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

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Annexes

SECTION A. General description of the project

A.1. Title of the project:

"Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region"

Sectoral scopes:

1. Energy industries (renewable - / non-renewable sources);
2. Energy distribution;
3. Energy demand.

PDD Version: 04, dated August 2, 2011.

A.2. Description of the project:

Project objective is to reduce greenhouse gas emissions due to fuel, in particular natural gas (which is imported to Ukraine) and coal, consumption reduction, as well as power consumption reduction, by means of rehabilitation of the district heating system in Cities of Donetsk region, including boiler-houses and distribution network equipment replacement and rehabilitation. The purpose of the project is sustainable development of the Cities of Donetsk region through implementation of energy saving technologies.

Regional Municipal Enterprise (RME) "Donetskteplocomunenergo" is one of the main enterprises in field of production and distribution of the heat energy in Donetsk region. Municipal Enterprise (ME) "Makiivteplomerezha" is the main heat supply organization in Makiivka City. Municipal Commercial Enterprise (MCE) "Mariupolteplomerezha" is the main heat supply organization in Mariupol City. "Artemivsk-Energy", Ltd. is one of the main heat supply organizations in Artemivsk City. They sell 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 «Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region» was initiated in 2006 to rehabilitate district heating systems in Cities of Donetsk Region, including boiler and distribution network equipment replacement and rehabilitation, and installation of cogeneration units as well as frequency controllers installation, heat exchangers and pumps replacement, transition from the existing central heat points (CHP) to individual heat points (IHP).

Project includes 156 boiler-houses with 505 installed boilers and 662 km in the 2-pipe calculation of heat distributing networks that are managed by ME "Makiivteplomerezha", MCE "Mariupolteplomerezha" and "Artemivsk-Energy", Ltd., see Appendix 1.

a) Situation existing prior to the starting date of the project:

The common practice for the district heating enterprises in Ukraine including district heating enterprises that implement the project is to fulfil 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.

b) Baseline scenario:

For Baseline scenario, the economically feasible and realistic scenario with very slow rehabilitation activities was chosen. Tariffs for heat do not include the resources for prospective rehabilitation of the district heating system, only the resources for probable necessary repairing after possible accidents. Minimal annual repairing doesn't lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the same level. This scenario is not 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 attractive.

c) Project scenario

The project employs the increase of fuel and electricity consumption efficiency to reduce greenhouse gas emissions relative to current practice.

The following activities will ensure fuel saving:

- Replacement of old boilers by the new highly efficient boilers;
- Rehabilitation of boilers with increasing of their efficiency;
- Switching of load from boiler-houses with obsolete equipment to modern equipped boiler houses;
- Switching of boiler-houses from coal to natural gas;
- Burners replacement;
- Installation of heat utilizers;
- Improving of the network organization;
- Application of the pre-insulated pipes;
- Transition from the existing CHSS to IHSS;
- Installation of cogeneration units;
- Replacement of heat exchangers;
- Replacement of pumps;
- Installation of frequency controllers at electric drives of draught-blowing equipment and pumps.

Project provides installation of 174 new highly efficient boilers, modernization of 221 boilers, replacement of burners at 87 boilers, installation of 43 heat utilizers, replacement of 32 heat exchangers, implementation of frequency controllers at electric drives at 45 boiler-houses, replacement of 221 pumps, installation of 11 IHP, rehabilitation of 91.5 km of heat distributing networks, as well as other fuel and energy saving measures.

Project provides also installation of cogeneration units for electricity generation for own needs at 3 boiler-houses – 3 gas engine-generator machines "Caterpillar" (USA) G3520B (1 un.) with capacity 1460 kW, G3520C (1 un.) with capacity 2000 kW, and G3516B (1 un.) with capacity 1165 kW.

After complete project implementation over 48.4 million Nm^3 of natural gas, 1350 ton of coal as well as 13370 MWh of power and additionally 37000 MWh due to own production are expected to be saved annually starting from 2013. Such reduction of fuel and power consumption is based on increase of boiler and boiler-houses equipment efficiencies, reduction of heat losses in networks, energy saving measures implementation and cogeneration units installation. The scope of the above project activities may be changed in dependence of financial abilities of the involved enterprises.

Estimated project annual reductions of GHG emissions, mainly CO_2, are 156.053 thousand tons per year after project complete implementation comparing to business-as-usual or baseline scenario.

Implementation of the project will provide substantial economic, environmental, and social benefits to the Cities of Donetsk Region. Social impact of the project is positive since after project implementation the heat supply service will be improved and tariffs for heat energy will not be raised to cover construction costs.

Environmental impact of the project is expected to be very positive as 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 additionally reducing electricity consumption, which is related to power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

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.

The brief history (the main milestones) of the project (including its JI component):

The project was initiated in 2006.

March, 2006 –Agreements were signed on development and promotion of the Joint Implementation Project “Rehabilitation of the District Heating Systems of Donetsk Region 2” between the RME

"Donetskteplocomunenergo" and the ME "Makiivteplomerezha" (#380 dated 15.03.2006) and between the RME "Donetskteplocomunenergo" and the CME "Artemivskteplomerezha" (dated 15.03.2006).

March, 2006 – Agreement was signed between the RME "Donetskteplocomunenergo"and the Institute of Engineering Ecology on preparing of material for the Joint Implementation project on green house gas emissions reduction through rehabilitation of the district heating systems in Donetsk region (#561 dated 15.03.2006).

July, 2006 – Agreement was signed on shared participation in development and promotion of the Joint Implementation Project "Rehabilitation of the District Heating Systems of Donetsk Region" between the RME "Donetskteplocomunenergo" and the MCE "Mariupolteplomerezha" (dated 20.07.2006).

August, 2006 – Agreement was signed between the RME "Donetskteplocomunenergo"and the ME "Makiivteplomerezha", the MCE "Mariupolteplomerezha" and the CME "Artemivskteplomerezha" on joining of efforts of the parties for realization of the Joint Implementation Project ""Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" (#55 dated 09.08.2006).

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)	RME "Donetskteplocomunenergo"	No
The Netherlands	"E – energy B.V."	No

- ***RME "Donetskteplocomunenergo":*** organization acting as Project Applicant and Supplier of GHG emission reductions on behalf of all partners of the Contract on Joint Activity. It represents the interests of partners of the Contract and is responsible for the organizational aspects of JI project.

Historical details:

The Regional production association "Donetskteploset" was organized in April, 1978, on the base of 13 enterprises in Donetsk Region. Since that time the enterprise had undergone substabtial structural changes – the amount of productive units and the name was changed (nowadays the Regional Municipal Enterprise "Donetskteplocomunenergo" includes 21 industrial units) as well as the amount of workers.

Today the Regional Municipal Enterprise (RME) "Donetskteplocomunenergo" is a powerful complex, which is a huge heat supply enterprise in Ukraine. It supplies heat to over 280 thousands of personal accounts in Donetsk Region. The stuff of the enterprise consists of about 6 ths workers. They provide continuous operation of the heat generating, transporting and distributing equipment.

The Heated area for the population are 78 %, for the legal entities – 22 %.

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

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

The rising work range and economical-social conditions caused the creation of vertically integrated company's structure, with the separation of group's operation fields. For this purpose, the company E energija UAB, which now is the management company of the whole E energija group, was established. E energija, UAB is an energy planning and management company, which implements turnkey projects from conceptual development and owns companies generating and supplying energy for industries and residents of the cities.

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

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

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

A.4. Technical description of the project:

A.4.1. Location of the project:

The Project is located in Donetsk Region in the South-Eastern part of Ukraine (Fig.1).

Fig. 1. The map of Ukraine with administrative division and neighboring countries

A.4.1.1. Host Party(ies):

The project is located in Ukraine.

Ukraine is an Eastern European country that ratified the Kyoto Protocol to UN FCCC on February 4th, 2004, it 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.:

Donetsk region is located in the South-Eastern part of Ukraine. Its territory is 26515 km^2 (about 4.4% of the total area of Ukraine). Its population (as of 2008) is about 4.62 million constitutes 10% of the overall Ukrainian population. It makes it the most densely populated region of the country. Its large population is due to the presence of several big industrial cities and numerous villages agglomerated around them.

The Donetsk region's climate is temperate continental, which is characterized by warm summers and relatively cold winters with changeable snow surfaces. The average temperatures are -7 ^{0}C in January and +19 ^{0}C in July. Average annual rainfall is 524 mm. The average heating period is 183 days. The average outside temperature over the heating period is -1.8 ^{0}C.

Donetsk region borders in the south-west and west upon Zaporizhzhya and Dnipropetrovsk regions, in the north-west - upon Kharkiv region, in the north-east – upon Lugansk region, in the east – upon Rostov region of Russian Federation. On the south Donetsk region is washed by Azov Sea. There are 28 cities of regional submission in Donetsk region, the territory is divided into 18 districts. Largest cities of the region are Donetsk, Mariupol, Makiivka, Gorlivka, Kramatorsk, Slavyansk, Enakievo.[1]

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

Makiyivka city: is situated at the center of Donetsk region. Population is 399 thousand inhabitants (1 April 2010). The area is 426 km^2.

Mariupol city: is situated at Azov Sea coast, south of the region. Population is 477.9 thousand inhabitants (2008). The area is 243.9 km^2.

Artemivsk city: is situated at the northern part of Donetsk region. Population is 80.5 thousand inhabitants (2006). The area is 74 km^2.

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

The following enterprises are included into the project:

RME "Donetskteplocomunenergo" - is the Applicant, it is one of the main heat supply organizations in Donetsk Region. It is empowered to represent the interests of heat-supply enterprises of Donetsk Region. It is the Supplier of ERUs. Location of the office: Donetsk city, 48.00 N 37.77 E ;

ME "Makiivteplomerezha" is the main heat supply organization in Makiivka City. Location: Makiivka city, 48.06 N 37.94 E;

MCE "Mariupolteplomerezha" is the main heat supply organization in Mariupol City. Location: Mariupol city, 47.12 N 37.55 E;

"Artemivsk-Energy", Ltd. is one of the main heat supply organizations in Artemivsk City. Location: Artemivsk city, 48.61 N 37.99 E.

The places involved in the project are marked with blue circles (Fig. 2).

[1] http://www.donoda.gov.ua/main/ua/2417.htm

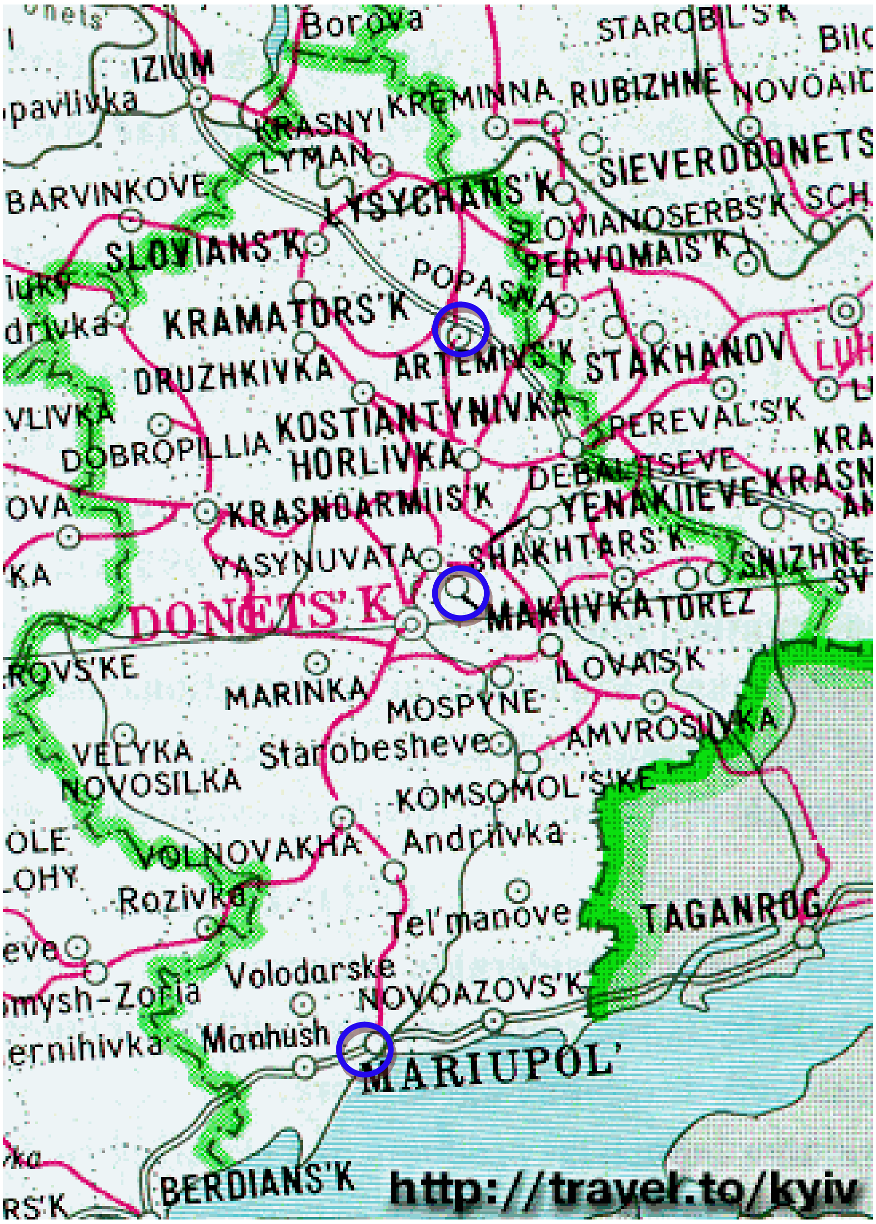

Fig. 2. Location of the Cities of Donetsk region where project will be implemented

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

Measures that will be used to improve the efficiency of district heating enterprises that implement the project 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 56-88% 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
TVG	www.tekom.com.ua/kotel/tvg.html
KVG	www.mktes.ru/catalogue/product_220
KVGM	www.pskovkotel.ru/catalog.html
Viessmann	viessmann-ua.com
LOOS	www.loos-int.com/loos/default.asp
Riello	www.riello.su
KSVa	www.tekom.com.ua/kotel/vk.html
KOLVI	www.kolvi.com/index.php?option=com_content&task=blogcategory&id=11&Itemid=105
KVT	www.ukrbbs.com/kotly_niistu_5_i_kvt_581355469.html
REX	www.termosystems.ru/catalog/boilers/ici_caldaie/rex/
Super Rac	www.oookk.ru/catalog/detail.php?ID=1578
БГВ	www.termo.ua/index.php?option=com_content&view=article&id=80&Itemid=170
Modul "Bernar"	www.ukrinterm.com.ua/goods/price.html
Sunier duval	www.saunierduval.ua
VPR	www.teplotrade.com.ua/catalog/397.html
E-1	www.tekom.com.ua/kotel/e-details
Protherm	www.protherm.com.ua/?a=catalog&item=73&catalog_id=9
Steam generator	www.certuss.de/index.php?id=19&L=1

Table 1. Boilers producer's web sites

- Rehabilitation of obsolete but able to work boilers with using various technologies, including rehabilitation of screen tubes, burners and control automatic equipment replacement, etc., will lead to 6-9% increase in efficiency.
- Switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment.
- Heat-recovery apparatuses (utilizers), including developed by the Institute of Engineering Ecology, will be installed in order to utilize and recover the exhaust gases heat. The implementation of this technology will result in increasing the fuel consumption efficiency by 6-10%.
- Obsolete coal-fired boilers will be mostly replaced by the new gas-fired boilers.
- The efficiency of distribution networks system will be considerably increased by:
  - decreasing pipelines length (moving heat generating source closer to consumer, etc.);
  - improving of network organization (replacing 4-pipe lines by 2-pine ones with simultaneous installation of heat exchangers directly at the consumers);
  - replacing of the main network pipes with diameter 57 mm and more by the pre-insulated ones, including produced by "Transprogres" Ltd.

(http://www.transprogress.com.ua/products.htm) and "Polimerteplo-Ukraine" Ltd. (http://polymerteplo.com.ua/). These pipes are presented at the Fig. 3.

Fig.3. Pre-insulated pipes.

- decreasing of losses in pipelines (renovation of thermal insulation, packing of controlling, locking and fitting elements, etc.).

- Transition from the existing central heat supply stations (CHSS) to individual heat supply stations (IHSS) with installation of heat exchangers directly at the consumers' houses makes it possible improving service of district heating enterprise, reducing heat losses in network and power consumption for power supply of circulation pumps.
- The old heat exchangers will be replaced by the highly efficient plate-type ones. This will enable to reduce power consumption and heat losses. Technical characteristic of new heat exchangers (Fig. 4) are presented at the producer's website http://teploenergo.com.ua.

