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

CONTENTS

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

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

"Rehabilitation of District Heating Systems in Dnipropetrovsk Region"

PDD Version: 3, dated December 15, 2010

Sectoral scopes:

1. Energy industries (renewable - / non-renewable sources);

2. Energy distribution;

3. Energy demand.

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

The project main goal is fuel consumption reduction, in particular reduction of natural gas consumption (which is imported to Ukraine) by means of rehabilitation of district heating systems in the Dnipropetrovsk region. Such fuel consumption reduction will result in decrease of greenhouse gas emissions (CO_2 mainly). The purpose of the project is sustainable development of the region through implementation of energy saving technologies.

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

The project was initiated in 2002 to rehabilitate Dnipropetrovsk region's district heating system, including boiler and distribution network equipment replacement and rehabilitation.

The 282 boiler-houses with 917 boilers (total maximal connected load 1186.65 Gkal/hour, 2002) and 495.5 km of heat distributing networks, in Dnipropetrovsk city and Dnipropetrovsk Region, which belong to district heating enterprises in Dnipropetrovsk Region that empowered OJSC "Oblteplocomunenergo" to represent their interests in this project, are involved in the project.

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

Project provides installation of 179 new highly efficient boilers, replacement of 208 boilers' burners, installation of 61 heat utilizers, reconstruction of by 91.5 km of heat distributing networks and other fuel and energy saving measures.

After complete project implementation about 36.5 million Nm^3 of natural gas, 708 t of coal and 2600 MWh of electric power will be saved annually. Such reduction of energy sources consumption is based on increase of the boiler efficiencies and reduction of heat losses in networks. The following activities will ensure fuel saving:

- Replacement of out-of-date low efficient boilers by new highly efficient boilers;
- Boiler equipment rehabilitation,
- Burners replacement;
- Installation of heat utilizers;
- Decreasing pipelines length and replacing the 4-pipe lines by 2-pipe lines, with application of the new insulation and the pre-insulated pipes.
- Construction of quarter gas boiler-houses on the basis of existing central heat points(CHP);
- Technical re-equipment of central heat points with heat exchangers;
- Installation of frequency controllers at smoke exhausters' electric drives;
- Use of modern devices of the heat account; monitoring systems of heat networks; the control, management and automation of warmly generating objects;
- Creation of optimum systems of monitoring and power audit of objects of power system.

Estimated project annual reductions of GHG emissions, in particular CO_2, will be about 74.2 thousand tonns 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 Dnipropetrovsk region. Social impact of the project is positive since after project implementation heat supply service will be improved and tariffs for heat energy will not be raised to cover construction costs.

Environmental impact of the project is expected to be very positive as an emission of the greenhouse and toxic gases such as CO_2, NO_x, and CO will be reduced. Also due to a better after-implementation service, some part of population will cease to use electric heaters thus reducing electricity consumption, which is related to power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

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

A.3.	**Project participants:**

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host Party)	OJSC "Oblteplocomunenergo"	No

- ***OJSC "Oblteplocomunenergo"**: organization acting as Project Applicant and Supplier of GHG emission reductions on behalf of all partners of the Contract on Joint Activity (#353/1 dated 18.08.2010) It represents the interests of partners of the Contract and is responsible for the organizational aspects of JI project.*

Historical details:

The enterprise "Chernihivteplomerezha" was founded on the basis of Order No. 353 of the Minister of Municipal Housing of USSR and Decision No.#714 of the Executive committee of the City Council of Deputies from December 31st, 1968. It has started its work on January 1st, 1969. Since 1982 the enterprise became the regional production association "Chernihivteplomerezha". On the 27-th of August, 1985, the enterprise was re-named to the Oblast Production Association (OPA) «Chernihivteplocomunenergo». On 25.03.1992 the enterprise became State Municipal Enterprise (SME)"Oblteplocomunenergo".

In 1995 the privatization of enterprise objects was hold. On 31.07.95 the SME "Oblteplocomunenergo" was re-named to the Joint Stock Company "Oblteplocomunenergo"

Today the OJSC "Oblteplocomunenergo" is the powerful heat supply complex. It has 12 boiler-houses and 2 heat points, automobile division, repairing-mechanical division, pre-isolated pipes manufacture division, measuring devices repairing and testing division, metrological lab, etc. The heat energy is also produced by 107 rented boiler-houses. 18 operation divisions in the region belong to the enterprise. The enterprise supplies heat energy to over 270 thousand of consumers (population, housing and administrative buildings) in 22 settlements in Chernihiv Region. The heating set load is nearly 288 Gcal/hour, hot water supply – nearly 92 Gcal/hour. The part of the housing (populated) heated area is about 81%, of legal persons – 19%.

A.4.	**Technical description of the project:**

	A.4.1. Location of the project:

The Project is located in Dnipropetrovsk Region of Ukraine, in the Eastern part of Ukraine (**Fig.1**).

Fig. 1. The map of Ukraine with dividing into regions and with 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, 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.:

The Project is situated in Dnipropetrovsk Region (Oblast). Dnipropetrovsk region is located in the Eastern part of Ukraine on the Dniper river. It has borders with 7 regions of Ukraine: Donetsk, Kharkiv, Poltava, Kirovograd, Mykolaiv, Kherson and Zaporizhka regions and it is occupying an area of 31.9 ths. km^2. The territory of Dnipropetrovsk region is divided into 22 administrative regions and 13 cities regional importance. Administrative centre of Dnipropetrovsk region is Dnipropetrovsk city, that is located at the geographical coordinates 48°28′N 35°07′E.

The population of the Dnipropetrovsk region is more than 3374.2 thousand inhabitants.

The climate of region is mostly mild-continentalwith - cool winter and warm summer. The average temperature in the winter balances from −5 °C to −7 °C and in the summer – +22 °C – +23 °C.

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

Dnipropetrovsk city, towns and villages of the Dnipropetrovsk Region:

Cities:

Dnipropetrovsk, Nikopol, Novomoskovsk, Dniprodzerzhinsk, Pavlograd, Ordzhonikidze, Pyatyhatky, Verhnedniprovsk, Pereschepino.

Districts:

Vasylkivskiy (Vasilkivka town, Velykoooleksandrivka village, Chaplyne town, Dubovyky village, Shevchenkove village, Mykolaevka village, Grygorivka village);

Pokrovskiy (Pokrovske town, Oleksandrivka village, Gavrylivka village);

Petrykivskiy (Petrykivka town, Chaplyns village, Poboykivka village, Elyzavetivka village, Ivanivka village, Chervono-Partyzanske village, Hutirske village);

Sofiivskiy (Sofiivka town);

Solonyanskiy (Solone town).

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

It should be noted that the district heating systems from almost all territorial districts of the Dnipropetrovsk Region are involved in the project (**Fig. 2**). Places involved in the project are marked with blue circles.

OJSC "Oblteplocomunenergo" is empowered to represent the interests of heat-supply enterprises of Dnipropetrovsk Region.

The enterprise Municipal enterprise RME "Dniproteploenergo" includes 9 daughter enterprises:
DE "Novomoskovskteploenergo";
DE "Petrykivkateploenergo";
DE "Vasylkivkateploenergo";
DE "Pokrovkateploenergo";
DE "Pyatyhatkyteploenergo";
DE "Verhnedniprovskteploenergo";
DE "Sofiivkateploenergo";
DE "Pereschepynoteploenergo";
DE "Soloneteploenergo".

They are included to the project.

Beside this project includes boiler-houses of the following enterprises:

ME "Dniprodzerzhinskteplomerezha";
Nikopol municipal enterprise "Nikopolteploenergo";
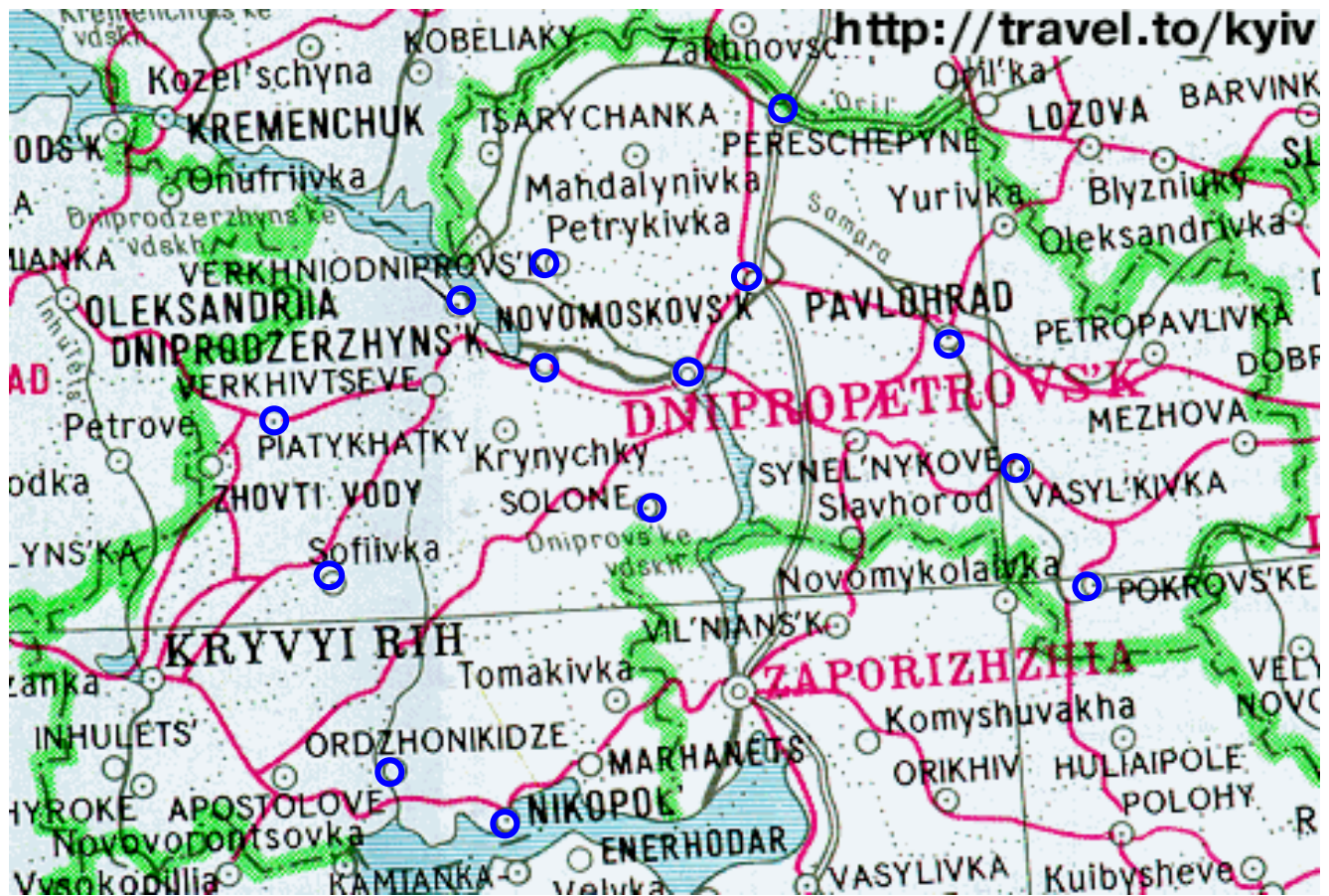ME «Pavlogradteploenergo»;
OCME "Ordzhonikidzeteploenergo".

Fig. 2. Location of Dnipropetrovsk Region's major cities and towns where project will be implemented.

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

Measures that will be used to improve the efficiency of Dnipropetrovsk region DH utility are the follows:

- Obsolete boilers will be replaced by new highly efficient ones that will result in efficiency increase from 65-89% up to 90-96%.

Type of boiler	Website of boiler producer
KSVa	www.tekom.com.ua/kotel/vk.html
AOGV	http://www.teplocom-m.ru/aogv/
HERZ	http://www.herz-gmbh.com/
Buderus Logano	http://www.buderus.ua/
DE	http://www.tekom.com.ua/kotel/de/
DKVR	http://www.generation-eo.ru/par_kotly/dkvr
E-1	www.tekom.com.ua/kotel/e-details
TVG	www.tekom.com.ua/kotel/tvg.html
KVGM	www.pskovkotel.ru/catalog.html
KSVa	www.tekom.com.ua/kotel/vk.html
KOLVI	www.kolvi.com/index.php?option=com_content&task=blogcategory&id=11&Itemid=105
KVG	www.mktes.ru/catalogue/product_220

Table 1.Boilers producer's web sites

New installed boilers after boiler-house reconstruction are presented at the Figure 3:

Fig. 3. Boiler KSVa-1,25 with efficiency 92%.

