – specific natural gas consumption by the boiler-house, where CHP units are scheduled to be installed, m^3/MW;

B_g – amount of fuel (gas) consumed by the installed CHP units for generation, ths m³;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

The emissions PE_y, which will occur during the year y due to utilizing the landfill gas with thermal energy production at the boiler house Glinky 66 are taken in to consideration in calculations of E_1^r. Therefore $PE_y=0$

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel consumption at boiler houses(B_b)	Every Boiler-house		m	Every two hours	100%	Registered in the journal (electronic and/or paper)	Fuel consumption at boiler houses is the main data which allows to calculate GHG emissions in the base year
1.1	Natural Gas		1000 m³					
1.2	Heavy oil		ton					

2	Average annual Heating Value of a fuel calculated by Lower Heating Value (LHV_b)	Fuel Supplier's Report or Chem. Lab Analysis Report, Every town		m, c	Once per month	100%	Registered in the journal (electronic and/or paper)	Data which allows to calculate GHG emissions in the base year
2.1	Natural Gas,		MJ/m3					
2.2	Heavy oil		MJ/kg					
3	Daily outside temperature during the heating season ($T_{out\ r}$) and ($T_{out\ b}$)	Meteorological Service	^{0}C (K)	m, c	Every day	100%	Meteorological Service Report (electronic file)	Auxiliary data which allows correcting the dynamic baseline
4	Average inside temperature during the heating season ($T_{in\ r}$) and ($T_{in\ b}$)	3 Typical Buildings for all boiler houses	^{0}C (K)	m, c	Once per week	100%	Paper and electronic	Auxiliary data which allows correcting the dynamic baseline
5	Number of Customers (n_b and n_r)	LE "Krymteplocomunenergo"		Statistics	Once per Quarter	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline

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6	Heating area (F_b and F_r)	LE "Krymteplocomunenergo"	m^2	Statistics	Once per Quarter	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline
7	Heat transfer factor of buildings (k_b and k_r)	LE "Krymteplocomunenergo"	$kJ/m^2{*}K$	c	Once per Quarter			Auxiliary data which allows correcting the dynamic baseline
8	Heating area of buildings with heat insulation improvement (F_i)	LE "Krymteplocomunenergo"	m^2	Statistics	Once per Quarter	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline
9	Heat transfer factor of buildings with new thermal insulation (k_i)	LE "Krymteplocomunenergo"	$kJ/m^2{*}K$	Statistics	Once per Quarter	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline
10	Heating period duration (N_r and N_b)	LE "Krymteplocomunenergo"	Hours	Statistics	Once per year	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline

11	Duration of period of hot water supply service (N_w)	LE "Krymteplocomunenergo"	Hours	Statistics	Once per year	100%	Special Reports (electronic files)	Auxiliary data which allows correcting the dynamic baseline
12	Scheduled electric power production (W_{gb})		MW	c				Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario
13	Scheduled heat energy production (Q_{gb})		MW	c				Data which allows to calculate GHG emissions in the baseline scenario

14	Power consumption (P_b)	Boiler houses and central heating points, where frequency controllers will be installed	MW*hour	m	Every month	100%	Data journal, (electronic file)	Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario
15	LFG temperature ($T_{lf,1}$)	Landfill	°C	(m)	Continuous	100%	Electronic	Necessary indicator for the methane density assessment
16	LFG pressure (p_1)	Landfill	Pascal	(m)	Continuous	100%	Electronic	Necessary indicator for methane density assessment

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D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO$_2$ equivalent):

$$E_b = \sum \left[E_{1i}^{\ b} + E_{gen\ i}^{\ b} + E_{cons\ i}^{\ b} \right] + BE_y$$

where:
E_b – baseline emissions, t CO_2
$E_{1i}^{\ b}$ – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the base year, t CO_2e;

$E_{gen\ i}^{b}$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year, t CO_2e;

$E_{cons\ i}^{b}$ – CO_2 emissions due to electric power consumption for an i boiler-house in the base year, t CO_2e.