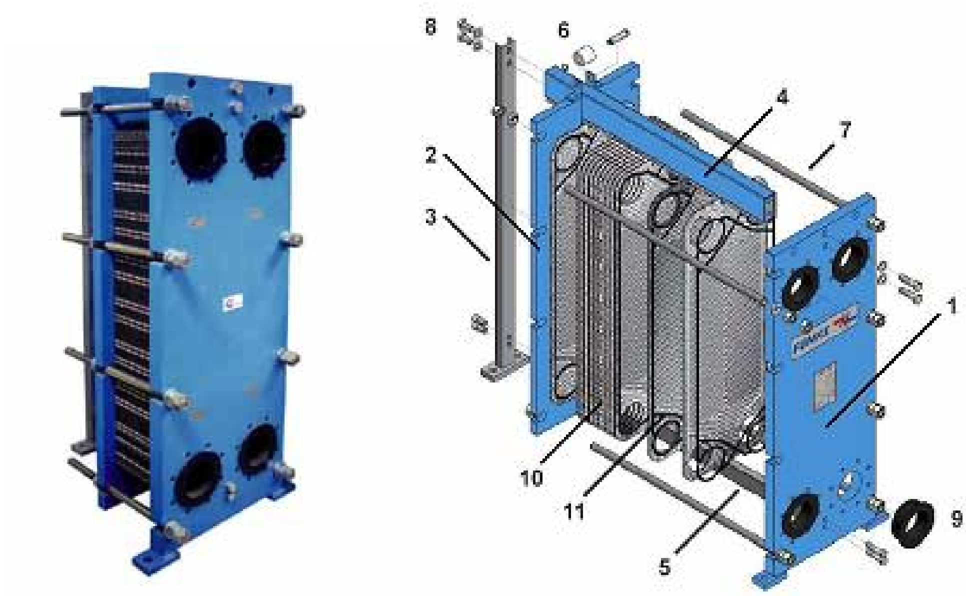

Fig.4.Heat exchangers produced by "Ukrteploenergo" corporation.

- Replacement of old pumps by the new ones will enable to considerably reduce power consumption for water pumping Technical characteristic of new pumps (Fig. 5) are presented at the producer's website www.kolmeks.fi.

Fig.5. Circulating pump produced by ”KOLMEKS”.

- Installation of cogeneration units will result in increasing the fuel consumption efficiency, escaping 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. Technical characteristic of cogeneration units G3520B and G3516B produced by "Caterpillar" (USA) (Fig. 6) are presented at the producer’s website http://rossiya.cat.com/cda/layout?f=416505&m=333535&x=97.

Fig.6. Cogeneration unit produced by "Caterpillar" (USA) G3520B with capacity 1460 kW.

- 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 depending on a boiler operation mode. Technical characteristic of frequency converters are presented on the website of "Danfoss" company: www.danfoss.com.

The generalised planned schedule of their implementation will be the following:

#	Project stages	Period
1	Rehabilitation of boiler-houses equipment	03/2006 – 12/2012
2	Rehabilitation of distribution network equipment	03/2006 – 12/2012
3	Installation of frequency controllers	03/2006 – 12/2012
4	Replacement of heat exchangers	03/2006 – 12/2009
5	Replacement of pumps	03/2006 – 12/2010
6	Installation of IHSS	04/2010 – 12/2012
7	Installation of cogeneration units	09/2010 – 12/2012

Table 2. Schedule of the Project implementation

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.

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 district heating enterprises that implement the project 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.

District heating enterprises that implement the project provide personnel retraining according to the labour protection norms. The enterprises have 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 Institute of Engineering Ecology, (IEE), and the special group that consisted of representatives of district heating enterprises and IEE was organized.

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 cogeneration units will increase energy efficiency of the district heating (DH) systems of the involved Cities of Donetsk region, thus enabling them to produce the same amount of heat energy with less fuel and power consumption. Reduced fuel and power consumption will lead to reduction of GHG emissions.

In the absence of the proposed project, all equipment, including the old low efficient but still workable for a long life period one, 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 dated 24.06.2004 № 1869-IV), The Law of Ukraine dated 01.07. 1994 № 74/94-VR “On energy saving” and The Law of Ukraine dated 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 dated 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:

Period before January 1, 2008:

	Years
Length of the crediting period	1.25
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2006 (01/10/2006 – 31/12/2006)	8078
2007	50719
Total estimated emission reductions over the early crediting period (tonnes of CO_2 equivalent)	**58797**
Annual average of estimated emission reductions over the early crediting period (tonnes CO_2 equivalent)	**37841**

Table 3. Estimated emission reductions for early crediting period before January 1, 2008 (2006-2007)

The First Kyoto Commitment period 2008 – 2012:

	Years
Length of the crediting period	5
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2008	76832
2009	86807
2010	110078
2011	148426
2012	156053
Total estimated emission reductions over the first commitment period (tonnes of CO_2 equivalent)	**578196**
Annual average of estimated emission reductions over the first commitment period (tonnes CO_2 equivalent)	**115639**

Table 4. Estimated emission reductions during the first commitment period 2008 – 2012

The Post-first commitment period 2013 – 2032:

	Years
Length of the crediting period	20
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2013	156053
2014	156053
2015	156053
2016	156053
2017	156053
2018	156053
2019	156053
2020	156053
2021	156053
2022	156053
2023	156053
2024	156053
2025	156053
2026	156053
2027	156053
2028	156053
2029	156053
2030	156053
2031	156053
2032	156053
Total estimated emission reduction over the post-first commitment period (tonnes of CO_2 equivalent)	**3121060**
Annual average of estimated emission reduction over the post- first commitment period (tonnes CO_2 equivalent)	**156053**

Table 5. Estimated emission reductions during the post- first commitment period 2013 – 2032

Total amount of Emission Reductions over the crediting period:

	Years
Length of the crediting period	27
	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**3758053**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**139813**

Table 6. Estimated emission reductions during the crediting period 2006 – 2032

A.5. Project approval by the Parties involved:

The project is already approved by local authorities and representative of the Government of Ukraine, namely by the Makiivka and Mariupol city councils, and the State Environmental Investment Agency of Ukraine (responsible authority for the Kyoto Protocol activity in Ukraine). Therefore, organizational risks are minimized.

In details:

April, 2011 – the Project was approved by local authorities (Decision of Mariupol city council on approval of the JI project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" implementation #6/7-550 dated 19.04.2011; Decision of Makiivka city council on approval of the participation of ME "Makiivteplomerezha" in JI project implementation #7/12 dated 27.04.2011; Decision of Artemivsk city council on approval of the JI project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" implementation #6/6-125 dated 27.04.2011).

July, 2011 - Ukrainian DFP – the State Environmental Investment Agency of Ukraine has issued the Letter of Endorsement for this project (# 1773/23/7 dated 07.07.2011).

According to the adopted 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:

According to the “Guidelines for users of the JI PDD form” version 04[2], the baseline shall be established on a project-specific basis, or where applicable, project participants may opt to apply approved clean development mechanism (CDM) baseline and monitoring methodologies.

In course of development of this JI project **“Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region”**, in accordance with paragraph 9(a) of the “Guidance on criteria for baseline setting and monitoring”, the project specific approach was used, developed in accordance with appendix B “Criteria for baseline setting and monitoring” of the JI guidelines.

This project specific approach is partly similar to the Baseline and monitoring methodology AM0044 “Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors” (version 1)[3],, however the AM0044 can not be used for the JI project “Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region” since this project has some differences from applicability conditions of this methodology.

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, 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"), etc.

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.

Approved Consolidated Methodology ACM0009 “Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas” (version 03.2)[4] proposes the dependences for baseline and reported year emissions quantity definition, 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.

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.

In additional, the proposition in ACM0009 to take (by conservatism approach) 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

[2] *http://ji.unfccc.int/Ref/Documents/Guidelines.pdf*

[3] *http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_L4AQZSBA770KNI0BUSG1JVIWCXIFU5*

[4] *http://cdm.unfccc.int/UserManagement/FileStorage/K4P3YG4TNQ5ECFNA8MBK2QSMR6HTEM*

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" (version 03)[5] 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 and its monitoring plan, it is necessary to realize, among other measurements, monthly measurement of *SCPCSG,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'. 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.

In view of above mentioned, the specialists of the European Institute for safety, security, insurance and environmental technics "SVT e.V." (Germany) and of the Institute of Engineering Ecology (Ukraine) have developed the project specific approach, which takes into account all activities involved in and the peculiarities of the JI projects on rehabilitation of the district heating systems in Ukraine.

This project specific approach is based on the permanent measuring of the fuel consumption and on amendment of the baseline for possible changes of parameters in a reported year. The changeable parameters may be the Net Calorific Value of fuels, quality of heating service, weather conditions, number of customers, etc. Taking into account only equipment efficiency change does not eliminate the possibilities of undersupply of heat to customers (worsening of heat supply service), and possible weather warming in reported year, change in fuel quality, disconnection of some consumers and other factors could lead to artificial overestimation of ERUs amount. The developed project specific approach eliminates any possibility to depreciate fuel consumption and correspondingly to underestimate GHG emissions due to underdelivery of heat to consumers.

This developed project specific approach has two important advantages (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

[5] *http://cdm.unfccc.int/methodologies/DB/Z4R6FBTQ5FMWU76ISIM5M5GJPN4F6Y*

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.

Thus, in contrast to the methodologies AM0044, ACM0009 and AM0048, this project specific approach, 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 Kharkiv City", "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Crimea", "Rehabilitation of the District Heating System in Luhansk city", etc. as well, is the most appropriate, precise, corresponding to the conservative approach, 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.

This project specific approach is presented in **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 rehabilitation 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 rehabilitation 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 heat delivery system

Current heat supply by DH systems of Makiivka, Mariupol, Artemivsk Cities of Donetsk Region is primarily based on Ukrainian and Russian made gas and coal fired boilers, including:

PTVM-50, PTVM-30, PKVM-40, KVGM-50, DKVR-10/13, DKVR-6.5/13, DKVR-4/13, DKVR-2.5/13, DE-10/14, DE-4/13, TVG-8, VK-21, KVG-6.5, KVG-4, KVG-0.3, KVGM-1.6, KVGM-1.25, KVGM-0.63, KBNG-2.5, Nadtochiy, Revokatova, Danstoker, Universal, NIISTU-5, KSV-1, KSV-2, E-1/9, Fakel, NR-18, NIKA-1.25, NIKA-0.5, TG-3, KChM, AOGV-50, KS-TG-50 and few other types. Detailed information is presented in **Appendix 1** (Boilers)**.** Current efficiencies of those boilers are in the range of 56-90%.

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

Construction of the Baseline Scenario

Current operation of DH systems of Makiivka, Mariupol, Artemivsk Cities of Donetsk Region 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 electricity production by the new cogeneration units. This power will replace consumption from the national power system, that's why the standardized emission factors for the Ukrainian electricity grid shall be taken into account for Baseline definition.

Baseline Carbon Emission Factors

For all fuels the CO_2 emission factors from 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 "Energy"[6] were used:

Cef (natural gas) = 0.0561 tCO_2/GJ;
Cef (coal) = 0.0946 tCO_2/GJ (was taken as "Other bituminous coal").

The CO_2 emission factors for the fuels are assumed to be the same for period 2006-2012. For calculations it is assumed that the Net Calorific Valueof a fuel (NCV) doesn't change during that time, however in the Monitoring Plan the NCV change factor will be taken into account for the baseline correction for any reported year.

Actual NCV of fuels used by district heating enterprises that implement the project changes insignificantly from year to year. Table 7 gives average Net Calorific Values for fuels used by the district heating enterprises in 2005 base year.

Fuel type	City	Average Net Calorific Value of fuel	
		kcal/m^3 (kcal/kg)	MJ/m^3 (MJ/kg)
Natural gas	Makiivka	8043	33.70
	Mariupol	8122	34.03
	Artemivsk	8041	33.69
Coal	Makiivka	4320	18.10
	Mariupol	4224	17.70

Table 7. Net Calorific Value for fuels

Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2005 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. For boiler houses that were taken to balances of district heating enterprises after starting of the project and if data for 2005 are unavailable, the Base year is established as the year previous to the first year in which an enterprise started to operate a boiler house (see table below).

City	Boiler house	Base year
Makiivka	M-52, Repina str., 159a	2006
	M-10, Deputatska str., 166a	2006
	M-10, Trubicina str.	2009
	M-16, village Ob'ednaniy	2009
	M-25, Lenina str., 94	2009

[6] http://www.ipcc-nggip.iges.or.jp/public/gl/invs5a.html

The baseline fuels and electricity consumptions are represented in Table 8.

City	Baseline Natural Gas consumption, ths Nm^3/yr	Baseline coal consumption, t/yr	Baseline electricity consumption, MWh
Makiivka	66291.9	1371.9	20622.3
Mariupol	183203.4	1865.1	55712.6
Artemivsk	38807.3	-	8218.9
Total	**288302.6**	**3237.0**	**84553.7**

Table 8. Baseline fuel and electricity consumption

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

Calculation of Baseline Carbon Emissions

There are two kinds of GHG emissions which are included in the baseline:

1) GHG emissions from boilers which are operated by the DH systems of the involved cities in Donetsk region. Baseline calculations were based on the assumption that baseline emissions from boilers operated during any reported year (2006-2012) remain the same as in the basis year 2005.
2) GHG emissions from current power consumption from the state grid which will be reduced due to implementation of energy saving measures at boiler-houses and installation of cogeneration units for power generation for own needs of boiler-houses.

Ukraine has united state power grid, therefore the averaged values for Carbon Emission factors (CEF) for electricity production should be used. The following CEF values are used in calculations in PDD:

Year	2005	2006-2007	2008	2009	2010	2011-2012
CEFc tCO2e/MWh	0.896*	0.896**	1.219***	1.237****	1.225*****	1.227******

Table 9. The baseline Carbon Emission factors (CEF) used for calculations in PDD

* according to the Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption" of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004 (ERUPT 4, Senter, the Netherlands)[7];

** according to the 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", confirmed by TUV SUD Industrie Service GmbH 17.08.2007[8]:;

*** according to the Order of the National Environmental Investment Agency of Ukraine # 62 dated 15.04.2011[9];

**** according to the Order of the National Environmental Investment Agency of Ukraine # 63 dated 15.04.2011[10];

***** according to the Order of the National Environmental Investment Agency of Ukraine # 43 dated

[7] http://ji.unfccc.int/CallForInputs/BaselineSettingMonitoring/ERUPT/GuidVol2.doc

[8] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

[9] http://www.neia.gov.ua/nature/doccatalog/document?id=127171

[10] http://www.neia.gov.ua/nature/doccatalog/document?id=127172

28.03.2011[11];

****** according to the Order of the National Environmental Investment Agency of Ukraine # 75 dated 12.05.2011[12].

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 year if systems of heat supply in Donetsk region remain unchanged, see in **Appendix 9 (Baseline)**.

The key information and data used to establish the baseline are provided in tables below:

Data / Parameter	$\mathbf{B_b}$
Data unit	ths. m^3 (t)
Description	Fuel consumption by boiler-houses in the base year
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	District heating enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	B_b (natural gas) = 288302.6 ths.m^3; B_b (coal) = 3237 t
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measurements are taken by gas meters at each boiler-house. Purchasing of coal is realized in accordance with invoices. Consumption of coal is measured by wheelbarrows and pails then recalculated to weight
QA/QC procedures (to be) applied	Equipment is calibrated and inspected according to the the State Standard of Ukraine № 2708:2006 “Metrology. Calibration of measuring equipment. The organization and procedure"[13].
Any comment	Fuel consumption by the boiler-houses is the basic data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

Data / Parameter	$\mathbf{P_b}$
Data unit	MWh
Description	Electric power consumption in the base year
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	District heating enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	84553.7
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measurement by electric power meters
QA/QC procedures (to be) applied	Equipment is calibrated and inspected according to the the State Standard of Ukraine № 2708:2006 “Metrology. Calibration of measuring equipment. The organization and procedure"[13]
Any comment	It is the basic data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

[11] *http://www.neia.gov.ua/nature/doccatalog/document?id=126006*

[12] *http://www.neia.gov.ua/nature/doccatalog/document?id=127498*

[13] *hths.tp://oscill.com/files/27082006.pdf*

Data / Parameter	**NCV_b**
Data unit	MJ/m^3 (MJ/kg)
Description	Average annual Net Calorific Value of fuel in the base year
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	District heating enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	see Table 7
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Fuel Supplier's Report
QA/QC procedures (to be) applied	N/A
Any comment	Data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form.