- Upgrading of boilers' burners will increase the efficiency by 3-5% due to improved combustion with excess air coefficient decreasing and reducing CO and NO_x emissions.

- Rehabilitation of obsolete but able to work boilers with using various technologies, including developed by the Institute of Engineering Ecology (project partner), will lead to 6-9% increase in efficiency. Particularly, existing burners will be replaced by modernized ones, intensity of furnace heat exchange and heat transfer will be raised due to increasing of the radiant component, excess air inflows will be diminished due to improving of the gas impermeability of boilers, etc.

- Contact and surface heat-recovery gas-cleaning apparatuses (utilizers), including developed by the Institute of Engineering Ecology, will be installed in order to utilize and recover the exhaust gases heat as well as the additional heat of steam condensation, occurring when the temperature of exhaust gases fall below dew point. The implementation of this technology will result in increasing the fuel consumption efficiency by 7-9%.

- The efficiency of distribution networks system will be considerably increased by:

    - decreasing pipelines length (moving heat generating source closer to consumer);

    - 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 25 mm and more by the pre-insulated ones;

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

Fig.4. Pre-insulated pipes.

- Construction of quarter gas boiler-houses on the basis of existing central heat points(CHP);

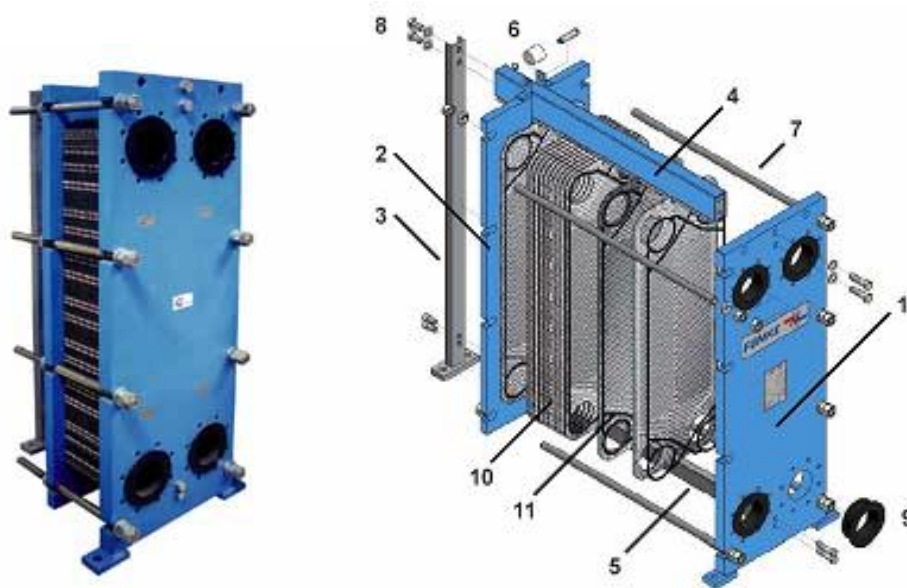- Technical re-equipment of central heat points with heat exchangers;

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

- Installation of frequency controllers at smoke exhausters' electric drives will result in considerably energy saving (www.danfoss.com.);

- Use of modern devices of the heat account; monitoring systems of heat networks; the control, management and automation of warmly generating objects;

- Creation of optimum systems of monitoring and power audit of objects of power system.

The implementation schedule for the measures to be implemented is presented in Table 2.

#	Project stages	Period
1	Replacement of out-of-date low efficient boilers	2003-2012
2	Boiler equipment rehabilitation	2003-2012
3	Burners replacement	2004-2011
4	Installation of heat utilizers	2003-2012
5	Heat exchangers and pumps replacement	2006-2012
6	Implementation of frequency controllers	2009-2011
7	Rehabilitation of heat distribution networks	2003-2012

Table 2. The implementation schedule for the measures to be implemented

Achieved results of employing of these technologies and measures are listed in the **Appendixes 1, 2.**

These technologies are already approved but some of them are not widespread. Therefore, there might be some bottlenecks, which are typical when implementing 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 have 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 provides 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 IEE, and the special group that consisted of representatives of OJSC "Oblteplocomunenergo" and Institute of Engineering Ecology was organized.

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

> **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 and heat distribution networks, will increase energy efficiency of Dnipropetrovsk Region DH system, thus enabling it to produce the same amount of heat energy with less fuel consumed. Reduced fuel consumption will make lower CO_2 emissions.

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

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

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

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

Period before January 1, 2008:

	Years
Length of the crediting period	5
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2003	14886
2004	19999
2005	24937
2006	27438
2007	32427
Total estimated emission reductions over the early <u>crediting period</u> (tonnes of CO_2 equivalent)	**119687**
Annual average of estimated emission reductions over the early <u>crediting period</u> (tonnes CO_2 equivalent)	**23937**

Table 3. Estimated emission reductions for early crediting period before January 1, 2008 (2003-2007)

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	38530
2009	43061
2010	45019
2011	61895
2012	74227
Total estimated emission reductions over the first commitment <u>period</u> (tonnes of CO_2 equivalent)	**262732**
Annual average of estimated emission reductions over the first commitment <u>period</u> (tonnes CO_2 equivalent)	**52546**

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

The Post-first commitment period 2013 – 2030:

	Years
Length of the crediting period	18
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2013	74227
2014	74227
2015	74227
2016	74227
2017	74227
2018	74227
2019	74227
2020	74227
2021	74227
2022	74227
2023	74227
2024	74227
2025	74227
2026	74227
2027	74227
2028	74227
2029	74227
2030	74227
Total estimated emission reduction over the post-first commitment period (tonnes of CO_2 equivalent)	**1336086**
Annual average of estimated emission reduction over the post- first commitment period (tonnes CO_2 equivalent)	**74227**

Table 5. Estimated emission reductions during the post- first commitment period 2013 – 2030

Total amount of Emission Reductions over the crediting period:

	Years
Length of the crediting period	28
	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**1718505**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**61375**

Table 6. Estimated emission reductions during the crediting period

For more detailed information see **Appendixes 1, 2**.

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

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

The project is already approved by local authorities, therefore, organizational risk for this project is minimized.

The project was initiated in 2002.

June, 2002 – Agreement was signed between the RME "Dniproteploenergo" and the Institute of Engineering Ecology on preparation of basic data for compilation of project application on CO2 Emissions Reduction due to fuel saving by system of the RME "Dniproteploenergo" (#476 dated 20.06.2002).

August, 2010 – Contract on Joint Activity was signed between the OJSC "Oblteplocomunenergo"and the RME "Dniproteploenergo" including 9 daughter enterprises: DE "Novomoskovskteploenergo"; DE "Petrykivkateploenergo"; DE "Vasylkivkateploenergo"; DE "Pokrovkateploenergo"; DE "Pyatyhatkyteploenergo"; DE "Verhnedniprovskteploenergo"; DE "Sofiivkateploenergo"; DE "Pereschepynoteploenergo"; DE "Soloneteploenergo" and ME "Dniprodzerzhinskteplomerezha"; NME "Nikopolteploenergo"; ME «Pavlogradteploenergo»; OCME "Ordzhonikidzeteploenergo" (#353/1 dated 18.08.2010).

August, 2010 - Agreement was signed between OJSC "Oblteplocomunenergo" and Institute of Engineering Ecology on development of the Joint Implementation Project on Green House Gas Emission Reductions due to fuel saving through rehabilitation of the district heating system of Dnipropetrovsk Region (# 732/496 dated 20.08.2010).

November, 2010 - Ukrainian DFP – the National Environmental Investment Agency of Ukraine has issued the Letter of Endorsement for this project (#1901/23/7 dated 16.11.2010).

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

SECTION B.	**Baseline**

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

In course of development this Project, the specific project approach was used that is partly similar to "Baseline and monitoring methodology AM0044". The project « Rehabilitation of District Heating Systems in Dnipropetrovsk Region » has some differences from applicability conditions of this methodology.

The main cause of impossibility of methodology AM0044 using for baseline calculation is no data for thermal energy output, because of thermal energy meters absence on the majority of boiler houses included in the project. That's why the European Institute for safety, security, insurance and environmental technics - "SVT e.V." (Germany) and Institute of Engineering Ecology (Ukraine) invented the special methodology, that takes into account all measures involved in the project and it's peculiarities. This specific project approach is presented in section D (monitoring plan). It was already approved by IAEs for the similar JI Projects for Chernihiv region, Donetsk region, Republic of Crimea, Kharkiv city, Luhansk city, Sevastopol city, etc. ..

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of monitoring devices for heat and heat-carrier expenditure in the municipal boiler-houses. Only the fuel consumption is registered on a regular basis. It makes practically impossible the application of AM0044 methodology which basic moment is monitoring of the value $EG_{PJ, i, y}$ (thermal energy output of project boiler 'i' in year y) - page 9 of Methodology AM0044 (version 1)[1], which should be measured every month by flow-meters (the expenditure of heat-carrier) and thermal sensors (temperatures at the input and output of the boiler, etc.).

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

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

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

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

· It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95% of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (CO_2) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as

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

registration of residents' complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.

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

Approved Consolidated Methodology ACM0009 "Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas" (version 03.2)[2] proposes the dependences for baseline and reporting year emissions quantity definition (see pages 4 and 5), that contain determination of Energy efficiency $\varepsilon_{project,i,y}$ and $\varepsilon_{baseline,i}$ for equipment. In the chapter "Baseline emissions" on the page 6 there is an explanation that: Efficiencies for the project activity ($\varepsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations, Efficiencies for the baseline scenario ($\varepsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations.

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

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

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

Approved Methodology AM0048 "New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels" (version 03)[3] already in its title shows the scope of applicability, that is different from the scope of the "District Heating" projects. In our projects, the cogeneration facilities produce hot water and not steam. Beside this, in according to AM0048 (page 22) and its monitoring plan (pages 23-30), it is necessary to realize, among other measurements, monthly measurement of $SC_{PCSG,i,y}$ (Total steam self-generated by project

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

[3]

http://cdm.unfccc.int/filestorage/EB52_repan06_AM0048_ver03.pdf?t=SHh8M0lHTFRBRkMxVlNZNEhRVU84V1pET jA2NTdFTVhKfDEyODgxNzIzNDEuNjc=|35jXwvrTnpGqUjSvdxUE9eB3Q6w=

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customer 'i' during year 'y' of the crediting period, TJ), measured by the steam meter at the customer 'i' (page 25). Thus Methodology AM0048 couldn't be implemented in original. In principle, it could be modified for conditions of hot water production for heating and hot water supply systems, but this will require modification of monitoring plan with introduction of other parameters that it is necessary to measure and register. But it would be the another methodology, that would require to measure such parameters as heat output, or hot water output with its temperature (in analogy with requirements of Methodology AM0048 to measure steam output, its pressure and temperature.

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

In view of the above mentioned, in contrast to the methodologies AM0044, ACM0009 and AM0048, the specific project approach, developed for "District Heating" projects in Ukrainian conditions and used in JI Projects "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System in Chernihiv Region", "Rehabilitation of the District Heating System in Crimea" and "Rehabilitation of the District Heating System in Kharkiv city", "Rehabilitation of the District Heating System in Luhansk city", "Rehabilitation of the District Heating System in Sevastopol City", etc. is the most appropriate, precise, corresponding to the principle of conservatism, and the most closely reflects the aims, goals and spirit of Kyoto Protocol.

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

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

The first version of Baseline scenario was a business-as-usual scenario with minimum reconstruction works balanced by overall degradation of DH system. For this Baseline scenario there are no barriers (no investment barrier since this scenario doesn't require the attraction of additional investments, and no technological barrier since the equipment is operated by existing skilled personnel, and additional re-training is not required), and represent the common practice in Ukraine.

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

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

Thus, the first version was chosen for Baseline scenario.

Status and adequacy of the current delivery system

Current supply of Dnipropetrovsk region DH systems is primarily based on Ukrainian and Russian made gas and coal fired boilers including KT-75, Fakel, AOGV-96k, VK-21, DE-25/14, DE-6.5, DKVR-20/13, DKVR-10/13, DKVR-6.5/13, DKVR-4/13, E-1/9, IShMA-100-A, KBNG-3.5, KBNG-2.5, KVG-7.56, KVG-6.5, KVG-4.65, KVGM-100, KSV-2.9G, KSVa-2.5, KSVa -0.63, KChM-10, MIT-630, NIISTU-5, TVG-8M, Nika, NM-150 JUMBO, NR-18, PKBMS-1M, PTVM-100, PTVM-30M, TVGM-30, Universal-3. Detailed information is presented in **Appendix 1 (Boilers)**. Current efficiencies of these boilers are in the range of 65-89 %.