BE_y – Baseline emissions in year y on the landfill, (tCO_2e) – see below and methodology ACM0001

The sum is taken over all boiler-houses which are included into the project.

$$E_1^b = LHV_b * Cef_b * [B_b * a_b * K_1 * K_2 * K_3 * K_4 * K_5 + B_b * (1-a_b) * K_1 * K_6 * K_7 + B_b * (1-a_r) * K_1 * K_8]$$

$$E_{gen}^b = W_b * CEF_g + Q_b * f_b / 1000 * LHV_r * Cef$$
$$E_{cons}^b = P_b * CEF_c$$

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, $KtCO_2/TJ$;

B – amount of fuel consumed by a boiler-house, ths m^3 or tons;

$K_1, K_2, K_3, K_4, K_5, K_6, K_7, K_8$ – adjustment factors;

a – portion of fuel (heat), consumed for heating purposes;

(1-a) – portion of fuel (heat), consumed for hot water supply services;

W_b – scheduled electric power production by the all new CHP units, MWh;

CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;

P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented, MWh;

CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Q_b – scheduled heat energy production by the all new CHP units, MWh;

f_b – specific natural gas consumption by the boiler-house, where CHP units are scheduled to be installed, m^3/MW;

[$_b$] index – related to the base year;

[$_r$] index – related to the reporting year.

$$a_b = L_h^b * q * N^b / (L_h^b * q * N^b + L_w^b * N_w^b);$$
$$a_r = L_h^r * q * N^r / (L_h^r * q * N^r + L_w^r * N_w^r)$$

where:

L_h, L_w – maximum connected load required for heating and for hot water supply service, MW;

q – recalculating factor for average load during heating period (usually 0,5-0,8);

N, N_w – duration of heating period and period of hot water supply service, hours.

Adjustment factors

1. K_1 (change in the lower heating value):

$K_1 = LHV_b / LHV_r$

2. K_2 (temperature change factor):
$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$

3. K_3 (heating area change factor):

$K_3 = (F_b * k_b + (F_r - F_b) * k_{r(b)}) / F_b * k_b = 1 + (F_r - F_b) * k_{r(b)} / F_b * k_b$
where:
F_b, F_r – heated area in base year and reported year, m^2;
k_b – average heat transfer factor of heated buildings in base year, (kW/m^2*K);
k_r – average heat transfer factor of connected buildings in the reported year, (kW/m^2*K).

4. K_4 (building thermal insulation improvement factor):

$K_4 = ((F_b - F_i) * k_b + F_i * k_i) / F_b * k_b = 1 + F_i * (k_i - k_b) / (F_b * k_b)$
where:
F_b and F_i – heating area in base year and heating area of buildings with the new (changed) thermal insulation, m^2;
k_b – average heat transfer factor of heated buildings in base year, (kW/m^2*K);
k_i – heat transfer factor of heated buildings with the new thermal insulation, (kW/m^2*K).
If there is no buildings with improved thermal insulation in reporting year ($F_i = 0$),
$K_4 = 1$.

5. K_5 (heating period duration change factor):

$K_5 = N_r / N_b$

6. K_6 (number of customers change factor):

$K_6 = n_r / n_b$
If there was no hot water supply service customers in base year ($n_b = 0$),
$K_6 = 0$

7. K_7 (hot water supply period duration change factor):

$K_7 = N_w^r / N_w^b$
If there was no hot water supply service in base year ($N_w^b = 0$),
$K_7 = 0$

8. K_8 (hot water supply service quality improvement factor):

If there was no hot water supply service in the base year ($N_w^b = 0$), and it appeared in the reporting year:
$K_8 = N_w^r / 8400$

If hot water supply service was provided in the base year ($N_w^b > 0$):
$K_8 = 0$
In this case, the change in hot water supply service quality is considered by K_7.

$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$

Where:
BE_y – Baseline emissions in year y (tCO2e)
$MD_{project,y}$ – The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4) in project scenario
$MD_{BL,y}$ – The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tones of methane (tCH4)
GWP_{CH4} – Global Warming Potential value for methane for the first commitment period is 21 tCO2e/tCH4

$MD_{BL,y} = MDproject,y * AF$

AF – adjustment factor
The methane combustion would not occur under the project activities absence in accordance with the chosen baseline. According to consolidated baseline methodology ACM0001 in this case "adjustment factor" (*AF*) have to be used and proven. In guiding documents of МГЕ3К the adjustment factor (methane oxidizing in the top layers of the landfill) by the failure to mention is zero. The Executive Committee allows determining adjustment factor as 0.