Data / Parameter	**Cef**
Data unit	t CO_2/GJ
Description	Carbon emission factor in the base year
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy
Value of data applied (for ex ante calculations/determinations)	Cef (natural gas) = 0.0561 tCO_2/GJ; Cef (coal) = 0.0946 tCO_2/GJ; (taken as “Other bituminous coal”).
Justification of the choice of data or description of measurement methods and procedures (to be) applied	IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy
QA/QC procedures (to be) applied	N/A
Any comment	Auxiliary data allowing adjustment of baseline

Data / Parameter	**CEF_c**
Data unit	t CO_2/MWh
Description	Carbon emission factor for electricity consumption in the base year
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption” of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004 (ERUPT 4, Senter, the Netherlands); 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”, confirmed by TUV SUD Industrie Service GmbH 17.08.2007; Orders of the National Environmental Investment Agency of Ukraine: # 62 dated 15.04.2011; # 63 dated 15.04.2011;

	# 43 dated 28.03.2011; # 75 dated 12.05.2011
Value of data applied (for ex ante calculations/determinations)	see Table 9
Justification of the choice of data or description of measurement methods and procedures (to be) applied	see Table 9
QA/QC procedures (to be) applied	N/A
Any comment	Auxiliary data allowing adjustment of baseline

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, replacement of heat exchangers and pumps, installation of cogeneration units, renovation of 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. 7).

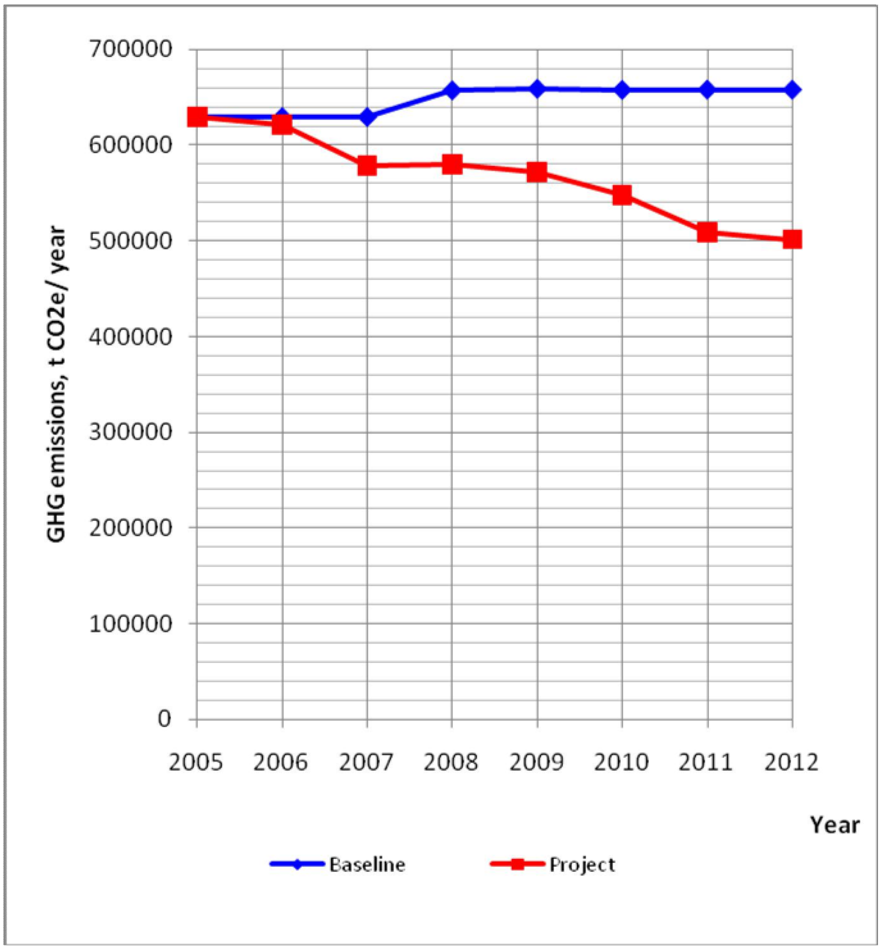

Fig. 7. Dynamic baseline and project emissions of GHG

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. 8). This tool was originally developed for CDM projects but may be applied to JI projects as well.

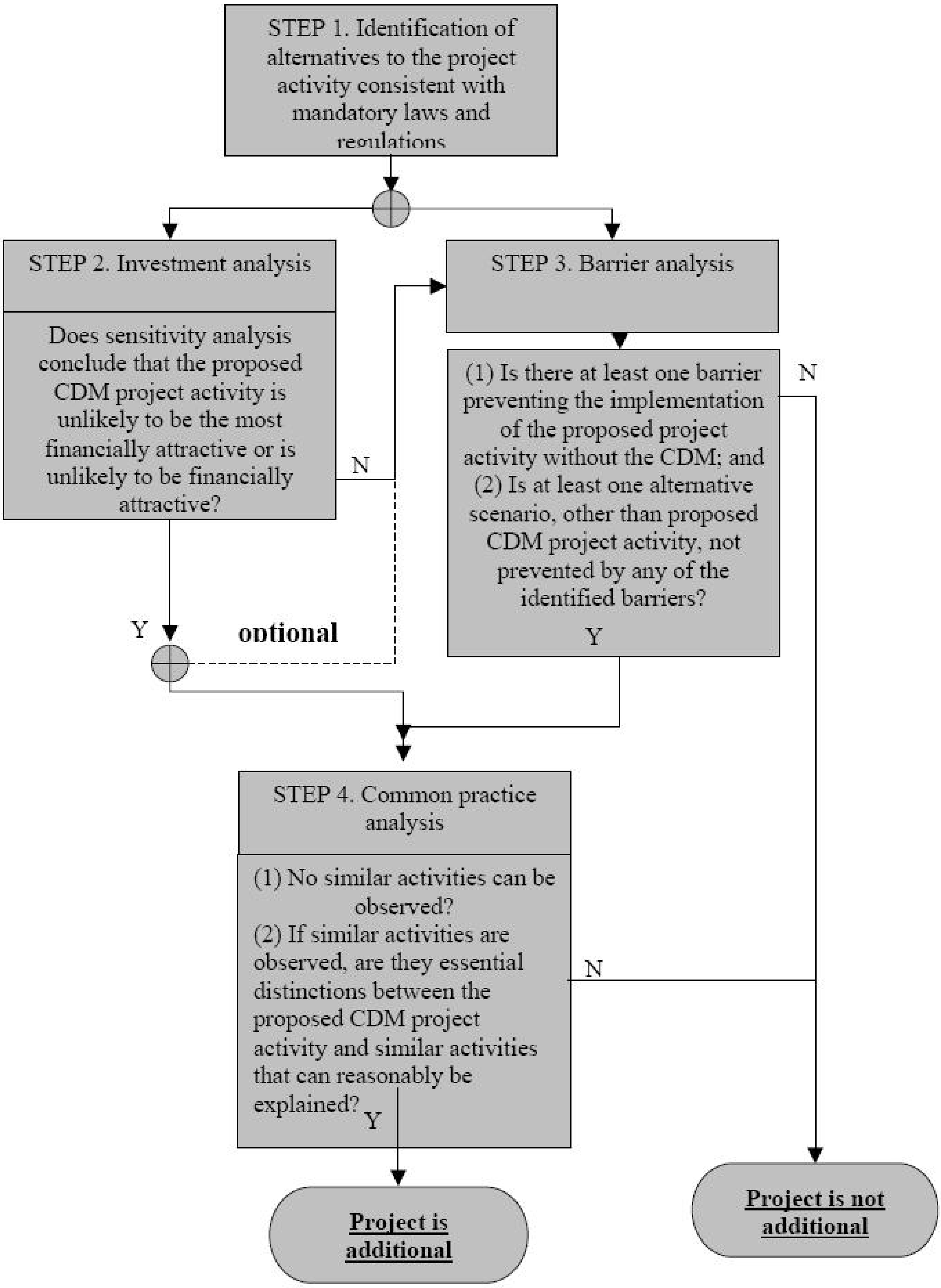

Fig.8. Steps for demonstration of additionality

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 rehabilitation works, approximately balanced by overall degradation of the DH systems.

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 in Ukraine to exploit boilers which were installed in 70th and even in 50-60th and earlier, if they pass the technical examination by the authorized body ("Derzhnagliadohoronpratsi").

2. The second alternative is to make rehabilitation 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, dated June 01, 2000 and "On heat energy supply" № 2633-IV dated 02.06.2005; Ukrainian Government Regulation "On introduction of changes to the Government Regulations №1698 dated 14.11.2000 and №756 dated 04.07.2001" №549 dated 19.04.2006 and "On approval of the list of licensing bodies" №1698 dated 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.

District heating enterprises that implement the project have such licenses (RME "Donetskteplocomunenergo" - AB # 345052; ME "Makiivteplomerezha" - AB # 345151; MCE "Mariupolteplomerezha" - AB # 347000; "Artemivsk-Energy", Ltd. - AB # 345158).

The Project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" has been prepared according to The Law of Ukraine dated 01.07.1994 №74/94-VR "On energy saving" and The Law of Ukraine dated 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 rehabilitation 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).

Step 2. Investment analysis.

Sub-step 2a: Determine appropriate analysis method

The appropriate analysis method is to be chosen in dependence of generating of financial or economic benefits by the project. If project activity generates no financial or economic benefits other than JI related income, then the simple cost analysis (Option I) may be applied, otherwise the investment comparison analysis (Option II) or the benchmark analysis (Option III) should be used.

The main sourse of income of the district heating enterprises in Ukraine are payments from customers according to the tariffs that are regulated by the "Procedure of setting tariffs for production, transportation and supply of heat energy and for centralized heating and hot water supply services"[14].

According to this Procedure, tariffs are to be set on the base of the scheduled prime cost, and doesn't allow to obtain benefit from reduction of fuel, power, raw materials, etc. consumption. Any reduction of expenses for these raw inputs should result in decrease of tariffs for the end consumers and corresponding decrease of an enterprise's revenue, thereby the enterprise doesn't obtain additional revenue.

Thus, the simple cost analysis (Option I) may be applied.

Sub-step 2b: Option I. Apply simple cost analysis

Implementation of the project activity will require substantial additional investments – about 31 million EUR only for the main equipment installation / rehabilitation. The prices for the new equipment, that is planned to be installed according to the project, are represented on the sheets "Parameters" in the **Appendixes 1, 2** 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 required investments for implementation of the project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" include the costs of the main equipment installation / rehabilitation listed in the Table 10, as well as the auxiliary costs such as personnel training, maintenance control, systematic data collection and archiving, etc.

#	**The measures for energy efficiency improvement**	**Ths. EUR**
1	Boiler houses rehabilitation	11213.30
2	Network rehabilitation	14728.70
3	Implementation of frequency controllers	1256.35
4	Heat exchangers replacement	258.80
5	Pumps replacement	284.12
6	IHPs implementation	118.00
7	CHP units installation	3050.00
	Total	**30909.26**

Table 10. The cost of measures for energy efficiency improvement

For more detailed information see **Appendixes 1-8.**

Estimated costs for implementation of the defined above alternatives to the project activity:

1. For the first alternative (continuation of the current situation, business-as-usual scenario) no additional investments are required.

2. For the second alternative (the proposed project activity without JI mechanism) the required additional investments are the same as for the project activity.

3. For the third alternative (shortened project activity) the required additional investments are less then the ones required for the project activity.

Outcome of Step 2: There is at least one alternative which is less costly than the project activity.

Hence, the Step 2 is satisfied.

[14] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=955-2006-%EF

Step 3: Barrier analysis

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

Investment barriers

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][15]

"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[16].

"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][17].

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[18].].

Moreover, no bank gives credits without the proper guarantees. District heating enterprises that implement the project are communal ownership enterprises, and all theirs main funds belong to territorial population. For this reason the property of enterprises can not be a credit mortgage. Thus, the DH system rehabilitation without additional external investments (grants, subsidy, subvention, etc.) practically isn't

[15] *http://www.energyagency.at/(publ)/themen/elektrizitaet_index.htm*

[16] *http://www.iea.org/Textbase/ publications/free_new_Desc.asp?PUBS_ID=1819*

[17] *www.case-ukraine.com.ua*

[18] *www.case-ukraine.com.ua*

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].

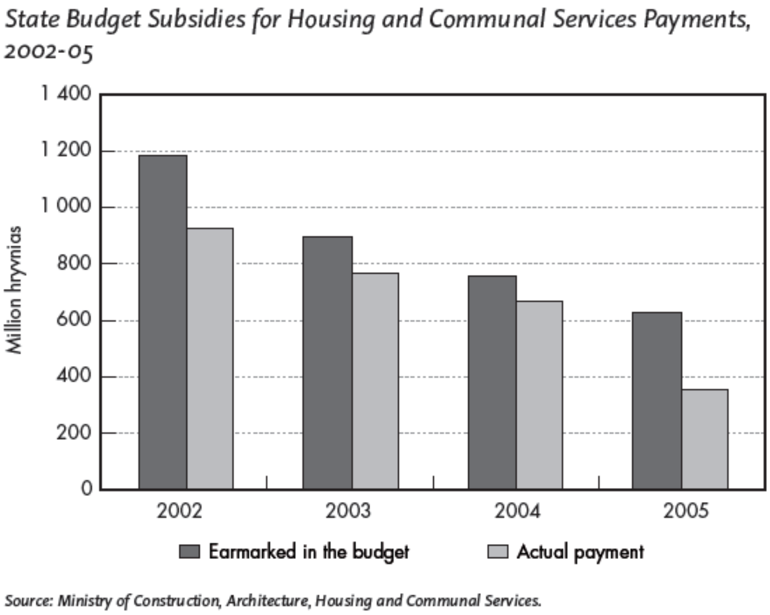

Fig.9. Diagram of the real State budget subsidies for Housing and communal services payments

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 also is a very positive factor that even can allow shifting the priorities of budget financing, 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 RME "Donetskteplocomunenergo" 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 district heating systems of the involved Cities of Donetsk Region, thus to provide fulfillment of international liabilities on the joint implementation project.

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 project implementation properly and 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 rehabilitation 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, etc.

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.

Organizational barriers

The management experience in implementation of JI projects is absent, including international collaboration, validation, 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 rehabilitation works without JI mechanism and to realise shortened project activity, without any of the non-key type of project activity.

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

One of the alternatives is to continue business-as-usual scenario. Therefore, as the barriers mentioned above are directly related to investing into upgrading of the district heating systems of the involved Cities of Donetsk Region, there is no impediment for district heating enterprises that implement the project to operate the district heating systems 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.

The common practice for district heating enterprises in Ukraine without JI is only a necessary repair of the old equipment, mainly in emergency cases, and not the renewal. Only with the JI component it is possible to obtain the necessary additional funds for real rehabilitation of the district heating system.

This is confirmed by the present situation that the real comprehensive rehabilitation of the district heating systems in Ukraine is performed only by the enterprises participating in JI projects. There are at least 9 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, Kharkiv city, Rivne region, Dnipropetrovsk Region, Luhansk city, Zaporizhzhia City, Sevastopol city. But other JI project activities are not to be included in Common practice analysis.

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

Sub-step 4b. Discuss any similar Options that are occurring

All District Heating Rehabilitation Projects in Ukraine are being implemented only within the framework of the Kyoto Protocol JI mechanism. In the absence of additional financing (such as grants, other non-commercial finance terms, carbon credits, etc) implementation of these projects would be impossible. Application of the JI mechanism is the only incentive to implement such projects.

Outcome of Step 4b: Based on the available facts, the following conclusions may be made:

- Activities similar to this Project are not widespread in the housing and utilities sector of the Ukraine.

- These activities are not a result of national policy being pursued in respect to promoting the utilization of gas as a fuel in municipal heat supply systems.

Thus, the Project activities do not fall under the category of *common practice.* This testifies to the additionality of this Project.

Hence, the Step 4 is satisfied.

Conclusion

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

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

Project boundaries for **Baseline scenario** are represented by black line rectangle at the graphical representation (Fig.10).