Current distribution networks are characterized by heat losses to 30 %. Detailed information is presented in **Appendix 2 (Networks)**.

Construction of the Baseline Scenario

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

Calculation of Baseline Carbon Emission Factors

For all fuels we used CO_2 emission factors from IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy [4]

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

We assume that CO_2 emission factors for the fuels will be the same for period 2002-2012. For our calculations we assume that the Net Calorific Value of a fuel (NCV) doesn't change during that time, however in the Monitoring Plan the NCV factor will be taken into account for the baseline adjustment for any year until 2012.

NCV of fuels changes insignificantly from year to year. Table 7 gives average NCV of fuels used by district heating enterprises.

Fuel type	Average Net Calorific value of fuel
	MJ/m^3 (MJ/kg)
Natural gas	34.5
Coal	19.8

Table 7. Average Net Calorific value of fuels

Calculation of conversion factors of CO_2:

CF (Conversion Factor) = NCV (Net Calorific Value)* Cef (Carbon Emission Factor)
CF (natural gas) = 1000 m^3 of natural gas input * 0.0345 [GJ/m^3]*0.0561 [tCO_2/GJ] = 1.935 tCO_2
CF (coal) = 1000 kg (1 t) of coal * 0.0198 [GJ/kg]*0.0946 [tCO_2/GJ] = 1.873 tCO_2.

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

Calculation of Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2002 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 balance of district heating enterprises after starting of the project and if data for 2002 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).

District heating enterprise that implement the project (project partner)	Boiler house	Base year
RME "Dniproteploenergo"	Gogolya str., 17	2004
	Robocha str., 24a	2005
	Naberezhna-Lenina str., 6	2005
	Shevchenko str., 8	2004
	Kirova str., 2	2007
ME "Dniprodzerzhinskteplomerezha"	Altayska str.,32-a	2004
	B.Hmelnitskogo str.,7	2004
	Harytonova str., 12a	2008

The base line fuels and electricity consumption are represented in Table 8.

District heating enterprise that implement the project (project partner)	Baseline natural gas consumption, ths Nm3/yr	Baseline coal consumption, t/yr	Baseline power consumption by boiler houses and heating points, MW*h
RME "Dniproteploenergo"	72702	0	15587
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	2241	0	454
ME «Pavlogradteploenergo»	44398	0	11025
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	2072	0	369
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	1037	0	196
DE RME "Dniproteploenergo" - "Vasylkivkateploenergo"	3079	0	626
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	1378	0	189
DE RME "Dniproteploenergo" "Verhnedniprovskteploenergo"	4825	0	887
Nikopol municipal enterprise "Nikopolteploenergo"	22457	0	5846

DE RME "Dniproteploenergo""Soloneteploenergo"	1401	0	186
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	844	708	257
OCME "Ordzhonikidzeteploenergo"	12006	0	6667
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	12769	0	3412
ME "Dniprodzerzhinskteplomerezha"	30074	0	6493
Total	**211283**	**708**	**52194**

Table 8. Baseline fuel and electricity consumption

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

Calculation of Baseline Carbon Emissions

There are 2 kinds of emissions which are included in the baseline:
   1) Emissions CO2 from boilers which are operated by systems of a heat supply in Dnipropetrovsk region. Baseline calculations were based on the assumption that baseline emissions from boilers operated by the Applicant during any report year (2003-2012) remain the same as in the basis year 2002.
   2) Emissions CO2 from current power consumption from the state grid which will be reduced due to implementation of energy saving measures at 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 (Annex 2):

Year	2002	2003	2004	2005	2006-2012	2013-2030
CEF_c tCO$_2$e/MWh	0.956	0.936	0.916	0.896	0.896	0.896
CEF_g tCO$_2$e/MWh	0.785	0.770	0.775	0.740	0.807	0.807

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

Calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if systems of a heat supply in Dnipropetrovsk region remains unchanged, see in **Appendix 4 (Baseline)**.

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

Data / Parameter	B_b
Data unit	ths. m^3 (t)
Description	Fuel consumption by boiler-houses
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) = 211283 ths.m^3; B_b (coal) = 708 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 quality management procedures "On metrology and metrological activity"[5] . Fuel Supplier's Report
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	P_b
Data unit	MWh
Description	Electric power consumption
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)	52194
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 quality management procedures "On metrology and metrological activity"
Any comment	It is the basic data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

Data / Parameter	NCV_b
Data unit	MJ/m^3 (MJ/kg)
Description	Average annual Net Calorific Value of fuel
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)	NCV_b (natural gas) = 34.5 MJ/m^3; NCV_b (coal) = 19.8 MJ/kg
Justification of the choice of	N/A

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[5] *http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1765-15*

data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	Fuel Supplier's Report
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
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	Normative documents
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	
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
Time of determination/monitoring	Once, at the beginning of the project
Source of data (to be) used	Normative documents
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	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)
QA/QC procedures (to be) applied	
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 will be reduced due to complex modernization of heat generating and distribution 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, installation of new modern burners as well as heat recovery apparatuses, renovation of degraded heat distribution networks with using the new insulation and 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. 6).

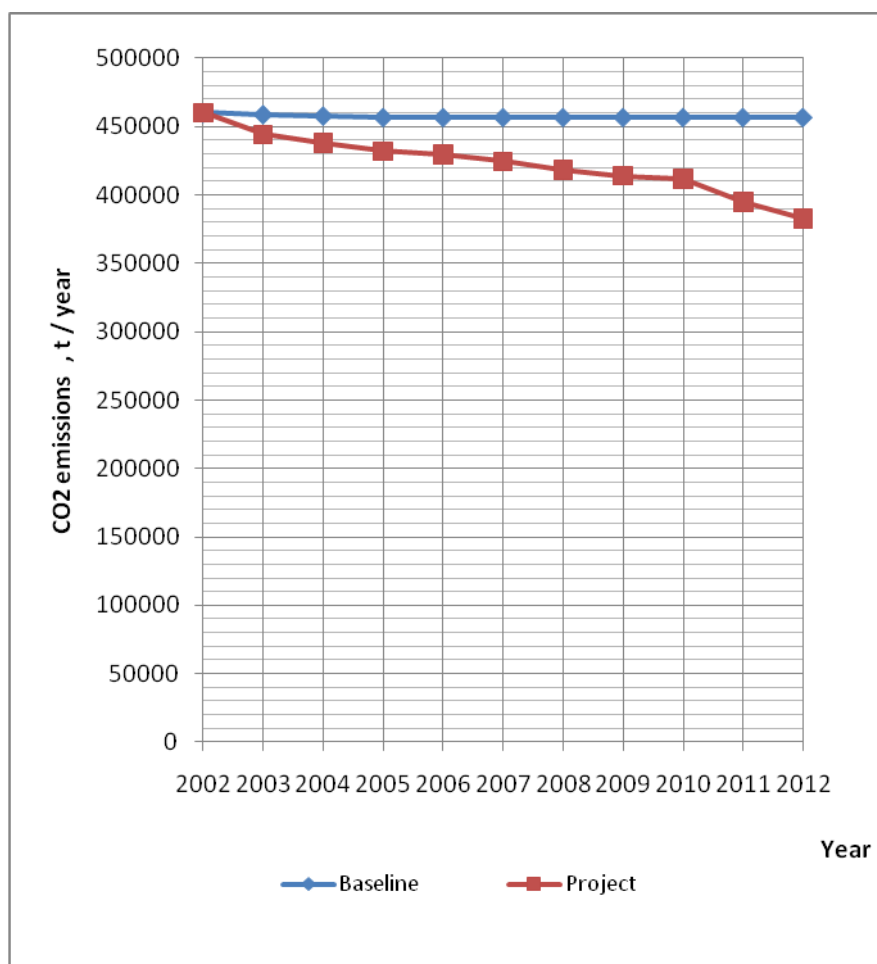*Fig. 6. Dynamic baseline and project emissions of GHG*

Additionality of the project

The additionality of the project activity is demonstrated and assessed below using the "Tool for the demonstration and assessment of additionality" (Version 5.2) (see **Fig. 7**). This tool was originally developed for CDM projects but can be applied to JI projects as well.
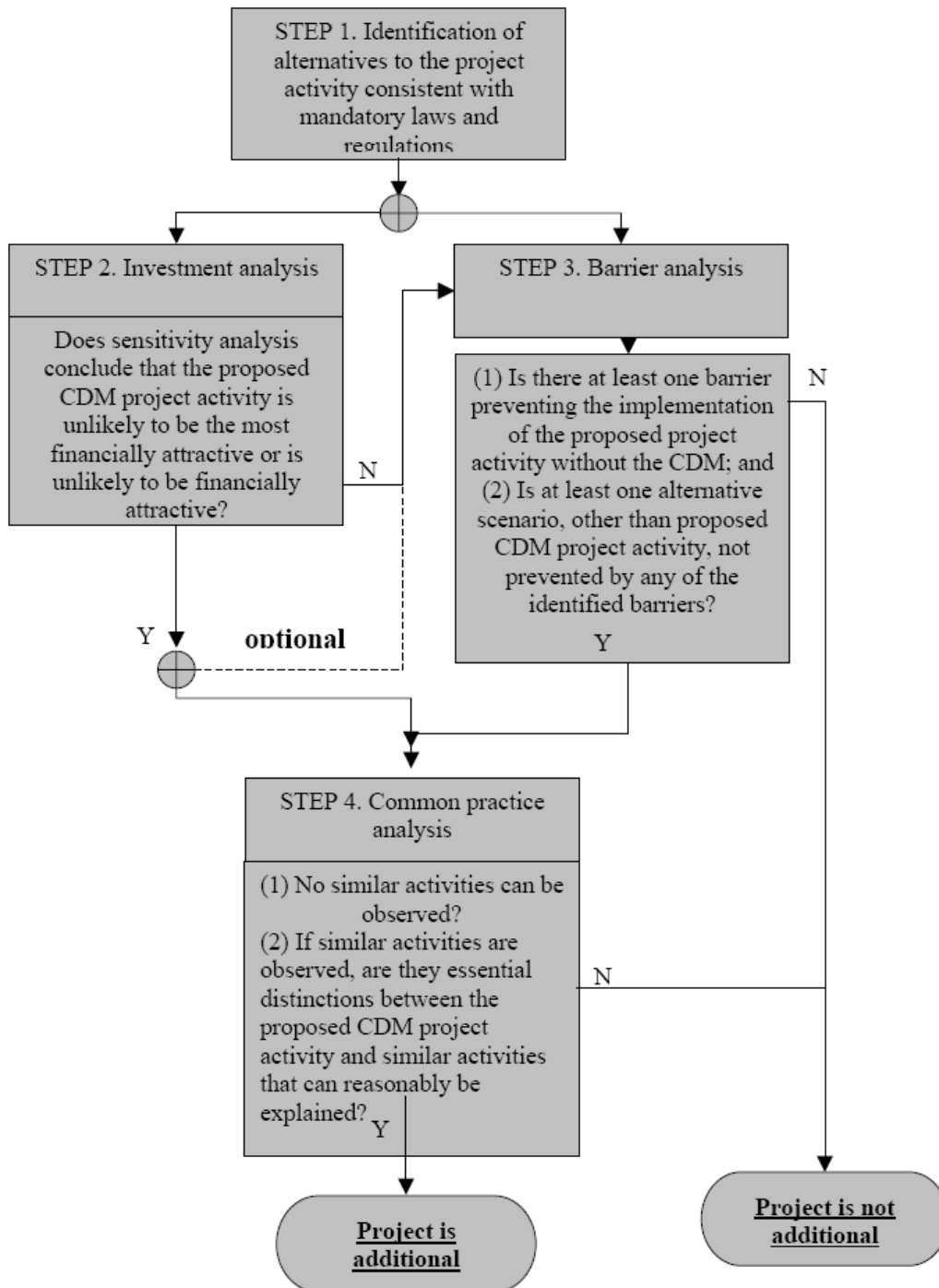

Fig. 7. Steps for demonstration of additionality

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

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

There are three alternatives to this project (as was already discussed in section B1).

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

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

2. The second alternative is to make reconstruction works (the proposed project activity) without JI mechanism.

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

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

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

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

District heating enterprises that implement the project have such licenses.

The Project "Rehabilitation of District Heating Systems in Dnipropetrovsk Region" has been prepared according to The Law of Ukraine from 01.07.1994 №74/94-VR "On energy saving" and The Law of Ukraine from 22.12.2005 №3260-IV "On changes in The Law of Ukraine "On energy saving".

Outcome of Step 1b: The alternatives, which are: to continue business-as-usual scenario, to make reconstruction works without JI mechanism and to implement shortened project activity, without any of the non-key type of project activity, are in compliance with the mandatory laws and regulations.

