JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

"Rehabilitation of the District Heating System in Luhansk City"

CONTENTS

SECTION A. General description of the project

A.1. Title of the project:

"Rehabilitation of the District Heating System in Luhansk City"

PDD Version: 06, dated December 11, 2009

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 coal consumption, by means of district heating system rehabilitation in Luhansk City, including boiler and distribution network equipment replacement and rehabilitation, installation of combined heat and power production plants and frequency controllers. 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.

Luhansk City Municipal Enterprise (LCME) "Teplocomunenergo"is one of the main enterprises in field of production and distribution of the heat energy in Luhansk City. Its share in district heating system of the city is approximately 92%. It sells heat energy in forms of heat, hot water and steam, to local consumers, namely households, municipal consumers and state-owned organizations. Heat supply market in the region is stable for years.

The project was initiated in 2006 to rehabilitate Luhansk City's district heating system, including boiler and distribution network equipment replacement and rehabilitation, and installation of combined heat and power production plants (CHP) as well as frequency controllers. Project includes 135 boiler-houses with 344 boilers (total connected load 550 Gkal/hour, 2006) and 269 km of heat distributing networks, that are managed by LCME "Teplocomunenergo".
Project provides installation of cogeneration units at the three boiler houses - 11 gas engines, 1064 kW. Gas engines-generators machines "Jenbacher" JGS 320 GS (Austria) are considered as potential candidates for installation.

The project employs the increase in fuel consumption efficiency to reduce greenhouse gas emissions relative to current practice. Over 35.8 million Nm^3 of natural gas and 710 ton of coal will be saved annually starting from 2011. Such reduction of fuel consumption is based on increase of the boiler efficiencies, reduction of heat losses in networks and CHP and frequency controllers installation. The following activities will ensure fuel saving:

- Replacement of old boilers by the new highly efficient boilers;
- Switching of load from boiler-houses with obsolete equipment to modern equipped boiler houses;
- Switching of boiler-houses from coal to natural gas;
- Improving of the network organization;
- Application of the pre-insulated pipes;
- Installation of combined heat and power production units;
- Replacement of heat exchangers;
- Installation of heat pump station;
- Installation of frequency controllers at electric drives of draught-blowing equipment and hot water pumps motors.

Estimated project annual reductions of GHG emissions, in particular CO_2, are 12.2 thousand tons in 2007, from 25.7 thousand tons to 121.8 thousand tons in 2008-2011 and by about 165 thousand tons per year starting from 2012 comparing to business-as-usual or baseline scenario.

Implementation of the project will provide substantial economic, environmental, and social benefits to the Luhansk city. Social impact of the project is positive since after project implementation the heat supply service will be improved.
Environmental impact of the project is expected to be very positive as emission of the exhaust gases such as CO_2, NO_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.

LCME "Teplocomunenergo"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 activity than to make a major overhaul of the heating system. 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 approximately 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)	LCME "Teplocomunenergo"	No
The Netherlands	"E – energy B.V."	No

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

- ***LCME "Teplocomunenergo":*** is a project implementation agency (**Supplier**). 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 (partly on credit base) and receives profits.

Historical details:

Luhansk city municipal enterprise "Teplokommunenergo" was found in compliance with decision of executive committee of Luhansk town council of members of parliament from 24.01. 1996 № 31. It was registered in the executive committee of Luhansk town council of members of parliament in

26.01. 1996, registration number № 99/5393, identification code 24047779. It provides heat supply of habitable and social buildings, institution of social cultural life.

Today there are 128 boiler-houses with the total installed capacity 1337, 08 Gkal/hour, which work for heating and hot water supply of 4 administrative regions of the city.

The enterprise operates 370 boiler installations, which capacity from 50 kW to 116 MW, including boilers DKVR, TVG, KVGM, NIISTU-5, and also modern fire-tube boilers VK-21, VK-32 and heating apparatus, block water heaters.

The total system of heat supply includes 43 HDS and 330,31 km of heat networks.

Boiler enterprises heat more than 5 mln. m2 accommodations of different patterns of ownership, 59 schools, 57 kindergartens and 49 patient care institutions.

Average headcount of staff – 1700 persons.

There are 4 branches at the enterprise which produce heat energy and serve heat networks (main production) and also 13 services of auxiliary process, that engaged in preparation and service of main production and also provide it's normal production activity.

Thought the instrumentality of highly qualified engineering staff the enterprise is ready to make the design efforts of inside and outside engineering networks, water supply and canalization systems and constructions, heating and ventilation, air-conditioning system, gas pipeline and gas equipment, electric power supply, electric equipment and lighting, communications.

Enterprise characteristics:

	01.01.2006
Total amount of the boiler-houses	130
Total amount of boilers	366
Length of the heat supply networks in the 2-pipe calculation, km	326,6
Total enterprise capacity, Gkal per hour	1339,47
Connected heat load, Gkal per hour	819,8
Heating area , 1000*m^2	7203,7
Amount of personal accounts	1083

Table 1. Enterprise characteristics

- ***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 project validation, 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 clean 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, AR Crimea and Kharkiv city already successfully passed the international validation process and received the Letters of Approval from Ukrainian government. Emission reductions achieved by these projects during period before 1 January 2008 and during 2008 are already successfully transferred to purchasers

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 a purchaser of the project. It is a company registered in the Netherlands, is one of subsidiaries belonging 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 project:

A.4.1. Location of the project:

The Project is located in Luhansk City in in the East part of Ukraine (**Fig.1**).

Fig. 1. The map of Ukraine with neighboring countries

A.4.1.1. Host Party(ies):

Ukraine is an Eastern European country that ratified the Kyoto Protocol to UN FCCC on February 4th, 2004, enters into the list of the countries of the Appendix 1 and is eligible for the Joint Implementation projects.

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

Luhansk region is located in the East part of Ukraine. Its territory is 26,7 thousand square km. Donetsk and Kharkiv regions. In the North and East of Luhansk region the national boundary with Russian Federation is passed. The administrative center of Luhansk region is the city of Luhansk.

The Luhansk region climate is mild-continental. The average temperatures are: +21°C in summer, -7°C in winter, with average annual rainfall of 459-505 mm.

Thus the heating period is usually 189 days. The average outside temperature over the heating period is - 2.1 ^{0}C (by SNIP).

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

Luhansk City

The territory of Luhansk City is 28604 hectare.
The population of the Luhansk City is more than 471.6 thousand inhabitants.

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

The territory is divided into 4 administrative districts*:* Leninskiy, Zhovtneviy, Kaminebrodskiy and Artemivskiy. LCME “Teplocomunenergo”is divided into 4 applicable branches. It should be noted that the district heating systems from all territorial districts of the Luhansk city are involved in the project (**Fig. 2**).

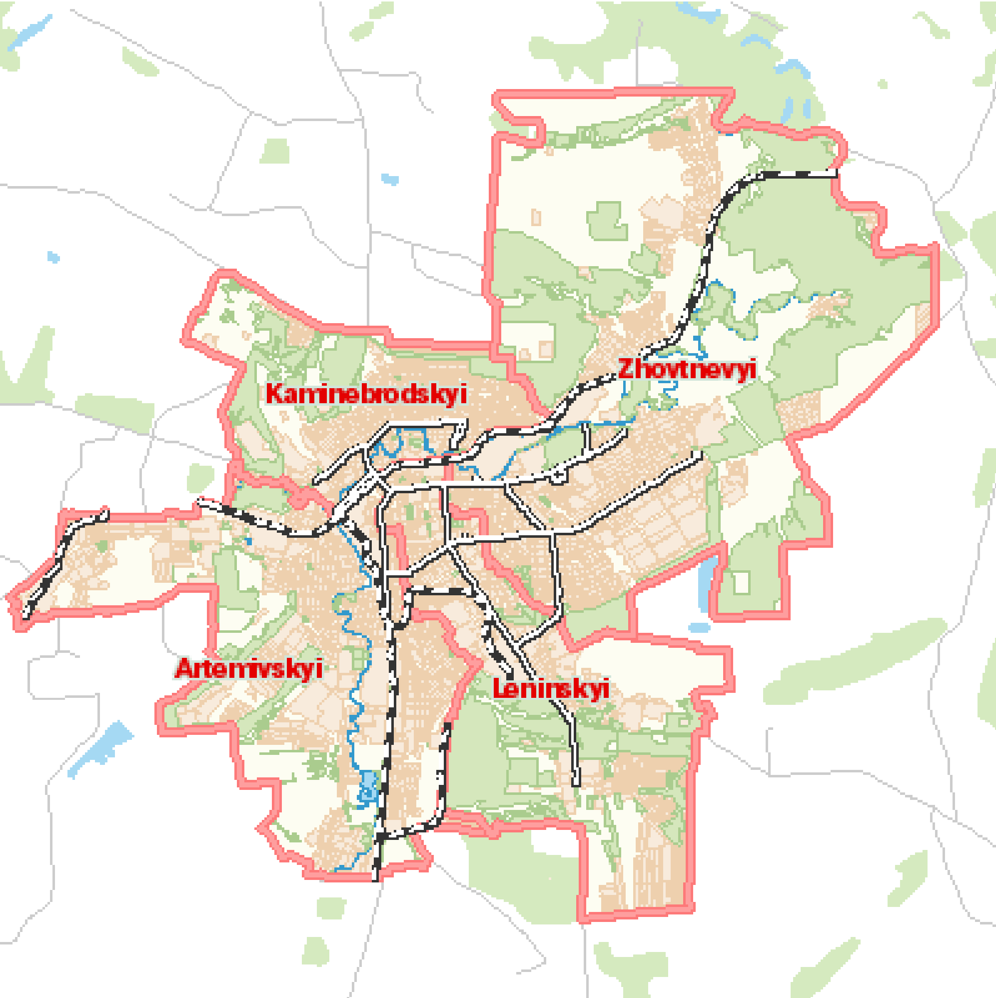

Fig. 2. The map of the Luhansk city with District Heating System scheme.

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.

Measures that will be used to improve the efficiency of LCME "Teplocomunenergo" are as follows:

- Old operating boilers with low efficiency will be replaced by the new highly efficient ones that will result in efficiency increase from 70-82% up to 90-93%. Technical characteristic of new boilers scheduled to be installed are presented at the producer's websites that are listed in table below.

Type of boiler	**Website of boiler producer**
KSVa	www.tekom.com.ua/kotel/vk.html
Protherm	www.protherm.com.ua/?a=catalog&item=73&catalog_id=9
Steam generator	http://www.certuss.de/index.php?id=19&L=1
KOLVI	www.kolvi.com/index.php?option=com_content&task=blogcategory&id=11&Itemid=105
MH120 EKO "Bernard"	http://www.ukrinterm.com.ua/goods/price.html
Vitomax 200 LW	www.viessmann.ua
IVAR Superac 290 2F	http://www.ivar.it/
BMK	http://www.ktlm.com.ua/mod.php
KBG-7,56	www.tekom.com.ua/kotel/vk.html
AOGV	www.majak.com.ua/products/majak12ks.html

Table 2.Boilers producer's web sites

Fig. 3. Boiler VK-21 with efficiency 92%.

- Boilers rehabilitation with burners and automatic equipment replacement
- Switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment.
- Contact and surface heat-recovery gas-cleaning apparatuses (utilizers), including developed by the Institute of Engineering Ecology, will be installed in order to utilize and recover the exhaust gases heat as well as the additional heat of steam condensation, occurring when the temperature of exhaust gases fall below dew point. The implementation of this technology will result in increasing the fuel consumption efficiency by 6-8%.
- Obsolete coal-fired boilers will be mostly replaced by the new electric boilers.
- The reconstruction of heat distribution networks system will help to reduce heat losses down to 1-2 % per km by replacing of the main and distribution networks pipes with diameter 57 mm -820 mm by the pre-insulated ones. LCME "Teplocomunenergo" uses pipes previously heat and hydro insulated with foamed polyurethane produced by JSC "Transprogress" (http://www.transprogress.com.ua/products.htm).

Fig.4. Pipes produced by JSC "Transprogress".

- Improvement of the heat networks system organization will be provided by liquidation of heating scheme with open heat-carrying agent pumping for hot water supply service and with simultaneous installation of heat exchangers directly at the consumers houses (Individual Heating

Point – IHP). It is necessary to install 630 lamellar heat exchangers. Due to this reconstruction, it will enable to liquidate pipes with different diameters, to reduce heat losses and to reduce power consumption for power supply of circulation pumps. Technical characteristic of new heat exchangers (see fig. 5) are presented on the producer's website http://teploenergo.com.ua.

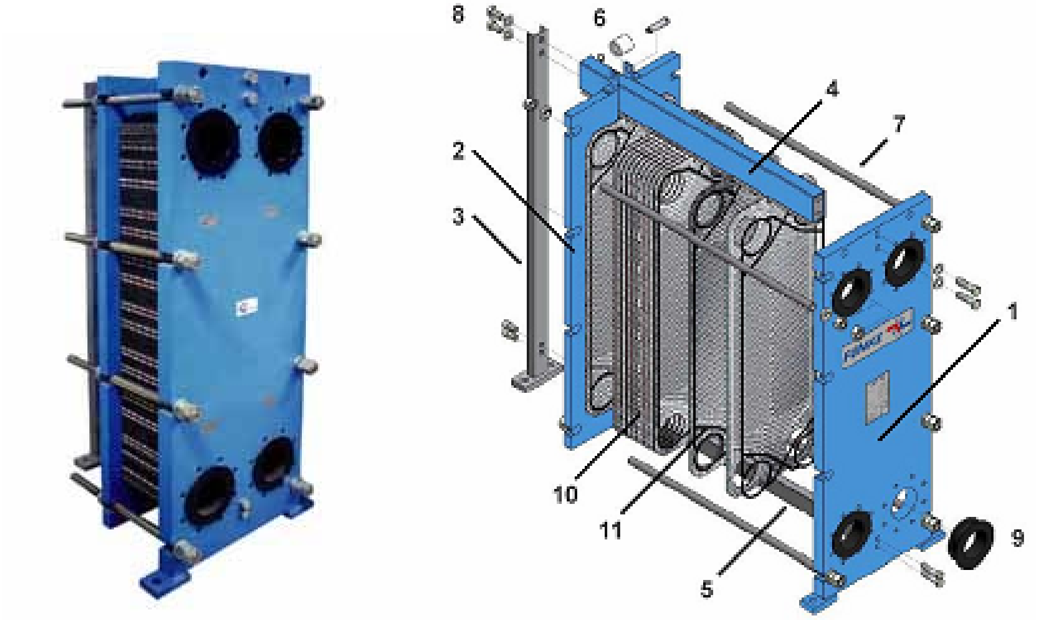

Fig.5.Heat exchangers produced by "Ukrteploenergo" corporation.

- Installation of cogeneration units will result in increasing the fuel consumption efficiency, decreasing of dependence on the grid power supply, improvement of operational stability and reliability, decreasing of power consumption from power stations, decreasing of power transfer losses, and decreasing of environmental pollution.

Fig.6. Cogeneration unit produced by "Jenbacher".

Technical characteristic of cogeneration units JGS 320 GS produced by "Jenbacher",Austria, (see fig. 6) are presented on the producer's website www.cogeneration.com.ua .

- Project of modernization of heating system of Zhovtneviy leaving region provides building of the Heat Pump Station (HPS) at the sewage disposal plant, that is situated near the boiler-house “Shidna”. It will realize raw water heating due to utilization of sewage water heat and heat from cogeneration units. Heat Pumps will use power from cogeneration units and produce heat energy with COP 3.5. It will allow to reduce heat energy demand from boilers at the boiler house “Shidna” and to save natural gas at this boiler-house.

Fig.7. Sewage disposal plant were Heat Pump Station is planning to be install.

Heat Pump Station will consist of 6 Heat Pumps and 2 cogeneration units. Total Heat capacity of CHP will bes – 6.2 MW, electric capacity of CHP- 6.7 MW, Heat capacity of Heat pumps will b 18.6 MW.