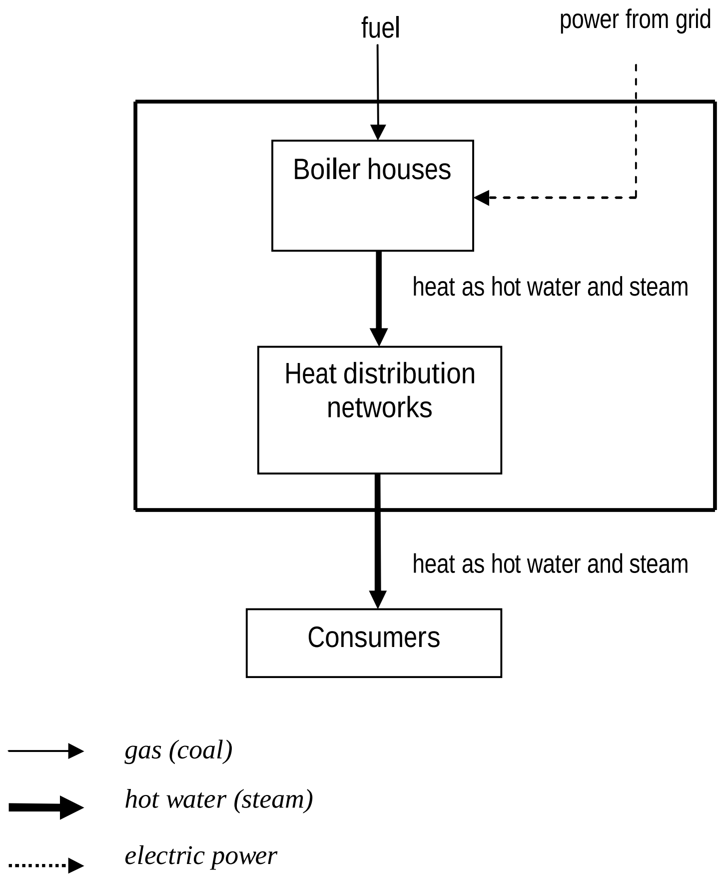

Fig.10. Boundaries for Baseline scenario

Project boundaries for **Project scenario** are represented by the black line rectangle at the graphical representation (Fig.11).

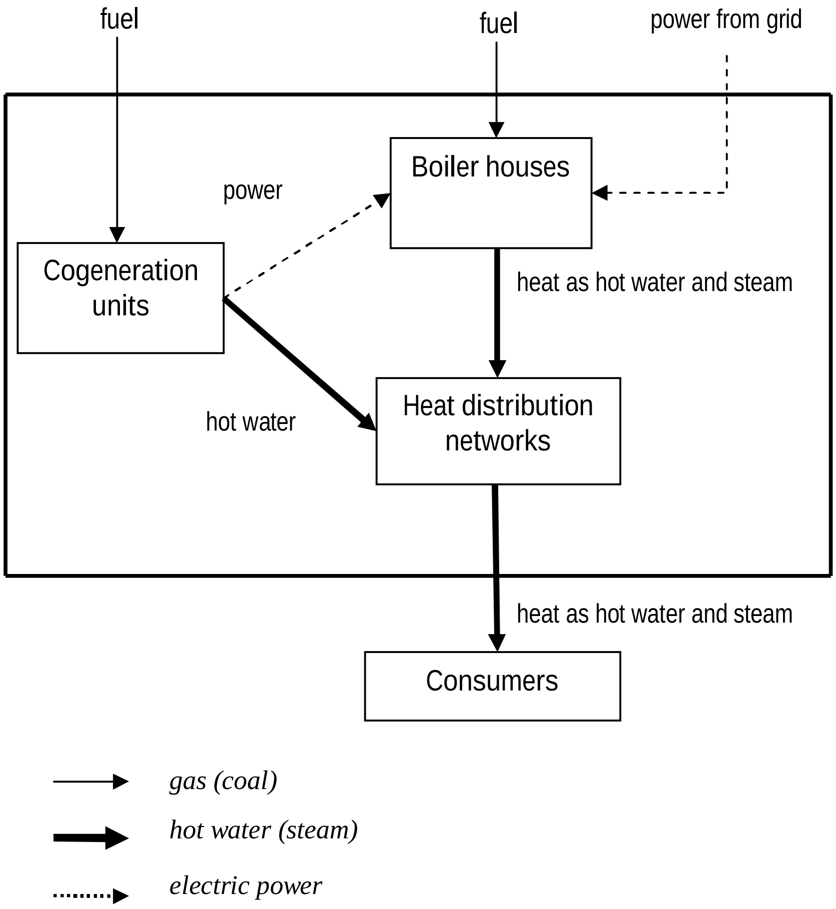

Fig.11. Project boundaries for Project scenario

Direct and Indirect Emissions

Direct on-site emissions: CO_2 emissions 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 cogeneration 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.

CH_4 and N_2O emissions from fuel combustion are negligible minor sources, and are excluded from considerations for simplification.

Direct off-site emissions: GHG emissions from power station(s) due to electricity production to the grid, that is consumed by boiler houses.

GHG emissions from power stations due to electricity production to the grid, that is consumed for heating of customers in Makiivka, Mariupol, Artemivsk Cities of Donetsk region. 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.

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	Included or excluded
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 cogeneration units will be installed due to additional fuel consumption by cogeneration units	Direct	Included
NO_x and CO emission from combustion in existing boilers/ burners	Reduced NO_x and CO emissions from fuel combustion after boiler / burners' replacement	Direct	Excluded. NO_x and CO 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, implementation of new heat exchangers, transition from the existing CHSS to IHSS	Direct	Included
Off-site emissions			
Current situation	Project	Direct or indirect	Included or excluded
CO_2 emissions from power plant(s) due to electricity production to the grid, that is consumed by boiler houses	Reduced CO_2 emissions from power plant(s) due to reduction of electricity consumption by boiler houses due to implementation of energy saving measurements and electricity production by new cogeneration units for own needs	Direct	Included
CO_2 emissions from power plant(s) due to power consumption used for heating by customers of cities of Donetsk region. 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 customers of the involved cities of Donetsk region. This will take place after project implementation when heat supply service will become more efficient. Exploitation of electric heaters will be decreased substantially	Direct	Excluded, 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	Excluded, not under control of project developer

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: 18/06/2010

The baseline is determined by the Institute of Engineering Ecology (IEE), the project developer, and RME "Donetskteplocomunenergo", the project supplier (project participant).

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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: 15/03/2006

The date 15/03/2006 was accepted as the project's starting date because on this date the agreements were signed between RME "Donetskteplocomunenergo" and the ME "Makiivteplomerezha", the MME "Artemivskteplomerezha" on development and promotion of the Joint Implementation Project "Rehabilitation of the District Heating Systems of Donetsk Region 2", as well as between RME "Donetskteplocomunenergo" and the Institute of Engineering Ecology on preparing of material for the Joint Implementation project on green house gas emissions reduction through rehabilitation of the district heating systems in Donetsk region.

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, therefore the expected operational lifetime of the project may be at least 30 years. For further calculations the end of the operational lifetime for the project is assumed equal to 20 years, or 240 months, since implementation of the last project activity (31.12.2012).

Thus, the expected operational lifetime of the project is 26.25 years (315 months), from 01.10.2006 till 31.12.2032.

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 October 1, 2006. The end of the crediting period is the end of the lifetime of the main equipment that is minimal December 31, 2032. Thus the length of the crediting period is 26.25 years (315 months), from 01.10.2006 till 31.12.2032.

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, burners and heat utilizers, specific gas consumption by cogeneration units, as well as heat losses in pre-insulated pipes are adequate.

Monitoring of project performance indicators

District heating enterprises that implement the project collect data on fuel purchasing for heating in form of fuel bills. Information on saved fuel will be used in course of preparation of monitoring reports on a yearly basis (till April 1st for every year following the reported one) with all relevant documentation and historical information on fuel purchasing by Supplier.

Monitoring of Emission Reduction Units and Baseline Scenario

The project specific approach developed for monitoring of the “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 net calorific value of fuel(s), number of customers, 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 Dynamic Baseline).

The following specific project approach is proposed to be used.

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

$$ERUs = \sum[E_{(i)}^{b} - E_{(i)}^{r}] \qquad (D.1.1\text{-}1)$$

where:
$E_{(i)}^{b}$ and $E_{(i)}^{r}$ - GHG emissions for an (i) boiler-house in the reported year for the dynamic baseline and project scenarios, respectively, t CO_2e.

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

$$E_{(i)}^{b} = E_{1(i)}^{b} + E_{gen\,(i)}^{b} + E_{cons\,(i)}^{b}, \qquad (D.1.1\text{-}2)$$

$$E_{(i)}^{r} = E_{1(i)}^{r} + E_{gen\,(i)}^{r} + E_{cons\,(i)}^{r}, \qquad (D.1.1\text{-}3)$$

where:
$E_{1(i)}^{b}$ and $E_{1(i)}^{r}$ – 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 $E_{gen\ (i)}^{r}$ – emissions due to electricity generation associated to the project for an (i) boiler-house in the base year (consumed from grid, 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 $E_{cons\ (i)}^{r}$ – emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with the related heat supply stations in the base year and in the reported year, respectively, t CO_2e.

For each (i) boiler-house:

$$E_1^{b} = NCV_b*Cef_b*B_b \quad (D.1.1\text{-}4)$$

$$E_1^{r} = NCV_r* Cef_r*B_r \quad (D.1.1\text{-}5)$$

$$E_{gen}^{b} = W_b*CEF_c+ Q_b*f_b* NCV_r* Cef \quad (D.1.1\text{-}6)$$

$$E_{gen}^{r} = (W_b - W_r)*CEF_g+ [(Q_b-Q_r)*f_b+ B_g]* NCV_r* Cef \quad (D.1.1\text{-}7)$$

$$E_{cons}^{b} = P_b*CEF_c \quad (D.1.1\text{-}8)$$

$$E_{cons}^{r} = P_r*CEF_c \quad (D.1.1\text{-}9)$$

where:

NCV – Net Calorific value of a fuel, GJ/ ths m^3 (GJ/t);
Cef – Carbon emission factor for a fuel, t CO_2/GJ;
B – amount of a fuel consumed by a boiler-house, ths m^3 or t;
W_b – scheduled electricity production by the new CHP units at a boiler-house, MWh;
W_r – electricity production by the installed CHP units, MWh;
CEF_g – Carbon emission factor for the Ukrainian grid, tCO_2e/MWh;
P_b – electricity consumption in the base year by a boiler-house where energy saving measures are scheduled to be implemented, MWh;
P_r – electricity consumption in the reported year by a boiler-house where energy saving measures are implemented, MWh;
CEF_c – Carbon emission factor for JI projects on 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 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, ths m^3/MWh;
B_g – amount of fuel (gas) consumed by the installed CHP units for heat and electricity 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:

$E_{1(i)}^b = E_{h(i)}^b, + E_{w(i)}^b$; (D.1.1-10)

where the first term describes emissions from fuel consumption for heating, and the second one – from fuel consumption for hot water supply service.

For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1\text{-}a_b) \neq 0$), the formulae for E_1^b is:

$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1\text{-}a_b)*K_1*K_w]$, (D.1.1-11)

where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply service.

For the case when in the base year the hot water supply service was absent at all $((1\text{-}a_b) = 0)$, 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:

$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r *(1\text{-}a_r)*K_1*K_{w0}]$ (D.1.1-12)

$E_1^r = NCV_r* Cef_r*B_r$ (D.1.1-13)

where:
NCV – Net Calorific value of a fuel, GJ/ ths m^3 (GJ/t);
Cef – Carbon emission factor for a fuel, t CO_2/GJ;
B – amount of a fuel consumed by a boiler-house, ths m^3 or tonnes 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 reported year.

$a_b= L_h^b*g^b*N_h^b/ (L_h^b*g^b*N_h^b+L_w^b*N_w^b)$; (D.1.1-14)

$a_r= L_h^r*g^r*N_h^r/ (L_h^r*g^r*N_h^r+L_w^r*N_w^r)$, (D.1.1-15)

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 for a boiler-house;
N_h, N_w – duration of heating period and period of hot water supply service per year, hours.
[$_h$] index – related to heating;
[$_w$] index – related to hot water supply.

$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min}) = (T_{in} - T_{out\ av}) / (T_{in} - T_{out\ min})$ (D.1.1-16)

where:
F_h – heated area of buildings, m^2;
k_h – average heat transfer factor of heated buildings, kW/m^2*K;
T_{in} – average inside temperature for the heating period, K (or ^0C);
$T_{out\ av}$ – average outside temperature for the heating period, K (or ^0C);
$T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^0C).

Adjustment factors:

1. K_1 (Net calorific value of a fuel change factor):

$K_1=NCV_b / NCV_r$ (D.1.1-17)

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, heated area, etc.

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

$B_h = B*a = Q_h / NCV*\eta_h$, (D.1.1-18)

where
Q_h - required amount of heat during heating period,
η_h – 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:

$Q_{h\ br} = Q_{h\ b}*K_h = Q_{h\ r}$ (D.1.1-19)

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.

This averaged adjustment factor may be determined from the equation:

$K_h = Q_{h\,r} / Q_{h\,b}$. (D.1.1-20)

Required amount of heat for heating of buildings during a year, according to the “Norms and instructions on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic needs in Ukraine “KTM 204 Ukraine 244-94”[19], is determined by [ibid, equation 2.17]:

$Q_h = F_h*k_h*(T_{in} - T_{out})*N_h$, (D.1.1-21)

where:
Q_h – required amount of heat for heating, kWh;
F_h – heated 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:
$K_h = (F_{h\,r} *k_{h\,r})*(T_{in\,r} - T_{out\,r})*N_{h\,r} / F_{h\,b}*k_{h\,b}*(T_{in\,b} - T_{out\,b})*N_{h\,b}$ (D.1.1-22)

The components of K_h:

2.1. K_2 (Temperature change factor):

$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b})$. (D.1.1-23)

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

$K_3 = (F_{h\,r} *k_{h\,r}) / F_{h\,b}*k_{h\,b} = [(F_{h\,r} – F_{h\,t\,r} – F_{h\,n\,r})*k_{h\,b} + (F_{h\,n\,r} + F_{h\,t\,r})*k_{h\,n}] / F_{h\,b}*k_{h\,b}$, (D.1.1-24)

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

[19] *http://www.twirpx.com/file/153194/*

$k_{h\,n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), kW/m^2*K.

2.3. K_4 (Heating period duration change factor):

$$K_4 = N_{h\,r} / N_{h\,b} \quad \text{(D.1.1-25)}$$

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,

$$K_h = K_2 * K_3 * K_4 \quad \text{(D.1.1-26)}$$

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.:

Amount of fuel consumed hot water supply service is proportional to the required amount of heat for the period of such service rendering, Q_w:

$$B_w = B*(1-a) = Q_w / NCV*\eta_w, \quad \text{(D.1.1-27)}$$

where
Q_w - required amount of heat during the service rendered period;
η_w - overall efficiency of the hot water supply system.

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:

$$Q_{w\,br} = Q_{w\,b} * K_w = Q_{w\,r} \quad \text{(D.1.1-28)}$$

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

This averaged adjustment factor may be determined from the equation:

$$K_w = Q_{w\,r} / Q_{w\,b}. \quad \text{(D.1.1-29)}$$

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

$$Q_w = n_w * v_w * N_w, \quad (D.1.1\text{-}30)$$

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:

$$K_w = n_{w\,r} * v_{w\,r} * N_{w\,r} / n_{w\,b} * v_{w\,b} * N_{w\,b} \quad (D.1.1\text{-}31)$$

where;
$n_{w\,r}$ and $n_{w\,b}$ – number of consumers in the reported year and the base year, respectively;
$v_{w\,r}$ and $v_{w\,b}$ - standard specific discharge of hot water per personal account (in heat units, kWh/h) in the reported year and the base year, respectively;
$N_{w\,r}$ and $N_{w\,b}$– duration of the service period per year, in the reported year and the base year, respectively, hours.

3.1. K_5 (Number of of hot water supply service customers change factor):

$$K_5 = n_{w\,r} / n_{w\,b} \quad (D.1.1\text{-}32)$$

3.2. K_6 (Standard specific hot water discharge per personal account change factor):

$$K_6 = v_{w\,r} / v_{w\,b} \quad (D.1.1\text{-}33)$$

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

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

$$K_7 = N_{w\,r} / N_{w\,b} \quad (D.1.1\text{-}34)$$

Thus,

$$K_w = K_5 * K_6 * K_7. \quad (D.1.1\text{-}35)$$

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

In case when there was no hot water supply service in the 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,

$K_5 = K_6 = K_7 = 1.$ (D.1.1-36)

Thus

$K_{w0} = 1.$ (D.1.1-37)

The tables of parameters included in the process of monitoring and verification for ERUs calculation, are represented in the Sections **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**.**

If expected monitored data for the boiler-house in any project year are unavailable:

- for statistic data unavailable the default values from IPCC reports will be taken;
- for non-statistic data unavailable, the calculations for this boiler-house in this year will not be made, in according to conservative approach the estimated emission reductions for this boiler-house in this year will be assumed equal to 0.