Hence, the Step 1 is satisfied.

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

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"[6].

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 14.8 million EUR only for the main equipment installation / rehabilitation. The prices for the new equipment, that is planned to be installed in the project, are represented on the sheets "Parameters" in the **Appendixes 1, 2** 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 District Heating Systems in Dnipropetrovsk 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	Replacement of out-of-date low efficient boilers	2655
2	Boiler equipment rehabilitation	3603
3	Burners replacement	935
4	Installation of heat utilizers	63
5	Heat exchangers and pumps replacement	67
6	Implementation of frequency controllers	25
7	Rehabilitation of heat distribution networks	7435
	Total	**14783**

Table 10. The cost of measures for energy efficiency improvement

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[6] http://www.kmu.gov.ua/kmu/control/uk/cardnpd

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.

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[7]

"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[8].

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

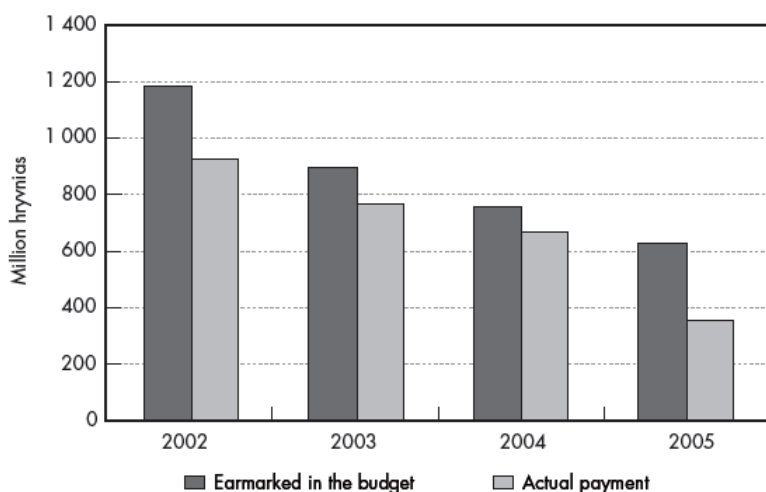[8] http://www.iea.org/Textbase/ publications/free_new_Desc.asp?PUBS_ID=1819

"District heating suffers from inefficiency and low level of investment. The major impediments for investment include the unclear pricing policy, unregulated management and ownership conditions, the accumulated debt of heat producers" [Overview of Heating Sector in Ukraine, CASE, 2007[9].

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[10].].

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 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.8. 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

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[9] www.case-ukraine.com.ua

[10] www.case-ukraine.com.ua

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 OJSC "Oblteplocomunenergo" 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 Dnipropetrovsk region district heating system, 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 reconstruction activity, instead of making a major overhaul of the heating system.

Most of proposed technologies are widely used in Ukraine for the similar JI projects. For example boilers replacement, network replacement with pre-insulated pipes, installation of frequency controllers.

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 reconstruction works without JI mechanism and to shortened project activity, without any of the non-key type of project activity.

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

One of the alternatives is to continue business-as-usual scenario. Therefore, as the barriers mentioned above are directly related to investing into upgrading of the Dnipropetrovsk Region district heating system, there is no impediment for district heating enterprises that implement the project to maintain 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 7 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, Luhansk 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:

Boundaries for **Baseline scenario** are represented by dotted line rectangle on the graphical representation (**Fig.9**).
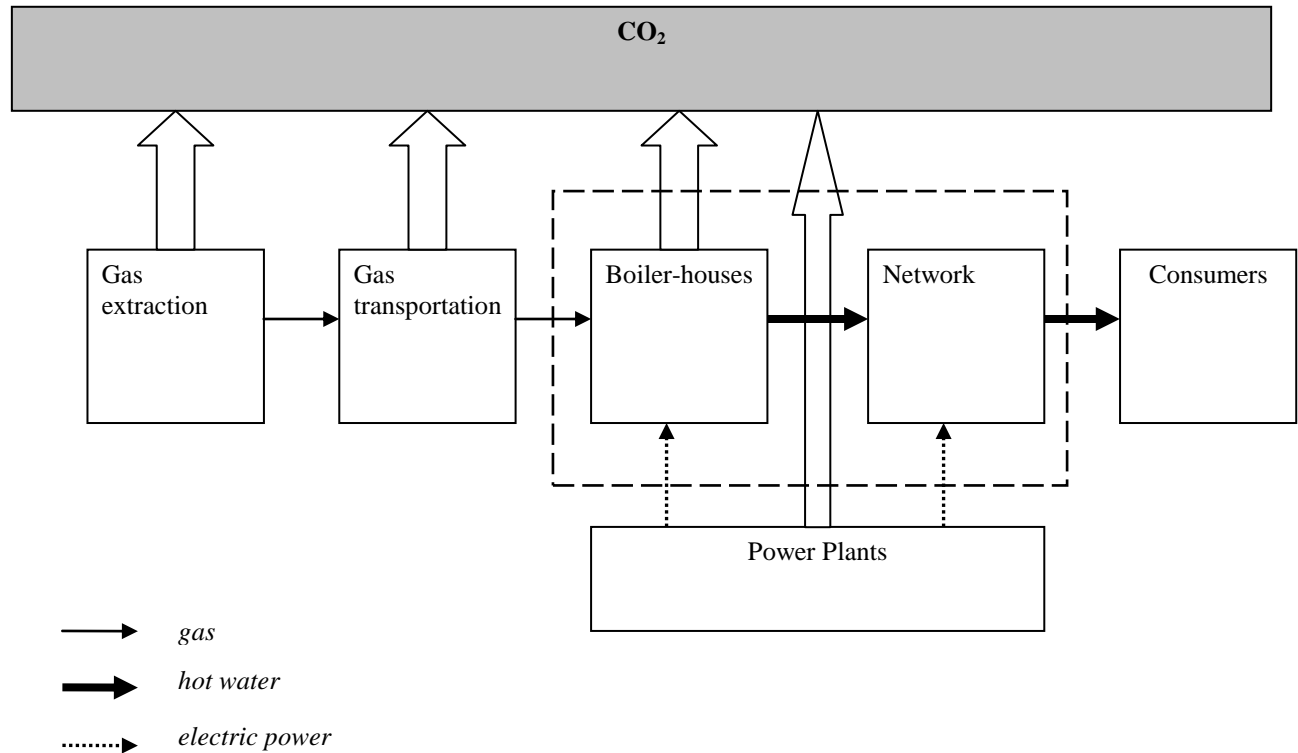
Fig.9. Boundaries for Baseline scenario

Project boundaries for **Project scenario** are represented by dotted line rectangle on the graphical representation (**Fig.10**).
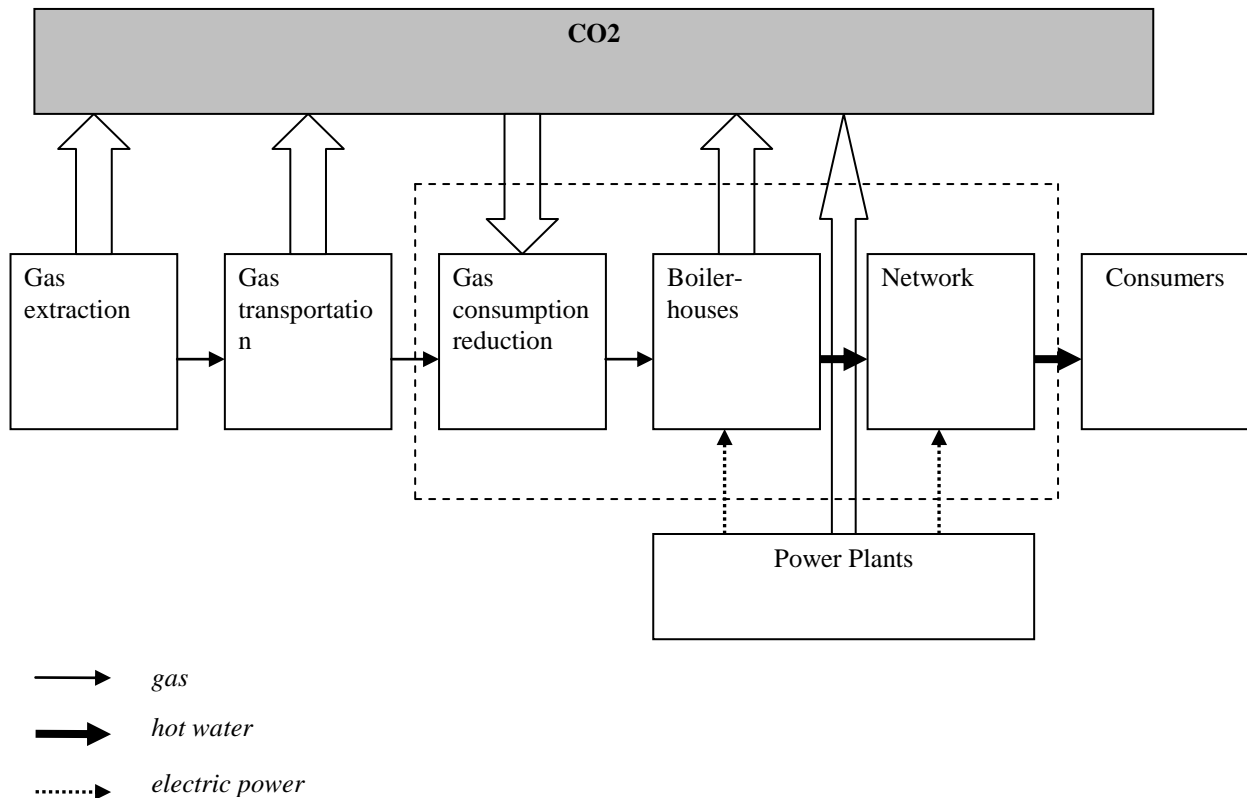
Fig.10. Project boundaries for Project scenario

Direct and Indirect Emissions

Direct on-site emissions: CO_2 from natural gas combustion in boilers. NO_x and CO emission from combustion in the existing boilers/ burners, 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: CO_2 emissions from power stations due to electricity production to the grid, that consumed by boiler houses . CO_2 emissions from power stations due to electricity production to the grid, that consumed for heating of Dnipropetrovsk oblast customers. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of power heaters is quite typical and widespread.

CO_2 emissions from power station(s) due to heat networks power consumption. It is not efficient due to water leakages, and extended networks' distance.

Indirect on-site emissions: none.

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

On-site emissions

Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from fuel combustion in boilers	Reduced CO_2 emissions from fuel combustion in boilers due to increased efficiency (fuel saving)	Direct	Include
NO_x and CO emission from combustion into existing boilers/ burners	Reduced NO_x and CO emissions from fuel combustion after boiler burners' replacement	Direct	Exclude. NO_x and CO are not GHGs.
CO_2 emissions from fuel combustion in boilers at the boiler houses due to the too large heat losses in the networks	Reduced CO_2 emissions from boiler houses due to decreasing of heat losses in the network pipes, due to replacement pipes with the pre-insulated ones, reconstruction of HDS, and reduction of networks' length	Direct	Include

Off-site emissions

Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from power plant(s) due to electricity production to the grid, that is consumed by boiler houses.	Reduced CO_2 emissions from power plant(s) due to reduction of electricity consumption by boiler houses	Direct	Include
CO_2 emissions from power plant(s) due to power consumption used for heating by Dnipropetrovsk region customers. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of electric heaters is quite typical and widespread.	Reduced CO_2 emissions from power plant(s) due to reduction of power consumption for heating by Dnipropetrovsk region customers. This will take place after project implementation when heat supply service will become more efficient. Exploitation of electric heaters will decrease substantially.	Direct	Exclude, not under control of project developer
CO_2 emissions from fuel extraction and transportation.	Reduced CO_2 emissions from fuel extraction and transportation.	Indirect	Exclude, not under control of project developer

Table 11. Project boundaries

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

Date of baseline setting: 01/12/2003.

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

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

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

The starting date of the project is: 20.06.2002.

This date 20.06.2002 was accepted as the project's starting date because on this date the agreement was signed between the RME "Dniproteploenergo" and the Institute of Engineering Ecology on preparation of basic data for compilation of project application on CO2 Emissions Reduction due to fuel saving by system of the RME "Dniproteploenergo" (#476 dated 20.06.2002).

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

The minimal nominal lifetime of the new boilers is **-** 20 years. The real average lifetime of the new boiler and network equipment is estimated to be up to 30 – 40 years. Thus the expected operational lifetime of the project may be about 30 years. According to conservatism principle, for further calculations we assume lifetime and corresponding crediting period for the project equal to 28 years or 336 months (2003 – 2030).