- Installation of frequency controllers at hot water pumps’ motors will result in energy saving. Those regulators make it possible to change actual capacity of the motors depending on connected load, both as during a day when water consumption is changes, and during a year when in summer motors work only for hot water supply.

Installation of frequency controllers at smoke exhausters’ electric drives will result in considerably energy saving.
Technical characteristic of frequency converters VLT 6000 HVAC are presented on the website of "Danfoss" company: www.danfoss.com.

The measures from this list will be implemented at boiler houses subject to rehabilitation.

The generalised schedule of their implementation will be the following:

- boiler houses rehabilitation – 2006 – 2011;
- network rehabilitation – 2006 – 2011;
- installation of CHP units – 2010 – 2011;
- installation of frequency controllers – since 2010.
- installation of HPS – 2010;
- installation of heat exchangers – 2006-2010.

Achieved results of employing of these technologies and measures are listed in the **Appendixes 1 – 7.**

These technologies are already approved but some of them are not widespread. Therefore, there might be some bottlenecks, which are typical when implementing the new technologies and equipment.

Taking into account the overall economic situation, it is not likely that the project technology will be substituted with any more efficient technology in the next 20 - 30 years.

As to the first commitment period from 2008 to 2012, it is ensured that there is absolutely no risk that this technology will be substituted by any other technology during this time.

As far as the main activity of LCME "Teplocomunenergo" will not change in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprise has sufficient knowledge and experience for implementation of the project activity and maintenance of the usual equipment.

In cases of the new (never used at this enterprise before), equipment installation, the company - producer of this equipment should provide trainings for personnel.

LCME "Teplocomunenergo" provides personnel retraining according to the labour protection norms. The enterprise has the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

The special training on the data collection according to Monitoring plan for this project was hold by the IEE, and the special group that consisted of representatives of LCME "Teplocomunenergo" and Institute of Engineering Ecology was organized.

The special training on the data collection for Monitoring reports for this project is provided. Cost of it is included into the total price of PDD development.

As far as the main activity of LCME "Teplocomunenergo" will not change in course of the JI project implementation, the special training and maintenances are not necessary.

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 production units will increase energy efficiency of Luhansk City DH system, thus enabling it to produce the same amount of heat energy with less fuel consumption. Additionally it will produce electric power with less specific fuel consumption. Reduced fuel consumption will lead to reduction of CO_2 emissions.

In the absence of the proposed project, all equipment, including the old low efficient one but still workable for a long life period, will operate in as-usual mode, and any emission reductions will 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 crediting period:

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

Length of the crediting period	Years
2007-2026	20
Year	**Estimate of annual emission reduction in tonnes CO_2 equivalent**
2007	12208.3
Subtotal 2004 - 2007	**12208.3**
2008	25669.3
2009	38321.0
2010	49764.6
2011	121853.4
2012	165687.3
Subtotal 2008 - 2012	**401295.6**
2013	165687.3
2014	165687.3
2015	165687.3
2016	165687.3
2017	165687.3
2018	165687.3
2019	165687.3
2020	165687.3
2021	165687.3
2022	165687.3
2023	165687.3
2024	165687.3
2025	165687.3
2026	165687.3
Subtotal 2013 - 2026	**2319622.2**
Total estimated emission reduction over the crediting period (tones of CO_2 equivalent	**2733126.2**
Annual average of estimated emission reduction over the crediting period (tones CO_2 equivalent)	**80259,5**

Table 3.Estimated amount of CO_2e Emission Reductions

Thus the estimated amount of emission reductions over the commitment period (2008-2012) is **401295,6** tons of CO_2e, over the crediting period **-** is **2733126.2** tons of CO_2e.

For more detailed information see **Appendixes 1 – 7**.

Average annual amount of ERUs will be the following:

During commitment period 2008-2012 years – **80259,1** t CO_2e;
After commitment period 2013-2026 years – **165687,3** t CO_2e.

Different amount of the emission reduction in PDD and Appendixes appeared due to rounding error. For example, Total amount of the emission reduction in Appendix_7 was calculated as the sum of emission reductions due to different implemented measures, and it is 165687.9 t CO_2 for 2012 year.

Total amount of the emission reduction in Appendix_8 was calculated as the difference of Baseline emissions and Project emissions 165687.3 t CO_2 for 2012 year

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

A.5. Project approval by the Parties involved:

The project is already approved by local authorities, namely Executive committee of Luhansk City Council, and Ukrainian government representatives, namely Ministry for Environmental Protection of Ukraine (at that time the Local focal point for Kyoto Protocol in Ukraine). Therefore, organizational risk for this project is minimized.

The main milestones of the project history and approval:

July, 2000 - LCME "Teplocomunenergo" signed with Institute of Engineering Ecology Ecology an agreement on preparing of raw material for forming request for the Project on CO2 Emissions Reduction due to fuel saving in system of LCME "Teplocomunenergo".

February, 2006 – Agreement was signed between the LCME "Teplocomunenergo" and the Institute of Engineering Ecology on development of the Joint Implementation Project on Green House Gas Emissions Reduction due to fuel saving through rehabilitation of the district heating system of Luhansk city (№ 543 from 07.02.2006).

October, 2007 - Ministry for Environmental Protection of Ukraine has issued the Letter of Endorsement for this JI project (№ 11569/11/10-07 from 24.10.2007).

February, 2008 – Agreement was signed between the LCME "Teplocomunenergo" and the company "E – energy B.V." (The Netherlands), purchaser of the ERUs to be generated from this project (№256-У/1-2008 from 09.06.2008).

According to the procedure, the LoAs by Parties involved will be issued after the project determination.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

In course of development of the project **"Rehabilitation of the District Heating System in Luhansk City"**, the **own-developed methodology** was used that is partly similar to "Baseline and monitoring methodology AM0044". The project "Rehabilitation of the District Heating System in Luhansk city" 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 the European Institute for safety, security, insurance and environmental technics - "SVT e.V." (Germany) and Institute of Engineering Ecology (Ukraine) invented the special 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, Donetsk Region, Republic of Crimea and Kharkiv city.

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 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 based 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 “Rehabilitation of the District Heating System in Kharkiv city”, 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.**

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. For this Baseline scenario there are no barriers (no investment barrier since this scenario doesn't require the attraction of additional investments, and no technological barrier since the equipment is operated by existing skilled personnel, and additional re-training is not required), and represent the common practice in Ukraine.

The second version of Baseline scenario was to make reconstruction works without JI mechanism. In this case there exist both investment barrier since this scenario requires the attraction of large additional investments, and due to very large payback time and high risks it is not attractive for investments, and as well the technological barrier since operation of the new modern equipment will require additional re-training of personnel. Rehabilitation of heat supply equipment in order to improve its efficiency is not a common practice in Ukraine.

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 installation, etc., 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 Luhansk city DH systems is primarily based on Ukrainian and Russian made gas and coal fired boilers including DKVR-10/13, DKVR-6.5/13, DKVR-4/13, DKVR-2,5/13, DKVR-8,5/13, KVGM-10, KVG-7,56, KSTG-16, KSG-18, KGB-50, TGV-8, TGV-4, Universal, Nadtochiya, NIISTU-5, E-1/9, Fakel, Minsk-1, HP-18, PTVM-30, PTVM-50, and few other types. Detailed information is presented in **Appendix 1 (Boilers).** Current efficiencies of those boilers are in the range of 70 - 87%.

Current distribution networks are characterized by heat losses from 20 to 35%. Detailed information is presented in **Appendix 2 (Networks).**

Construction of the Baseline Scenario

Current operation of the Luhansk city 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 0.4).

Cef (natural gas) = 0.0561 $KtCO_2/TJ$;
Cef (coal) = 0.0946 $KtCO_2/TJ$ (was taken as "Other bituminous coal").

We assume that CO_2 emission factors for the fuels will be the same for period 2006-2012. 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 LCME "Teplocomunenergo" changes insignificantly from year to year. Table 4 gives average Lower Heating Values for fuels that are used by the Applicant in 2006:

Type of fuel	Average lower heating value of fuel	
	Kcal	MJ/m^3 (MJ/kg)
Natural gas	8050	33.73
Coal	4200	17.6

Table 4. Lower heating value for fuels used by the Applicant

For determination of Lower Heating Value of natural gas LCME "Teplocomunenergo" uses data, provided by gas supply organization on the base of phisical-chemical indexes passports. These passports are transferred monthly and contain as many values of LHV as many times it has changed.
Average Lower Heating Value of natural gas that was used for baseline approach was calculated as average value of data that was provided by DE "Ukrtransgas" for 2006[1].

Calculation of CO_2 Conversion Factor (CF)

1

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

1000 m^3 of natural gas input = 33.73 [MJ/m^3]*0.0561 [KtCO_2/TJ] = 1.892 tCO_2

1t of coal input = 17.6 [MJ/kg]*0.0946 [KtCO_2/TJ] = 1.665 tCO_2

Calculation of Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2006 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. The fuels and electricity consumption in base year is represented in Table 5 and 6.

Boiler houses of LCME “Teplocomunenergo”	Baseline Natural Gas Consumption, ths Nm^3/yr	Baseline coal Consumption, t/yr
Boiler houses of LCME “Teplocomunenergo”	147853.6	710.0

Table 5. Baseline fuel consumption

Boiler houses of LCME “Teplocomunenergo”	Baseline electricity consumption, ths. kW*h
Boiler houses of LCME “Teplocomunenergo” and central heating points	52722.3

Table 6. Baseline electricity consumption

Detailed information is presented in **Appendix 1 and Appendix 4.**

Calculation of Baseline Carbon Emissions

There are 3 types of GHG emissions involved in the baseline scenario:

1) CO_2 emissions from boilers operated by LCME “Teplocomunenergo” due to historical fuel consumption in 2006.
2) CO_2 emissions due to electricity consumption from the grid in amount, which will be replaced after CHP units and Heat Pump Station installation.
3) CO_2 emissions due to electricity production to the grid in amount that is consumed by boiler houses and central Heating Points, on which frequency controllers, new pumps and heat exchangers will be installed.

Ukraine has united state power grid, therefore the averaged values for Carbon Emission factors (CEF) for electricity production should be used.

It is possible to use the new Carbon Emission factors (CEF) for 2006-2012, taken from Table 8 "Emission Factors for the Ukrainian grid 2006-2012” of Annex 2 "Standardized Emission Factors for the Ukrainian Electricity Grid” to “Ukraine - Assessment of new calculation of CEF”, verified by TUV SUD Industrie Service GmbH 17.08.2007 (Table 7).

Type of project	Parameter	EF (tCO2/MWh)
JI project producing electricity	$EF_{grid,produced,y}$	0.807
JI projects reducing electricity	$EF_{grid,reduced,y}$	0.896

Table 7. New Carbon Emission factors (CEF) for electricity generation and consumption in Ukraine

In course of development of the Monitoring reports for this project, the valid values for corresponding period will be used.

Calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if Luhansk systems remains unchanged, see in **Appendix 8 (Baseline)**. They consist of an exact amount of total CO_2 emissions that took place during the base (2006) 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 , and electricity which will be saved after energy saving measures implementation.

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 in the project scenario will be reduced due to complex modernization of heat generating and distributing equipment with 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 coal-fired boilers by the modern gas-fired ones, frequency controllers installation, installation of cogeneration units and heat pump station at the boiler houses, renovation of degraded heat distribution networks with using of the pre-insulated pipes.

The 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, may be represented by dynamic baseline, which is the function of the stage of project implementation (see **Fig. 8**).

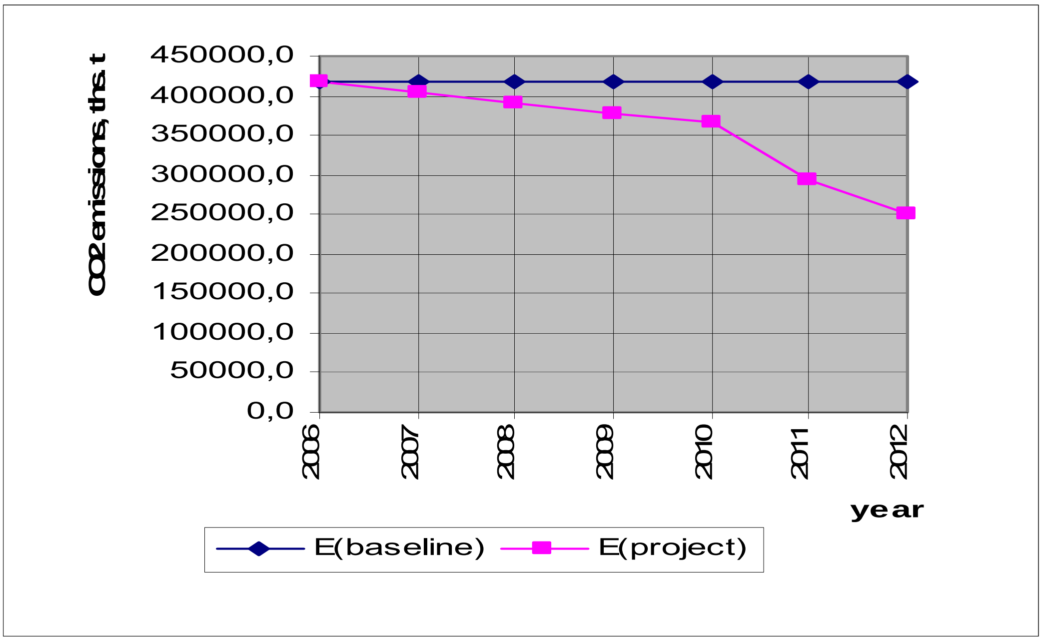

Fig. 8. Dynamic baseline and project emissions of GHG

Additionality of the project

The additionality of the project activity is demonstrated and assessed below with using the "Tool for the demonstration and assessment of additionality" (Version 5.2) (see **Fig. 9**). This tool was originally developed for CDM projects but may be applied to JI projects as well. This tool is used for the project in accordance with the guidance on its use provided in the partly similar "Baseline and monitoring methodology AM0044".

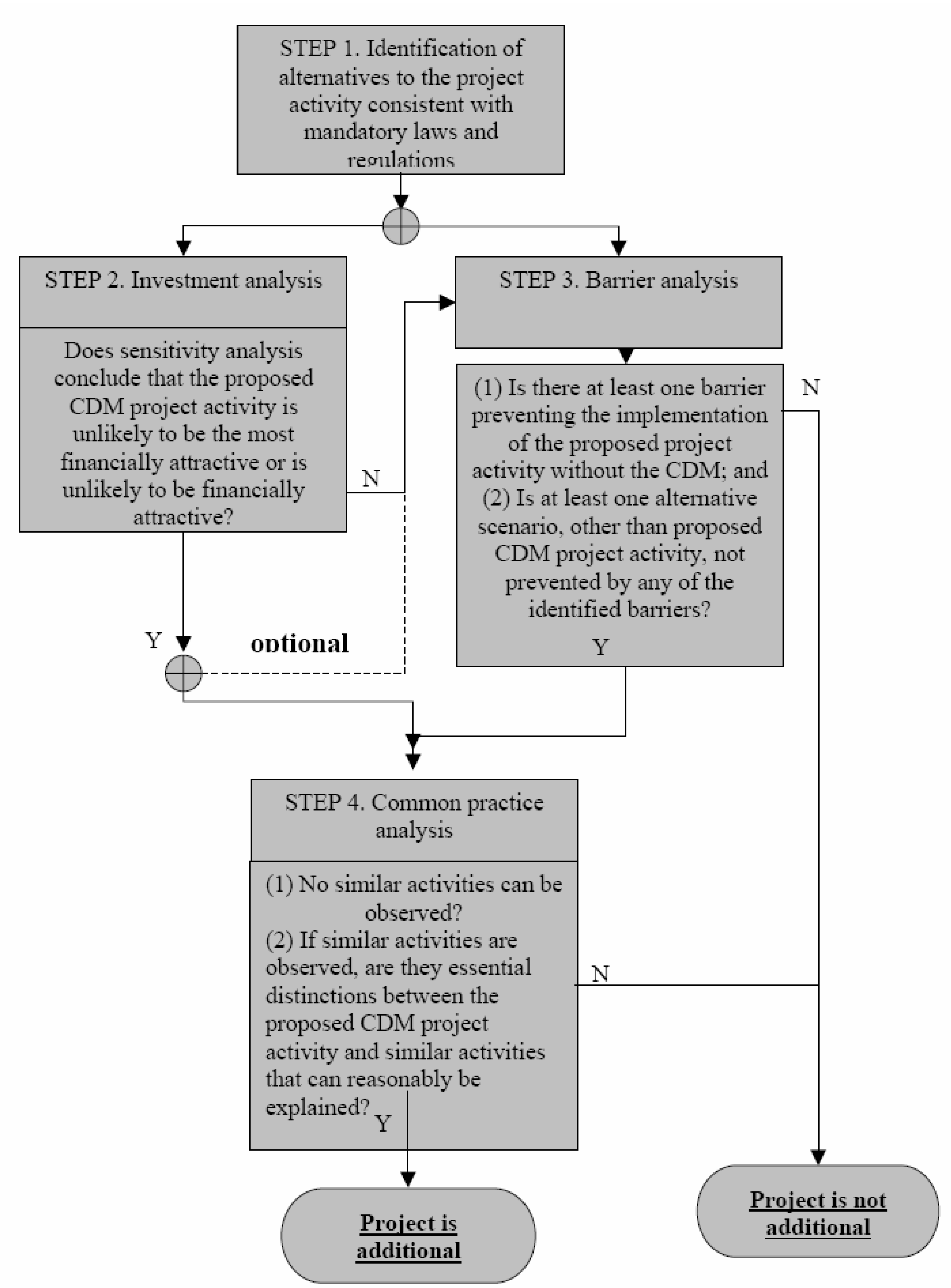

Fig. 9. Steps for demonstration of additionality

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 (as was already discussed in section B1).
1. The first alternative is continuation of the current situation (no project activity or other alternatives undertaken), i.e. business-as-usual scenario with minimum reconstruction works, approximately balanced by overall degradation of the DH system.
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 (the proposed project activity) 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.