The emissions ($ET_{LFG,y} * CEF_{ther,BL,y}$ in formulae (1) of ACM 0001) which would occurred in the absence of the project activity due to thermal energy production from onsite/offsite fossil fuel are taken in to consideration in calculations of E_{1i}^{b} – CO_2 emissions due to fuel consumption for heating and hot water supply service for the Glinky 66 boiler-house in the base year

$MD_{project,y} = LFG_{thermal,y} * w_{CH4,y} * D_{CH4}$

Where:
$LFG_{thermal,y}$ – the quantity of landfill gas fed into the boiler, m³
$w_{CH4,y}$ – Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m³ CH4 / m³ LFG)
D_{CH4} – Methane density expressed in tones of methane per cubic meter of methane, tCH4/m3CH4

$D_{CH4} (T_{lf}, p) = D_{CH4} (T_{lf,o}, p_o) \times (p_1 - p_0) / (T_{lf,1} - T_0)$

$D_{CH4} (T_{lf,o}, p_o) = 0.0007168$ t_{CH4}/m^3_{CH4} (methane density in normal conditions $T_{lf,o} = 273.15$Кб $p_0 = 101300$ pascal)

D. 1.2. Option 2 – Direct <u>monitoring</u> of emission reductions from the <u>project</u> (values should be consistent with those in section E.):

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
D.1.2.1. Data to be collected in order to monitor emission reductions from the <u>project</u>, and how these data will be archived:								

There are no data to be collected in order to monitor emission reductions from the project, because emission reductions will be calculate by means of formulae presented in paragraph **D.1.2.2.**

D.1.2.2. Description of formulae used to calculate emission reductions from the <u>project</u> (for each gas, source etc.; emissions/emission reductions in units of CO$_2$ equivalent):

Amount of the Emission Reduction Units (ERUs), t CO$_2$e:
$$ERUs = \sum[E_i^b - E_i^r]$$

The sum is taken over all boiler-houses which are included into the project.
$$E_i^b = E_{1i}^b + E_{gen\,i}^b + E_{cons\,i}^b,$$
$$E_i^r = E_{1i}^r - E_{gen\,i}^r - E_{cons\,i}^r,$$

where:

E_{1i}^{b} and E_{1i}^{r} – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the base year and reported year, t CO_2e;
$E_{gen\,i}^{b}$ and $E_{gen\,i}^{r}$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year (greed, amount to be substituted in the reported year) and reported year, t CO_2e;
$E_{cons\,i}^{b}$ and $E_{cons\,i}^{r}$ – CO_2 emissions due to electric power consumption for an i boiler-house in the base year and reported year, t CO_2e.

D.1.3.	**Treatment of leakage in the monitoring plan:**

No leakage is expected. Dynamic baseline (based on collected monitoring data) will exclude all possible leakages.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Any occasional leakage emissions (for example, caused by pipes' leakages, etc.) should be eliminated as soon as possible.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

No leakages are expected.

> **D.1.4.   Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO$_2$ equivalent):**

GHG emission reductions from the project are estimated by means of the following formulae:

$ERUs = E_b - E_r$.

where:
ERUs – emission reduction units, t CO$_2$e;
E_r – project emissions, t CO$_2$e
E_b – baseline emissions, t CO$_2$e

Baseline emissions
Baseline emissions consist of four types of GHG emissions:

1)   CO$_2$ emissions from boilers operated by LE "Krymteplocomunenergo" DH systems. Baseline calculations were based on the assumption that baseline emissions during any report year (2008-2012) remain the same as in the basis year 2003.
2)   CO$_2$ emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units.
3)   CO$_2$ emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed.
4)   CH$_4$ emissions from Simferopol landfill.

$E_b = E_{heat} + E_{chp}\ E_{el} + E_{CH4}$

Where:
E_b – emissions from boilers operated by the Applicant, t CO$_2$e;
E_{chp} – emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units, t CO$_2$e;
E_{el} – emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed, t CO$_2$e;
E_{CH4} – emissions from Simferopol landfill, t CO$_2$e.

1) Emissions from heat generating sources operated by an Applicant:

$E_{heat} = \sum (B_{b(i)} * LHV_{b(i)} * Cef_i)$,

where:

$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), 1000 m^3 (t);
$LHV_{b(i)}$ – Lower Heating Value for each fuel, MJ/m^3 (MJ/kg);
Cef_i – Carbon Emission Factors for each fuel, Kt CO_2/TJ.