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

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

The starting date of the crediting period is set to the date where the first emission reduction units are expected to be generated from the project, that is January 1, 2003. The end of the crediting period is the end of the lifetime of the main equipment that is December 31, 2030. Thus the length of the crediting period is 28 years (336 months).

If the post-first commitment period under the Kyoto Protocol will be applicable, the commitment period may be expanded up to the end of the expected operational lifetime of the project (28 years, 2003 – 2030).

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 a projected level than all other relevant indicators such as efficiencies of new boilers, efficiencies of heat utilizers, and burners, as well as heat losses in pre-insulated pipes are adequate.

Verification of project performance indicators

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

Verification of Emission Reduction Units and Baseline Scenario

The monitoring specific project approach developed for "District Heating" projects in Ukrainian conditions consists in the following:

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

The following specific project approach is proposed to be used.

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

$$ERUs = \sum[E_i^b - E_i^r] \tag{D.1.1-1}$$

where:
E_i^b and E_i^r - CO_2 emissions for an i boiler-house in the base year and in the reported year, respectively, t CO_2e.

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

$$E_i^b = E_{1i}^b + E_{gen\,i}^b + E_{cons\,i}^b,$$ (D.1.1-2)
$$E_i^r = E_{1i}^r + E_{gen\,i}^r + E_{cons\,i}^r,$$ (D.1.1-3)

where:

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

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

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

For each i boiler-house:

$$E_1^b = NCV_b * Cef_b * B_b$$ (D.1.1-4)

$$E_1^r = NCV_r * Cef_r * B_r$$ (D.1.1-5)

$$E_{gen}^b = W_b * CEF_g + Q_b * f_b / 1000 * NCV_r * Cef$$ (D.1.1-6)

$$E_{gen}^r = (W_b - W_r) * CEF_g + [(Q_b - Q_r) * f_b / 1000 + B_g] * NCV_r * Cef$$ (D.1.1-7)

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

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

where:

NCV – Net Calorific value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, t CO_2/GJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tonns;
W_b – scheduled electric power production by the new CHP units at a boiler-house, MWh;
W_r – electric power production by the installed new CHP units, MWh;
CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;

Q_b – scheduled heat energy production by the new CHP units at a boiler-house, MWh;

Q_r – heat energy production by the installed new CHP units at a boiler-house in reported year, MWh;

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

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

P – electric power consumption by a boiler-house and heating points, MWh;

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

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

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

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

According to the Dynamic Baseline assumption, the efficient value of E_1^b may be defined as follows:

$$E_{1i}^b = E_{hi}^b + E_{wi}^b; \tag{D.1.1-10}$$

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

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:

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

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

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:

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

$$E_1^r = NCV_r * Cef_r * B_r \tag{D.1.1-13}$$

where:

NCV – Net Calorific value, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, $kt\ CO_2$/TJ;

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

K_1, K_h, K_w, K_{w0} – adjustment factors;
a – portion of fuel (heat), consumed for heating purposes;
(1-a) – portion of fuel (heat), consumed for hot water supply services;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

$$a_b = L_h^b * g * N_h^b / (L_h^b * g * N_h^b + L_w^b * N_w^b); \qquad\qquad (D.1.1-14)$$
$$a_r = L_h^r * g * N_h^r / (L_h^r * g * N_h^r + L_w^r * N_w^r), \qquad\qquad (D.1.1-15)$$

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 (is determined for each boiler-house on historical base, usually is in the range 0,4 – 0,8);
N_h, N_w – duration of heating period and period of hot water supply service per year, hours.

Adjustment factors:

1. K_1 (change in the Net Calorific value of fuel):

$$K_1 = NCV_b / NCV_r \qquad\qquad (D.1.1-16)$$

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

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

$$B_h = B * a = Q_h / NCV * \eta, \qquad\qquad (D.1.1-17)$$

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

$$Q_{h\,br} = Q_{h\,b}*K_h = Q_{h\,r} \tag{D.1.1-18}$$

where:

$Q_{h\,br}$ – required heat for Dynamic Baseline, is assumed equal to $Q_{h\,r}$ – required heat in the reported year,

$Q_{h\,b}$ – required heat in the base year,

K_h – averaged adjustment factor for heating.

From this equation it is possible to determine the averaged adjustment factor:

$$K_h = Q_{h\,r} / Q_{h\,b.} \tag{D.1.1-19}$$

Required amount of heat for heating of buildings during a year, according to the "Codes and regulations on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic requirements in Ukraine. KTM 204 Ukraine 244-94"[11], is determined by [ibid, equation 2.17]:

$$Q_h = F_h*k_h*(T_{in} - T_{out})*N_h, \tag{D.1.1-20}$$

where:

Q_h – required amount of heat for heating, kWh;

F_h – heating area of buildings, m^2;

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

T_{in} – average inside temperature for the heating period, K (or ^0C);

T_{out} – average outside temperature for the heating period, K (or ^0C);

N_h – duration of the heating period per year, hours.

Then:

$$K_h = (F_{h\,r}*k_{h\,r})*(T_{in\,r} - T_{out\,r})*N_{h\,r} / F_{h\,b}*k_{h\,b}*(T_{in\,b} - T_{out\,b})*N_{h\,b} \tag{D.1.1-21}$$

2.1. K_2 (temperature change factor):

$$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b}). \tag{D.1.1-22}$$

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

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

$$K_3 = (F_{hr}*k_{hr}) / F_{hb}*k_{hb} = [(F_{hr} - F_{htr} - F_{hnr})*k_{hb} + (F_{hnr} + F_{htr})*k_{hn}] / F_{hb}*k_{hb},$$ (D.1.1-23)

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

2.4. K_4 (heating period duration change factor):

$$K_4 = N_{hr} / N_{hb}$$ (D.1.1-24)

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

Thus,

$$K_h = K_2* K_3* K_4$$ (D.1.1-25)

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

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

$$B_w = B*(1-a) = Q_w / NCV*\eta,$$ (D.1.1-26)

where:
Q_w - required amount of heat during the service rendered period

η is overall hot water supply system efficiency.

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

$$Q_{w\,br} = Q_{w\,b}*K_w = Q_{w\,r} \qquad (D.1.1-27)$$

where:

$Q_{w\,br}$ – required heat for hot water supply service for Dynamic Baseline, is assumed equal to $Q_{w\,r}$ – required heat for hot water supply service in the reported year,

$Q_{w\,b}$ – required heat for hot water supply service in the base year,

K_w – averaged adjustment factor for hot water supply service.

From this equation it is possible to determine the averaged adjustment factor:

$$K_w = Q_{w\,r} / Q_{w\,b.} \qquad (D.1.1-28)$$

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

$$Q_w = n_w*v_w *N_w, \qquad (D.1.1-29)$$

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:

$$K_w = n_{w\,r}*v_{w\,r}*N_{w\,r} / n_{w\,b}*v_{w\,b}*N_{w\,b} \qquad (D.1.1-30)$$

3.1. K_5 (number of customers change factor):

$$K_5 = n_{w\,r} / n_{w\,b} \qquad (D.1.1-31)$$

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

$$K_6 = v_{w\,r} / v_{w\,b} \qquad \text{(D.1.1-32)}$$

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

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

$$K_7 = N_{w\,r} / N_{w\,b} \qquad \text{(D.1.1-33)}$$

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

Thus,

$$K_w = K_5 * K_6 * K_7. \qquad \text{(D.1.1-34)}$$

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

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

$$K_5 = K_6 = K_7 = 1.$$

Thus

$$K_{w0} = 1.$$

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

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 principle of conservatism 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):					100%	Registered in the journal (paper (initial) and electronic (later))	It is the main data which allows to calculate GHG emissions in the report year
1.1	Natural gas	Gas meters at each boiler-house	m^3	m	Every day	100%		
1.2	Coal	Consumption of coal is measured by wheelbarrows and pails then recalculated to weight	tonn	m	Every day	100%		
2	Power consumption (P_r)	Electric power meters at each boiler-house and	MWh	m	Every month	100%	Registered in the journal (paper and/or	

		heating points						electronic)
3	Average annual Calorific Value 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 (initial) and electronic (later))	
3.1	Natural gas		MJ/m^3	c				
3.2	Coal		MJ/kg	c				
4	Carbon emission factor (Cef$_r$)	IPCC		Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	
4.1	Natural Gas		t CO_2/GJ	Normative documents				
4.2	Coal		t CO_2/GJ	Normative documents				
5	Carbon emission factor for electricity consumption (CEF$_c$)	Operational Guidelines for PDD's of JI projects.	t CO_2/MWh	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	

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 verifying (once per year).

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

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

> **D.1.1.2. Description of formulae used to estimate <u>project</u> emissions (for each gas, source etc.; emissions in units of CO$_2$ equivalent):**

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

where:
E_{1i}^r – CO$_2$ emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, t CO$_2$e;
$E_{cons\,i}^r$ – CO$_2$ emissions due to electric power consumption from greed by the i boiler-house in the reported year, t CO$_2$e.

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

where:
NCV_{ri} – Average annual Net Calorific value, MJ/m^3 (MJ/kg)
Cef – carbon emission factor, ktCO$_2$/TJ;
B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tonns;

$E_{cons\,i}^r = P_r * CEF_c$;   (D.1.1.2-3)

where:
P_r – electric power consumption by the boiler-houses and central heating points with energy saving measures implemented in the reported year, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO$_2$e/MWh;

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

D.1.1.3. Relevant data necessary for determining the <u>baseline</u> 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)						Registered in the journal (paper (initial) and electronic (later))	It is the main data which allows to calculate GHG emissions in the report year
1.1	Natural Gas	Gas meters at each boiler-house	m^3	m	Every day	100%		
1.2	Coal	Consumption of coal is measured by wheelbarrows and pails then recalculated to weight	tonn	m	Every day	100%		
2	Power consumption (P_b)	Electric power meters at each boiler-house and heating points	MWh	m	Every month	100%	Registered in the journal (paper (initial) and electronic (later))	

No.	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?	Comment
3	Average annual Calorific Value of a fuel calculated by Net Calorific Value (NCV_b and NCV_r)	Fuel Supplier or Chemical Analysis Lab		m, c	Once per month	100%	Registered in the journal (paper (initial) and electronic (later))	
3.1	Natural Gas		MJ/m^3	c				
3.2	Coal		MJ/kg	c				
4	Carbon emission factors (Cef)	IPCC		Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
4.1	Natural Gas		$t\ CO_2/GJ$	Normative documents				
4.2	Coal		$t\ CO_2/GJ$	Normative documents				
5	Carbon emission factor for electricity consumption (CEF_c)	Operational Guidelines for PDD's of JI projects.	$t\ CO_2/MWh$	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

6	Daily outside temperature in the heating season ($T_{out\,r}$) and ($T_{out\,b}$)	Each district heating enterprise; Meteorological Service	^{0}C (K)	m, c	Once per heating season. Daily temperature is registered every day	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
7	Average inside temperature in the heating season.($T_{in\,r}$) and ($T_{in\,b}$)	Each district heating enterprise. The average inside temperature will be calculated from the sum of returned payments caused by insufficient heating (in case of normative level is not satisfied)	^{0}C (K)	m, c	Once per heating season	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
8	Number of customers of hot water supply service (n_r and n_b)	Each district heating enterprise		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
9	Heating area (F_b and F_r)	Each district heating enterprise	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

10	Average heat transfer factor of heated buildings in the base year (k_{hb})	Each district heating enterprise	W/m^2*K	Normative documents	Once per year		Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
11	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year (F_{htr})	Each district heating enterprise	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
12	Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year (F_{hnr})	Each district heating enterprise	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

13	Heat transfer factor of buildings with new thermal insulation (k_i)	Each district heating enterprise, State Buildings Norms (B.2.6-31:2006)	W/m^2*K	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
14	Heating period duration (N_r and N_b)	Each district heating enterprise	Hours	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
15	Duration of period of hot water supply service, (N_w)	Each district heating enterprise	Hours	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
16	Connected load to the boiler-house, that is required for heating (L_h^b and L_h^r)	Each district heating enterprise	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
17	Connected load to the boiler-house, that is required for hot water supply service (L_w^b and L_w^r)	Each district heating enterprise	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

18	Standard specific discharge of hot water per personal account (v_{wr} and v_{wb})	Each district heating enterprise	kWh/h	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

For the base year (2002) all parameters (with [b] index) presented above excluding parameters 11-13 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 (2003-2012) all parameters (with [r] index) presented above excluding parameters 1, 2, 10 are monitored throughout the crediting period.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO₂ equivalent):

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

where:

E_i^b – baseline emissions, t CO_2

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

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

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:

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

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:

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

where:

NCV_b – Average annual Net Calorific value in the base year, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, KtCO_2/TJ;

B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tonns;

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.