Outcome of Step 1a: Three realistic and credible alternative scenarios to the project activity are identified.

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.

LCME "Teplocomunenergo" has such licenses.

The Project "District Heating System Rehabilitation in Luhansk City" 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".

Outcome of Step 1b: The alternatives, which are: to continue business-as-usual scenario, to make reconstruction works without JI mechanism and to implement 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.

According to the "Tool for the demonstration and assessment of additionality" (Version 5.2), for further additionality analysis it is possible to follow the Step 2 or Step 3 (or both).

We shall follow the Step 3.

Step 3: Barrier analysis

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

Investment barriers

All project activities require substantial investment – about 81,3 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 4-6** in Excel format, based on the averaged prices of the manufacturers. These prices are used for 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 5**. 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).

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**). Calculations were made with the help of Microsoft office Excel financial functions.

The simple pay back period without JI mechanism will be 14.9 years, with JI mechanism – 14.6 years.

In both cases the project is not attractive for investment, since the IRR values (-2.8 % and -2.1 % respectively) are very much lower than typical values of deposit interest rate in Ukrainian banks (from 9 % to 12 % in Euro/USD and up to 18 % in Ukrainian hryvnas, see for example information of KreditPromBank [www.kreditprombank.com], UkrGasBank [www.ukrgasbank.com] and deposit market review [http://news.finance.ua/ru/orgtrg/~/3/1/114/130266], etc.). Using of JI mechanism enables to slightly improve project attractiveness.

The general situation in District Heating sector in Ukraine may be characterized as quite insufficient, and is analyzed and described in several available reviews and reports. Some citations, especially describing technical and financial situation, are given below.

"The existing district heating systems suffer from the same, well-known problems as those in other Central and European Countries. Old-fashioned Russian technology, oversized equipment, neglected maintenance and repairs, have resulted in increasing inefficiency. Typically, the overall efficiency of the DH systems (from fuel consumption in boilers to heat supplied to the building entrance) is about 50%. Including the losses within the buildings, it is estimated that only one third of the energy of the fuel is useful heat for the final consumers.

The bad technical state of the DH systems has its counterpart in the bad financial state. Non cost-covering tariffs can not meet the revenue requirements and subsidy payments are too small to cover all costs and are often delayed. In addition, collection rates are going in line with increasing tariffs" [Report: Market Potential for District Heating Projects in the Ukraine and their Modernization with Austrian Technology, Vienna, 2004, p.3. http://www.energyagency.at/(publ)/themen/elektrizitaet_index.htm].

"The current regulatory framework and tariff policy makes it difficult to attract private investors to district heating. Yet the main stakeholders, *e.g.* municipalities and residents, in most cases lack the necessary financing capacity. (P. 324).
District heating in Ukraine suffers from inefficiency and urgently needs investment in refurbishment and modernisation. … Yet, the current policy framework does not make district heating attractive for investment, which undermines its sustainability. Barriers to investment and efficiency improvements include (but are not limited to): the current pricing policy; lack of metering; the focus on heat production, not consumption; unclear ownership and management of buildings; and difficult access to financing for interested parties. It is vital to create adequate policy and regulatory conditions for attracting private

investments in the sector. (P. 328). [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006. http://www.iea.org/Textbase/ publications/free_new_Desc.asp?PUBS_ID=1819].

"District heating suffers from inefficiency and low level of investment. The major impediments for investment include the unclear pricing policy, unregulated management and ownership conditions, the accumulated debt of heat producers" [Overview of Heating Sector in Ukraine, CASE, 2007. www.case-ukraine.com.ua].

The energy efficiency projects in the district heating sector in Ukraine could not be implemented at the expense of tariffs for heat energy, since the innovative constituent in tariffs is usually absent, and even "In some regions of Ukraine heat tariffs are below the cost coverage level, which results in debt accumulation of heat producers to the creditors (fuel supply companies, staff etc.)" [Overview of Heating Sector in Ukraine, CASE, 2007. www.case-ukraine.com.ua].

As to loans, the Ukrainian DH heat supply companies practically couldn't get loans from Ukrainian banks, where the annual interest rates due to high risks, etc. are usually up to 20 % and even more [http://news.finance.ua/ru/~/3/20/all/2008/07/14/131967]. Moreover, no bank gives credits without the proper guarantees. LCME "Teplocomunenergo" is a communal ownership enterprise, and all its main funds belong to territorial population. For this reason the property of enterprise can not be a credit mortgage. Thus, the DH system rehabilitation without additional external investments (grants, subsidy, subvention, etc.) practically isn't possible, and in current situation practically only municipal or state financing might be used for this purposes. But Ukrainian government does not have enough funds for this, and insufficiency and delay of the budget financing of activity in this sector is the main its problem.

Moreover, the real budget financing is usually significantly lower than scheduled (see diagram below, [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006].

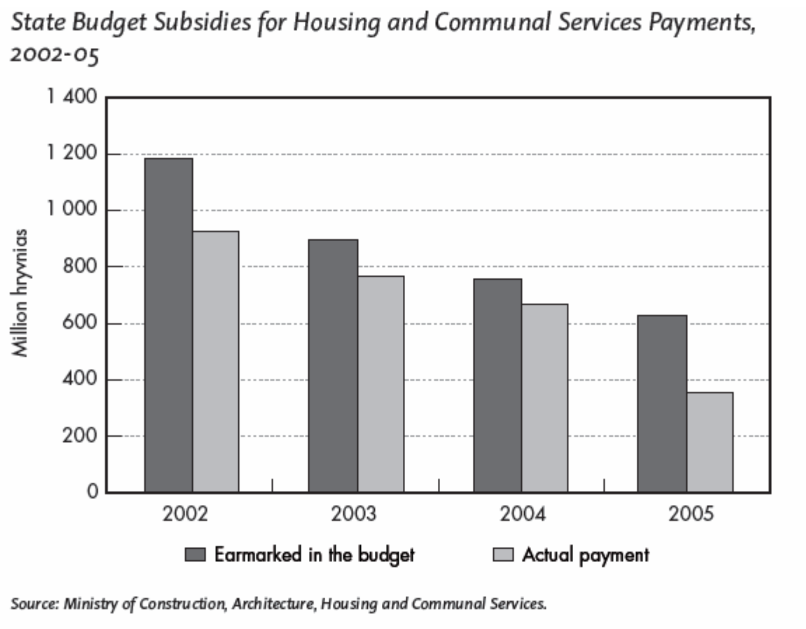

Fig.10. Diagram of the real State budget subsidies for Housing and communal services payments

Also, as discussed earlier, "district heating tariffs do not cover costs and the difference must be covered by direct subsidies to heat providers, which come from local or state budgets". But even these payments are often delayed or even not paid: "Budget payments, however, are often delayed, which results in significant accumulated debt to district heating companies" [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006].

From the other side, the additional financing of the project activity from JI mechanism is not only important for project financing, but the fact of signing of the external economic contract between Supplier and Purchaser itself is a very positive factor that even can enable to shift the priorities of budget financing in favor of the project, thus decreasing the investment barrier. The evidence for this, in particular for the very similar JI project on rehabilitation of the heat supply system of Chernihiv region, is available in the letter from the local authority – the Chernihiv Regional State Administration #01.04-05/1554 from 03.06.2008.

For this project, also the fact of signing of the external economic contract between LCME "Teplocomunenergo" and the purchaser of the Emissions reduction units provides the priority for distribution of funds from the state and local budgets to the rehabilitation of the city district heating system, thus to provide fulfillment of international liabilities on the joint implementation project. This is evidenced by the real situation with budget financing for LCME "Teplocomunenergo": after the decision on development of the Joint Implementation Project on Green House Gas Emissions Reduction (2006) the abrupt increasing of financing from the city budget took place.

Technological barriers

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 proper activity implementation in time.

Most of communal heating enterprisers in Ukraine fulfill annual minimal repairing of the DH system to keep it working. Particularly they execute repairing of network's parts and boilers that might cause accidents. The most economically feasible and realistic scenario without carbon credits sales is a very slow reconstruction activity, instead of making a major overhaul of the heating system.

Most of proposed technologies are widely used in Ukraine for the similar JI projects. For example boilers replacement, network replacement with pre-insulated pipes, installation of frequency controllers and CHP units. The technology of Heat Pump Station deployment at municipal DH systems was not used before in Ukraine.

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 barriers

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

Outcome of Step 3a: 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 (except the proposed project activity)

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 Luhansk City district heating system, there is no impediment for LCME "Teplocomunenergo" to maintain the district heating system at its present level.

Outcome of Step 3b: The identified barriers would not prevent the implementation of at least one of the alternatives – the business-as-usual scenario.

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 of LCME "Teplocomunenergo" includes all territorial districts (Leninskiy, Zhovtneviy, Kaminebrodskiy and Artemivskiy) of the Luhansk City. The enterprise LCME "Teplocomunenergo is the main heat-supply enterpris in the city. Its share in district heating system of the city is approximately 92%. Beside LCME "Teplocomunenergo" the next heating enterprises operate in Luhansk city: CME "Servis-plus", ME "Oblteplo" and PE "Teploservis".
Mainly they operate small local boiler houses. Thus there is no similar project activity in Luhansk city.

At present there are at least 4 District Heating Rehabilitation Projects with JI mechanism in Ukraine at advansed stages beside this project: for DH systems in Chernihiv region, Donetsk region, AR Crimea and Kharkiv city. But other CDM (JI) project activities are not to be included in Common practice analysis. The common practice for district heating enterprises in Ukraine without JI is only a necessary repairment of the old equipment, mainly in emergensy cases, and not the renewal. With the JI component it is possible to obtain the additional funds for real rehabilitation of the district heating system.

Outcome of Step 4a: Since the similar projects are not observed in the region, there is no basis for analysis of similar activities.

Conclusion:

The results of the above discussed analysis lead 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:

The project's spatial (geographical) boundaries coincide with territory of Luhansk city that is divided into 4 administrative districts*:* Leninskiy, Zhovtneviy, Kaminebrodskiy and Artemivskiy. LCME "Teplocomunenergo"is divided into 4 applicable branches. The district heating systems from all territorial districts of the Luhansk city are involved in this project.

Greenhouse Gas Sources and Project Boundaries:

Project boundaries for Baseline scenario are represented by dotted line on the graphical picture on the **Fig. 11.**

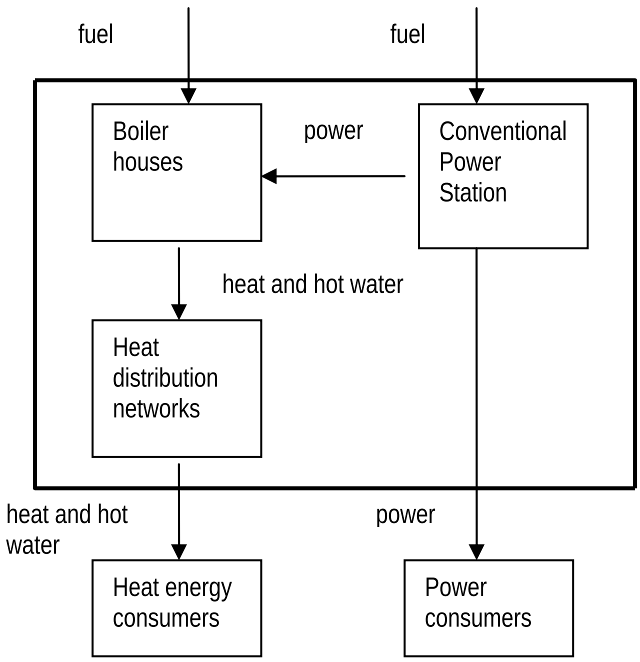

Fig.11. Flowchart of Project boundaries for Baseline scenario

Project boundaries for Project scenario are represented by black rectangle on the graphical picture on the **Fig.12.**

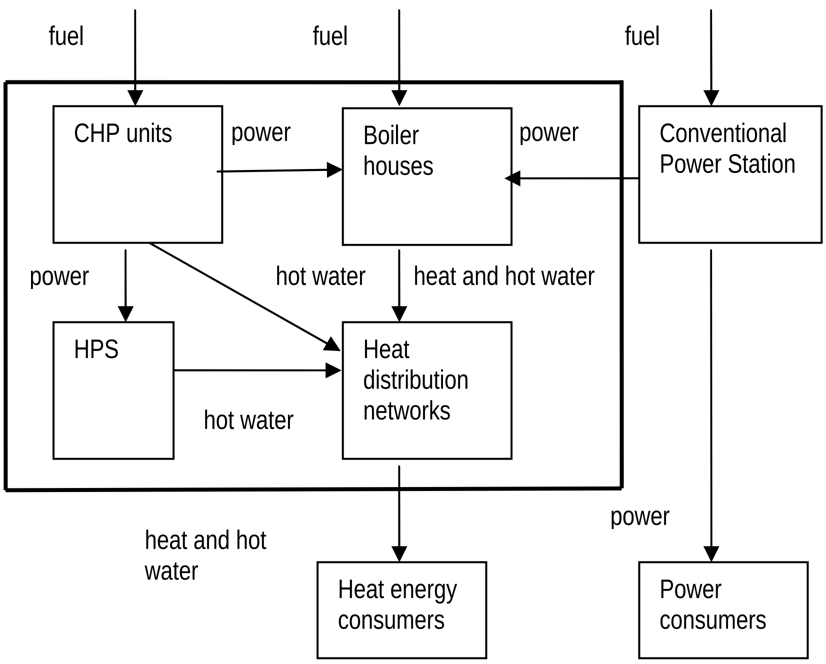

Fig.12. Flowchart of the Project boundaries for Project scenario

As we can see from the picture, Project boundaries for Baseline scenario include CO_2 emissions from boiler houses that belong to LCME “Teplocomunenergo” for heat and hot water supply service providing; and also include CO_2 emissions due to electricity production to the grid in amount that consumed by boiler houses and will be replaced after CHP units installation.
Project boundaries for Baseline scenario also include CO_2 emissions due to electricity production to the grid in amount that consumed by boiler-houses (where power saving measures are schedule) for heat and hot water supply service providing.