2) Baseline emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units:

$E_{chp} = W * CEF_g$,

where:

W – annual power production of CHP units which will be installed by the Applicant, MWh;
CEF_g – Carbon Emission factors for electricity generation in Ukraine, tCO_2e/MWh, see **Table 4**.

The heat that will be generated on these CHP units will be used for hot water supply service.

3) Baseline emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed:

$E_{el} = P_b * CEF_c$,

where:

P_b – Baseline power consumption at the boiler houses and central heating points, where frequency controllers will be installed, MW*hour;
CEF_c – Carbon Emission factor for reducing electricity consumption in Ukraine, tCO_2e/MWh, see **Table 5.**

4) CH_4 emissions from Simferopol landfill, t CO_2e.
$E_{CH4} = M_b * q * K_G$,
where:
M_b – Baseline emissions of methane, 1000 m^3;
q – Methane's density = 0.7168 kg/m^3 (from ACM001);
K_G – Equivalence factor for converting CH4 to CO2 e - GWP (CH_4) = 21(ACM001).
For more detailed information see **Appendix 6**.

Project emissions

Project emissions consist of four types of GHG emissions:

1) CO_2e emissions from boilers operated by LE "Krymteplocomunenergo" DH systems.
2) CO_2e emissions from new CHP units.
3) CO_2 emissions from power plant(s) due to power production to the grid, that consumed by boiler houses where frequency controllers will be installed.

4) Methane emissions from landfill, which technologically can't be collected in the project.

$$E_r = E1 + E2 + E3 + E4$$

where:
E_r – Project emissions in any reported year, t CO_2e;
E1 – CO_2e emissions from boilers operated by LE "Krymteplocomunenergo" DH systems (including emissions from LFG-fired boilers at 66 Glynki Street in Simferopol city), t CO_2e;
E2 – CO_2e emissions from new CHP units, t CO_2e;
E3 – CO_2 emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed.
E4 – Methane emissions from landfill, which technologically can't be collected in the project t CO_2e;

1) Project scenario emissions from boiler-houses and new CHP units are a sum of actual fuel amounts to be used in any report year (starting from 2009) multiplied by corresponding conversion factors (CF). Actual – means with subtracted fuel saving due to improving of the network efficiency:
$$E_1 = \sum ([B_{r(i)} - V_{(i)} - H_{(i)}] * LHV_{r(i)} * Cef_i),$$

where:
E_r – project emissions in any reported year, t CO_2e
$B_{r(i)}$ – fuel consumption in the project scenario by boilers(for each fuel), 1000 m^3 (t);

$V_{(i)}$ –fuel saving due to network rehabilitation for each fuel, 1000 m^3 (t);
$H_{(i)}$ –fuel saving due to heat exchangers replacement, 1000 m^3
$LHV_{r(i)}$ – Lower Heating Value for each fuel, MJ/m^3 (MJ/kg);
$Cef_{i\text{-}}$ – Carbon Emission Factors for each fuel, Kt CO_2/TJ.

$B_{r(i)}$ = $[B_{b(i)}*LHV_{b(i)}*$ (Baseline Boilers Efficiency)$_i$] / $[LHV_{r(i)} *$ (Project Boilers Efficiency)$_i$],

$V_{(i)} = B_{b(i)} - B_{b(i)} *$ (100-L_b)/(100-L_r),

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario by boilers(for each fuel), 1000 m^3 (t);
L_b – heat losses in the network in the baseline scenario, %;
L_r – heat losses in the network in the project scenario, %.
For more detailed information see **Appendix 1 (Boilers), Appendix 2 (Networks)** and **Appendix 3.**

   2) CO_2e emissions from new CHP units:

  E2= $B_{chp} * LHV_{r(i)} *Cef_i$,

   where:
   B_{chp} – gas consumption by CHP units, 1000 m^3;
   $LHV_{r(i)}$ – Lower Heating Value for gas, MJ/m^3;
   $Cef_{i\text{-}}$ – Carbon Emission Factors for gas, Kt CO_2/TJ.