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel consumption at boiler houses: (**B_r**)	Every boiler house		m	Every 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 reported year
1.1	Natural Gas		ths m^3					
1.2	Coal		ton					
2	Average annual Calorific Value of a fuel calculated by Net calorific value (**NCV_r**)	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 reported year
2.1	Natural Gas		MJ/m^3					
2.2	Coal		MJ/kg					
3	Electricity consumption (**P_r**)	Boiler houses and heat supply stations	MWh	m	Every month	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate GHG emissions in the reported year
4	Carbon emission factor	Normative documents		c	Once per year	100%		Auxiliary data which allows

	(**Cef_r, CEF_c**)							correcting the dynamic baseline
4.1	Natural Gas		kt CO_2/TJ					
4.2	Coal		kt CO_2/TJ					
4.3	Reducing electricity consumption		t CO_2e/ MWh					
5	Fuel consumption by the cogeneration units: (**B_g**)	Every cogeneration units	ths m^3	m	Every day	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate GHG emissions in the reported year

All the data above are monitored throughout the crediting period.

According to valid legislation, all measuring equipment in Ukraine should meet the specified requirements of corresponding standards and is subject to the periodical calibration.

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):

$E_{(i)}^{r} = E_{1(i)}^{r} + E_{gen\ (i)}^{r} + E_{cons\ (i)}^{r}$; (D.1.1.2-1)

where:
$E_{1(i)}^{r}$ – emissions due to fuel consumption for heating and hot water supply service for an (i) boiler-house in the reported year, t CO_2e;
$E_{gen\ (i)}^{r}$ – emissions due to fuel consumption by the new cogeneration units at an (i) boiler-house in the reported year, t CO_2e;
$E_{cons\ (i)}^{r}$ – emissions due to electric power consumption from grid by the (i) boiler-house and heat supply stations related to the *i* boiler-house in the reported year, t CO_2e.

$E_{1(i)}^{r} = NCV_r * Cef_r * B_{r(i)}$, (D.1.1.2-2)

where:
$NCV_{r(i)}$ – average annual net calorific value of (i) fuel, GJ/ ths m^3 (GJ/t)
Cef – carbon emission factor of (i) fuel, tCO_2/GJ;
$B_{r(i)}$ – amount of fuel consumed by a boiler-house in the reported year, ths m^3 (t).

$E_{gen(i)}^{r} = B_{g(i)} * NCV_r * Cef$; (D.1.1.2-3)

where:
B_g– natural gas consumption by installed cogeneration units, ths m^3/MW;
NCV_r – average annual Net Calorific Value in reported year, GJ/ths m^3 (GJ/t)
Cef – carbon emission factor, tCO_2/GJ.

$E_{cons\ (i)}^{r} = P_r * CEF_c$; (D.1.1.2-4)

where:
P_r – electric power consumption by the boiler-houses and heat supply stations, MWh;
CEF_c – Carbon Emission factors for JI projects on 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		ths. m^3					
1.2	Coal		ton					
2	Average annual Calorific Value of a fuel calculated by Net calorific value (**NCV_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 period (**$T_{out\ b}$** and **$T_{out\ r}$**)	Meteorological Service	^{0}C (K)	m, c	Once per heating period. Daily temperature 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 period ($\mathbf{T}_{in\ b}$ and $\mathbf{T}_{in\ r}$)	District heating enterprises that implement the project	^{0}C (K)	m, c	Once per heating period	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
5	Number of Customers of hot water supply service ($\mathbf{n}_{wb}$ and $\mathbf{n}_{wr}$)	District heating enterprises that implement the project		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
6	Heated area (total) ($\mathbf{F}_{h\ b}$ and $\mathbf{F}_{h\ r}$)	District heating enterprises that implement the project	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 ($\mathbf{k}_{hb}$)	District heating enterprises that implement the project	$W/m^2 \cdot K$	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
8	Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year ($\mathbf{F}_{h\ t\ r}$)	District heating enterprises that implement the project	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

9	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year (**$F_{h\,n\,r}$**)	District heating enterprises that implement the project	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 (**$k_{h\,n}$**)	District heating enterprises that implement the project, Normative documents	W/m^2*K	Statistics	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 **$N_{h\,r}$**)	District heating enterprises that implement the project	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 **$N_{w\,r}$**)	District heating enterprises that implement the project	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 ($\mathbf{L_h^b}$ and $\mathbf{L_h^r}$)	District heating enterprises that implement the project	Gcal/h	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 ($\mathbf{L_w^b}$ and $\mathbf{L_w^r}$)	District heating enterprises that implement the project	Gcal/h	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 ($\mathbf{v_{w\,r}}$ and $\mathbf{v_{w\,b}}$)	District heating enterprises that implement the project, Normative documents	kWh/h	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
16	Carbon emission factor ($\mathbf{Cef_b}$, $\mathbf{Cef_r}$, and $\mathbf{CEF_c}$)	Normative documents		c	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					
16.3	Reducing electricity consumption		t CO_2e/ MWh					

17	Electricity consumption (**P_b**)	Boiler houses and heat supply stations	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

For the base year (2005) all parameters (with [$_b$] index) presented above excluding parameters 8-10 are not monitored throughout the crediting period, are determined only once after the end of the base year and thus remain fixed throughout the crediting period. These data are available already at the stage of determination.

Far any reported year (2006-2012) all parameters (with [$_r$] index) presented above excluding parameters 1, 7, 17 are monitored throughout the crediting period.

See **Annex 3.**

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

$E_{(i)}^{b} = E_{1(i)}^{b} + E_{cons\ (i)}^{b}$; (D.1.1.4-1)

where:
$E_{(i)}^{b}$ – baseline emissions (dynamic for a reported year), t CO_2e;
$E_{1(i)}^{b}$ – emissions due to fuel consumption for heating and hot water supply service for an (i) boiler-house in the base year in terms of a reported year, t CO_2e;
$E_{cons\ (i)}^{b}$ –emissions due to electric power consumption by an (i) boiler-house and heat supply stations related to the (i) boiler-house in the base year in terms of a reported 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:

$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$, (D.1.1.4-2)

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:

$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r *(1-a_r)*K_1*K_{w0}]$. (D.1.1.4-3)

where:
NCV_b – average annual net calorific value of fuel in the base year, GJ/ ths m^3 (GJ/t);
Cef – carbon emission factor of fuel, tCO_2/GJ;
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.

$a_b = L_h^b*g^b*N_h^b/ (L_h^b*g^b*N_h^b+L_w^b*N_w^b)$; (D.1.1.4-4)

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;
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.

$$a_r = L_h^r * g^r * N_h^r / (L_h^r * g^r * N_h^r + L_w^r * N_w^r) \quad \text{(D.1.1.4-5)}$$

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;
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.

$$g = Q_{av}/Q_{max} = F_h * k_h * (T_{in} - T_{out\ av})/F_h * k_h * (T_{in} - T_{out\ min}) = (T_{in} - T_{out\ av}) / (T_{in} - T_{out\ min}) \quad \text{(D.1.1.4-6)}$$

where:
F_h – heated area of buildings, m^2;
k_h – average heat transfer factor of heated buildings, kW/m^2*K;
T_{in} – average inside temperature for the heating period, K (or ^0C);
$T_{out\ av}$ – average outside temperature for the heating period, K (or ^0C);
$T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^0C).

$$K_1 = NCV_b/NCV_r; \quad \text{(D.1.1.4-7)}$$

where:
NCV_b – average annual net calorific value of fuel in the base year, GJ/ ths m^3 (GJ/t);
NCV_r – average annual net calorific value of fuel in the reported year, GJ/ ths m^3 (GJ/t).

$$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b}); \quad \text{(D.1.1.4-8)}$$

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

$$K_3 = [(F_{h\ r} - F_{h\ t\ r} - F_{h\ n\ r})*k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r})*k_{h\ n}] / F_{h\ b}*k_{h\ b}; \quad \text{(D.1.1.4-9)}$$

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

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

$K_4 = N_{hr}/N_{hb}$; (D.1.1.4-10)

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

$K_5 = n_{wr} / n_{wb}$; (D.1.1.4-11)

where:
n_{wb},– number of customers in the base year;
n_{wr} – number of customers in the reported year

$K_6 = v_{w\,r} / v_{w\,b}$; (D.1.1.4-12)

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).

$K_7 = N_{wr}/ N_{wb}$; (D.1.1.4-13)

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.

$E_{cons}^{b} = P_b{*}CEF_c$; (D.1.1.4-14)

where:
P_b – electric power consumption by the boiler-houses and heat supply stations, MWh;
CEF_c – Carbon Emission factors for projects on reducing electricity consumption in Ukraine, tCO_2e/MWh;

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

The Specific project approach 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 a number of cities and regions in 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 dated 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 period 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 conservative approach) 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: (D.1.1.4-15)

If R = 0 (according to conservative approach, R < 0.05 is assumed for the baseline):
$\mathbf{T_{in\ b}} = 18\ ^oC$.
If $0.05 < R \leq 0.3$:
$\mathbf{T_{in\ b}} = 18 - (R/0.05)\ [^oC]$
If $0.3 < R < 1$:
$\mathbf{T_{in\ b}} = 12 - [(R - 0.3)/0.1]\ [^oC]$

where:
R - portion of returned payment of NP;

NP – amount of normative payment.

Thus if the inside temperature will be 18 ^{o}C or higher, it will be accepted as 18 ^{o}C according to conservative approach, and if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented above.

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

This section is left blank for purpose. Option 1 is chosen.

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):

This section is left blank for purpose. Option 1 is chosen.

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 sections D.1.1. - D.1.3. will be used for monitoring of the emissions in the project scenario and in the baseline scenario. They will be used in course of preparation of Monitoring reports. The baseline is dynamic and depends on conditions of every reported year. Therefore it is impossible to use these formulae in PDD to estimate emission reductions because there are no data (whether conditions, net calorific value of fuels, etc.) available for any reported year yet.

Formulae presented in this section 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 - 7**. These calculations are based on planned equipment efficiency increasing. Parameters' names corresponding to these formulae are pointed out in **Appendices 1 - 7**.

Every Appendix contains calculations of GHG emission reductions that correspond to specified technology used in the JI project.

Appendix 1 - Boiler equipment.
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 - Rehabilitation of network.
Partial replacement of the main and distribution networks pipes by the pre-insulated ones.
Appendix 3 - Frequency controllers installation.
Installation of frequency controllers at electric drives of pumps and draught-blowing equipment.
Appendix 4 – Heat exchangers replacement.
Replacement of old heat exchangers by the highly efficient ones.
Appendix 5 – Pumps replacement.
Replacement of pumps by the new ones with less capacity and better efficiency.
Appendix 6 – Implementation of Individual supply stations (IHSS).
Transition from Central Heat supply stations (CHSS) to Individual Heat supply stations (IHSS).
Appendix 7 – Implementation of cogeneration units.
Installation of cogeneration units for power energy production for own needs of the boiler houses.
Appendix 8 - Contains total sums of emission reductions, reductions of fuel and electricity consumption for every year for each technology.
Appendix 9 - Contains calculations of baseline emissions and project emissions as well as GHG emission reductions for every project year, based on formulae presented in D.1.4.

Appendixes 8 and **9** contain links with all **Appendixes 1 - 7**.

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

$ERUs = E_b – E_r$. (D.1.4-1)

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 two types of GHG emissions:

1) GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region;
2) GHG emissions from current power consumption from the state grid which will be reduced due to implementation of energy saving measures at boiler-houses and installation of cogeneration units for power generation for own needs of boiler-houses.

$E_b = E1_b + E2_b$ (D.1.4-2)

where:
$E1_b$ – emissions from heat generation sources operated by the heat supply systems of the involved Cities in Donetsk region, t CO_2e;
$E2_b$ – emissions due to electricity production to the grid, that is consumed by boiler houses and heat supply stations, t CO_2e;

1) Emissions from heat generating sources:

$E1_b = \sum (B_{b(i)} * NCV_{b(i)} * Cef_i)$, (D.1.4-3)

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), ths m^3 (t);
$NCV_{b(i)}$ – Net calorific value for each fuel, GJ/ths m^3 (GJ/t);
Cef_{i-} – Carbon Emission Factors for each fuel, t CO_2/GJ.

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

2) GHG emissions due to electricity production to the grid, that is consumed by boiler houses and heat supply stations.

$E2_b = P_b * CEF_c$, (D.1.4-4)

where:

P_b – annual power consumption of boiler houses and heat supply stations, MWh;
CEF_c – Carbon Emission factor for projects on reducing electricity consumption, tCO_2e/MWh., see **Table 7**.

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

Project emissions

There are three kinds of emissions which are included in the project scenario:

1) GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region;
2) GHG emissions from fuel consumption by the new cogeneration units;
3) GHG emissions from the power consumption from the state grid in the reported year.

Project emissions consist of three types of GHG emissions:

$$E_r = E1_r + E2_r + E3_r \qquad (D.1.4\text{-}5)$$

Where:
$E1_r$ – emissions from heat generation sources operated by the heat supply systems of the involved cities in Donetsk region, t CO_2e;
$E2_r$ – emissions from fuel consumption by the new cogeneration units, t CO_2e;
$E3_r$ – emissions due to electricity production to the grid, that consumed by boiler houses and heat supply stations, t CO_2e;

Project scenario emissions from boiler-houses are a sum of prognostic fuel amounts to be consumed in any reported year multiplied by corresponding conversion factors. Prognostic – means estimated fuel consumption in the project scenario after rehabilitation of boiler equipment, with subtracted fuel saving due to improving of the network efficiency, reconstruction and liquidation of heat supply stations.

$$E1_r = \sum ([B_{r(i)} - V_{(i)} - Q_{(i)}] * NCV_{(i)} * Cef_i) ; \qquad (D.1.4\text{-}6)$$

where:
$E1_r$ – project emissions from boiler-houses in any reported year, t CO_2e;
$B_{r(i)}$ – fuel consumption by (i) boiler-house in the project scenario (for each fuel), ths m^3 (t);
$V_{(i)}$ –fuel saving due to rehabilitation of network relative to (i) boiler-house for each fuel, ths m^3 (t);
$Q_{(i)}$ - fuel saving due to rehabilitation of heat supply stations for each fuel (including heat exchangers replacement, transition from CHSS to IHSS) for each fuel, ths m^3 (t);
$NCV_{(i)}$ – Net calorific value for each fuel, GJ/ ths m^3 (GJ/t);
Cef_{i-} – Carbon Emission Factor for each fuel, t CO_2/GJ.

$B_{r(i)} = [B_{b(i)} * NCV_{b(i)} * BBE_{(i)}] / [NCV_{r(i)} * PBE_{(i)}]$, (D.1.4-7)

where:
$BBE_{(i)}$ - Baseline Boilers Efficiency, %;
$PBE_{(i)}$ - Project Boilers Efficiency, %.

$V_{(i)} = B_{b(i)} - B_{b(i)} * (100-L1_b)/(100-L1_r)$, (D.1.4-8)

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), ths m^3 (t);
$L1_b$ – heat losses in the network in the baseline scenario, %;
$L1_r$ – heat losses in the network in the project scenario, %.

$Q_{(i)} = B_{b(i)} - B_{b(i)} * (100-L2_b)/(100-L2_r)$, (D.1.4-9)

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), ths m^3 (t);
$L2_b$ – heat losses in the heat supply stations in the baseline scenario, %;
$L2_r$ – heat losses in the heat supply stations in the project scenario, %.

$E2_r = B_g * NCV * Cef$; (D.1.4-10)

where:
B_g – calculated amount of fuel (gas) consumed by the new cogeneration units, ths m^3;

$E3_r = (P_b – P1_r – P2_r – P3_r – P4_r) * CEF_c$ (D.1.4-11)

where:
P_b – annual power consumption of boiler houses, MWh;
CEF_c – Carbon Emission factors for projects on reducing electricity consumption, tCO_2e/MWh;
$P1_r$ – calculated power saving due to frequency controllers installation, MWh;
$P2_r$ – calculated power saving due to heat exchangers replacement, MWh;
$P3_r$ - calculated power saving due to replacement of pumps, MWh;
$P4_r$ - power generation by the new cogeneration units, MWh.

$P1_r = \Sigma(N(i)_b * (1-\psi) * t)$ (D.1.4-12)

where:
$N(i)_b$ – capacity of draught-blowing equipment and/or pumps where frequency controllers are scheduled to be implemented, MW;
ψ – engine loading factor;
t - working period duration, hour/year.