Emissions due to production and transportation of fuel are not included in project boundaries as well.

Project boundaries for Project scenario will remain without changes in general, but load from some boiler houses will be switched to another boiler houses (see **Appendix 1**).

Also, at three boiler-houses: Oboronna, 34, quarter Leninskogo komsomolu, 3-a and quarter Shidniy - CHP units will be installed, that will supply residential community with hot water, and partly cover the own needs in electric energy. Beside this it will be build heat pump station in the Zhovtneviy leaving region, that will take part of heat load from boiler house quarter Shidniy.

Direct and Indirect Emissions

Direct on-site emissions: CO_2 from natural gas combustion in boilers (in some cases coal is 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 at the new CHP units, additional CO_2 emissions from fuel combustion in boilers at the boiler houses due to the too large heat losses in the distribution networks.

Direct off-site emissions: CO_2 emissions from power stations due to electricity production to the grid, consumption of which will be replaced after CHP units installation.
CO_2 emissions from power stations due to electricity production to the grid, that consumed by boiler houses, where frequency controllers, new pumps and heat exchangers will be set.
CO_2 emissions from power stations due to electricity production to the grid, that consumed for heating of Luhansk city 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 conventional power station(s) due to electricity consumption for network’s work providing. 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 at the boiler houses where the new CHP units will be installed due to additional fuel consumption by CHP	Direct	Include
NO_x and CO emission from	Reduced NO_x and CO	Direct	Exclude. NO_x and CO

combustion in existing boilers/ burners	emissions from fuel combustion after boiler / burners' replacement		are not GHGs.
CO_2 emissions from fuel combustion in boilers at 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 pipes, due to replacement pipes with the pre-insulated ones, reconstruction of HDS, and reduction of networks' length	Direct	Include
Off-site emissions			
Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from power plant(s) due to electricity 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 electricity production to the grid, that is consumed by boiler houses, where frequency controllers, new pumps and heat exchangers will be installed.	Reduced CO_2 emissions from power plant(s) due to reduction of electricity consumption by boiler houses	Direct	Include
CO_2 emissions from power plant(s) due to power consumption used for heating by Luhansk city 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 by Luhansk city customers. This will take place after project implementation when heat supply service will become more efficient. Exploitation of electric heaters will be decreased substantially.	Direct	Exclude, not under control of project developer
CO_2 emissions from fuel extraction and transportation.	Reduced CO_2 emissions from fuel extraction and transportation due to fuel saving.	Indirect	Exclude, not under control of project developer

Table 8. 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: 12/01/2007

The baseline is determined by the Institute of Engineering Ecology (IEE), project developer and project partner and LCME "Teplocomunenergo", the project supplier.

IEE:

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SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

The starting date of the project is: 07/02/2006

The date 07/02/2006 was accepted as the project's starting date because on this date the agreement was signed between the LCME "Teplocomunenergo" and the Institute of Engineering Ecology on development of the Joint Implementation Project on Green House Gas Emissions Reduction due to fuel saving through rehabilitation of the district heating system of Luhansk city

C.2. Expected operational lifetime of the project:

The minimal nominal lifetime of the new boilers is - 20 years. The real average lifetime of the new 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 operational lifetime for the project equal to 20 years or 240 months (2007-2026).

C.3. Length of the crediting period:

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, 2007. The end of the crediting period is the end of the lifetime of the main equipment that is minimal December 31, 2026. Thus the length of the crediting period is 20 years (240 months).

If the past 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, 2007-2026).

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.

Verification of project performance indicators

LCME "Teplocomunenergo" collects data on fuel purchasing 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

The monitoring methodology developed for "District Heating" projects in Ukrainian conditions consists in the following:

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 (i) 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 in the reported year, respectively, 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 (consumed from greed, amount to be substituted in the reported year), and generated by included into the project objects in the reported year, respectively, t CO_2e;
$E_{cons\ i}^b$ and $E_{cons\ i}^r$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the base year and in the reported year, respectively, t CO_2e.

For each i boiler-house:

$E_1^b = LHV_b*Cef_b*B_b$

$E_1^r = LHV_r*Cef_r*B_r$

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

$E_{gen}^r = (W_b - W_r)*CEF_g + [(Q_b-Q_r)*f_b/1000 + B_g]*LHV_r*Cef$

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

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

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, kt CO_2/TJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tons;
W_b – scheduled electric power production by the new CHP units at a boiler-house, MWh;
W_r – electric power production by the installed new CHP units, MWh;

CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;
P_b – electric power consumption by a boiler-house where energy saving measures are scheduled to be implemented, MWh;
P_r – electric power consumption by a boiler-house with energy saving measures implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Q_b – scheduled heat energy production by the new CHP units at a boiler-house, MWh;
Q_r – heat energy production by the installed new CHP units at a boiler-house in reported year, MWh;
f_b – specific natural gas consumption by a 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 heat and power generation, ths m^3;
$[_b]$ index – related to the base year;
$[_r]$ index – related to the reported year.

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.

According to the Dynamic Baseline assumption, the efficient value of E_1^b may be defined as follows:
$E_{1i}^b = E_{hi}^b, + E_{wi}^b$;
where the first term describes emissions from fuel consumption for heating, and the second one – from fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$,
where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$

$E_1^r = LHV_r* Cef_r*B_r$

where:
LHV – lower heating value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, kt CO_2/TJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tons per year;
K_1, K_h, K_w, K_{w0} – adjustment factors;

a – portion of fuel (heat), consumed for heating purposes;
(1-a) – portion of fuel (heat), consumed for hot water supply services;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

$a_b = L_h^b * g * N_h^b / (L_h^b * g * N_h^b + L_w^b * N_w^b)$;
$a_r = L_h^r * g * N_h^r / (L_h^r * g * N_h^r + L_w^r * N_w^r)$,

where:
L_h, L_w – maximum connected load to the boiler-house, that is required for heating and for hot water supply service, MW;
g – recalculating factor for average load during heating period (is determined for each boiler-house on historical base, usually is in the range 0,4 – 0,8);
N_h, N_w – duration of heating period and period of hot water supply service per year, hours.

Adjustment factors:

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

$K_1 = LHV_b / LHV_r$

2. Adjustment factors for heating should be used for creation the Dynamic Baseline which takes into account changes of the external factors such as weather conditions, heating area, etc.

Fuel consumption for heating is proportional to the required amount of heat during heating period, Q_h:

$B_h = B * a = Q_h / LHV * \eta$,

where η is overall heating system efficiency.

According to the assumption of the Dynamic Baseline, the required amount of heat in the base year for correct comparison should be reduced to real conditions (external to the project) in the reported year:

$Q_{h\,br} = Q_{h\,b} * K_h = Q_{h\,r}$

where:

$Q_{h\,br}$ – required heat for Dynamic Baseline, is assumed equal to Q_r – required heat in the reported year,
$Q_{h\,b}$ – required heat in the base year,
K_h – averaged adjustment factor for heating.

From this equation it is possible to determine the averaged adjustment factor:
$K_h = Q_{h\,r} / Q_{h\,b.}$

Required amount of heat for heating of buildings during a year, according to the "Codes and regulations on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic requirements in Ukraine. KTM 204 Ukraine 244-94"[6], is determined by [ibid, equation 2.17]:

$Q_h = F_h * k_h * (T_{in} - T_{out}) * N_h,$

where:
Q_h – required amount of heat for heating, kWh;
F_h – heating area of buildings, m^2;
k_h – average heat transfer factor of buildings, kW/m^2*K;
T_{in} – average inside temperature for the heating period, K (or ^0C);
T_{out} – average outside temperature for the heating period, K (or ^0C);
N_h – duration of the heating period per year, hours.

Then:
$K_h = (F_{h\,r} * k_{h\,r}) * (T_{in\,r} - T_{out\,r}) * N_{h\,r} / F_{h\,b} * k_{h\,b} * (T_{in\,b} - T_{out\,b}) * N_{h\,b}$
2.1. K_2 (temperature change factor):

$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b}).$

2.2. K_3 (heating area and building thermal insulation change factor):

[6] Codes and regulations on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic requirements in Ukraine. KTM 204 Ukraine 244-94. Kyiv, 2001, 376 p.

$K_3 = (F_{h\,r} * k_{h\,r}) / F_{h\,b} * k_{h\,b} = [(F_{h\,r} – F_{h\,t\,r} – F_{h\,n\,r}) * k_{h\,b} + (F_{h\,n\,r} + F_{h\,t\,r}) * k_{h\,n}] / F_{h\,b} * k_{h\,b}$,

where:
$F_{h\,b}$ – heating area of buildings in the base year, m^2;
$F_{h\,r}$ – heating area of buildings in the reported year, m^2;
$F_{h\,n\,r}$ – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2;
$F_{h\,t\,r}$ – heating area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2;
$k_{h\,b}$ – average heat transfer factor of heated buildings in the base year, W/m^2*K;
$k_{h\,r}$ – average heat transfer factor of heated buildings in the reported year, W/m^2*K;
$k_{h\,n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), W/m^2*K.

2.4. K_4 (heating period duration change factor):

$K_4 = N_{h\,r} / N_{h\,b}$

where:
$N_{h\,b}$ – duration of the heating period in the base year, hours;
$N_{h\,r}$ – duration of the heating period in the reported year, hours.

Thus,

$K_h = K_2 * K_3 * K_4$

3. Adjustment factors for hot water supply service should be used for creation the Dynamic Baseline which takes into account changes of the external factors such as weather conditions, number of customers, etc.:

Fuel consumption for hot water supply service is proportional to the required amount of heat during the service rendered period, Q_w:

$B_w = B*(1\text{-}a) = Q_w / LHV*\eta$,

where η is overall hot water supply system efficiency.

According to the assumption of the Dynamic Baseline, the required amount of heat for hot water supply service in the base year for correct comparison should be reduced to real conditions (external to the project) in the reported year:

$Q_{w\,br} = Q_{w\,b} * K_w = Q_{w\,r}$

where:
$Q_{w\,br}$ – required heat for hot water supply service for Dynamic Baseline, is assumed equal to $Q_{w\,r}$ – required heat for hot water supply service in the reported year,
$Q_{w\,b}$ – required heat for hot water supply service in the base year,
K_w – averaged adjustment factor for hot water supply service.

From this equation it is possible to determine the averaged adjustment factor:
$K_w = Q_{w\,r} / Q_{w\,b}$.

The components of K_w may be illustrated by correlation of heat used for hot water supply service in the base and reported years:

$Q_w = n_w * v_w * N_w$,

where:
Q_w – required amount of heat for hot water supply service, kWh;
n_w – average number of service's customers, personal accounts;
v_w – standard specific discharge of hot water per personal account (in heat units, kWh/h);
N_w – duration of the service period per year, hours.

Then:
$K_w = n_{w\,r} * v_{w\,r} * N_{w\,r} / n_{w\,b} * v_{w\,b} * N_{w\,b}$

3.1. K_5 (number of customers change factor):

$K_5 = n_{w\,r} / n_{w\,b}$

3.2. K_6 (standard specific discharge of hot water per personal account change factor):
$K_6 = v_{w\,r} / v_{w\,b}$

At present the standard specific discharge of hot water is valid in Ukraine that was established by the KTM 204 Ukraine 244-94[1] in 1993. and no information is available on any propositions to change it, thus $K_6 = 1$ and does not require special monitoring.

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

$K_7 = N_{w\,r} / N_{w\,b}$

where:
$N_{w\,b}$ – duration of the hot water supply period in the base year, hours;
$N_{w\,r}$ – duration of the hot water supply period in the reported year, hours.

Thus,

$K_w = K_5 * K_6 * K_7$.

3.4. Adjustment factors for hot water supply service in case when there was no hot water supply service in base year, and in the reported year this service was provided:

Since in case when there was no hot water supply service in base year, number of customers, standard specific discharge of hot water per personal account and duration of hot water supply period in the base year are assumed to be equal to these values in the reported year,

$K_5 = K_6 = K_7 = 1$.

Thus

$K_{w0} = 1$.

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	Every Boiler house		m	Every day	100%	Registered in the journal	Fuel consumption at

	boiler houses: (**B_r**)						(paper and/or electronic)	boiler houses is the main data which allows to calculate GHG emissions in the reported year
1.1	Natural Gas		m^3					
1.2	Coal		ton					
2	Average annual Heating Value of a fuel calculated by Lower Heating Value (**LHV_r**)	Fuel Supplier's Report or Chem. Lab Analysis Report		m, c	Once per month	100%	Registered in the journal (paper and/or electronic)	
2.1	Natural Gas		MJ/m^3					
2.2	Coal		MJ/kg					
3	Power consumption (**P_r**)	Boiler houses and heating points where frequency controllers, new pumps and heat exchangers will be installed, as well as heat pump station	MWh	m	Every month	100%	Registered in the journal (paper and/or electronic)	
4	Power production (**W_{gr}**)	New CHP units	MWh	m	Every day	100%	Registered in the journal (paper and/or electronic)	

5	Heat energy production (**Q_{gr}**)	New CHP units, heat pump station	MWh	m	Every day	100%	Registered in the journal (paper and/or electronic)	
6	Fuel consumption at the CHP units: (**B_g**)	Every CHP units	1000 m^3	m	Every day	100%	Registered in the journal (paper and/or electronic)	

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

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 project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

$E_i^r = E_{1i}^r + E_{gen\ i}^r + E_{cons\ i}^r$;

where:
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 generated by included into the project objects in the reported year, t CO_2e;
$E_{cons\ i}^r$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the reported year, t CO_2e.

$E_{1i}^r = LHV_r * Cef_r * B_{ri}$,

where:
LHV_{ri} – Average annual lower heating value, MJ/m^3 (MJ/kg)
Average annual Heating Value is calculated for every town;
Cef – carbon emission factor, ktCO_2/TJ;
B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons;

$E_{gen}^{r} = (W_b - W_r)*CEF_g + [(Q_b - Q_r)*f_b/1000 + B_g]* LHV_r * Cef$

where:
W_b – scheduled electric power production by the all new CHP units, MWh;
W_r – 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;
Q_b – scheduled heat energy production by the all new CHP units, MWh;
Q_r – 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;

$E_{cons\ i}^{r} = P_r * CEF_c$;

where:
P_r – electric power consumption by the boiler-houses and central heating points with energy saving measures implemented (frequency controllers, new pumps and heat exchangers will be installed), MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;
[$_r$] index – related to the reporting year

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 day	100%	Registered in the journal (paper and/or electronic)	Fuel consumption at boiler houses is the main data which allows to calculate GHG emissions in the base year
1.1	Natural Gas		m^3					
1.2	Coal		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		m, c	Once per month	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate GHG emissions in the base year
2.1	Natural Gas		MJ/m3					
2.2	Coal		MJ/kg					
3	Average outside temperature during the heating season (**$T_{out\ b}$** and **$T_{out\ r}$**)	LCME "Teplocomunenergo", Meteorological Service	^{0}C (K)	m, c	Once per heating season. Daily temperatur e is registered every day	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline

4	Average inside temperature during the heating season (**$T_{in\ b}$** and **$T_{in\ r}$**)	LCME "Teplocomunenergo" The average inside temperature will be calculated from the sum of returned payments caused by insufficient heating (in case of normative level is not satisfied)	^{0}C (K)	m, c	Once per heating season	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
5	Number of Customers (**n_{wb}** and **n_{wr}**)	LCME "Teplocomunenergo"		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
6	Heating area (total) (**$F_{h\ b}$** and **$F_{h\ r}$**)	LCME "Teplocomunenergo"	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
7	Average heat transfer factor of heated buildings in the base year (**k_{hb}**)	LCME "Teplocomunenergo"	W/m^2*K	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

8	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year (**$F_{h\,t\,r}$**)	LCME "Teplocomunenergo"	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
9	Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year (**$F_{h\,n\,r}$**)	LCME "Teplocomunenergo"	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
10	Heat transfer factor of buildings with new thermal insulation (**$k_{h\,n}$**)	LCME "Teplocomunenergo", State Buildings Norms (B.2.6-31:2006)	W/m^2*K	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

11	Heating period duration (**$N_{h\,b}$** and **$N_{h\,r}$**)	LCME "Teplocomunenergo"	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
12	Duration of period of hot water supply service (**$N_{w\,b}$** and **$N_{w\,r}$**)	LCME "Teplocomunenergo"	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
13	Maximum connected load to the boiler-house, that is required for heating (**L_h^b** and **L_h^r**)	LCME "Teplocomunenergo"	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
14	Connected load to the boiler-house, that is required for hot water supply service (**L_w^b** and **L_w^r**)	LCME "Teplocomunenergo"	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
15	Standard specific discharge of hot water per personal account (**$v_{w\,r}$** and **$v_{w\,b}$**)	LCME "Teplocomunenergo"	kWh/h	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

16	Carbon emission factor (**Cef_b** and **Cef_r**)	IPCC		Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
16.1	Natural Gas		kt CO_2/TJ					
16.2	Coal		kt CO_2/TJ					
17	Recalculating factor for average load during heating period (**g**)	LCME "Teplocomunenergo"		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	
18	Scheduled electric power production (**W_{gb}**)	New CHP units	MWh	c	Once	100%	Special Reports (paper and/or electronic)	Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario
19	Scheduled heat energy production (**Q_{gb}**)	New CHP units	MWh	c	Once	100%	Special Reports (paper and/or electronic)	Data which allows to calculate GHG emissions in the baseline scenario

20	Power consumption (**P_b**)	Boiler houses and heating points, where frequency controllers, new pumps and heat exchangers will be installed	MWh	m	Every month	100%	Data journal, (paper and electronic file)	Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario

See Annex 3 for more detailes.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

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

where:
E_i^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.