For more detailed information see **Appendix 4.**

3) CO_2 emissions from power plant(s) due to power production to the grid, which consumed by boiler houses and central heating points where frequency controllers will be installed:

  E3= $P_r * CEF_c$,

   where:
P_r– Project power consumption at the boiler houses and central heating points, where frequency controllers will be installed, MW*hour;

CEF_c – Carbon Emission factor for reducing electricity consumption in Ukraine, tCO_2e/MWh, see **Table 5.**
For details see **Appendix 5**.

4) Methane emissions from landfill, which technologically can't be collected in the project.

A half of landfill gas will be utilized, while another half will be emitted to the atmosphere.

$E4 = M_b * q * K_G * 0,5,$

   Where:

M_b – baseline methane emissions, $1000 m^3$;
q – Methane's density = 0.7168 kg/m^3 (from ACM001);
K_G – GWP (CH_4) = 21(ACM001).

For details see **Appendix 6**.

D.1.5. Where applicable, in accordance with procedures as required by the <u>host Party</u>, information on the collection and archiving of information on the environmental impacts of the <u>project</u>:

According to the common Ukrainian practice for such type projects, the environmental impact of the project will be estimated by fuel consumption and combustion.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Quantity of natural gas consumed by boiler houses.	Low for gas.	Measuring instruments must be calibrated according to national regulations
Amount of fuel oil consumed by boiler houses.	Low for fuel oil	
Amount of methane consumed by boiler houses.	Low for methane	
Outside temperature.	Low	Measuring instruments must be calibrated according to national regulations
Inside temperature.	Low	Measuring instruments must be calibrated according to national regulations

Fuel quality (Lower Heating Values).	Low	Measuring instruments must be calibrated according to national regulations
Number of customers (heating area).	Low	Statistic data. No quality assurance is needed.

D.3.   Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

The operational structure will include operation departments (adjustment and alignment, etc.) of Supplier (LE "Krymteplocomunenergo")and boiler house operation personnel.
The management structure will include management departments of Supplier and specialists of project developer (Institute of Engineering Ecology).

D.4.   Name of person(s)/entity(ies) establishing the monitoring plan:

The monitoring plan is determined by the Institute of Engineering Ecology (IEE), project developer and project partner, in collaboration with European Institute for safety, security, insurance and environmental techniques (SVT e.V.), project consultant, and LE "Krymteplocomunenergo", project supplier.

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SECTION E.   Estimation of greenhouse gas emission reductions

E.1.   Estimated <u>project</u> emissions:

Project Carbon Emission Factors are assumed equal to the Baseline Carbon Emission Factors.

Calculation of Project Activity Level

Project's activity level, estimated by fuel consumption, will be reduced comparing to the baseline activity level due to fuel saving.

Filial	Project Natural Gas Consumption, ths Nm^3/yr	Project Heavy Fuel Oil Consumption, t/yr	Project Methane Consumption, ths Nm^3/yr
Simferopol' city	111145	1814	3818
New CHP units	6816		
Alushta filial	12724	14	
Dzhankoj filial	12855	1255	
Evpatoria filial	25950	0	
Kerch filial	27844	738	
Rozdolne filial	4079	0	
Feodosia filial	12172	419	
Yalta filial	20046	284	
Total	233636	4523	3818

Table 6. Project fuel consumption

Detailed information is presented in **Appendix 1 -8.**

Estimation of Direct Project Emissions

	2008	2009	2010	2011	2012
CO_2e emissions from boilers operated by LE "Krymteplocomunenergo" DH systems	544425.0	498846.0	474066.8	469938.0	469938.0
CO_2e emissions from new CHP units.	16680.0	16320.0	13463.5	13463.5	13463.5
CO_2 emissions from power plant(s) due to power production to the grid, that consumed by boiler houses where frequency controllers will be installed	9216.7	7197.0	7020.6	6844.2	6667.8
Methane emissions from landfill, which technologically can't be collected in the project.	108309.1	77067.0	55897.7	56706.0	57474.9
E(project), t CO2e	678630.9	599430.0	550448.6	546951.7	547544.2

Table 7. Project Emissions of CO_2e after project implementation

E.2.	**Estimated leakage:**

We assume that possible leakage is negligible that is less than 1% of the total direct emissions. These indirect emissions are not under control of project developer so we do not include them in calculations.

E.3.	**The sum of E.1. and E.2.:**

Project Emissions + Leakages = **547544.2**+ **0** = **547544.2t CO_2**.