$P2_r = \Sigma N(i)_b * BHEE_i / PHEE_i * t$, (D.1.4-13)

where:
$N(i)_b$ – capacity of heat exchangers that are scheduled to be replaced/rehabilitated, MW;
$BHEE_i$ - Baseline Heat Exchangers Efficiency, %;
$PHEE_i$ - Project Heat Exchangers Efficiency, %;
t - working period duration, hour/year.

$P3_r = \Sigma(N(i)_b - N(i)_r) * t$ (D.1.4-14)

where:
$N(i)_b$ and $N(i)_r$ – capacity of pumps that are scheduled to be replaced and of new pumps to be installed, respectively, MW;
t - working period duration, hour/year.

$P4_r = \Sigma N(i) * t$ (D.1.4-15)

where:
N - electric capacity of cogeneration units that are scheduled to be implemented, MW;
t - working period duration, hour/year.

For more detailed information see **Appendices 1 – 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" dated 25.06.1991;
- Law of Ukraine # 2707-XII "On atmospheric air protection" dated 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 on 27.06.2006, #309 and registered by Ministry of Justice of Ukraine on 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.
1.1. Amount of natural gas consumed by boiler houses 1.2. Amount of coal consumed by boiler houses	Low for gas. Medium for coal	Measuring instruments must be calibrated according to national regulations
2. Fuel quality (Net Calorific Value)	Low	Even though there is no need to mistrust fuel suppliers, the Supplier will periodically check the data provided by fuel suppliers through performing chemical analyzes of supplied fuel (usually once per heating period).
3. Outside temperature	Low	Statistic data. No quality assurance is needed.
4. Inside temperature	Low	Statistic data. No quality assurance is needed.
5. Number of customers of hot water supply service	Low	Statistic data. No quality assurance is needed.
6. Heated area	Low	Statistic data. No quality assurance is needed.
7. Average heat transfer factor of heated buildings	Low	Normative documents data. No quality assurance is needed.
8. Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation	Low	Statistic data. No quality assurance is needed.

9. Heated area of newly connected buildings (assumed with the new (improved) thermal insulation)	Low	Statistic data. No quality assurance is needed.
10. Heat transfer factor of buildings with new thermal insulation	Low	Normative documents data. No quality assurance is needed.
11. Heating period duration	Low	Statistic data. No quality assurance is needed.
12. Duration of period of hot water supply service	Low	Statistic data. No quality assurance is needed.
13. Connected load to the boiler-house for heating	Low	Calculated data (data are calculated taking into account connected Heated area by methodology of normative documents). No quality assurance is needed.
14. Connected load to the boiler-house for hot water supply service	Low	Calculated data (data are calculated taking into account number of connected customers of hot water supply service by methodology of normative documents). No quality assurance is needed.
15. Standard specific discharge of hot water per personal account	Low	Normative documents data. No quality assurance is needed.
16. Carbon emission factors	Low	Normative documents data. No quality assurance is needed.
17. Amount of electric power consumed by boiler houses	Low	Measuring instruments must be calibrated according to national regulations

18. Fuel consumption by the cogeneration units	Low	Measuring instruments must be calibrated according to national regulations

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

The scheme identifying the responsibilities and the authority regarding the monitoring activitiy as to the parameters to be monitored is presented in **Annex 3**.

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

The monitoring plan is determined by the Institute of Engineering Ecology (IEE), the project developer, and RME "Donetskteplocomunenergo", the project supplier (project participant).

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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 activity level, estimated by fuel and power consumption, will be reduced comparing to the baseline activity level due to fuel and power saving.

Project energy resources consumption is presented in the Table 11.

Types of project activity	Energy resources consumption
Natural gas consumption by boiler houses and new cogeneration units, ths. m^3	239934.1
Coal consumption, t	1890.8
Power consumption by boiler houses and heat supply stations, MWh	34184.1

Table 11. Project Energy resources consumption

Detailed information is presented in **Appendices 1 - 7.**

Estimation of Project Emissions

There are three kinds of emissions which are included in the project scenario:

1) GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region (E1r);
2) GHG emissions from fuel consumption by the new cogeneration units (E2r);
3) GHG emissions from the power generation that is consumed by boiler houses and heat supply stations from the state grid (E3r).

Project Emissions after project implementation are shown in Table 12.

Project emissions		Project emissions, t CO_2e
GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region	E1r	441229
GHG emissions from fuel consumption by the new cogeneration units	E2r	18419
GHG emissions from the power generation that is consumed by boiler houses and heat supply stations from the state grid	E3r	41944
Total		**501592**

Table 12. Project Emissions after project implementation

See **Appendix 9**.

Project emissions after project implementation are ~ **501592** t CO_2e

In the PDD calculations, according to the conservative approach, only the minimal guaranteed effects from all energy saving measures were taken into account.

Also, emission reductions were calculated for the next year after implementation of the fuel and energy saving measures. In fact the resulted emission reductions are achieved just after implementation of these measures in the same year of rehabilitation, especially if it has taken place at the beginning of the year.

Project emissions from the beginning until the end of the crediting period for each year see in **section E.6** and **Appendix 9 (Baseline)**.

E.2. Estimated leakage:

No leakage is expected in proposed project activity.

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

Project Emissions + Leakages = 501592 + 0 = 501592 t CO_2e.

E.4. Estimated baseline emissions:

Baseline emissions consist of two types of GHG emissions:

1) GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region in the base year (E1b);
2) GHG emissions from the power generation that is consumed by boiler houses and heat supply stations from the state grid in the base year (E2b).

Baseline emissions by the sources of GHG emission are presented in the Table 13.

Baseline emissions by the sources of GHG emission		Baseline emissions, t CO_2e
GHG emissions from boilers which are operated by the heat supply systems of the involved cities in Donetsk region in the base year	E1b	553898
GHG emissions from the power generation that is consumed by boiler houses and heat supply stations from the state grid in the base year	E2b	103747
Total		**657645**

Table 13. Baseline Emissions

Baseline emissions are: ~ **657645**t CO_2e.

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

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating period if DH systems of district heating enterprises that implement the project remains unchanged, see in **section B** and **Appendix 9 (Baseline)**.

Baseline emissions for each year from the beginning until the end of the crediting period see in **section E.6** and **Appendix 9 (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) =

= 657645 – (501592+ 0) = 156053 t CO_2e / year.

In course of the project implementation, the different emission reductions will be achieved at the different stages of project implementation. The amounts of emission reductions are represented in the **Table 3-6** Paragraph **A.4.3.1.**

Project Emission Reductions by the types of project activity are presented in the Table 14.

Year	GHG emission reductions, t CO_2e							
	Due to boiler houses rehabilitation	Due to network rehabilitation	Due to implementation of frequency controllers	Due to heat exchangers replacement	Due to pumps replacement	Due to IHSSs implementation	Due to cogeneration units installation	**Total**
2006	3758.9	3374.9	0.0	335.8	608.5	0.0	0.0	**8078.1**
2007	14862.5	30176.2	0.0	1672.3	4008.1	0.0	0.0	**50719.1**
2008	19802.6	44146.6	2295.7	3023.5	7564.0	0.0	0.0	**76832.4**
2009	22731.1	46917.9	3976.4	3135.3	10046.5	0.0	0.0	**86807.2**
2010	30538.6	52174.5	4371.8	3126.0	10434.2	238.3	9194.1	**110077.5**
2011	39122.0	53625.7	4967.6	3127.6	10451.3	649.2	36482.8	**148426.2**
2012	46749.1	53625.7	4967.6	3127.6	10451.3	649.2	36482.8	**156053.3**
Total 2006 – 2012	**177564.8**	**284041.5**	**20579.1**	**17548.1**	**53563.9**	**1536.7**	**82159.7**	**636993.8**

Table 14. Estimated Project Emission Reductions

For more details see **Appendix 1-7**.

Project Emission Reductions by the district heating enterprises that implement the project are presented in the Table 15.

Year	GHG emissions reduction, t CO_2e			
	Makiivka	Mariupol	Artemivsk	**Total**
2006	1767.3	5761.9	548.9	**8078.1**
2007	8410.7	38822.2	3486.2	**50719.1**
2008	10498.9	61374.0	4959.4	**76832.4**
2009	12134.1	64630.9	10042.2	**86807.2**
2010	15573.0	81261.9	13242.6	**110077.5**
2011	23144.2	111169.0	14112.8	**148426.2**
2012	27326.8	114516.8	14209.6	**156053.3**
Total 2006 – 2012	**98855.0**	**477536.7**	**60601.7**	**636993.8**

Table 15.Estimated Emission Reductions for each district heating enterprises that implement the project

For more details see **Appendix 8**.

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)
2006	621580	0	629658	8078
2007	578939	0	629658	50719
Subtotal 2006 - 2007	**1200519**	**0**	**1259316**	**58797**
2008	580137	0	656969	76832
2009	571684	0	658491	86807
2010	547399	0	657476	110078
2011	509220	0	657645	148426
2012	501592	0	657645	156053
Subtotal 2008 - 2012	**2710032**	**0**	**3288226**	**578196**
2013	501592	0	657645	156053
2014	501592	0	657645	156053
2015	501592	0	657645	156053
2016	501592	0	657645	156053
2017	501592	0	657645	156053
2018	501592	0	657645	156053
2019	501592	0	657645	156053
2020	501592	0	657645	156053
2021	501592	0	657645	156053
2022	501592	0	657645	156053
2023	501592	0	657645	156053
2024	501592	0	657645	156053
2025	501592	0	657645	156053
2026	501592	0	657645	156053
2027	501592	0	657645	156053
2028	501592	0	657645	156053
2029	501592	0	657645	156053
2030	501592	0	657645	156053
2031	501592	0	657645	156053
2032	501592	0	657645	156053
Subtotal 2013 - 2032	**10031840**	**0**	**13152900**	**3121060**
Total (2006 - 2032)	**13942391**	**0**	**17700442**	**3758053**

Table 16. Table providing values obtained when applying formulae above.

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 regulations, the design documentation for the new building, reconstruction and major technical re-equipment of industrial and civil objects must include the environmental impact assessment.

Environmental Impact Assessment (EIA) is directed on determination of scales and levels of the project activity impact on an environment, on development of measures for prevention or reduction of this impact, on estimation of acceptability of project decisions from the ecological point of view. The EIA is inalienable part of project documentation of any above economical activity, but does not influence on the process of economic decisions acceptance. The EIA is conducted under the strict requirements.

The legislative requirements to EIA materials content are enshrined in the Article 36 of the Law of Ukraine «On ecological expertise»[20]. Requirements to the structure, composition and content of the EIA sections are enshrined in the state building norms of Ukraine DBN A.2.2-1-2003 "Composition and content of the Environmental Impact Assessment (EIA) materials at designing and construction of enterprises, buildings and premises"[21].

District heating enterprises that implement the project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" make the necessary Environmental Impact Assessment for elements of this activity according to Ukrainian legislation.

For example, during implementation of the project activity the EIA for reconstruction of boiler-house #33 Uvileyna str.,117 Artemivsk City (#152 in the Project) has been fulfilled. In this EIA the following points are mentioned: impact on vegetative and animal world is not present, the project activity will not lead to changes in use of land, emissions will not exceed the immission limit level, and the project activity in general will not lead to worsening of environment conditions. The summary indicator of air pollution extent is 0.125, that is less than 1.0, which corresponds to allowable pollution level and safe level of danger.

Overall, this JI project will have a positive effect on environment. Following points will give detailed information on environmental benefits.

1. Project implementation will allow saving over 48.4 million Nm^3 of natural gas, about 1350 ton of coal per year after project complete implementation. Natural gas and coal are the non-renewable resources and their saving is important.

2. Project implementation will reduce GHG emissions in Makiivka, Mariupol and Artemivsk Cities by about 156 thousand tons CO_2e per year after project complete implementation due to increased efficiency of the DH systems. This will be achieved through installation of up-to-date boiler-houses equipment, particularly new boilers, cogeneration units, heat exchangers, pumps, and using of pre-insulated networks pipes instead of existing regular networks pipes, etc.

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

4. Due to scheduled better heat supply service, population of Makiivka, Mariupol, Artemivsk Cities is expected to reduce electricity consumption by electric heaters thus reducing power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

[20] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=45%2F95-%E2%F0

[21] http://www.budinfo.com.ua/dbn/8.htm

DBN A.2.2-1-2003 does not contain the requirement as to the obligatory analysis of the transboundary impact, and in accordance with this the EIAs usually do not contain such special analysis. However, for this project transboundary impact is not considered, taking into account the insignificant emissions and that these emissions are localized not far away from the source sites.

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 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 impact on the atmosphere (due to lower temperatures of flue gases) will be decreased;
4) Lower emissions per unit of produced heat at the same load on boiler house.

Impact on the water medium

Impact on water resources will be the same as in baseline scenario. The existing technology of heat energy production exploited at the objects of district heating enterprises that implement the project 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 waste water 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.

Impact on the land use

Impact on the land is not present.

Relevant regulation in 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”.

Impact on the biodiversity

Impact on biodiversity is not present.

Waste generation, treatment and disposal

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 district heating enterprises that implement the project deliver old equipment to metal recycling.

Reporting on statistic supervision on environmental protection

The district heating enterprises that implement the project regularly fill all forms of statistic supervision reporting required for their activity according to the valid Ukrainian legislation, that are:

- Form #1–ecologycal expenses "Report about expenses for environmental protection and ecologycal payments";
- Form #1–danger waste "Report about generation, handling and treatment of waste of the I-III classes of danger";
- Form #1-tp (air) - report about amount of potential environmental polluting emissions to atmosphere.

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 (city councils that are the representatives of the population) of Makiivka, Mariupol and Artemivsk Cities of Donetsk region have expressed the support for the project.

Project "Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region" was presented at the XX and XXI International Conferences "Problems of Ecology and Exploitation of Energy Objects" (Yalta, 2010 and 2011), where it was comprehensively discussed with representatives of governmental and district heating organizations.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Supplier:

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Annex 2

BASELINE INFORMATION

The key elements of the baseline (including variables, parameters and data sources) are presented in table below.

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	$\mathbf{B_b}$	Fuel consumption by boiler-houses (Natural gas/coal)		
1.1	B_b (natural gas)	Natural gas consumption	ths.m^3	m
1.2	B_b (coal)	Coal consumption	t	m
2	$\mathbf{P_b}$	Electric power consumption	MWh	m
3	$\mathbf{NCV_b}$	Average annual Net Calorific Value		
3.1	NCV_b (natural gas)	Average annual Net Calorific Value for natural gas	MJ/m^3	m, c
3.2	NCV_b (coal)	Average annual Net Calorific Value for coal	MJ/kg	m, c
4	$\mathbf{Cef_b}$	Carbon emission factor		Normative documents
4.1	Cef (natural gas)	Carbon emission factor for natural gas	t CO_2/GJ	IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy
4.2	Cef (coal)	Carbon emission factor for coal	t CO_2/GJ	IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy

5	**CEF_c**	Carbon emission factor for JI projects reducing electricity consumption	t CO_2e/ MWh	Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption" of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004 (ERUPT 4, Senter, the Netherlands); 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", confirmed by TUV SUD Industrie Service GmbH 17.08.2007; Orders of the National Environmental Investment Agency of Ukraine: # 62 dated 15.04.2011; # 63 dated 15.04.2011; # 43 dated 28.03.2011; # 75 dated 12.05.2011

Table An2-1. The key elements of the baseline

Annex 3

MONITORING PLAN

This monitoring plan describes the project specific approach that will be used to calculate the ongoing amount of greenhouse gas emission reductions resulting from implementation of the JI project in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region. 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 of greenhouse gas emissions. The reductions of GHG emissions will be quantified using the project specific approach presented in this Monitoring Plan.

Relevant monitoring approach

In course of development of the monitoring plan for the JI project **"Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region"**, the project specific approach for "District Heating" projects in Ukrainian conditions was used (see section B.1).

Monitoring project specific approach developed for "District Heating" projects in Ukrainian conditions

Monitoring project specific approach is presented in details in section D.1.1. of this PDD (Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario).

Formulae for monitoring

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

Total emission reduction

Formula 1 – Total emission reduction	
	ERUs = $\sum[E_{(i)}^{b} - E_{(i)}^{r}]$; [t CO_2e]
	ERUs - total annual emission reduction, t CO_2e $E^{b}_{(i)}$ – dynamic baseline emissions, t CO_2e $E^{r}_{(i)}$ - 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)**	
	$E_{(i)}^{r} = E_{1(i)}^{r} + E_{gen\ (i)}^{r} + E_{cons\ (i)}^{r}$; [t CO_2e]
	$E_{1(i)}^{r}$ –emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, t CO_2e; $E_{gen\ (i)}^{r}$ – emissions due to fuel consumption by the new cogeneration units at an (i) boiler-house in the reported year, t CO_2e; $E_{cons\ (i)}^{r}$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with the related heat supply stations in the reported year, t CO_2e.