For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$,
where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.

where:
LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, $KtCO_2/TJ$;
B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tons;
K_1, $K_h = K_2 * K_3 * K_4$; $K_w = K_5 * K_6 * K_7$ – adjustment factors;
a_b – portion of fuel (heat), consumed for heating purposes in the base year;
$(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year;
a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

$a_b = L_h^b*q*N_h^b / (L_h^b*g*N_h^b + L_w^b*N_w^b)$;

where:
L_h^b – maximum connected load required for heating in the base year, MW;
L_w^b – connected load required for hot water supply service in the base year, MW;

g – recalculating factor for average load during heating period (usually 0,5-0,8);
N_h^b – duration of heating period in the base year , hours
N_w^b – duration of hot water supply service in the base year, hours

$a_r = L_h^r*q*N_h^r / (L_h^r*g*N_h^r+L_w^r*N_w^r)$

where:
L_h^r – maximum connected load required for heating in the reported year, MW;
L_w^r – connected load required for hot water supply service in the reported year, MW;
g – recalculating factor for average load during heating period (usually 0,5-0,8);
N_h^r – duration of heating period in the reported year, hours,
N_w^r – duration of hot water supply service in the reported year, hours.

$K_1=LHV_b/LHV_r$;

where:
LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg);
LHV_r – Average annual lower heating value in the reported year, MJ/m^3 (MJ/kg)

$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$;

where:
$T_{in\ r}$ – average inside temperature for the heating period in the reported year, K (or ^{0}C);
$T_{in\ b}$ – average inside temperature for the heating period in the base year, K (or ^{0}C);
$T_{out\ r}$ – average outside temperature for the heating period in the reported year , K (or ^{0}C);
$T_{out\ b}$ – average outside temperature for the heating period in the reported year , K (or ^{0}C)

$K_3 = [(F_{h\ r} - F_{h\ t\ r} - F_{h\ n\ r})*k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r})*k_{h\ n}] / F_{h\ b}*k_{h\ b}$;

where:
$F_{h\ b}$ – heating area in the base year, m^2;
$F_{h\ r}$ – heating area in the reported year, m^2;

$F_{h\,n\,r}$ – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2;
$F_{h\,t\,r}$ – heating area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2;
$k_{h\,b}$ – average heat transfer factor of heated buildings in the base year, W/m^2*K;
$k_{h\,n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), W/m^2*K.

$K_4=N_{hr}/N_{hb}$;

where:
N_{hb},– duration of heating period in the base year, hours
N_{hr} – duration of heating period in the reported year, hours

$K_5 = n_{wr} / n_{wb;}$
where:
N_{wb},– number of customers in the base year;
N_{wr} – number of customers in the reported year

$K_6 = v_{w\,r} / v_{w\,b}$;

where:
$v_{w\,r}$ – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h);
$v_{w\,b}$ – standard specific discharge of hot water per personal account in the base year, (in heat units, kWh/h).

$K_7 = N_{wr}/ N_{wb}$;

where:
N_{wr}– duration of hot water supply service in the reported year, hours.
N_{wb} – duration of hot water supply service in the base year, hours.

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

where:
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;

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;
LHV_r – Average annual lower heating value in reported year, MJ/m^3 (MJ/kg)
Cef – carbon emission factor, KtCO_2/TJ;

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

where:
P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented (power consumption of the boiler houses, where frequency controllers, new pumps and heat exchangers will be installed), MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

The Methodology for "District Heating" projects in Ukrainian conditions was developed for application in different Regions of Ukraine. In some Regions the consumers receive less than necessary amount of heat, in result of which the temperature inside the buildings is much lower than normative one (18 ^{0}C), and hot water supply is insufficient or absent. Therefore this Methodology allows to take into account improving of the heat supply quality for the consumers and excludes deliberate reduction of heat delivery, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project activity.

Delivery of the less than necessary amount of heat and hot water really took place previously in cities and regions of Ukraine (and takes place even now in some cities and regions where situation business-as-usual is continued), and is reflected for example in JI Projects "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Chernihiv Region", etc.
According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, the heat supply enterprises must make the return payments to population for delivery less than necessary for providing normative heating level amount of heat. The normative inside temperature should be not lower than 18 ^{o}C.
Amount of such return payment is the following:
– 5% from normative payment for every degree from 18 to 12 ^{o}C;
– 10% from normative payment for every degree from 12 to 5 ^{o}C;
– when inside temperature is lower than 5 ^{o}C the payment is to be returned completely.

Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied).

Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative.
Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.

The average inside temperature is calculated by formulae:

If R = 0 (according to conservatism principle for the baseline assume R < 0.05):
$\mathbf{T}_{\mathbf{in\ b}}$ = 18 ^{o}C.

If 0.05 < R ≤ 0.3 NP:
$\mathbf{T}_{\mathbf{in\ b}}$ = 18 – (R/5) [^{o}C]

If 0.3 NP < R < NP:
$\mathbf{T}_{\mathbf{in\ b}}$ = 12 – [(R – 0.3 NP)/10] [^{o}C]

where:
R - % of return payment from NP;
NP – amount of normative payment.

Thus if the inside temperature will be 18 ^{o}C or higher we will accept it as 18 ^{o}C according to conservatism principle, if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented before.

LCME "Teplocomunenergo made return payments to consumers for underheating in 2006 base year. The sum was 6 mln. UAH, that is more then 4,5% from normative payment for heat energy. Thus inside temperature in 2006 base year according to conservatism principle is considered to be not lower than 17 ^{o}C.

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

D.1.2.1. Data to be collected in order to monitor emission reductions 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

There are no data to be collected in order to monitor emission reductions from the project, because emission reductions will be calculated 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 project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

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 (grid, 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):

Formulae presented in D.1.1. - D.1.3. will be used for monitoring of the emissions in the project scenario and the baseline scenario. They will be used in Monitoring report. The baseline is dynamic and depends on conditions of every reporting year. Therefore we can't use these formulae in PDD to estimate emission reductions because we have no data (whether conditions, low heating value of fuels, etc.) for any reporting year yet.

Formulae presented in D.1.4. are used to estimate emission reductions in PDD. Results of the corresponding calculations made with using of these formulae are listed in **Appendices 1 - 8**. These calculations are based on equipment efficiency increasing. Parameters' names corresponding to these formulae are pointed out in **Appendices 1 - 8**.

Every Appendix contains calculations of GHG emissions reduction that corresponds to specified technologies used in the JI project.

Appendix 1 - Replacement of boilers.

Replacement of old operating boilers with low efficiency by the new highly efficient ones, replacement of obsolete coal-fired boilers by the new gas-fired boilers, switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment.

Appendix 2 - Replacement of network pipes.

Replacement of the main and distribution networks pipes with diameter 57 mm - 820 mm by the pre-insulated ones.

Due to Improvement of the heat networks system organization will be provided by liquidation of heating scheme with open heat-carrying agent pumping for hot water supply service, it will enable to liquidate pipes with different diameters, to reduce heat losses and to reduce power consumption for power supply of circulation pumps.

Appendix 3 - Cogeneration units installation.

Installation of combined heat and power production units.

Appendix 4 - Frequency controllers installation.

Installation of frequency controllers at hot water pumps' motors and electric drive of draught-blowing equipment.

Appendix 5 – Installation of heat pump station.

Installation of heat pump station that includes 6 heat pumps and 2 cogeneration units.

Appendix 6 – Replacement of heat exchangers.

Replacement of old heat exchangers by the new highly efficient ones. Installation of heat exchangers directly at the consumers houses (Individual Heating Point – IHP).

Appendix 7 - Contains total sums of emission reductions for every year for each technology.

Appendix 8 - Contains calculations of baseline emissions and project emissions as well as GHG emissions reduction for every project year, based on formulae presented in D.1.4.

Appendix 7 and **Appendix 8** contain links with all **Appendices 1 - 6**.

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_2e;

E_r – project emissions, t CO_2e

E_b – baseline emissions, t CO_2e

Baseline emissions

Baseline emissions consist of three types of GHG emissions:

1) CO_2e emissions from boilers operated by the Supplier.
2) CO_2e emissions due to electricity production to the grid, that will be replaced after CHP units installation and pump station installation.
3) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses with energy saving measures (where frequency controllers, new pumps and heat exchangers will be installed).

$$E_b = E1_b + E2_b + E3_b$$

Where:

$E1_b$ – emissions from boilers operated by the Supplier, t CO_2e;
$E2_b$ –emissions due to electricity production to the grid, that will be replaced after CHP units installation, t CO_2e;
$E3_b$ – emissions due to electricity production to the grid, that consumed by boiler houses, where frequency controllers, new pumps and heat exchangers will be installed, t CO_2e;

1) Emissions from heat generating sources operated by the Supplier:

$$E1_b = \sum (B_{b(i)} * LHV_{b(i)} * Cef_i),$$

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.
For more detailed information see **Appendix 1.**

2) Baseline CO_2e emissions due to electricity production to the grid, that will be replaced after CHP units installation.

$$E2_b = W_b * CEF_g,$$

where:

W_b - annual power production of new CHP units, and additional power production of CHP units at the Heat Pump Station, which will be installed by Supplier, MWh;

CEF_g - Carbon Emission factors for electricity production, tCO_2e/MWh, see **Table 7**.

Heat, that will be produced from new CHP units, will be used for the hot water supply service. For more detailed information see **Appendix 3 and Appendix 5.**

3) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses, with energy saving measures (where frequency controllers, new pumps and heat exchangers will be installed).
$E3_b = P_b * CEF_c$,

where:
P_b – annual power consumption of boiler houses with energy saving measures (where frequency controllers, new pumps and heat exchangers will be installed), MWh;
CEF_c – Carbon Emission factor for reducing electricity consumption, tCO_2e/MWh., see **Table 7**.

For more detailed information see **Appendix 4 and Appendix 6.**

Project emissions

Project emissions consist of four types of GHG emissions:

$E_r = E1_r + E2_r + E3_r$

Where:
$E1_r$ – emissions from boilers operated by the Supplier, t CO_2e;
$E2_r$ – emissions from new CHP units, t CO_2e.
$E3_r$ – emissions due to electricity production to the grid, that consumed by boiler houses, with energy saving measures (where frequency controllers, new pumps and heat exchangers will be installed), t CO_2e;

Project scenario emissions from boiler-houses are a sum of actual fuel amounts to be used in any report year (starting from 2008) multiplied by corresponding conversion factors. Actual – means with subtracted fuel saving due to improving of the network efficiency:

$E1_r = \sum ([B_{r(i)} – V_{(i)} – Q1_{(i)}] *LHV_{(i)} *Cef_i)$;

where:
$E1_r$ – project emissions from boiler-houses in any reported year, t CO_2e
$B_{r(i)}$ – fuel consumption by boiler-houses in the project scenario (for each fuel), 1000 m^3 (t);
$V_{(i)}$ –fuel saving due to network rehabilitation for each fuel, 1000 m^3 (t);
$Q1_{(i}$ - fuel saving due to reconstruction of HDS for each fuel, 1000 m^3 (t);
$LHV_{(i)}$ – Lower Heating Value for each fuel, MJ/m^3 (MJ/kg);
Cef_{i-} – Carbon Emission Factors for each fuel, kt CO_2/TJ.

$B_{r(i)} = [B_{b(i)}*LHV_{b(i)}* BBE_i] / [LHV_{r(i)} * PBE_i]$,

where:
BBE_i - Baseline Boilers Efficiency, %;
PBE_i - Project Boilers Efficiency, %.

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

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (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, %.

$E2_r = (W_b - W_r)*CEF_g +B_g *LHV *Cef + (Q_b-Q_r)*f_b/1000* LHV* Cef$,
where:
W_b – scheduled electric power production by the all new CHP units and additional scheduled power production of CHP units at the Heat Pump Station , MWh;
W_r – electric power production by the installed new CHP units and additional power production of CHP units at the Heat Pump Station , MWh;
B_g – calculated amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;
Q_b – scheduled heat energy production by the all new CHP units, MWh;
Q_r – 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.

$E3_r = (P_b – P1_r – P2_r)* CEF_c,$
where:
P_b – annual power consumption of boiler houses with energy saving measures (where frequency controllers, new pumps and heat exchangers will be installed), MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption, tCO_2e/MWh;
$P1_r$ – calculated power saving due to frequency controllers installation, MWh;
$P2_r$ – calculated power saving due to reconstruction of heat exchangers, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption, tCO_2e/MWh.

For more detailed information see **Appendices 1 – 6 and 8.**

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

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

- Law of Ukraine # 1264-XII "On environmental protection" from 25.06.1991
- Law of Ukraine # 2707-XII "On atmospheric air protection" from 16.10.1992.
- Actual rules on emissions limitation: "Norms of limit admissible emissions of pollution agents from stationary sources" – adopted by Ministry for Environmental Protection of Ukraine 27.06.2006, #309 issued Ministry of and registered in Ministry of Justice of Ukraine 01.09.2006, #912/12786.

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.

Amount of natural gas consumed by boiler houses. Amount of coal consumed by boiler houses.	Low for gas. Medium for coal	Measuring instruments must be calibrated according to national regulations
Outside 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.
Average inside temperature during the heating season	Low	Calculated from the sum of returned payments caused by insufficient heating (in case of normative level is not satisfied. 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 (LCME "Teplocomunenergo") 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 and LCME "Teplocomunenergo", project supplier.

IEE:

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SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project 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 and power consumption, will be reduced comparing to the baseline activity level due to fuel saving.

Types of project activity	Energy resources consumption
Gas consumption by boiler houses, new CHP units, ths. m^3	112070.6
Coal consumption, t	0.0
Power consumption by boiler houses and heating stations with energy saving measures (where frequency controllers new heat exchangers will be installed), ths. kWh	43508.3

Table 9. Project Energy resources consumption

Detailed information is presented in **Appendices 1 - 6.**

Estimation of Direct Project Emissions

Project emissions consist of three types of GHG emissions:

1) CO_2 emissions from boilers and CHP units operated by LCME "Teplocomunenergo" due to fuel consumption, t CO_2e
2) CO_2 emissions due to electricity production to the grid, which will be replace after installation of CHP units and Heat Pump Stationdue, t CO_2e
3) CO_2 emissions due to electricity production to the grid in amount that is consumed by boiler houses and central Heating Points, on which frequency controllers, new pumps and heat exchangers will be installed.