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

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 (usually 0,5-0,8);
N_h^b – duration of heating period in the base year , hours
N_w^b – duration of hot water supply service in the base year, hours

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

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 (usually 0,5-0,8);
N_h^r – duration of heating period in the reported year, hours,
N_w^r – duration of hot water supply service in the reported year, hours.

$$K_1 = NCV_b / NCV_r ; \qquad\qquad (D.1.1.4-6)$$

where:
NCV_b – Average annual Net Calorific value in the base year, MJ/m^3 (MJ/kg);
NCV_r – Average annual Net Calorific value in the reported year, MJ/m^3 (MJ/kg)

$$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b}); \qquad\qquad (D.1.1.4-7)$$

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

$$K_3 = [(F_{h\,r} - F_{h\,t\,r} - F_{h\,n\,r}) * k_{h\,b} + (F_{h\,n\,r} + F_{h\,t\,r}) * k_{h\,n}] / F_{h\,b} * k_{h\,b}; \qquad\qquad (D.1.1.4-8)$$

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

F_{hr} – heating area in the reported year, m^2;

F_{hnr} – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2;

F_{htr} – heating area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2;

k_{hb} – average heat transfer factor of heated buildings in the base year, W/m^2*K;

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

$$K_4 = N_{hr}/N_{hb};$$
(D.1.1.4-9)

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.1.1.4-10)

where:

N_{wb},– number of customers in the base year;

N_{wr} – number of customers in the reported year

$$K_6 = v_{wr}/v_{wb};$$
(D.1.1.4-11)

where:

v_{wr} – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h);

v_{wb} – 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.1.1.4-12)

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.

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 Specific project approach allows taking into account improving of the heat supply quality for the consumers and excludes deliberate reduction of heat delivery, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project activity.

Delivery of the less than necessary amount of heat and hot water really took place previously in cities and regions of Ukraine (and takes place even now in some cities and regions where situation business-as-usual is continued), and is reflected for example in JI Projects "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Chernihiv Region", etc.

According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, the heat supply enterprises must make the return payments to population for delivery less than necessary for providing normative heating level amount of heat. The normative inside temperature should be not lower than 18°C.

Amount of such return payment is the following:
 – 5% from normative payment for every degree from 18 to 12 $^{\circ}$C;
 – 10% from normative payment for every degree from 12 to 5 $^{\circ}$C;
 – when inside temperature is lower than 5 $^{\circ}$C the payment is to be returned completely.

Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18^{0}C) is not satisfied).
Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative.
Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.

The average inside temperature is calculated by formulae: (D.1.1.4-13)

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

If $0.05 < R \leq 0.3$ NP:
$\mathbf{T_{in\ b}} = 18 - (R/5)$ [$^{\circ}$C]

If 0.3 NP $< R <$ NP:
$\mathbf{T_{in\ b}} = 12 - [(R - 0.3\ NP)/10]$ [$^{\circ}$C]

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

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

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

where:
P_b – electric power consumption by the boiler-houses and central heating points in the base year, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

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

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 CO₂ equivalent):

No leakages are expected.

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

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

Formulae presented in D.1.4. are used to estimate emission reductions in PDD. Results of the corresponding calculations made with using of these formulae are listed in **Appendices 1, 2**. These calculations are based on equipment efficiency increasing.

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

Appendix 1 - Boilers.
> Replacement of old operating boilers with low efficiency by the new highly efficient ones, replacement of obsolete coal-fired boilers by the new gas-fired boilers, re-equipment of boiler-houses and heating points.

Appendix 2 - Networks.
> Replacement of the main and distribution networks pipes with diameter 57 mm - 820 mm by the pre-insulated ones.

Appendix 3 - Contains total sums of emission reductions, reductions of fuel and power energy consumption for every year for each technology.

Appendix 4 - Contains calculations of baseline emissions and project emissions as well as GHG emissions reduction for every project year, based on formulae presented in D.1.4.

Appendixes 3 and **4** contain links with **Appendixes 1, 2**.

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) Emissions of CO2 from boilers which are operated by systems of a heat supply in Dnipropetrovsk region;
2) Emissions of CO2e from current power consumption from the state grid which will be reduced due to implementation of energy saving measures at boiler-houses.

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

Where:
$E1_b$ – emissions of CO2 from heat generation sources operated by systems of heat supply of Dnipropetrovsk region, t CO_2e;
$E2_b$ – emissions of CO2 due to electricity production to the grid, that consumed by boiler houses and heating points, 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), 1000 m^3 (t);
$NCV_{b(i)}$ – Net calorific value for each fuel, MJ/m^3 (MJ/kg);
Cef_{i-} – Carbon Emission Factors for each fuel, Kt CO_2/TJ.

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

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2) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses and heating points.

$$E2_b = P_b * CEF_c, \tag{D.1.4-4}$$

where:

P_b – annual power consumption of boiler houses and heating points, MWh;

CEF_c – Carbon Emission factor for reducing electricity consumption, tCO_2e/MWh., see Table 9.

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

Project emissions

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

1) Emissions of CO2 from boilers which are operated by systems of Dnipropetrovsk region;

2) Emissions of CO2e from the power consumption from the state grid in the reported year 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.

$$E_r = E1_r + E2_r \tag{D.1.4-5}$$

Where:

$E1_r$ – emissions of CO2 from heat generation sources operated by systems of heat supply of Dnipropetrovsk region, $t\,CO_2e$;

$E2_r$ – emissions of CO2 due to electricity production to the grid, that consumed by boiler houses and heating points, $t\,CO_2e$;

Project scenario emissions from boiler-houses are a sum of actual fuel amounts to be used in any report year (starting from 2003) multiplied by corresponding conversion factors. Actual – means with subtracted fuel saving due to improving of the boiler-houses and network efficiency, reconstruction and liquidation of heating points.

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

where:

$E1_r$ – project emissions from boiler-houses in any reported year, t CO_2e

$B_{r(i)}$ – fuel consumption by boiler-houses in the project scenario (for each fuel), 1000 m^3 (t);

$V_{(i)}$ –fuel saving due to network rehabilitation for each fuel, 1000 m^3 (t);

$NCV_{(i)}$ – Net calorific value for each fuel, MJ/m^3 (MJ/kg);

Cef_i – Carbon Emission Factors for each fuel, kt CO_2/TJ.

$$B_{r(i)} = [B_{b(i)}*NCV_{b(i)}* BBE_i] / [NCV_{r(i)} * PBE_i], \qquad (D.1.4-7)$$

where:

BBE_i - Baseline Boilers Efficiency, %;

PBE_i - Project Boilers Efficiency, %.

$$V_{(i)} = B_{b(i)} - B_{b(i)} * (100-L_b)/(100-L_r), \qquad (D.1.4-8)$$

where:

$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), 1000 m^3 (t);

L_b – heat losses in the network in the baseline scenario, %;

L_r – heat losses in the network in the project scenario, %.

$$E2_r = (P_b – P_r)* CEF_c \qquad (D.1.4-9)$$

where:

P_b – annual power consumption of boiler houses, MWh;

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

P_r – calculated power saving due to re-equipment of boiler-houses and heating points, MWh.

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

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

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

- Law of Ukraine # 1264-XII "On environmental protection" from 25.06.1991;

- Law of Ukraine # 2707-XII "On atmospheric air protection" from 16.10.1992;

- Actual rules on emissions limitation: "Norms of limit admissible emissions of pollution agents from stationary sources" – adopted by Ministry for Environmental Protection of Ukraine 27.06.2006, #309 issued Ministry of and registered in Ministry of Justice of Ukraine 01.09.2006, #912/12786.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
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 (usually every year)
2. Amount of electric power consumed by boiler houses.	Low	Measuring instruments must be calibrated according to national regulations (every 4-16 years)
3. Fuel quality (Net Calorific Values).	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 season).
4. Carbon emission factors for fuels	Low	Normative documents data. No quality assurance is needed.
5. Carbon emission factor for electricity consumption	Low	
6. Outside temperature	Low	Outside temperature data from two boiler houses located in the same town should be similar.
7. Inside temperature	Low	Each boiler house operator who uses services of the boiler house he operates will be responsible for accurate data acquisition during heating season.

8. Number of customers of hot water supply service	Low	Statistic data. No quality assurance is needed.
9. Heating area.	Low	Statistic data. No quality assurance is needed.
11. Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation.	Low	
12. Heating area of newly connected buildings (assumed with the new (improved) thermal insulation)	Low	
10. Average heat transfer factor of heated buildings.	Low	Normative documents data. No quality assurance is needed.
13. Heat transfer factor of buildings with new thermal insulation		
14. Heating period duration.	Low	Statistic data. No quality assurance is needed.
15. Duration of period of hot water supply service	Low	

16. Connected load to the boiler-house for heating. 17. Connected load to the boiler-house for hot water supply service.	Low	Calculated data (data are calculated taking into account connected heating area and number of customers of hot water supply service respectively by methodology of normative documents). No quality assurance is needed.
18. Standard specific discharge of hot water per personal account	Low	Normative documents data. No quality assurance is needed.

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

The scheme identifying the responsibilities and the authority regarding the monitoring activities for the parameters to be monitored are presented in Annex 3.

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

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

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SECTION E.	Estimation of greenhouse gas emission reductions

E.1.	Estimated project emissions:

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

Calculation of Project Activity Level

Project's activity level, estimated by fuel consumption, will be reduced comparing to the baseline activity level due to fuel saving. Project energy resources consumption is presented in the Table 12.

District heating enterprise that implement the project (project partner)	Project natural gas consumption, ths Nm3/yr	Project coal consumption, t/yr	Project power consumption by boiler houses and heating points, MW*h
RME "Dniproteploenergo"	66798	0	15574
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	2021	0	435
ME «Pavlogradteploenergo»	29288	0	10202
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	1719	0	323
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	831	0	196
DE RME "Dniproteploenergo" - "Vasylkivkateploenergo"	2843	0	626
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	980	0	189
DE RME "Dniproteploenergo" "Verhnedniprovskteploenergo"	4286	0	887
Nikopol municipal enterprise "Nikopolteploenergo"	20558	0	5311
DE RME "Dniproteploenergo""Soloneteploenergo"	1109	0	186
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	1153	0	257
OCME "Ordzhonikidzeteploenergo"	9238	0	6009
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	10792	0	3267
ME "Dniprodzerzhinskteplomerezha"	23205	0	6133
Total	**174821**	**0**	**49594**

Table 12. Project energy resources consumption

Detailed information is presented in **Appendix 1 (Boilers), Appendix 2 (Networks).**

Estimation of Direct Project Emissions

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

1) Emissions of CO2 from heat generation sources operated by systems of heat supply of Dnipropetrovsk region (E1r);
2) Emissions of CO2e due to electricity production to the grid, that consumed by boiler houses and heating points (E2r).

Project Emissions of CO_2e after project implementation (from 2013) are shown in Table 13.

Project emissions		Project emissions, t CO_2
Emissions of CO2 from heat generation sources operated by systems of heat supply of Dnipropetrovsk region	E1r	338356
Emissions of CO2 due to electricity production to the grid, that consumed by boiler houses and heating points	E2r	44436
Total	Er	**382792**

Table 13. Project Emissions of CO₂e after project implementation

See **Appendix 4**.

Project emissions after project implementation are ~ **382792** t CO_2

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

Project emissions from the beginning until the end of the crediting period for each year see in **section E.6** and **Appendix 4 (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 = **382792** +0 = **382792** t CO_2.

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

Baseline emissions estimation

Baseline emissions consist of two types of GHG emissions:
1) Emissions of CO2 from heat generation sources operated by systems of heat supply of cities of Dnipropetrovsk region (E1b);
2) Emissions of CO2 due to electricity production to the grid, that consumed by boiler houses and heating points (E2b).

Baseline emissions by the sources of GHG emission are presented in the Table 14.

Baseline emissions by the sources of GHG emission		Baseline emissions, t CO_2
Emissions of CO2 from heat generation sources operated by systems of heat supply of cities of Dnipropetrovsk region	E1b	410253
Emissions of CO2 due to electricity production to the grid, that consumed by boiler houses and heating points	E2b	46766
Total	Eb	**457019**

Table 14. Baseline Emissions of CO_2

Baseline emissions ~ **457019** t CO_2.

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

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if if DH systems of district heating enterprises that implement the project remains unchanged, see in **section B** and **Appendix 4 (Baseline)**.

Baseline emissions from the beginning until the end of the crediting period for each year see in **section E.6** and **Appendix 4 (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) = **457019 - 382792 = 74227 t CO_2 / yr**.

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

Emission Reductions by the types of project activity are presented in the Table 15.