Formula 3 – Emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, ($E_{1(i)}^r$)	
	$E_{1(i)}^r = NCV_r * Cef_r * B_{r(i)}$, [t CO_2e]
	$NCV_{r(i)}$ – average annual Net Calorific Value of a fuel, GJ/ths m^3 (GJ/t); Cef – Carbon emission factor for a fuel, tCO_2/GJ; $B_{r(i)}$ – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons

Formula 4 – Emissions due to fuel consumption by the new cogeneration units at an (i) boiler-house in the reported year ,($E_{gen\ (i)}^r$)	
	$E_{gen(i)}^r = B_{g(i)} * NCV_r * Cef$ [t CO_2e]
	B_g– natural gas consumption by installed cogeneration units at an (i) boiler-house in the reported year, ths m^3/MW; NCV_r – average annual Net Calorific Value in reported year, GJ/ths m^3 (GJ/t) Cef – carbon emission factor, tCO_2/GJ.

Formula 5 – Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the reported year ($E_{cons\ (i)}^r$)	
	$E_{cons\ (i)}^r = P_r * CEF_c$ [t CO_2e]
	P_r – electricity consumption in the reported year by a boiler-house, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, tCO_2e/MWh.

Baseline emissions

Formula 6 – Dynamic baseline emissions **(**E_b)	
	$E_{(i)}^b = E_{1(i)}^b + E_{cons\ (i)}^b$; [t CO_2e]
	$E_{1(i)}^b$ – baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the base year in terms of a reported year, t CO_2e; $E_{cons\ (i)}^b$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year in terms of a reported year, t CO_2e.

Formula 7 – Baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the base year in terms of a reported year, ($E_{1(i)}^b$)	
	For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$): $E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w]$, where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply service. 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):

	$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.
	NCV_b – average Net Calorific Value of a fuel in the base year, GJ/ths m^3 (GJ/t); Cef – Carbon emission factor for a fuel, tCO_2/GJ; 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)	
	$a_b= L_h^b*g^b*N_h^b/ (L_h^b*g^b*N_h^b+L_w^b*N_w^b)$;
	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^b – recalculating factor for average load during heating period in the base year; 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)	
	$a_r= L_h^r*g^r*N_h^r/ (L_h^r*g^r*N_h^r+L_w^r*N_w^r)$
	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^r – recalculating factor for average load during heating period in the reported year; 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 – Recalculating factor for average load during heating period (g)	
	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min}) = (T_{in} - T_{out\ av}) / (T_{in} - T_{out\ min})$
	F_h – heated area of buildings, m^2; k_h – average heat transfer factor of heated buildings, kW/m^2*K; T_{in} – average inside temperature for the heating period, ^0C ; $T_{out\ av}$ – average outside temperature for the heating period, ^0C; $T_{out\ min}$ – minimal outside temperature for the heating period, ^0C.

Formula 11 – Net calorific value of a fuel change factor (K_1)	
	$K_1=NCV_b / NCV_r$
	NCV_b – average Net Calorific Value in the base year, GJ/ths m^3 (GJ/t); NCV_r – average Net Calorific Value in the reported year, GJ/ths m^3 (GJ/t).

Formula 12 – 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, ^0C; $T_{in\ b}$ – average inside temperature for the heating period in the base year, ^0C; $T_{out\ r}$– average outside temperature for the heating period in the reported year, ^0C; $T_{out\ b}$– average outside temperature for the heating period in the base year, ^0C

Formula 13 – Heated area and building thermal insulation change factor (K_3)	
	$K_3 = [(F_{h\ r} – F_{h\ t\ r}– F_{h\ n\ r})*k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r})*k_{h\ n}] / F_{h\ b}*k_{h\ b}$,
	$F_{h\ b}$ – heated area in the base year, m^2; $F_{h\ r}$ – heated area in the reported year, m^2; $F_{h\ n\ r}$ – heated area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2; $F_{h\ t\ r}$ – heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in reported year, m^2; $k_{h\ b}$ – average heat transfer factor of heated buildings in the base year, kW/m^2*K; $k_{h\ n}$ – average heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), kW/m^2*K.

Formula 14 – 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 15 – Number of customers of the hot water supply service change factor (K_5)	
	$K_5 = n_{wr} / n_{wb}$
	N_{wb},– average number of customers of the hot water supply service in base year; N_{wr} – average number of customers of the hot water supply service in the reported year.

Formula 16 – 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 17 – Hot water supply period duration change factor (K_7)	
	$K_7 = N_{wr} / N_{wb}$
	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 18 –Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with heat supply stations in the base year ($E_{cons\,(i)}^{b}$)	
	$E_{cons}^{b} = P_b * CEF_c$
	P_b – electricity consumption by a boiler-house with heat supply stations in the base year, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, t CO_2e/MWh

Parameters to be monitored

Monitoring project specific approach 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 spreadsheets that will track GHG emission reductions annually.

List of parameters to be monitored are in the tables below.

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	According to the conservative approach, the volume of consumed natural gas will be corrected by measurement error. Amount of natural gas consumed in the reported year that will be used for Project emissions calculations will be increased by the portion proportional to the level of accuracy of gas flow meter installed at a boiler-house.

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. Amount of coal is measured by wheelbarrows and pails, and then is converted 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 Calorific Value of Natural Gas
Description	Average annual Calorific Value of Natural Gas calculated by Net calorific 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 Calorific Value of Coal
Description	Average annual Calorific Value of Coal calculated by Net calorific 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 period
Description	Average outside temperature during the heating period
Monitoring method	Average outside temperature during the heating period is calculated by district heating enterprises that implement the project from the values of daily outside temperature taken by dispatchers of enterprises from local Meteorological Centre at 10 to 11 a.m. every day of heating period.
Recording frequency	Average outside temperature is calculated once per year. Daily outside temperature is recorded every every day of heating period
Background data	Meteorological Centre every month sends the Report for every day of heating period. Reports are filed in special journals
Calculation method	Average value

Parameter number and name	**4.** Average inside temperature during the heating period
Description	Average inside temperature during the heating period 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 period
Background data	Accounting documents
Calculation method	According to item 24 of “Rules of rendering of heat and hot water supply service to population” № 1497 from 30.12.1997[22],, enterprise makes the return payment of: – 5% from payment for every degree from 18 to 12 ^{o}C; – 10% from 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 conservative approach, R < 0.05 is assumed for the baseline): $\mathbf{T_{in\ b}}$ = 18 ^{o}C. If $0.05 < R \leq 0.3$: $\mathbf{T_{in\ b}}$ = 18 – (R/0.05) [^{o}C] If $0.3 < R < 1$: $\mathbf{T_{in\ b}}$ = 12 – [(R – 0.3)/0.1] [^{o}C] where: R - portion of returned payment of NP; NP – amount of normative payment. Thus if the inside temperature will be 18 ^{o}C or higher, it will be accepted as 18 ^{o}C according to conservative approach, and if it will be lower than 18 ^{o}C it will be calculated from return payments by the alghorithm presented above.

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 district heating enterprises
Recording frequency	Contracts with population, organizations and legal entities are concludes directly with district heating enterprise. 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	The data is taken for January, 01 of the year next to the reported year

[22] *http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1497-97-%EF*

Parameter number and name	**6.** Heated area (Total)
Description	Heated area for a boiler house
Monitoring method	Statistics of district heating enterprises
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 District heating enterprises by the certificates of owners in accordance with technical passport of building. Total area with balconies and stairs and Heated area are displayed in the special journal
Calculation method	The data is taken for January, 01 of the year next to the reported year

Parameter number and name	**7.** Heat transfer factor of buildings
Description	Heat transfer factor of buildings for a boiler-house
Monitoring method	Statistics of district heating enterprises
Recording frequency	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any Heated area to boiler-houses included in project.
Background data	SNiP 2-3-79 (1998), State Buildings Norms B.2.6-31:2006
Calculation method	For calculation of Heat transfer factor of buildings for a boiler-house, the method of weighted average value was used, that depends on heated area of existing buildings and heated area of the new buildings. Values of the heat transfer factor for existing buildings were taken from SNiP 2-3-79 (1998) (Table 1a) - not higher than 0.63 W/m^2*K. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms B.2.6-31:2006 (Table 1) - not higher than 0.36 W/m^2*K.

Parameter number and name	**8.** Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heated area of reconstructed buildings with application of new thermal insulation
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Statistics of district heating enterprises
Calculation method	The data is taken for January, 01 of the year next to the reported year

Parameter number and name	**9.** Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heated area of newly connected buildings with application of the new thermal insulation
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Statistics of district heating enterprises
Calculation method	The data is taken for January, 01 of the year next to the reported year

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	Statistics of the district heating enterprises
Recording frequency	Once per year
Background data	State Buildings Norms B.2.6-31:2006, Table 1
Calculation method	n.a.

Parameter number and name	**11.** Heating period duration
Description	Heating period duration for a boiler house
Monitoring method	Statistics of the District heating enterprises
Recording frequency	Once per year
Background data	The nominal duration (beginning and ending) of the heating period is defined for every town separately, in accordance with item 7.9.4 of “Rules of technical exploitation of heating equipment and networks. 2007”[23]. 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. Actual duration of the heating period is to be taken for a boiler house
Calculation method	Sum of durations from the beginning of the calendar year till data of ending of the heating season, and from data of beginning of the new heating season till ending of this calendar year

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for a boiler house.
Monitoring method	Statistics of the District heating enterprises
Recording frequency	Once per year
Background data	Hot water supply service is realized by hot water delivery schedule for every boiler-house.
Calculation method	Total duration of the hot water supply time per the calendar year

[23] *http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?page=6&nreg=z0197-07*

Parameter number and name	**13.** Maximum connected load to a boiler-house required for heating
Description	Maximum connected load to a boiler-house, that is required for heating.
Monitoring method	Calculated by District heating enterprises
Recording frequency	Once per year
Background data	Maximum connected load to a boiler-house, that is required for heating, is calculated by District heating enterprises for every heating period. It is calculated according to heat demand at nominal minimum outside temperatures [KTM 204 Ukraine 244-94, Annex 1]: Makiivka city – (-26) ^{o}C Mariupol city - (-23) ^{o}C Artemivsk city - (-25) ^{o}C.
Calculation method	n.a.

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

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”, and no information is available on any propositions to change it
Calculation method	n.a.

Parameter number and name	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels, for JI projects on reducing electricity consumption in Ukraine, for the Ukrainian grid
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	For all fuels the Carbon emission factors are used from the data table provided in IPCC 1996 Guidelines for National Greenhouse Gas Inventories. Vol.2 Energy. The values of the carbon emission factors for JI projects on reducing electricity consumption in Ukraine were taken for relevant years according to:

	- Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption" of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004 (ERUPT 4, Senter, the Netherlands); - 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", confirmed by TUV SUD Industrie Service GmbH 17.08.2007; - Orders of the National Environmental Investment Agency of Ukraine # 62 dated 15.04.2011; # 63 dated 15.04.2011; # 43 dated 28.03.2011; # 75 dated 12.05.2011.
Calculation method	n.a.

Parameter number and name	**17.** Electricity consumption
Description	Electricity consumption by boiler-houses
Monitoring method	Electricity meter
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	According to the conservative approach, the volume of consumed electricity will be corrected by measurement error. Amount of electricity consumed in the reported year that will be used for Project emissions calculations will be increased by the portion proportional to the level of accuracy of electricity meter installed at a boiler-houses.

Parameter number and name	**18**. Fuel consumption by the cogeneration units
Description	Fuel (natural gas) consumption by the new cogeneration units
Monitoring method	Gas flow meter
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	According to the conservative approach, the volume of consumed natural gas will be corrected by measurement error. Amount of natural gas consumed in the reported year that will be used for Project emissions calculations will be increased by the portion proportional to the level of accuracy of gas flow meter installed at a boiler-house.

Scheme of monitoring system

The control and monitoring system comes to fuel and power 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 carried 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. An3-1.

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.

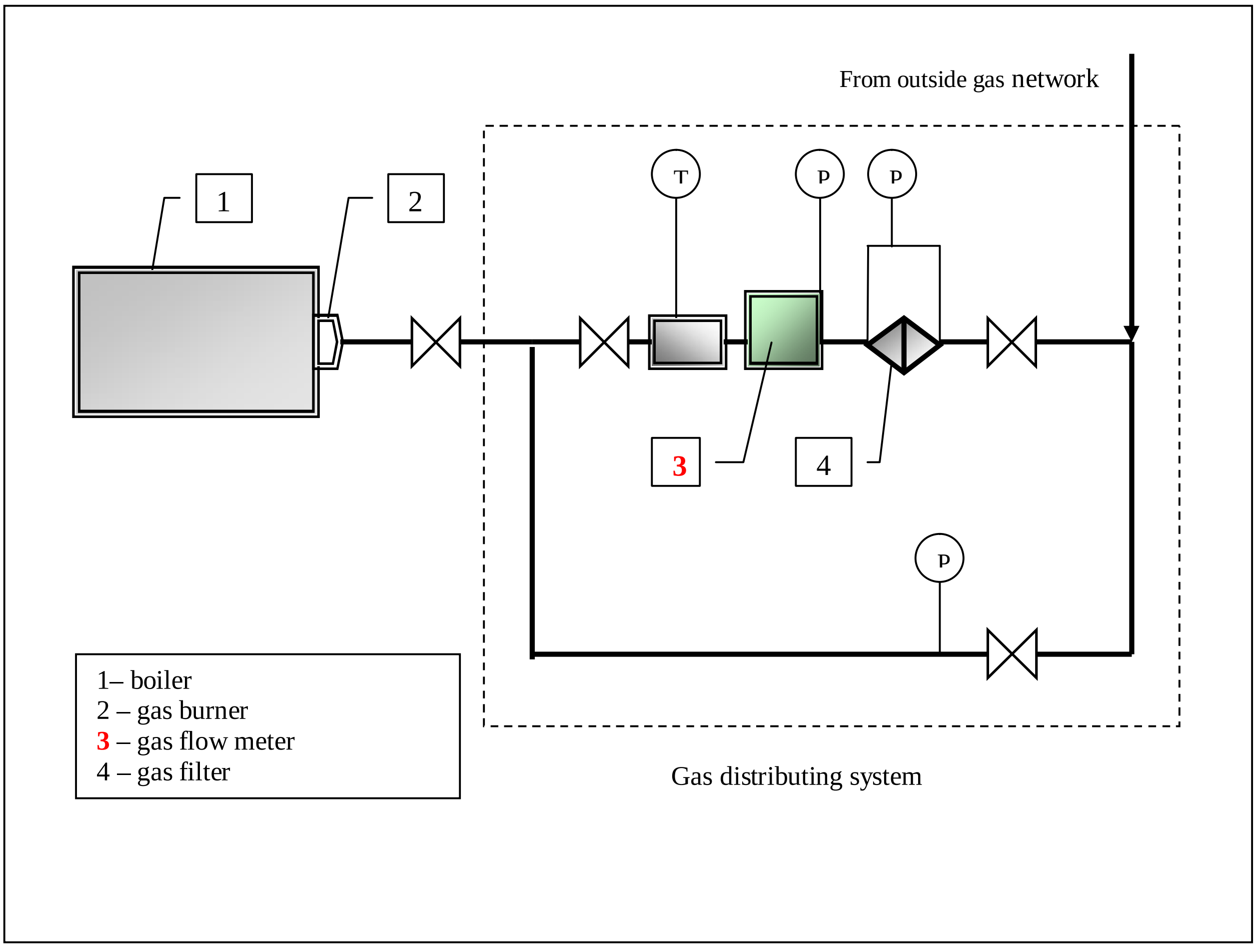

Fig. An3-1. Scheme of the Gas distribution system

The typical scheme of monitoring system for boiler-house where the cogeneration units will be installed is shown at the Fig. An3-2. 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