Project Emissions of CO_2e after project implementation are shown in Table 10.

Project emissions	Project emissions, t CO_2
E1	212065.0
E2	0.0
E3	38983.5

Total	**251048.5**

Table 10. Project Emissions of CO_2e after project implementation

See **Appendix 8**.

Project emissions are ~ **251048.5** t CO_2

In the PDD calculations, by the conservatism principle, the minimal guaranteed effects from all energy saving measures were taken in to account .

Also, emission reductions from implemented measures were calculated only for the next years after energy saving measures implementation. In fact result in the form of emissions reduction is achieved immediately after energy saving measures implementation in the year of reconstruction, especially if it was done at the beginning of the year.

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 = 251048.5 + 0 = 251048.5 t CO_2.

E.4. Estimated baseline emissions:

Baseline emissions consist of four types of GHG emissions:

1) CO_2 emissions from boilers operated by LCME "Teplocomunenergo" due to historical fuel consumption in 2006.
2) CO_2 emissions due to electricity consumption from the grid in amount, which will be replaced after CHP units and Heat Pump Station installation.
3) CO_2 emissions due to electricity production to the grid in amount that is consumed by boiler houses and central Heating Points, on which frequency controllers, new pumps and heat exchangers will be installed.

Baseline emissions by the types of project activity	Baseline emissions, t CO_2
E1	280958.5
E2	88538.1
E3	47239.2
Total	**416735.8**

Table 11. Baseline Emissions of CO_2
Baseline emissions ~ **416735.8** t CO_2.

The following conservative assumption is used to calculate baseline and project GHG emissions:
Average inside temperature during the heating season above the normative level (18 ^{0}C) is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative.

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if LCME "Teplocomunenergo" 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) =
416735.8 - 251048.5 = 165687.3 t CO_2 / year

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 3,** Paragraph **A.4.3.1.**

Year	Emissions reduction of CO2, t						
	Due to boiler houses rehabilitation	Due to network rehabilitation	Due to CHP installation	Due to frequency controllers installation	Due to HPS installation	Due to heat exchangers installation	Total
2007	3017.4	8239.6				951.5	12208.4
2008	4604.4	17710.0				3354.9	25669.3
2009	8038.9	26927.3				3354.9	38321.1
2010	9384.9	33356.9				7022.9	49764.7
2011	13891.3	40428.1	24687.9	4749.7	31074.4	7022.9	121854.3
2012	21259.7	47499.4	54081.9	4749.7	31074.4	7022.9	165687.9
Total	**60196.4**	**174161.1**	**78769.7**	**9499.3**	**62148.9**	**28730.1**	**413505,6**

Table 12.Estimated CO_2e Emission Reductions

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

Year	Estimated project emissions (t CO_2 equivalent)	Estimated leakage (t CO_2 equivalent)	Estimated baseline emissions (t CO_2 equivalent)	Estimated emissions reduction (t CO_2 equivalent)
2007	404527.5	0.0	416735.8	12208.3
Subtotal - 2007	**404527.5**	**0.0**	**416735.8**	**12208.3**
2008	391066.5	0.0	416735.8	25669.3
2009	378414.8	0.0	416735.8	38321.0
2010	366971.2	0.0	416735.8	49764.6
2011	294882.4	0.0	416735.8	121853.4
2012	251048.5	0.0	416735.8	165687.3
Subtotal 2008 - 2012	**1682383.4**	**0.0**	**2083679.0**	**401295.6**
2013	251048.5	0.0	416735.8	165687.3
2014	251048.5	0.0	416735.8	165687.3
2015	251048.5	0.0	416735.8	165687.3
2016	251048.5	0.0	416735.8	165687.3
2017	251048.5	0.0	416735.8	165687.3
2018	251048.5	0.0	416735.8	165687.3
2019	251048.5	0.0	416735.8	165687.3
2020	251048.5	0.0	416735.8	165687.3
2021	251048.5	0.0	416735.8	165687.3
2022	251048.5	0.0	416735.8	165687.3
2023	251048.5	0.0	416735.8	165687.3
2024	251048.5	0.0	416735.8	165687.3
2025	251048.5	0.0	416735.8	165687.3
2026	251048.5	0.0	416735.8	165687.3
Subtotal 2013 - 2026	**3514679.0**	**0.0**	**5834301.2**	**2319622.2**
Total (t CO_2 equivalent)	**5601589.8**	**0.0**	**8334716.0**	**2733126,2**

SECTION F. Environmental impacts

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

According to the Ukrainian rules, the design documentation for the new building, reconstruction and technical re-equipment of industrial and civil objects must include the environmental impact assessment, the main requirements for which are listed in the State Building Norms of Ukraine A.2.2-1-2003.

LCME "Teplocomunenergo" has the necessary Environmental Impact Assessment for its activity according to Ukrainian legislation.

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

1. Project implementation will allow saving over 35.8 million Nm^3 of natural gas and over 710 ton of coal per year starting from 2012. Natural gas and coal are a non-renewable resources and its economy is important.

2. Project implementation will reduce CO_2 emissions in Luhansk city by 165.7 thousand tons per year starting from 2012 due to increased boilers efficiencies, achieved through installation of up-to-date boiler equipment, particularly new boilers, CHP units, heat exchangers and installation of pre-insulated networks pipes instead of existing regular networks pipes.

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 service population of Luhansk city will reduce electricity consumption from electric heaters thus reducing power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

Requirements for Environmental Impact Assessment are listed in the State Building Norms of Ukraine A.2.2-1-2003.

LCME "Teplocomunenergo" has the appropriately approved Environmental Impact Assessments (EIA) for all capital constructions.

For reconstructed objects that require Environmental Impact Assessment according to Ukrainian legislation PE "Firma Priroda" has developed EIA as a separate section of the project. Calculations of contaminant dispersion to atmosphere were made by the program complex "EOL plus" in accordance with requirements ОНД-86 "Methodology of calculation of concentration in atmosphere contaminant that containing in enterprisers emissions.

There is "Technical report on inventory taking of contaminant emissions sources at the enterprise LCME "Teplocomunenergo" presented in the Appendix_ 10_ EIA of the PDD version 06. It was developed by PE "Firma Priroda" in 2007.

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

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 LCME "Teplocomunenergo" 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:

1) Reduction of NO_x, SO_x, CO and PM due to application of cleaner technologies at boiler houses;
2) Reduction of electricity consumption results in lower emissions of the same air pollutants;
3) Heat stress on the atmosphere (due to lower temperatures of flue gases);
4) 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.

According to the “Law on waste products”, (article 17) ”Obligations of economical activity subjects in sphere of waste treatment”

- enterprises must apply statistic reports on waste creating, gathering, transporting keeping, treating, utilizing, decontaminating and excreting.
- provide complete gathering, appropriate keeping and non-admission waste destruction and spoilage, for utilization of which there is an appropriate technology in Ukraine.

Reasoning from aforesaid LCME “Teplocomunenergo” delivers old equipment to metal recycling.

SECTION G. Stakeholders’ comments

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

As project activity won’t provide negative influence on environment and negative social effect, special public discussion was not hold. The authorities of Luhansk city have expressed the support for the project.

Project “Rehabilitation of the District Heating System in Luhansk City” was presented at the XVII (Yalta, June 5-9, 2007) and XVIII (Yalta, June 10-14, 2008) International Conferences “Problems of Ecology and Exploitation of Energy Objects”, where it was comprehensively discussed with representatives of governmental and district heating organizations.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

See Section B for the Baseline information

Annex 3

MONITORING PLAN

1. REHABILITATION OF THE DISTRICT HEATING SYSTEM IN LUHANSK CITY

This monitoring plan describes the methodology that will be used to calculate the ongoing amount of greenhouse gas emission reduction units (ERUs) resulting from installation and commissioning of the JI project in Luhansk City. Upgrades to the district heating system are expected to result in improved system performance. Each component of the JI project is expected to result in a reduction in greenhouse gas emissions. The reduction in greenhouse gas emissions will be quantified using the methodology presented in this Monitoring Plan.

2. PROJECT DESCRIPTION

Project includes 135 boiler-houses with 344 boilers (total connected load 550 Gkal/hour, 2006) and 269 km of heat distributing networks, that are managed by LCME "Teplocomunenergo".

Measures that will be used to improve the efficiency of LCME "Teplocomunenergo" utility are as follows:

- Old operating boilers with low efficiency will be replaced by the new highly efficient ones that will result in efficiency increase from 70-82% up to 90-93%.
- Boilers rehabilitation with burners and automatic equipment replacement
- Switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment.
- Contact and surface heat-recovery gas-cleaning apparatuses (utilizers), including developed by the Institute of Engineering Ecology, will be installed in order to utilize and recover the exhaust gases heat as well as the additional heat of steam condensation, occurring when the temperature of exhaust gases fall below dew point. The implementation of this technology will result in increasing the fuel consumption efficiency by 6-8%.
- Obsolete coal-fired boilers will be mostly replaced by the new electric boilers.
- The reconstruction of heat distribution networks system will help to reduce heat losses down to 1-2 % per km by replacing of the main and distribution networks pipes with diameter 57 mm -820 mm by the pre-insulated ones.
- Improvement of the heat networks system organization will be provided by liquidation of heating schema with open heat-carrying agent pumping for hot water supply service and with simultaneous installation of heat exchangers directly at the consumers houses (Individual Heating Point – IHP). It is necessary to install 630 lamellar heat exchangers. Due to this reconstruction, it will enable to liquidate pipes with different diameters, to reduce heat losses and to reduce power consumption for power supply of circulation pumps.
- Installation of cogeneration units will result in increasing the fuel consumption efficiency, decreasing of dependence on the grid power supply, improvement of operational stability and reliability, decreasing of power consumption from power stations, decreasing of power transfer losses, and decreasing of environmental pollution.

- Project of modernization of heating system of Zhovtneviy leaving region provides building of the Heat Pump Station (HPS) at the sewage disposal plant, that is situated near the boiler-house “Shidna”. It will realize raw water heating due to utilization of sewage water heat and heat from cogeneration units. Heat Pumps will use power from cogeneration units and produce heat energy with COP 3.5. It will allow to reduce heat energy demand from boilers at the boiler house “Shidna” and to save natural gas at this boiler-house. Heat Pump Station will consist of 6 Heat Pumps and 2 cogeneration units. Total Heat capacity of CHP will bes – 6.2 MW, electric capacity of CHP- 6.7 MW, Heat capacity of Heat pumps will b 18.6 MW.
- Installation of frequency controllers at hot water pumps’ motors will result in energy saving. Those regulators make it possible to change actual capacity of the motors depending on connected load, both as during a day when water consumption is changes, and during a year when in summer motors work only for hot water supply.

3. MONITORING METHODOLOGY

Relevant monitoring methodologies

In course of development of the project **“Rehabilitation of the District Heating System in Luhansk City”**, the **own-developed methodology** was used that is partly similar to “Baseline and monitoring methodology AM0044”. The project “Rehabilitation of the District Heating System in Luhansk city” has some differences from applicability conditions of this methodology.
The main cause of impossibility of using the methodology AM0044 for baseline calculation is absence of data for heat energy output, because of heat energy meters absence at the majority of boiler houses included in the project. That’s why “SVT e.V.” (Germany) and Institute of Engineering Ecology (Ukraine) have developed the project specific methodology, which takes into account all activity involved in the project and its peculiarities.

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of direct monitoring devices for heat and heat-carrier expenditure in the municipal boiler-houses. Only such main characteristic as 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 $EG_{PJ, i, y}$ – the thermal energy output of project boiler i in year y (pages 9, 13 of Methodology AM0044), that 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 such kind of modernization as well as some others such as the replacement of burner equipment, installation of cogeneration units, etc.

The developed project specific "Methodology" is based on the permanent monitoring of fuel consumption and on the account of various other factors, such as connection or disconnection of the consumers, change of fuel heating value, weather conditions change, ratio of the heat consumption for heating and for hot water supply, consumption for own needs, 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 report, 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 "District Heating System Rehabilitation of Chernihiv Region", "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System in Crimea", "Rehabilitation of the District Heating System in Kharkiv city" and others, is the most appropriate, precise, corresponding to the principle of conservatism, and in the most closely manner reflects the aims, goals and spirit of Kyoto Protocol.

The baseline study will be fulfilled every year of the emission reduction selling, to correct adjustment factors which have an influence at the baseline.

<u>Monitoring methodology developed for "District Heating" projects in Ukrainian conditions</u>

Monitoring methodology developed for "District Heating" projects in Ukrainian conditions is presented in section D.1.1. of this PDD (Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario).

<u>Formulae for monitoring</u>

Formulae used for computing project emissions, baseline emissions and the total emission reduction are presented in the tables below.

Total emission reduction

The total annual emission reduction is the difference between the baseline emissions and the project emissions.

Formula 1 – Total emission reduction (ERUs)	
	ERUs = $\sum[E_i^b - E_i^r]$; [t CO_2e]
	ERUs - Total annual emission reduction [t CO_2e] E^b_i - Baseline CO_2 emissions [t CO_2e] E^r_i - CO_2 emissions in the reported year [t CO_2e]
	The sum is taken over all boiler-houses (i) which are included into the project

Project emissions

Formula 2 –Emissions in the reported year **(**E^r**)**	
	$E_i^r = E_{1i}^r + E_{gen\ i}^r + E_{cons\ i}^r$; [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 generated by included into the project objects in the reported year, t CO_2e; $E_{cons\ i}^r$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the reported year, t CO_2e.

Formula 3 – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, (E_{1i}^r)	
	$E_{1i}^r = LHV_r * Cef_r * B_{ri}$, [tCO2-eq.]
	LHV_{ri} – Average annual lower heating value, MJ/m^3 (MJ/kg) Average annual Heating Value is calculated for every town; Cef – carbon emission factor, ktCO_2/TJ; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons;

Formula 4 – CO_2 emissions due to electric power generated by included into the project objects in the reported year ($E_{gen\ i}^r$)	
	$E_{gen}^r = (W_b - W_r)*CEF_g + [(Q_b - Q_r)*f_b/1000 + B_g]* LHV_r * Cef$
	W_b – scheduled electric power production by the all new CHP units, MWh; W_r – electric power production by the installed new CHP units, and additional power production by the CHP at the HPS (that is not used for Heat Pump) in reported year, MWh; CEF_g – Carbon Emission factor for electricity generation in Ukraine, t CO_2e/MWh; Q_b – scheduled heat energy production by the all new CHP units, MWh; Q_r – 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;

Formula 5 – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the reported year ($E_{cons\ i}^{r}$)	
	$E_{cons\ i}^{r} = P_r*CEF_c$
	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;

Baseline emissions

Formula 6 – Annual baseline emissions **(**E_b)	
	$E_i^b = E_{1i}^b + E_{gen\ i}^b + E_{cons\ i}^b$; [t CO_2e]
	E_{1i}^b – baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house , 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 (consumed from greed, amount to be substituted in the reported year), t CO_2e; $E_{cons\ i}^b$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the base year, t CO_2e.

Formula 7 – Baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house, (E_{1i}^b)	
	For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is: $E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$, where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply. For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is: $E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.
	LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg); Cef – carbon emission factor, $KtCO_2/TJ$; B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tons; K_1, $K_h = K_2* K_3* K_4$; $K_w = K_5 * K_6 * K_7$ – adjustment factors; a_b – portion of fuel (heat), consumed for heating purposes in the base year; $(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year; a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

Formula 8 – Portion of fuel (heat), consumed for heating purposes in the base year (a_b)	
	$a_b = L_h^b*q*N_h^b/ (L_h^b*g*N_h^b+L_w^b*N_w^b)$;

	L_h^b– maximum connected load required for heating in the base year, MW; L_w^b– connected load required for hot water supply service in the base year, MW; g – recalculating factor for average load during heating period (usually 0.4-0.8); N_h^b– duration of heating period in the base year , hours; N_w^b – duration of hot water supply service in the base year, hours.