E.4.	**Estimated baseline emissions:**

	2008	2009	2010	2011	2012
CO_2e emissions from boilers operated by LE "Krymteplocomunenergo" DH systems	564501.7	564501.7	564501.7	564501.7	564501.7
CO_2 emissions from power plant(s) due to power production to the grid, which will be replaced after installation of CHP units	16680.0	16320.0	15840.0	15624.0	15264.0
CO_2 emissions from power plant(s) due to power production to the grid, that consumed by boiler houses where frequency controllers will be installed	9216.7	8996.2	8775.7	8555.2	8334.7
Methane emissions from landfill	108309.1	110095.8	111795.3	113411.9	114949.7
E(baseline), t CO2e	698707.5	699913.7	700912.7	702092.9	703050.2

Table 8. Baseline Emissions of CO_2

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if RME LE "Krymteplocomunenergo"DH system, remains unchanged, see in **section B** and **Appendix 8 (Baseline)**.

E.5.	**Difference between E.4. and E.3. representing the emission reductions of the project:**

Project Emission Reduction = Baseline emission-(Project emission +Estimated leakage)

Year	GHG emissions reduction, t CO2						
	Due to boiler houses rehabilitation	Due to network rehabilitation	Due to heat exchangers replacement	Due to CHP installation	Due to frequency controllers installation	Due to landfill gas utilization	Total
2005	4959.7	809.1	70.7				5839.5
2006	7056.9	2211.4	396.1				9664.4
2007	9994.6	2746.9	594.2				13335.7
2008	16002.3	3480.1	594.2				20076.7
2009	51795.7	6914.7	6945.3		1799.2	33028.7	100483.7
2010	64099.3	12324.1	6945.3	9442.7	1755.1	55897.7	150464.2
2011	64099.3	16452.9	6945.3	9226.7	1711.0	56706.0	155141.2
2012	64099.3	16452.9	6945.3	8866.7	1666.9	57474.9	155506.0
Total	**282107.1**	**61392.2**	**29436.3**	**27536.1**	**6932.4**	**203107.2**	**610511.3**

Table 9. Emissions reduction from the project

In course of the project implementation, the different emission reduction will be achieved at the different stages of project implementation. The amounts of emission reduction are represented in the **Table 1**. Paragraph **A.4.3.1.**

E.6.	Table providing values obtained when applying formulae above:

Year	Estimated project emissions (tones of CO_2 equivalent)	Estimated leakage (tones of CO_2 equivalent)	Estimated baseline emissions (tones of CO_2 equivalent)	Estimated emission reduction (tones of CO_2 equivalent)
2005	688680.9	0	694520.4	5839.5
2006	686351.3	0	696015.7	9664.4
2007	684074.1	0	697409.8	13335.7
Subtotal 2005 - 2008	**2059106.4**	**0**	**2087945.9**	**28839.5**
2008	678630.9	0	698707.5	20076.7
2009	599430.0	0	699913.7	100483.7
2010	550448.6	0	700912.7	150464.1
2011	546951.7	0	702092.9	155141.2
2012	547544.2	0	703050.2	155506.0
Subtotal 2008 - 2012	**2923005.4**	**0**	**3504677.1**	**581671.7**
2013	545321.6	0	698024.5	152702.9
2014	542074.7	0	692111.3	150036.6
2015	539538.4	0	687038.6	147500.2
2016	537125.7	0	682213.3	145087.6
2017	534830.8	0	677623.4	142792.6
2018	532647.7	0	673257.3	140609.6
2019	530571.2	0	669104.2	138533.0
2020	528595.9	0	665153.6	136557.7
2021	524929.6	0	657821.0	132891.4
2022	521612.2	0	651186.2	129574.0
2023	518610.5	0	645182.8	126572.3
2024	515894.4	0	639750.7	123856.3
Subtotal 2013 - 2024	**6371752.5**	**0**	**8038466.8**	**1666714.3**
Total	**11332221.1**	**0**	**13631089.8**	**2298868.7**

Table 10. Estimated emission reduction

SECTION F.   Environmental impacts

F.1.   Documentation on the analysis of the environmental impacts of the <u>project</u>, including transboundary impacts, in accordance with procedures as determined by the <u>host Party</u>:

LE "Krymteplocomunenergo" has the necessary Environmental Impact Assessment for its activity according to Ukrainian legislation. The text is available in Russian.