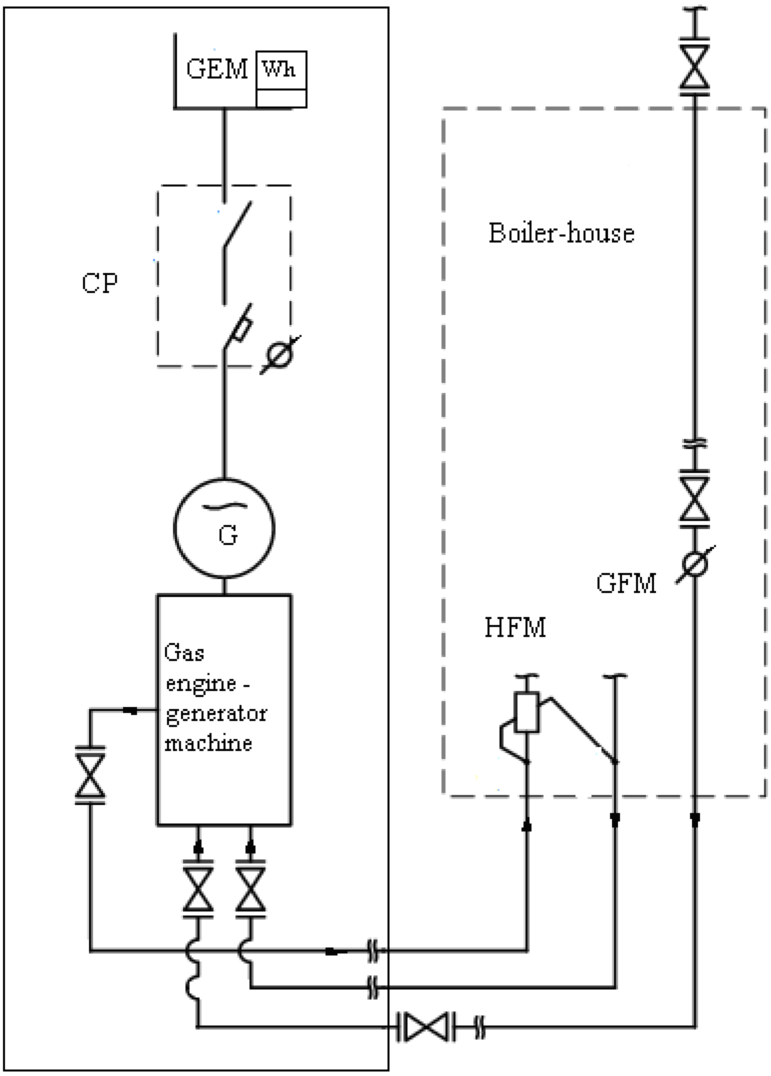

Fig. An3-2. Scheme of monitoring system for boiler-house where the cogeneration units are to be installed

Monitoring equipment

The equipment to be used by the project executors 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 authority	Calibration interval	Procedure in case of failure
1.1. Natural Gas consumption	Gas flow meters	+/- (0.5…2.0) % Usually 1%	SE «Donetskstandartmetrologiya»	According to technical specifications of the meters	Failure should be immediately 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 are to be recorded in the site events log book.
17. Electricity consumption	Electricity meters	+/- (0.2…1) % Usually 0.2%	SE «Donetskstandartmetrologiya»	According to technical specifications of the meters	Failure should be immediately 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 are to be recorded in the site events log book.
18. Fuel consumption by the cogeneration units	Gas flow meters	+/- (0.5…2.0) % Usually 1%	SE «Donetskstandartmetrologiya»	According to technical specifications of the meters	Failure should be immediately 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 are to be recorded in the site events log book.

Table An3-1. Monitoring equipment

For gas consumption measurement the following gas flow meters are used:

Type of gas flow meter	Manufacturer	Calibration interval (years)
G - 1600 -ЛГК – 200	OJSC "Pomprilad", Ivano-Frankivsk	2
G – 160- ЛГК - 80	OJSC "Pomprilad", Ivano-Frankivsk	2
G - 400 - ЛГК- 150	OJSC "Pomprilad", Ivano-Frankivsk	2
G - ЛГК - 80 – 650	OJSC "Pomprilad", Ivano-Frankivsk	2
G - РГК - 400 - 250	OJSC "Pomprilad", Ivano-Frankivsk	2
РГК-40 … РГК-1000	OJSC "Pomprilad", Ivano-Frankivsk	2
ЛГК-80 … ЛГК-200	OJSC "Pomprilad", Ivano-Frankivsk	2
РГС-65-Ex	OJSC "Pomprilad", Ivano-Frankivsk	2
GMS- G16 … G250	"Arsenal", Kiyv	2
Kurs G400 A2	PKF "KURS" Ltd., Dnipropetrovsk	2
"Kurs -01" G16A1	PKF "KURS" Ltd., Dnipropetrovsk	2
САМГАЗ ВК-G10	"Samgaz" Ltd., Rivne	2
ВРСГ-1	"Irvis", Harkiv	2
AMG10	«Apator Metrix», Poland	2
Diaphragm"Potik"	Dnipropetrovsk	1

Table An3-2. Gas flow meters and their calibration

For electricity consumption measurement the following electricity meters are used:

Type of electricity meter	Manufacturer	Calibration interval (years)
NIK2303APK1	"Nik-elektronika" Ltd., Kiyv	6
NIK 2301, 2303	"Nik-elektronika" Ltd., Kiyv	6
Delta 8010-02	OJSC MITEL, Dnipropetrovsk	6
Delta 8010-08	OJSC MITEL, Dnipropetrovsk	6
Delta 8010-06	OJSC MITEL, Dnipropetrovsk	6
СА4У - 196	"LEMZ" Ltd., Sankt-Peterburg	4
СА4У - И672М	"LEMZ" Ltd., Sankt-Peterburg	4
СР4У - И673М	"LEMZ" Ltd., Sankt-Peterburg	4
СА4 – И678	"LEMZ" Ltd., Sankt-Peterburg	4
Itron SL7000 Smart	DE "Aitron Ukraina", Kiyv	6
SL 761BO71	"Actaris", France	6
Меркурий 230	"Firma INKOTEKS" Ltd.,Moskva	8
EMS-135001… 134.10.1	OJSC "ELGAMA elektronika", Vilnus	6
LZQM	OJSC "ELGAMA elektronika", Vilnus	6
A1140 RAL	"Elster Metronik", Moskva	16
СТК-3	OJSC "Elvin", Kiyv	6

Table An3-3. Electricity meters and their calibration

Level of uncertainty and errors

Possible uncertainty and errors for such type project may arise from two main reasons: 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 18 monitoring points, only 3 of these (natural gas consumption, electricity consumption, natural gas consumption by the new CHP units) are measured directly. The remaining monitoring parameters used in calculation of the baseline and project 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 measurement errors (maximal) for the three parameters, that impact on the Standard Error, and their level of accuracy are presented in Table An3-4.

ID number and data variable	Measurement error	Comment
1.1 Natural Gas consumption	± (0.5…2.0) %	Accuracy of data is high due to necessity of information for commercial account purposes.
20. Power consumption	± (0.2…1.0) %	Accuracy of data is high due to necessity of information for commercial account purposes.
18. Fuel consumption by the cogeneration units	± (0.5…2.0) %	Accuracy of data is high due to necessity of information for commercial account purposes.

Table An3-4. Measurement errors

Monitoring of environmental impacts

As the project involves rehabilitation of an existing district heating system leading to an improvement of energy efficiency and therefore to the better environmental performance of the system, and is not a new building project, no negative environmental impacts are expected.
District heating enterprises that implement the project make the Environmental Impact Assessments in cases when it is required according to ukrainian regulations.

There is therefore no need to monitor specified environmental impact indicators during implementation and operation of the project activities.

Project management planning

The overall responsibility for the project management and implementation is carried out by the General Director of RME "Donetskteplocomunenergo", Mr. Vasyl Vorotyntsev. He has appointed responsible persons leaded by Ms. Viktoriya Kucherenko, Deputy General director on investments and strategic development of RME "Donetskteplocomunenergo". The stuff of PTD of ME "Makiivteplomerezha", MCE "Mariupolteplomerezha" and "Artemivsk-Energy", Ltd. are also responsible for project activity.

Possible bottlenecks and mistakes in project implementation should be identified and solved by responsible stuff of PTDs.

Responsibilities for data collection

The General Director of the RME "Donetskteplocomunenergo", Mr. Vasyl Vorotyntsev, has appointed a responsible person, Ms. Victoriya Kucherenko, Deputy director on investments and strategic development of RME "Donetskteplocomunenergo", for the implementation and management of the monitoring process for the project. Ms. Kateryna Pahomova, senior engineer of the prospective development department of RME "Donetskteplocomunenergo", is responsible for data collection, measurements, calibration, data recording and storage.

Dr. Dmytro Paderno, Deputy director of the Institute of Engineering Ecology, is responsible for baseline and monitoring JI project specific approach development.

Ms. Kateryna Korinchuk, engineer of the Institute of Engineering Ecology, is responsible for data processing.

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

1. Natural gas consumption is measured by gas flow meter, installed at a boiler-house. All boiler-houses are equipped with gas flow meters.

2. The majority of boiler-houses are equipped with automatic correctors for temperature and pressure. Gas consumption is registered automatically. Every day operator of a boiler house makes registration of daily gas consumption in the special paper journal "Journal of registration of boiler-house's operation parameters".

3. At the boiler-houses that are not equipped with gas volume correctors, operator of a boiler house every 2 hours registers parameters of natural gas (temperature and pressure) in the paper journal "Journal of registration of boiler-house's operation parameters". These parameters are used to bring gas consumption to normal conditions.

4. Every day operators report values of gas consumption by phone to Production-Technical Department (PTD) of ME "Makiivteplomerezha", MCE "Mariupolteplomerezha" and "Artemivsk-Energy", Ltd., correspondingly, where they are storing and used for payments to gas suppliers.

5. Every month the account centers transfer data to gas suppliers.

Data monitored and required for emission reductions calculation and verification, according to paragraph 37 of the JI guidelines, are to be kept for two years after the last transfer of ERUs for the project. In accordance with this, the General director of RME "Donetskteplocomunenergo" has issued the Order dated 04.07.2011 "On creation of the operation team and period of storage of documents II project", in which the personnel of the created operation team is established, and keeping of the primary documentation for two years after the last transfer of ERUs for the project is appointed.

Scheme of data collection for Monitoring Report is shown at the Fig. An3-3.

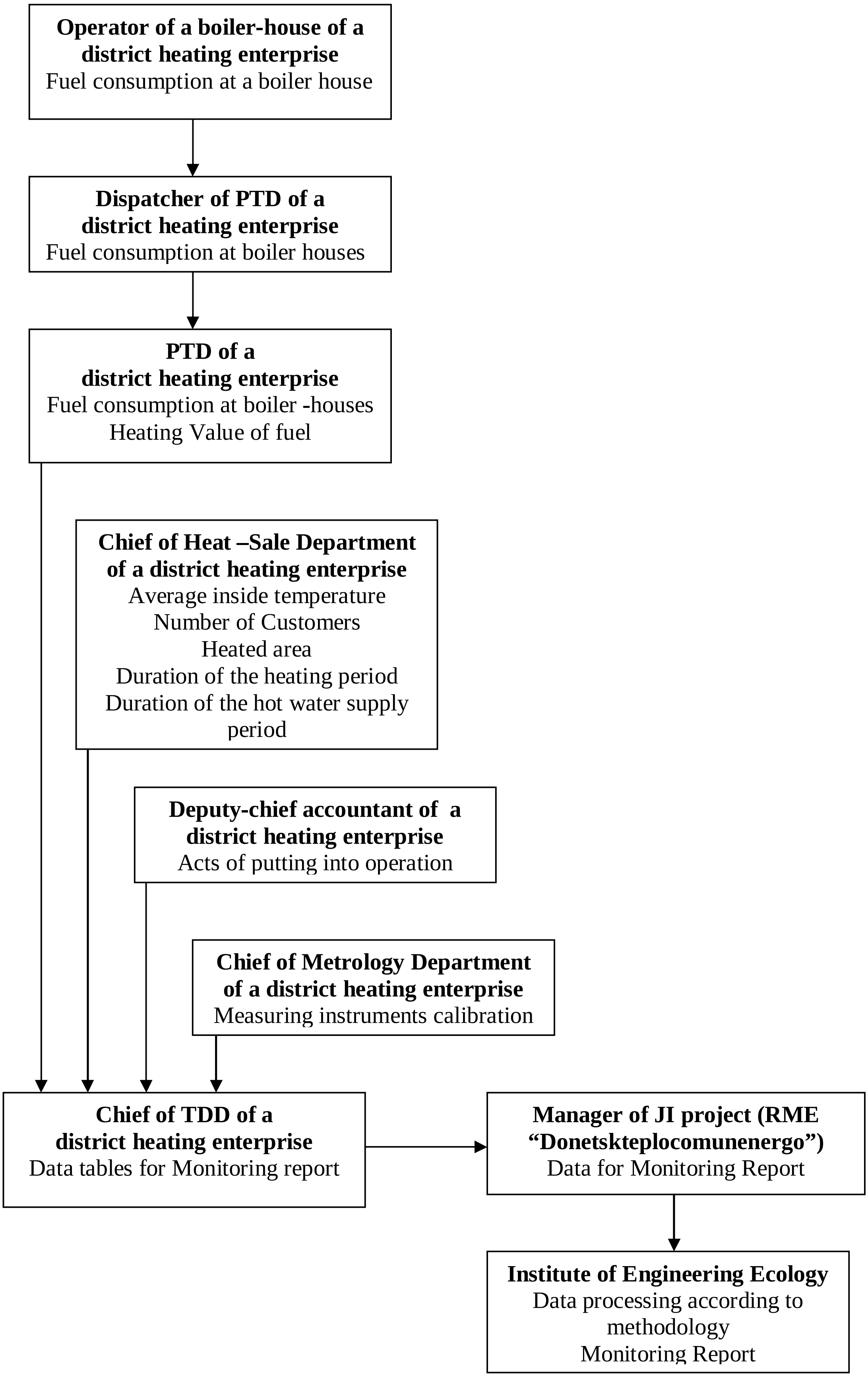

Fig.An3-3. Scheme of data collection for Monitoring Report

<u>Trainings</u>

As far as the main activity of district heating enterprises that implement the project 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, for example: cogeneration units, foreign produced boilers, etc.) equipment installation, the company - producer of this equipment should provide trainings for personnel.

District heating enterprises that implement the project provide 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 2006), specialists of Institute of Engineering Ecology carried out a comprehensive consultations and trainings for involved representatives of district heating enterprises on the necessary data collection according to Monitoring plan for the project.

The special training was held in June, 2010.
The special group was organized consisted of representatives of RME "Donetskteplocomunenergo", ME "Makiivteplomerezha", MCE "Mariupolteplomerezha", "Artemivsk-Energy", Ltd. and Institute of Engineering Ecology, in particular:
Vasyl Vorotyntsev - RME "Donetskteplocomunenergo", the General Director;
Viktoriya Kucherenko - RME "Donetskteplocomunenergo", Deputy General director on investments and strategic development;
Kateryna Pahomova - RME "Donetskteplocomunenergo", the first category engineer of the Prospective development department;
Natalia Ryazantseva - ME "Makiivteplomerezha", senior engineer of exploitation service;
Tetyana Shabanova - MCE "Mariupolteplomerezha", head of the Production-Technical Department;
Lubov Kravtsova - "Artemivsk-Energy", Ltd., head of the Production-Technical Department;
Dmytro Paderno - Institute of Engineering Ecology, Deputy director;
Kateryna Korinchuk - Institute of Engineering Ecology, engineer.

The responcible stuff of the Production-Technical Departments of the district heating enterprises are involved in this process.

<u>Responsibilities for data management</u>

All collected data will be transferred to Kateryna Pahomova, who will be responsible for data storage and archiving, entry of the data into the monitoring spreadsheets. Kateryna Korinchuk will be responsible for the data processing according to the JI project specific approach and for development of Monitoring Reports. Support and coordination of monitoring and verification processes will be undertaken by Dmytro Paderno. Responsibilities for data management are presented in Table An3-5.

Activity	Responsible person	
	Name	Position and department
Data storage and archiving	Natalia Ryazantseva	Senior engineer of exploitation service of ME “Makiivteplomerezha”
Data storage and archiving	Tetyana Shabanova	Chief of PTD of MCE “Mariupolteplomerezha”
Data storage and archiving	Lubov Kravtsova	Chief of PTD of “Artemivsk-Energy”, Ltd.
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Kateryna Pahomova	Senior engineer of the Prospective development department of RME “Donetskteplocomunenergo”
Management of the JI project	Viktoriya Kucherenko	Deputy General director on investments and strategic development of RME “Donetskteplocomunenergo”
Coordination of monitoring and verification processes	Vasyl Vorotyntsev	The General Director of RME “Donetskteplocomunenergo”
Support and coordination of monitoring and verification processes	Dmytro Paderno	Deputy Director of Institute of Engineering Ecology, Ltd
Data processing according to the JI project specific approach, development of Monitoring Reports	Kateryna Korinchuk	Engineer of Institute of Engineering Ecology, Ltd

Table An3-5. Responsibilities for data management