Formula 9 – Portion of fuel (heat), consumed for heating purposes in the reported year (a_r)	
	$a_r = L_h^r*q*N_h^r / (L_h^r*g*N_h^r+L_w^r*N_w^r)$
	L_h^r– maximum connected load required for heating in the reported year, MW; L_w^r– connected load required for hot water supply service in the reported year, MW; g – recalculating factor for average load during heating period (usually 0.4-0.8); N_h^r– duration of heating period in the reported year, hours; N_w^r– duration of hot water supply service in the reported year, hours.

Formula 10 – Change in the lower heating value (K_1)	
	$K_1=LHV_b/LHV_r$
	LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg); LHV_r – Average annual lower heating value in the reported year, MJ/m^3 (MJ/kg)

Formula 11 – Temperature change factor (K_2)	
	$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$
	$T_{in\ r}$ – average inside temperature for the heating period in the reported year, K (or ^{0}C); $T_{in\ b}$ – average inside temperature for the heating period in the base year, K (or ^{0}C); $T_{out\ r}$– average outside temperature for the heating period in the reported year , K (or ^{0}C); $T_{out\ b}$– average outside temperature for the heating period in the reported year , K (or ^{0}C)

Formula 12 – Heating area and building thermal insulation change factor (K_3)	
	$K_3 = [(F_{h\ r} – F_{h\ t\ r} – F_{h\ n\ r})*k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r})*k_{h\ n}] / F_{h\ b}*k_{h\ b}$,
	$F_{h\ b}$ – heating area in the base year, m^2; $F_{h\ r}$ – heating area in the reported year, m^2; $F_{h\ n\ r}$ – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2; $F_{h\ t\ r}$ – heating area of buildings (previously existed in the base year) in reported year with the

	renewed (improved) thermal insulation, m^2; $k_{h\ b}$ – average heat transfer factor of heated buildings in the base year, (W/m^2*K); $k_{h\ n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), (W/m^2*K).

Formula 13 – Heating period duration change factor (K_4)	
	$K_4=N_{hr}/N_{hb}$
	N_{hb},– duration of heating period in the base year, hours N_{hr} – duration of heating period in the reported year, hours

Formula 14 – Number of customers change factor (K_5)	
	$K_5 =n_{wr} / n_{wb}$
	N_{wb},– number of customers in base year; N_{wr} – number of customers in the reported year

Formula 15 – Standard specific discharge of hot water per personal account change factor (K_6)	
	$K_6 = v_{w\ r} / v_{w\ b}$
	$v_{w\ r}$ – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h); $v_{w\ b}$ – standard specific discharge of hot water per personal account in the base year, (in heat units, kWh/h).

Formula 16 – Hot water supply period duration change factor (K_6)	
	$K_7 = N_{wr}/ N_{wb}$
	N_{wr}– duration of hot water supply service in the reported year, hours. N_{wb} – duration of hot water supply service in the base year, hours.

Formula 17 – CO_2 emissions due to electric power generation associated to the project for an i boiler-

house in the base year ($E_{gen\ i}^{b}$)	
	$E_{gen}^{b} = W_b*CEF_g + Q_b*f_b/1000* LHV_r* Cef$
	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; 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; LHV_r – Average annual lower heating value in reported year, MJ/m^3 (MJ/kg) Cef – carbon emission factor, $ktCO_2/TJ$;

Formula 18 – CO_2 emissions due to electric power consumption for an i boiler-house in the base year ($E_{cons\ i}^{b}$)	
	$E_{cons}^{b} = P_b*CEF_c$
	P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented in the base year, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

4. MONITORING OF BASELINE AND PROJECT EMISSIONS

Parameters to be monitored

Monitoring methodology identifies and takes into account the parameters that are need to be measured or monitored at regular intervals. These parameters will then be input into a project Tracking Database, which will be an Excel based spreadsheet that will track GHG emission reductions annually.
List of parameters to be monitored are in the table below.

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	($\mathbf{B_b}$) and ($\mathbf{B_r}$)	Fuel consumption at boiler houses		m
1.1		Natural Gas	m^3	
1.2		Coal	ton	
2	($\mathbf{LHV_b}$) and ($\mathbf{LHV_r}$)	Average annual Heating Value of a fuel calculated by Lower Heating Value		m, c
2.1		Natural Gas	MJ/m^3	
2.2		Coal	MJ/kg	
3	($\mathbf{T_{out\ b}}$) and ($\mathbf{T_{out\ r}}$)	Average outside temperature during the heating season	^0C (K)	m, c
4	($\mathbf{T_{in\ b}}$) and ($\mathbf{T_{in\ r}}$)	Average inside temperature during the heating season	^0C (K)	m, c
5	($\mathbf{n_{wb}}$ and ($\mathbf{n_{wr}}$)	Number of Customers		Statistics
6	($\mathbf{F_{h\ b}}$ and ($\mathbf{F_{h\ r}}$)	Heating area (total)	m^2	Statistics
7	($\mathbf{k_{hb}}$)	Average heat transfer factor of heated buildings in the base year	W/m^2*K	c
8	($\mathbf{F_{h\ t\ r}}$)	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year	m^2	Statistics
9	($\mathbf{F_{h\ n\ r}}$)	Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m^2	Statistics
10	($\mathbf{k_{h\ n}}$)	Heat transfer factor of buildings with the new thermal insulation	W/m^2*K	Normative documents
11	($\mathbf{N_{h\ b}}$) and ($\mathbf{N_{h\ r}}$)	Duration of the heating period	Hours	m
12	($\mathbf{N_{w\ b}}$) and ($\mathbf{N_{w\ r}}$)	Duration of the hot water supply period	Hours	m
13	($\mathbf{L_h^b}$) and ($\mathbf{L_h^r}$)	Maximum connected load to the boiler-house, that is required for heating	MW	c
14	($\mathbf{L_w^b}$) and ($\mathbf{L_w^r}$)	Connected load to the boiler-house, that is required for hot water supply service	MW	c

15	(**$v_{w\,r}$**) and (**$v_{w\,b}$**)	Standard specific discharge of hot water per personal account	kWh/h	Normative documents
16	(**Cef_r**) and (**Cef_b**)	Carbon emission factor		Normative documents
16.1		Natural Gas	kt CO_2/TJ	
16.2		Coal	kt CO_2/TJ	
17	**g**	Recalculating factor for average load during heating period		Statistics
18	(**W_b**) and (**W_r**)	Scheduled electric power production by the all new CHP units and electric power generation by the installed new CHP units in reported year, MWh	MWh	c/m
19	(**Q_b**) and (**Q_r**)	Scheduled heat power production by the all new CHP units and heat power generation by the installed new CHP units in reported year, MWh	MWh	c/m
20	(**P_b**) and (**P_r**)	Electric power consumption by the boiler-houses and heating points where energy saving measures are scheduled to be implemented	MWh	m

Data to be monitored

Parameter number and name	**1.1** Natural gas consumption at boiler houses
Description	Natural gas consumption at boiler houses. Consumption of fuel is the main parameter affecting greenhouse gas emissions. The most objective and accurate indicator of project performance will therefore be the changes in fuel consumption. Changes in fuel consumption in result of the project implementation, when compared to baseline fuel consumption, will integrate all other relevant indicators such as improvement of boiler efficiency, reduction of network losses, etc.
Monitoring method	Gas flow meters
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	n.a.

Parameter number and name	**1.2** Coal consumption at boiler houses
Description	Coal consumption at boiler houses
Monitoring method	Purchasing of coal is realized in accordance with invoices. Consumption of coal is measured by wheelbarrows and pails then recalculated to weight

Recording frequency	Every day
Background data	Coal consumption is registered in the paper journals at every boiler-house. Invoices are filed in special journals.
Calculation method	n.a.

Parameter number and name	**2.1** Average annual Heating Value of Natural Gas
Description	Average annual Heating Value of Natural Gas calculated by Lower Heating Value for every town
Monitoring method	Accepted in accordance with reference or telephone message from natural gas supplier or independent chemical lab analysis report. Independent chemical lab analysis is used in questionable cases. It is used rarely.
Recording frequency	Data is provided by natural gas suppliers usually 3 times per month
Background data	Registered in the paper journal
Calculation method	Weighted average value

Parameter number and name	**2.2** Average annual Heating Value of Coal
Description	Average annual Heating Value of Coal calculated by Lower Heating Value for every town
Monitoring method	Accepted in accordance with quality certificate from coal supplier's or independent chemical lab analysis report. Independent chemical lab analysis is used in contentious cases. It is used rarely.
Recording frequency	Quality certificate is given by coal supplier's for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value

Parameter number and name	**3.** Average outside temperature during the heating season
Description	Average outside temperature during the heating season
Monitoring method	Average outside temperature during the heating season is calculated by LCME “Teplocomunenergo” from the daily outside temperature values taken by dispatcher of LCME “Teplocomunenergo” from Luhansk Meteorological Centre from 10 to 11 a.m. every day of heating season.
Recording frequency	Once per heating season. Daily temperature is registered every day of heating season

Background data	Meteorological Centre sends the Report every decade or month for every day of heating season. Reports are filed in special journals
Calculation method	Average value

Parameter number and name	**4.** Average inside temperature during the heating season
Description	Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied) Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative. Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.
Monitoring method	Sum of returned payments
Recording frequency	Once per heating season
Background data	Sums of return payment
Calculation method	According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, the enterprises must make the return payments to population for delivery less than necessary amount of heat. The normative inside temperature should be not lower than 18 ^{o}C. Amount of the return payment is: – 5% from normative payment for every degree from 18 to 12 ^{o}C; – 10% from normative payment for every degree from 12 to 5 ^{o}C; – when inside temperature is lower than 5 ^{o}C the payment is to be returned completely. Therefore the inside temperature will be calculated by formulae: If R = 0 (according to conservatism principle for the baseline assume R < 0.05): $\mathbf{T_{in\ b}} = 18\ ^oC$. If $0.05 < R \leq 0.3$ NP: $\mathbf{T_{in\ b}} = 18 - (R/5)\ [^oC]$ If 0.3 NP < R < NP: $\mathbf{T_{in\ b}} = 12 - [(R - 0.3\ NP)/10]\ [^oC]$ where: R - % of return payment from NP; NP – amount of normative payment. Thus if the inside temperature will be 18 ^{o}C or higher we will accept it as 18 ^{o}C according to conservatism principle, if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented before.

Parameter number and name	**5.** Number of Customers for hot water supply service
Description	Number of Customers for hot water supply service for every boiler houses
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Contracts with population, organizations and legal entities are concludes directly with LCME "Teplocomunenergo". They are updated once per year.
Background data	The information is collected in special electronic journals "Registration of income from population" (for inhabitants). For organizations and legal entities such information is taken from contracts concluded with them
Calculation method	

Parameter number and name	**6.** Heating area (Total)
Description	Heating area for every boiler houses
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	The revise is made in case of new contracts with Customers or in case of contracts break.
Background data	The information is collected at the sale departments of LCME "Teplocomunenergo" by the certificates of owners in accordance with technical passport of building. Total area with balconies and stairs and Heating area are displayed in the special journal
Calculation method	The data is taken for January, 01 for every year

Parameter number and name	**7.** Heat transfer factor of buildings
Description	Heat transfer factor of buildings for every boiler-house
Monitoring method	Statistics LCME "Teplocomunenergo"
Recording frequency	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any heating area to boiler-houses included in project.
Background data	
Calculation method	For calculation of Heat transfer factor of buildings for every boiler-house, the method of Weighted average value was used, that depends on heating area of existing buildings and heating area of the new buildings. Values of the heat transfer factor for existing buildings were taken from SNiP 2-3-79 (1998) - not higher than 0.63. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms (B.2.6-31:2006) - not higher than 0.36.

Parameter number and name	**8.** Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heating area of reconstructed buildings with application of new insulations for walls

Monitoring method	Statistics of LCME “Teplocomunenergo”
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name	**9.** Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heating area of newly connected buildings with application of the new insulation for walls
Monitoring method	Statistics of LCME “Teplocomunenergo”
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name)	**10.** Heat transfer factor of new buildings and buildings with new thermal insulation
Description	Heat transfer factor of buildings with new thermal insulation
Monitoring method	According to State Buildings Norms (B.2.6-31:2006)
Recording frequency	
Background data	
Calculation method	

Parameter number and name	**11.** Heating period duration
Description	Heating period duration in every town
Monitoring method	Measured by LCME “Teplocomunenergo”
Recording frequency	Once per year
Background data	The duration of the Heating period is accepted in accordance with item 7.9.4 of “Rules of technical exploitation of heating equipment and networks. 2007”. Beginning and ending of the heating period are determined in every town separately. The heating period begins if the average daily outside temperature is 8 ^{o}C or lower during 3 days, and finishes if average daily outside temperature is 8 ^{o}C or higher during 3 days. According to SNiP 2.01.01-84 (Climatology in heating engineering) the duration of heating period for project development is to be taken as 183 days, and usually it is from October,15, till April 15.
Calculation method	

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for every boiler house.
Monitoring method	Measured by LCME “Teplocomunenergo”
Recording frequency	Once per day

Background data	Hot water supply service is realized by hot water delivery schedule for every town. There are two types of Hot water supply service shadule - 24 houers per day throughout the year and 24 houers per day only in the heating period. Hot water supply service is foreseen. There is a plan of disconnection of load for Hot water supply service for maintenance and preventive measures for every boiler-house.
Calculation method	

Parameter number and name	**13.** Maximum connected load to the boiler-house, that is required for heating
Description	Maximum connected load to the boiler-house, that is required for heating.
Monitoring method	Calculated by LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	Maximum connected load to the boiler-house, that is required for heating, is calculated by LCME "Teplocomunenergo" for every heating season. It is calculated according to heat demand at outside temperature -25 ^{o}C.
Calculation method	

Parameter number and name	**14.** Connected load to the boiler-house, that is required for hot water supply service
Description	Connected load to the boiler-house, that is required for providing the hot water supply service
Monitoring method	Calculated by LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	Connected load to the boiler-house, that is required for hot water supply service, is calculated by LCME "Teplocomunenergo" every year according to contracts with consumers.
Calculation method	

Parameter number and name	**15.** Standard specific discharge of hot water per personal account
Description	Standard specific discharge of hot water per personal account
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	At present the standard specific discharge of hot water is valid in Ukraine that was established by the "KTM 204 Ukraine 244-94" in 1993, and no information is available on any propositions to change it.
Calculation method	

Parameter number and name	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels
Monitoring method	Normative documents
Recording frequency	Once per year

Background data	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 (coal) = 0.0946 $ktCO_2$/TJ; (taken as "Other bituminous coal").
Calculation method	

Parameter number and name	**17.** Recalculating factor for average load during heating period
Description	Recalculating factor for determination of the average load during heating period
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	Recalculating factor for average load during heating period is determined for each boiler-house on historical base, usually it is in the range (0,4 – 0,8)
Calculation method	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min})$ where: g – recalculating factor for average load during heating period; F_h – heating area of buildings, m^2; k_h – average heat transfer factor of heated buildings,(W/m^2*K); T_{in} – average inside temperature for the heating period, K ; $T_{out\ av}$ – average outside temperature for the heating period, K (or ^0C); $T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^0C).

Parameter number and name	**18.** Electric power generation
Description	Electric power generation by the installed new CHP units
Monitoring method	Measurement of generated electricity by power meter
Recording frequency	Every day
Background data	
Calculation method	

Parameter number and name	**19.** Heat power generation
Description	Heat power generation by the installed new CHP units
Monitoring method	Measurement of generated eheat energy by Heat flow meter
Recording frequency	Every day
Background data	
Calculation method	

Parameter number and name	**20.** Electric power consumption
Description	Electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented
Monitoring method	Measurement by Electricity supply meters
Recording frequency	Every day
Background data	Electric power consumption should be measured at the boiler-houses where energy saving measures are scheduled to be implemented, for example:: 1. Boiler-houses, in the heating area of which, installation of heat exchangers will be take place. 2. Boiler-houses where replacement of pumps will be take place. 3. Boiler-houses, where frequency controllers will be installed
Calculation method	

Scheme of monitoring system

The control and monitoring system comes to fuel consumption measurement. Other parameters are defined by calculations or taken from statistic data. Fuel consumption measurement is realized at the Gas distributing units of the boiler-houses. Gas registration is carring out in volume units reduced to standard conditions by means of automatic correction for temperature and pressure. The scheme of typical Gas distribution unit is shown at the Fig. 1.