Year	GHG emissions reduction, t CO_2e			
	E1r		E2r	Er
	Due to boiler houses rehabilitation	Due to network rehabilitation	Due to power saving	**Total**
2003	13330	1543	13	**14886**
2004	15719	4268	13	**19999**
2005	18153	6512	272	**24937**
2006	18576	8538	324	**27438**
2007	20943	10713	772	**32427**
2008	23351	13704	1476	**38530**
2009	24938	15884	2239	**43061**
2010	25123	17657	2239	**45019**
2011	32112	27453	2330	**61895**
2012	35892	36005	2330	**74227**
Total	**228137**	**142276**	**12008**	**382419**

Table 15.Estimated amount of CO_2e Emission Reductions by the types of project activity

Emission Reductions by the enterprises that implement the project after project implementation (from 2013) are presented in the Table 16.

District heating enterprise that implement the project (project partner)	GHG emissions reduction, t CO2
RME "Dniproteploenergo"	11439
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	443
ME «Pavlogradteploenergo»	29982
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	726
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	399
DE RME "Dniproteploenergo" -"Vasylkivkateploenergo"	458
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	770
DE RME "Dniproteploenergo" "Verhnedniprovskteploenergo"	1043
Nikopol municipal enterprise "Nikopolteploenergo"	4154
DE RME "Dniproteploenergo""Soloneteploenergo"	566
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	729
OCME "Ordzhonikidzeteploenergo"	5946
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	3956
ME "Dniprodzerzhinskteplomerezha"	13615
Total	**74227**

Table 16.Estimated amount of CO_2e Emission Reductions by the enterprises that implement the project

For more details see **Appendixes 1, 2**.

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reduction (tonnes of CO_2 equivalent)
2003	444221	0	459107	14886
2004	438064	0	458063	19999
2005	432082	0	457019	24937
2006	429581	0	457019	27438
2007	424592	0	457019	32427
Subtotal 2003 - 2007	**2168539**	**0**	**2288226**	**119687**
2008	418489	0	457019	38530
2009	413958	0	457019	43061
2010	412000	0	457019	45019
2011	395124	0	457019	61895
2012	382792	0	457019	74227
Subtotal 2008 - 2012	**2022363**	**0**	**2285095**	**262732**
2013	382792	0	457019	74227
2014	382792	0	457019	74227
2015	382792	0	457019	74227
2016	382792	0	457019	74227
2017	382792	0	457019	74227
2018	382792	0	457019	74227
2019	382792	0	457019	74227
2020	382792	0	457019	74227
2021	382792	0	457019	74227
2022	382792	0	457019	74227
2023	382792	0	457019	74227
2024	382792	0	457019	74227
2025	382792	0	457019	74227
2026	382792	0	457019	74227
2027	382792	0	457019	74227
2028	382792	0	457019	74227
2029	382792	0	457019	74227
2030	382792	0	457019	74227
Subtotal 2013 - 2030	**6890254**	**0**	**8226340**	**1336086**
Total (tonnes of CO_2 equivalent)	**11081156**	**0**	**12799661**	**1718505**

Table 17. 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 rules, the design documentation for the new building, reconstruction and technical re-equipment of industrial and civil objects must include the environmental impact assessment, the main requirements for which are listed in the State Building Norms of Ukraine A.2.2-1-2003.

District heating enterprises that implement the project have the necessary Environmental Impact Assessment for its activity according to Ukrainian legislation.

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

1. Project implementation will allow saving about 36.5 million Nm^3 of natural gas, 708 t of coal and 2600 MWh per year after project complete implementation. Natural gas and coal are non-renewable resources and their saving is important.

2. Project implementation will reduce direct CO_2 emissions from city and regional boilers about 74.2 thousand tonns per year after project complete implementation due to increased boilers efficiencies, achieved through installation of up-to-date boiler equipment, particularly new boilers, heat utilizers and new boiler burners, and installation of pre-insulated network pipes instead of existing regular network pipes.

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

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

District heating enterprises that implement the project do necessary Environmental Impact Assessments for reconstruction objects which require EIA as special section of project of reconstruction.

The transboundary effects are not considered (no effect can be deduced). Emissions are mainly localised not far from the sourse sites.

The transboundary effects may appear only in the case of maximum permissible emissions (MPE) of contaminant to atmosphere exceeding. There were no MPE exceeding fixed at the district heating enterprises that implement the project.

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

Impact on the water medium

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

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

Effects on the medium air

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

Effects on land use

Impact on the land medium is not present.

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

Effects on biodiversity

Impact on biodiversity is not present.

Waste generation, treatment and disposal

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

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

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

- enterprises must apply statistic reports on waste creating, gathering, transporting keeping, treating, utilizing, decontaminating and excreting.

- provide complete gathering, appropriate keeping and non-admission waste destruction and spoilage, for utilization of which there is an appropriate technology in Ukraine.

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

SECTION G. Stakeholders' comments

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

According to the Ukrainian legislation, Employer of projects of new building, reconstruction and technical re-equipment of industrial and civil objects that may have negative influence on environment during implementation (building, exploitation etc.), must to ensure transparency and to consider public opinion on planned or ongoing activities. The respective announcements were made in the media[12,13], comments haven't been received.

The authority of Dnipropetrovsk region has expressed the support for the project.

Project "Rehabilitation of District Heating Systems in Dnipropetrovsk Region" was presented at the XV (Sevastopol, June 13-16, 2005) and XVI (Sevastopol, June 6-10, 2006) Conferences of CIS with international participants and XX International Conference "Problems of Ecology and Exploitation of Energy Objects" (Yalta, June 8-12, 2010), where it was comprehensively discussed with representatives of governmental and district heating organizations.

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[12] «Vidomosti» dated 29.10.03 Dniprodzerzhinsk city, p.14

[13] «Dilovi vidomosti» dated 19.09.07 Dniprodzerzhinsk city, p.1

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Supplier:

Organisation:	Joint Stock Company "Oblteplocomunenergo
Street/P.O.Box:	Komsomolska str
Building:	55b
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State/Region:	Chernihiv Region (Oblast)
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URL:	
Represented by:	
Title:	Head of the Board
Salutation:	Mr.
Last name:	Barbarov
Middle name:	Anatolievich
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Annex 2

BASELINE INFORMATION

The main Baseline information is listed in **Section B.** In this Annex 2 some detailed are represented.

Information on the power grid Baseline situation:

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

For calculations the values of the carbon emission factors at the combined approach base are used:

- for 2002-2005– according to the Table B1 "Baseline carbon emission factors for JI projects generating electricity" and 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) [14]:

Year	2002	2003	2004	2005
CEF_c tCO$_2$e/MWh	0.956	0.936	0.916	0.896
CEF_g tCO$_2$e/MWh	0.785	0.770	0.775	0.740

Table 1. Carbon Emission factors (CEF) for consumption and generation in Ukraine

- for 2006-2012 (and for the later period in the forecasting calculations in PDD as well) – 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", verified by TUV SUD Industrie Service GmbH 17.08.2007 [15]:

CEF_c tCO$_2$e/MWh	0.896
CEF_g tCO$_2$e/MWh	0.807

Table 2. New Carbon Emission factors (CEF) for electricity consumption and generation in Ukraine

It should be noted that according to "Ukraine - Assessment of new calculation of CEF"[13]: "This baseline can be used as ex-ante (fixed for the period 2006 – 2012) or ex-post. In case an ex-post baseline is chosen the data of the Ukrainian grid have to be obtained of the year in which the emission reductions are being claimed. Monitoring will have to be done in accordance with the monitoring plan of ACM0002 with the following exceptions:
• the Monitoring Plan should also include monitoring of the grid losses in year y;
• power plants at which JI projects take place should be excluded. Such a JI project should have been approved by Ukraine and have been determined by an Accredited Independent Entity."

Thus. TUV SUD Industrie Service GmbH has validated the certain value of CEF for 2006 and possibly future up to 2012, as well as the methodology for calculations of this factor, and its "team recommends updating the calculation annually depending on point of time when national consolidated data are available", with taking into account the above monitoring conditions.

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[14] *http://ji.unfccc.int/CallForInputs/BaselineSettingMonitoring/ERUPT/index.html*

[15] "Ukraine – Assessment of new calculation of CEF", from "Objective; Conclusion", assessed by TUV SUD, 2007

EBRD in 2009 expressed that "these factors are in need for an update further to a request from the Ministry of Fuel and Power of Ukraine and the National Environmental Investment Agency of Ukraine."[16]

According to this, after obtaining the more recent input data for calculations according to the methodology developed by Global Carbon and validated by TÜV SÜD (or may be another one developed by EBRD, after its acceptance), the grid emission factor may and should be renewed annually, to be in line with actual situation.

Therefore, the following CEF values are used in calculations in PDD:

Year	2002	2003	2004	2005	2006-2012	2013-2030
CEF_c tCO$_2$e/MWh	0.956	0.936	0.916	0.896	0.896	0.896
CEF_g tCO$_2$e/MWh	0.785	0.770	0.775	0.740	0.807	0.807

Table 3. The baseline Carbon Emission factors (CEF) used for calculations in PDD

In course of development of the Monitoring reports for this project, if available, the valid at that time CEF values for corresponding period will be used.

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[16] TERMS OF REFERENCE. Development of the electricity carbon emission factors for Russia and Ukraine for the period 2009 – 2020. EBRD, 2009

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	B_b	Fuel consumption by boiler-houses (Natural gas/coal)		m
1.1	B_b (natural gas)	Natural gas consumption	ths.m^3	m
1.2	B_b (coal)	Coal consumption	t	m
2	P_b	Electric power consumption	MWh	m
3	NCV_b	Average annual Net Calorific Value		m, c
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	Cef_b	Carbon emission factor	t CO_2/TJ	IPCC 1996 Guidelines for National Greenhouse Gas Inventories Vol.2 Energy [17]
4.1	Cef (natural gas)	Carbon emission factor for natural gas		
4.2	Cef (coal)	Carbon emission factor for coal		
5	CEF_c	Carbon emission factor for electricity consumption	t CO_2/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 4. The key elements of the baseline

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

Annex 3

MONITORING PLAN

This monitoring plan describes the specific project approach that will be used to calculate the ongoing amount of greenhouse gas emission reduction units (ERUs) resulting from installation and commissioning of the JI project in Dnipropetrovsk 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 in greenhouse gas emissions. The reduction in greenhouse gas emissions will be quantified using the specific project approach presented in this Monitoring Plan.

Relevant monitoring methodologies

In course of development of the project **"Rehabilitation of District Heating Systems in Dnipropetrovsk Region"**, the specific project approach for "District Heating" projects in Ukrainian conditions was used (see section B.1).

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

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

Formulae for monitoring

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

Total emission reduction

The total annual emission reduction is the difference between the baseline emissions (BE) and the project emissions (PE).

Formula 1 – Total emission reduction (ERUs)	
	$ERUs = \sum[E_i^b - E_i^r]; \quad [t\ CO2e.]$
	ERUs - Total annual emission reduction [t CO2e.] E_i^b - Baseline CO_2 emissions [t CO2-eq.] E_i^r - CO_2 emissions in the reported year [t CO2e.]
	The sum is taken over all boiler-houses (i) which are included into the project

Project emissions

Formula 2 –Emissions in the reported year (E^r)
$E_i^r = E_{1i}^r + E_{cons\ i}^r$; [t CO_2e]
E_{1i}^r – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, t CO_2e; $E_{cons\ i}^r$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house and heating points related to the i boiler-house in the reported year, t CO_2e.

Formula 3 – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, (E_{1i}^r)
$E_{1i}^r = NCV_r * Cef_r * B_{ri}$, [tCO2e]
NCV_{ri} – Average annual Net Calorific value, MJ/m^3 (MJ/kg)   Cef – carbon emission factor, ktCO$_2$/TJ; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tonnes;

Formula 4 – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the reported year ($E_{cons\ i}^r$)
$E_{cons\ i}^r = P_r * CEF_c$
P_r – electric power consumption by the boiler-houses and heating points in the reported year, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO$_2$e/MWh;

Baseline emissions

Formula 5 – Annual baseline emissions (E_b)
$E_i^b = E_{1i}^b + E_{cons\ i}^b$; [t CO_2e]
E_{1i}^b – baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house , t CO_2e; $E_{cons\ i}^b$ – CO_2 emissions due to electric power consumption by an i boiler-house and heating points related to the i boiler-house in the base year, t CO_2e.