Overall, the project "Rehabilitation of the District Heating System of Crimea" will have a positive effect on environment. Following points will give detailed information on environmental benefits.

1. Project implementation will allow saving over 21 million Nm^3 of natural gas and over 15 thousand ton of fuel oil per year starting from 2010. Natural gas and fuel oil are a non-renewable resources and its economy is important.

2. Project implementation will reduce direct CO_2 emissions from LE "Krymteplocomunenergo" boilers 83 thousand tons per year starting from 2010 due to increased boilers efficiencies, achieved through installation of up-to-date boiler equipment, particularly new boilers, CHP units and installation of pre-insulated networks pipes instead of existing regular networks pipes. Landfill gas extraction technology with future utilization of captured landfill gas will be able to reduce CO_2 emissions by more than 55 thousand tons per year.

3. Due to fuel economy and new environmentally friendlier technologies of fuel combustion, project implementation will reduce emissions of SO_x, NO_x, CO and particulate matter (co-products of combustion).

4. It is expected that due to a better DH service Crimean population will reduce electricity consumption from electric heaters thus reducing power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

F.2.   If environmental impacts are considered significant by the <u>project participants</u> or the <u>host Party</u>, please provide conclusions and all references to supporting documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the <u>host Party</u>:

Impact on the water medium

Impact on the water medium is present. Impact on water resources is will be the same as in baseline scenario. The existing technology of heat energy production exploited at the objects of LE "Krymteplocomunenergo"foresees discharging of waste water to the sewage network with obligatory chemical control in accordance to Water Code of Ukraine, GOST 28.74-82 "Hygienic regulations and quality control", SNiP 4630-92 on determining maximum concentration limits for internal water bodies. Discharge of wastewater to the open water bodies will not take place.

Project implementation will have positive environmental effect. It will allow to decrease the water consumption and as a result – to decrease the amount of waste water.

Effects on the ambient air

The project implementation will have positive effect on ambient air:
- Reduction of NO_x, SO_x, CO and PM due to application of cleaner technologies at boiler houses;
- Reduction of electricity consumption results in lower emissions of the same air pollutants;
- Heat stress on the atmosphere (due to lower temperatures of flue gases);
- Lower emissions per unit of fuel at the same load on boiler house.

Effects on land use

Impact on the land medium is not present.

Relevant regulation is the sphere of land use is presented by the Land Code of Ukraine. National technological practice / standard: GOST 17.4.1.02.-83 "Protection of Nature, Soils. Classification of chemical substances for pollution control".

Effects on biodiversity

Impact on biodiversity is not present.

Waste generation, treatment and disposal

Waste generation, treatment and disposal are present. In the process of project implementation the generation of waste will occur after disassembling of physically and morally obsolete equipment, burners, pipes, etc. Also there will occur some construction waste due to destruction of boiler settling, boiler house foundations, etc.

Possible recycling of the old equipment will by definition have a positive effect on the environment.

Example of the Environmental Impact Assessment for one of the objects included in the Project is given in **Appendix 10 (EIA).**

SECTION G.   Stakeholders' comments

G.1.   Information on stakeholders' comments on the project, as appropriate:

The authorities in Crimea have expressed the strong support for the project.

The project is already approved by local authorities, namely Parliament of Autonomous Republic of Crimea, and Ukrainian government representatives, namely Ministry for Environmental Protection of Ukraine and Ministry of Construction, Architecture, Housing and Municipal Economy of Ukraine.

According to Ukrainian rules, all projects for new building, reconstruction and technical re-equipment of industrial and civil objects that require EIA, also requires information of population about it through the local administration [State Building Norms of Ukraine A.2.2-1-2003, p.1.6].

In line with this, information on each sub-project on rehabilitation of the each object included in the Project was published in a local newspaper. According to information from LE "Krymteplocomunenergo", no local stakeholder comments were received.

In addition, the Project was presented at the XVI (Sevastopol, June 6-10, 2006) and XVII (Yalta, June 5-9, 2007) International Conferences "Problems of Ecology and Exploitation of Energy Objects", where it was comprehensively discussed with representatives of governmental and District heating organisations.

Annex 1

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Annex 2

BASELINE INFORMATION

See Section B for the Baseline information.

Annex 3

MONITORING PLAN

See Section D for the Monitoring plan.