The typical Gas distributing system usually consists of the following equipment:

- Gas filter;
- Control and measuring devices for gas operation pressure measurement and control of pressure difference at the gas filter;
- Gas flow meter;
- stop valve;
- bypass facility.

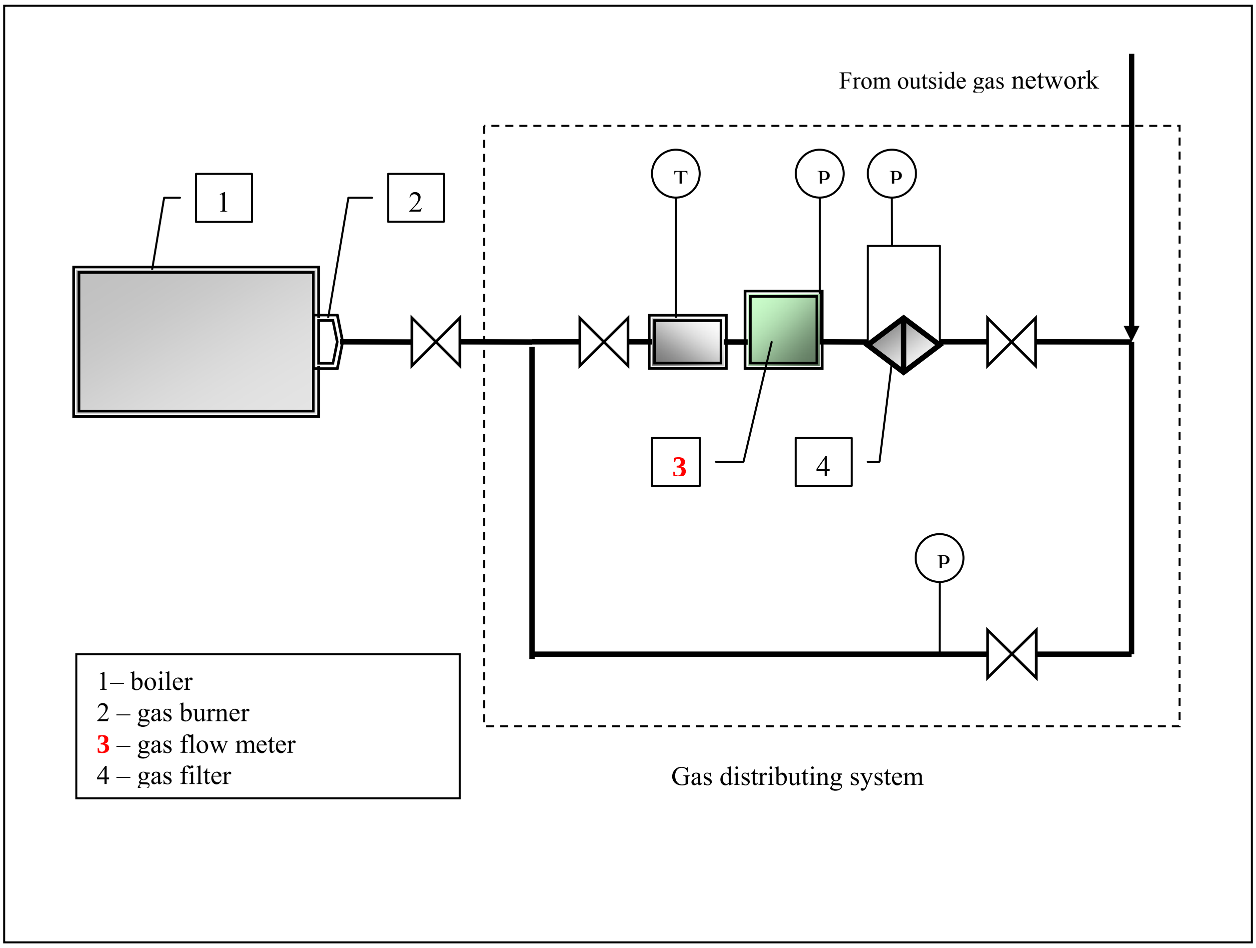

Fig. 1. Scheme of the Gas distribution system

The typical scheme of monitoring system for boiler-house where the CHP units will be installed is shown at the Fig. 2. Usually it consists of the following equipment:

GFM – gas flow meter;

HFM – heat flow meter with sensors;
GEM - generated electricity meter;
CP - control panel of gas engine-generator machine

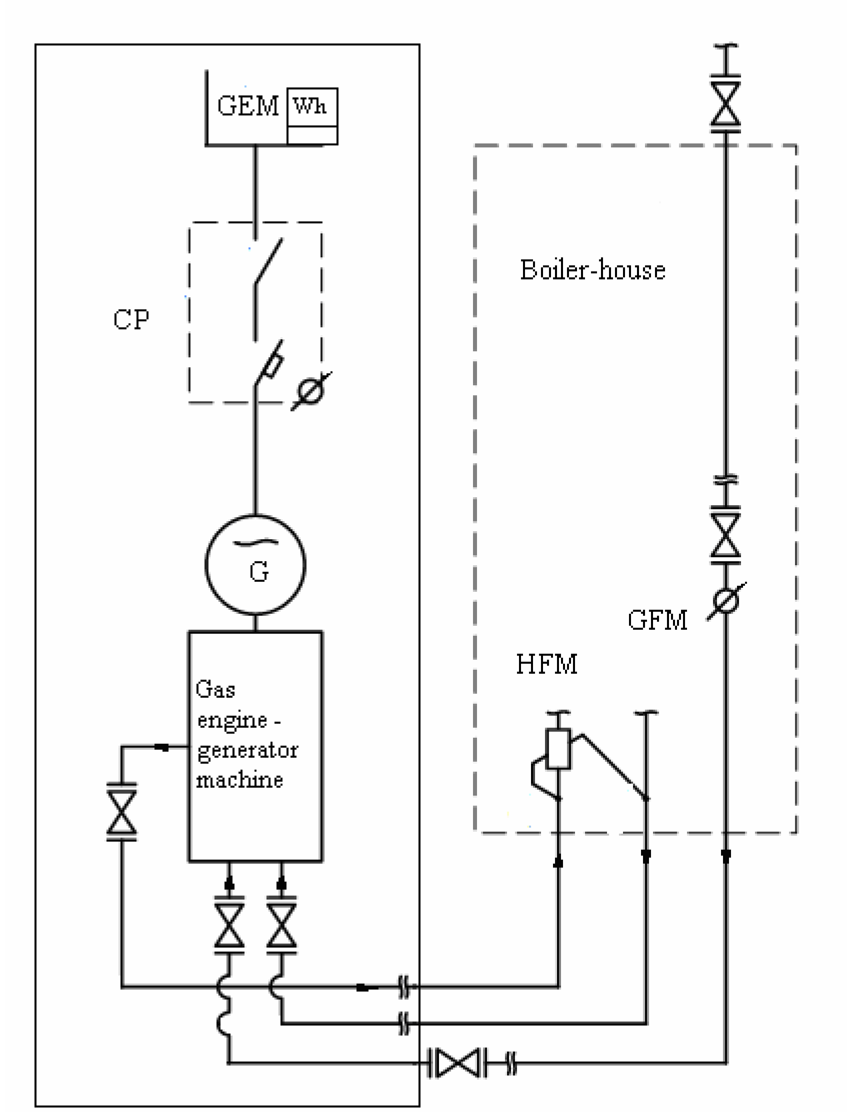

Fig. 2. Scheme of monitoring system for boiler-house where the CHP units will be installed

Monitoring equipment

The equipment to be used by the project executor for monitoring of the relevant parameters are summarized in Table 1. The table also provides information on equipment type, calibration and procedures to follow in case of equipment failure.

ID number and data variable	Equipment	Accuracy	Calibration	Frequency	Procedure in case of failure
1.1 Natural Gas consumption	Gas flow meters	+/-(0.5…2)% Usually 1%	JSC “Luhansk State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.
17. Power consumption	Electricity supply meters	+/-(0.2…0.5)% Usually 0.2%	JSC “Luhansk State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.
18. Power production by the new CHP unit	Generated electricity meter	+/-(0.2…0.5)% Usually 0.2%	JSC “Luhansk State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.
19. Heat production by the new CHP unit	Heat flow meter	+/-2.0%	JSC “Luhansk State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.

Table 1. Monitoring equipment

Level of uncertainty and errors

Possible uncertainty and errors for such type project may arise from two main reasins: measurement and stipulation. Measurement error is due to metering equipment inaccuracies. Stipulation occurs when some values are required to complete calculations, but these values cannot be measured directly. In these cases estimates are used in place of actual measurements, and therefore error may be introduced. The stipulation error itself may be estimated based on the expected accuracy of the stipulated values.

The project error can be calculated from the two error components described above. The total project error (Standard Error, SE) can be calculated by taking the square root of the sum of the squares of the individual error components, as below:
$SE = \sqrt{[(\text{measurement error})^2 + (\text{stipulation error})^2]}$

The monitoring plan developed for this project does not rely on any estimates and is therefore free of any stipulation errors.

Thus, $SE = \sqrt{[(\text{measurement error})^2 + (0)^2]} = (\text{measurement error})$

Although the project has 20 monitoring points, only four of these (quantity of natural gas consumption, power consumption, power production on the new CHP and heat production on the new CHP unit) are measured directly. The remaining monitoring points used in calculation of the baseline and project line emissions are taken as statistic data. Furthermore, they are used for adjustment factors calculation. Calculations of adjustment factors are based on reported and base year parameters ratio. For example, temperature change factor is calculated as ratio of inside and outside temperature differences in reported and base years: $K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$. Therefore any error in statistic data will be cancelled.

The four measurement errors (maximal values) which impact on the Standard Error and their level of accuracy are presented in Table 2.

ID number and data variable	Measurement error (maximal)	Comment
1.1 Natural Gas consumption	± 1.0%	Accuracy of data is high due to necessity of information for commercial account purposes.
18. Power production by the new CHP unit	±0.5%	Accuracy of data is high due to necessity of information for account purposes.
19. Heat production by the new CHP unit	±1.0%	Accuracy of data is high due to necessity of information for account purposes.
20. Power consumption	± 0.5%	Accuracy of data is high due to necessity of information for commercial account purposes.

Table 2: Measurement errors (accuracy) for standard error

5. MONITORING OF ENVIRONMENTAL IMPACTS

As the project involves rehabilitation of an existing district heating network leading to an improvement of energy efficiency and therefore better environmental performance of the system, and is not a new build project, no negative environmental impacts are expected, and therefore no formal environmental impact assessment is required by the relevant Ukrainian authorities.
There is therefore no need to monitor specified environmental impact indicators during implementation and operation of the project activities.

6. PROJECT MANAGEMENT PLANNING

The overall responsibility for the project management and implementation is carried out by the director of LCME "Teplocomunenergo", Mr. Oleksiy Rusakov, and appointed responsible persons leaded by Mr. Yuriy Negriy, Chief engineer of LCME "Teplocomunenergo". The stuff of PTD is responsible for project activity.

Compliance of the project activity with the operational requirements is constantly controlled by responsible stuff of a boiler-house, and according to their reports – by PTD.
Possible bottlenecks and mistakes in project implementation should be identified and solved by responsible stuff of PTD.

Responsibilities for data collection

The director of LCME "Teplocomunenergo", Mr. Oleksiy Rusakov, appointed the responsible person, Mr. Andriy Repin, for the implementation and management of the monitoring process at the LCME "Teplocomunenergo". Mr. Yuriy Negriy is responsible for supervising of data collection, measurements, calibration, data recording and storage.
Dr. Dmitri Paderno, vice director of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development.
Ms. Tetiana Grechko, senior engineer of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development and data processing.

Data collection for fuel consumption is providing in the following way:

1. All boiler-houses are equipped with gas flow meters.

2. Operators of all boiler-houses register the instrument readings in the paper journals "Journal of registration of boiler-house's operation parameters" every day.

3. At the boiler-houses that are not equipped with gas volume correctors (at present about 2% of the total number of boiler-houses), operators register parameters of gas: temperature and pressure in these journals every 2 hours. These parameters are used to bring gas consumption to normal conditions.

4. Every day operators transfer values of gas consumption to dispatcher of the regional branch of LCME "Teplocomunenergo" by phone. Monthly they transfer the paper report.

5. Regional branches transfer data to Production-Technical Department (PTD) of LCME "Teplocomunenergo" where they are storing and used for payments with gas suppliers.

Scheme of data collection for Monitoring Report is shown at the Fig. 3.

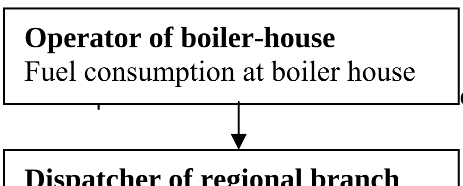

Fig.3. Scheme of data collection for Monitoring Report

Trainings

As far as the main activity of LCME "Teplocomunenergo" will not change in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprise has sufficient knowledge and experience for implmentation of the project activity and maintenance of the usual equipment.
In cases of the new (never used at this enterprise before, for example: cogeneration units, foreign produced boilers, etc.) equipment installation, the company - producer of this equipment should provide trainings for personnel.
LCME "Teplocomunenergo" provides personnel retraining according to protection of labour norms. The enterprise has the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

In course of the JI project development (starting from 2004), specialists of Institute of Engineering Ecology and carried out a comprehensive consultations and trainings for involved representatives of LCME "Teplocomunenergo" on the necessary data collection according to Monitoring plan for the project.

The special training is scheduled to be held before the development of the Monitoring report, in January, 2010.

The special group was organized consisted of representatives of LCME "Teplocomunenergo" and Institute of Engineering Ecology, in particular:
Oleksiy Rusakov - LCME "Teplocomunenergo", Director;
Yuriy Negriy - LCME "Teplocomunenergo", Chief engineer;
Eleonora Schigoleva - LCME "Teplocomunenergo", Engineer of technical development group of industrial safety department;
Tetiana Grechko - Institute of Engineering Ecology, senior engineer;
Dmitri Paderno - Institute of Engineering Ecology, vice director.

The responcible stuff of the Production-Technical Service of LCME "Teplocomunenergo" is involved in this process.

Responsibilities for data management

All collected data will be transferred to Yuriy Negriy, who will be responsible for data storage and archiving, entry of the data into the monitoring spreadsheets. Tetiana Grechko will be responsible for the data processing according to methodology and for development of Monitoring Report. Support in co-ordination of verification process will be undertaken by Dmitry Paderno. Responsibilities for data management are presented in Table 3.

Activity	Responsible person	
	Name	Position and department
Data storage and archiving	Natalia Balalaeva	chief of PTD of LCME "Teplocomunenergo"
Data storage and archiving	Oksana Konstantinenko	Chief of Heat –Sale Department of LCME "Teplocomunenergo"
Data storage and archiving	Ekaterina Scherbakova	Chief of consumers Department of LCME "Teplocomunenergo"
Data storage and archiving	Andriy Ulchenko	Chif of Metrology department of LCME "Teplocomunenergo"
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Eleonora Schigoleva	Engineer of technical development group of industrial safety department of LCME "Teplocomunenergo"
Data monitoring and reporting, coordination of verification process	Yuriy Negriy	Chief engineer of LCME "Teplocomunenergo"
Data processing according to methodology, development of Monitoring Report	Tetiana Grechko	Senior engineer of Institute of Engineering Ecology, Ltd
Support in coordination of verification process	Dmitri Paderno	Vice Director of Institute of Engineering Ecology, Ltd

Table 3: Responsibilities for data management