Formula 6 – Baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house, (E_{1i}^{b})	
	For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^{b} is: $$E_1^{b} = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w],$$ where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply. 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: $$E_1^{b} = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_r * (1-a_r) * K_1 * K_{w0}].$$
	NCV_b – Average annual Net Calorific value in the base year, MJ/m^3 (MJ/kg); Cef – carbon emission factor, $KtCO_2/TJ$; B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tonnes; 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 7 – Portion of fuel (heat), consumed for heating purposes in the base year (a_b)	
	$a_b = L_h^{b} * g * N_h^{b} / (L_h^{b} * g * N_h^{b} + L_w^{b} * N_w^{b})$;
	L_h^{b} – maximum connected load required for heating in the base year , MW; L_w^{b} – connected load required for hot water supply service in the base year , MW; g – recalculating factor for average load during heating period (usually 0,5-0,8); N_h^{b} – duration of heating period in the base year , hours N_w^{b} – duration of hot water supply service in the base year, hours.

Formula 8 – Portion of fuel (heat), consumed for heating purposes in the reported year (a_r)	
	$a_r = L_h^{r} * g * N_h^{r} / (L_h^{r} * g * N_h^{r} + L_w^{r} * N_w^{r})$
	L_h^{r} – maximum connected load required for heating in the reported year , MW; L_w^{r} – connected load required for hot water supply service in the reported year , MW; g – recalculating factor for average load during heating period (usually 0,5-0,8); N_h^{r} – duration of heating period in the reported year, hours N_w^{r} – duration of hot water supply service in the reported year, hours.

Formula 9 – Change in the Net Calorific value (K_1)
$K_1 = NCV_b / NCV_r$
NCV_b – Average annual Net Calorific value in the base year, MJ/m^3 (MJ/kg); NCV_r – Average annual Net Calorific value in the reported year, MJ/m^3 (MJ/kg)

Formula 10 – Temperature change factor (K_2)
$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b})$
$T_{in\,r}$ – average inside temperature for the heating period in the reported year, K (or ^{0}C); $T_{in\,b}$ – average inside temperature for the heating period in the base year, K (or ^{0}C); $T_{out\,r}$ – average outside temperature for the heating period in the reported year , K (or ^{0}C); $T_{out\,b}$ – average outside temperature for the heating period in the reported year , K (or ^{0}C)

Formula 11 – Heating area and building thermal insulation change factor (K_3)
$K_3 = [(F_{h\,r} - F_{h\,t\,r} - F_{h\,n\,r})*k_{h\,b} + (F_{h\,n\,r} + F_{h\,t\,r})*k_{h\,n}] / F_{h\,b}*k_{h\,b}$,
$F_{h\,b}$ – heating area in the base year, m^2; $F_{h\,r}$ – heating area in the reported year, m^2; $F_{h\,n\,r}$ – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2; $F_{h\,t\,r}$ – heating area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2; $k_{h\,b}$ – average heat transfer factor of heated buildings in the base year, (W/m^2*K); $k_{h\,n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), (W/m^2*K).

Formula 12 – 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 13 – Number of customers of hot water supply service change factor (K_5)
$K_5 = n_{wr} / n_{wb}$
N_{wb},– number of customers in base year; N_{wr} – number of customers in the reported year

Formula 14 – Standard specific discharge of hot water per personal account change factor (K_6)
$K_6 = v_{wr} / v_{wb}$
v_{wr} – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h); v_{wb} – standard specific discharge of hot water per personal account in the base year, (in heat units, kWh/h).

Formula 15 – Hot water supply period duration change factor (K_6)
$K_7 = N_{wr} / N_{wb}$
N_{wr} – duration of hot water supply service in the reported year, hours. N_{wb} – duration of hot water supply service in the base year, hours.

Formula 16 – CO_2 emissions due to electric power consumption for an i boiler-house in the base year ($E_{cons\,i}^{b}$)
$E_{cons}^{b} = P_b * CEF_c$
P_b – electric power consumption by the boiler-houses in the base year, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Parameters to be monitored

Monitoring specific project 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 spreadsheet 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	n.a.

Parameter number and name	**1.2** Coal consumption at boiler houses
Description	Coal consumption at boiler houses
Monitoring method	Purchasing of coal is realized in accordance with invoices. Consumption of coal is measured by wheelbarrows and pails then recalculated to weight
Recording frequency	Every day
Background data	Coal consumption is registered in the paper journals at every boiler-house. Invoices are filed in special journals.
Calculation method	n.a.

Parameter number and name	**2.1.** Average annual 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 season
Description	Average daily outside temperature during the heating season
Monitoring method	Average outside temperature during the heating season is calculated by district heating enterprises that implement the project from the daily outside temperature values taken by dispatcher of enterprise from local Meteorological Centre from 10 to 11 a.m. every day of heating season.
Recording frequency	Once per heating season. Daily temperature is registered every day of heating season
Background data	Meteorological Centre sends the Report every decade or month for every day of heating season. Reports are filed in special journals
Calculation method	Average value

Parameter number and name	**4.** Average inside temperature during the heating season
Description	Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied) Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative. Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.
Monitoring method	Sum of returned payments
Recording frequency	Once per heating season
Background data	Sums of return payment
Calculation method	According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, the enterprises must make the return payments to population for delivery less than necessary amount of heat. The normative inside temperature

should be not lower than $18\,^{o}$C.

Amount of the return payment is:

– 5% from normative payment for every degree from 18 to 12 ^{o}C;

– 10% from normative payment for every degree from 12 to 5 ^{o}C;

– when inside temperature is lower than 5 ^{o}C the payment is to be returned completely.

Therefore the inside temperature will be calculated by formulae:

If R = 0 (according to conservatism principle for the baseline assume R < 0.05):

$\mathbf{T_{in\,b}} = 18\,^{o}$C.

If $0.05 < R \leq 0.3$ NP:

$\mathbf{T_{in\,b}} = 18 - (R/5)\ [^{o}$C]

If 0.3 NP < R < NP:

$\mathbf{T_{in\,b}} = 12 - [(R - 0.3\ NP)/10]\ [^{o}$C]

where:

R - % of return payment from NP;

NP – amount of normative payment.

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

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 enterprises. They are updated once per year.
Background data	The information is collected in special electronic journals "Registration of income from population" (for inhabitants). For organizations and legal entities such information is taken from contracts concluded with them
Calculation method	

Parameter number and name	6. Heating area (Total)
Description	Heating area for every boiler houses
Monitoring method	Statistics of 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 Heating area are displayed in the special journal
Calculation method	The data is taken for January, 01 for every year

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

Parameter number and name	**8.** Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heating area of reconstructed buildings with application of new insulations for walls
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	
Calculation method	

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

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

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

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for every boiler house.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per day
Background data	Hot water supply service is realized by hot water delivery schedule for every town.
Calculation method	

Parameter number and name	**13.** Maximum connected load to the boiler-house, that is required for heating
Description	Maximum connected load to the boiler-house, that is required for heating.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year .
Background data	Maximum connected load to the boiler-house, that is required for heating, is calculated by district heating enterprises for every heating season. It is calculated according to heat demand at outside temperature -23 $^{\circ}$C.
Calculation method	

Parameter number and name	**14.** Connected load to the boiler-house, that is required for hot water supply service
Description	Connected load to the boiler-house, that is required for providing the hot water supply service
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year .
Background data	Connected load to the 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	

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

Parameter number and name	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	For all fuels we used CO_2 emission factors from the IPCC 1996 Guidelines for National Greenhouse Gas Inventories. Cef (natural gas) = 0.0561 tCO_2/GJ; Cef (coal) = 0.0946 tCO_2/GJ; (taken as "Other bituminous coal").
Calculation method	

Parameter number and name	**17.** Recalculating factor for average load during heating period
Description	Recalculating factor for determination of the average load during heating period
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Recalculating factor for average load during heating period is determined for each boiler-house on historical base, usually it is in the range (0,4 – 0,8)
Calculation method	$g = Q_{av}/Q_{max} = F_h * k_h * (T_{in} - T_{out\ av}) / F_h * k_h * (T_{in} - T_{out\ min})$

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

$T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^0C).

Parameter number and name	**18.** Electric power consumption
Description	Electric power consumption by the boiler-houses
Monitoring method	Measurement by Electricity supply meters
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	

Scheme of monitoring system

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

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

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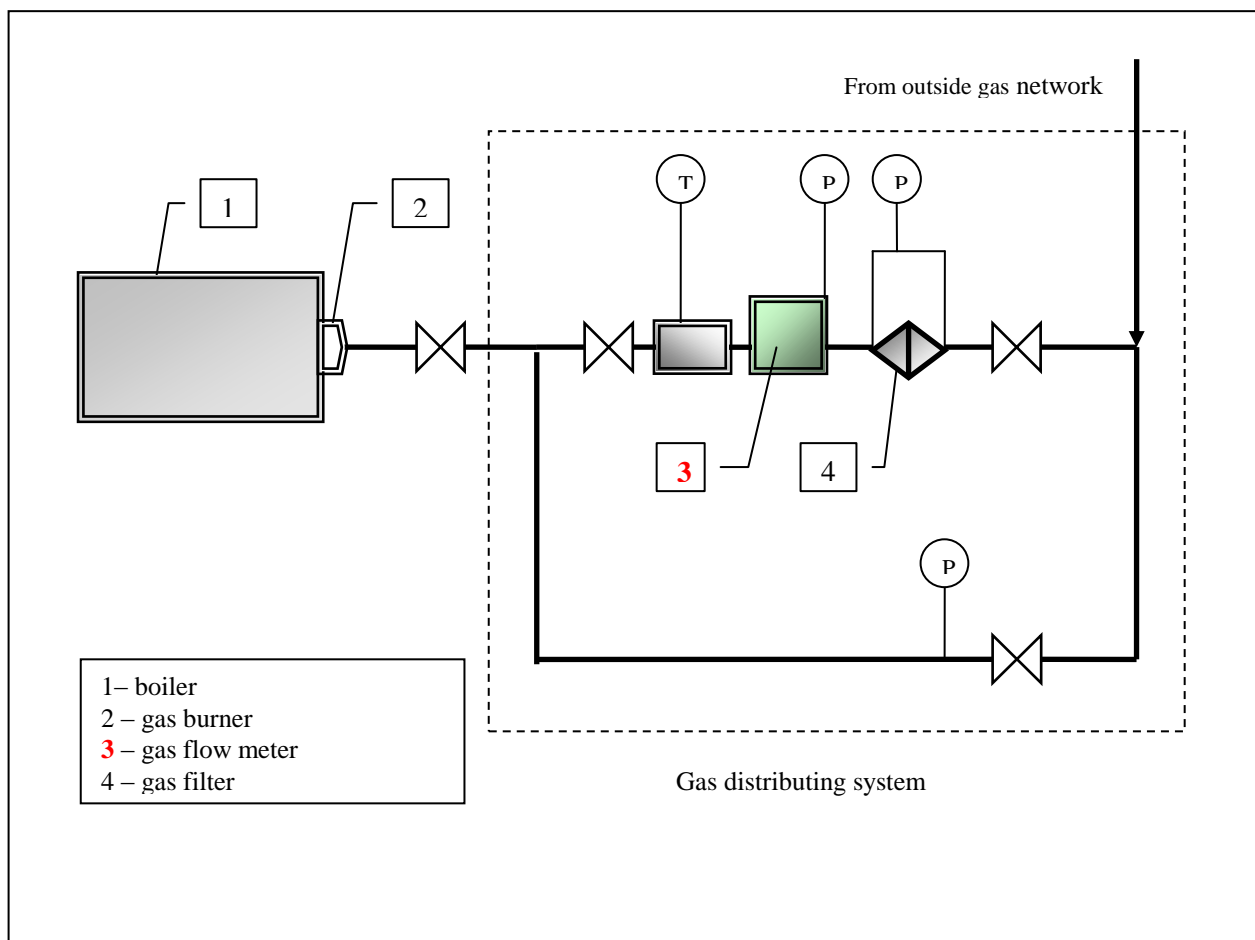- stop valve;
- bypass facility.

Fig. 1. Scheme of the Gas distribution system

Monitoring equipment

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

ID number and data variable	Equipment	Accuracy	Calibration	Frequency	Procedure in case of failure
1.1. Natural Gas consumption	Gas flow meters	+/- (0.5…2)% Usually 1%	PE «Atamanchuk», "Derzhspozhivstandart" of Ukraine.	Once per from 1 to 5 years, usually two years	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.
18. Power consumption	Electricity supply meters	+/- (0.2…0.5)% Usually 0.2%	«Dnipropetrovsk municipal electricity network »	Once per from 4 to 16 years, according to passport	Failure should be firstly reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events will be recorded in the site events log book.

Table 1. Monitoring equipment

Level of uncertainty and errors

Possible uncertainties 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 parameters, only 2 of them (volume of natural gas consumption, power consumption) is measured directly. The remaining monitoring parameters used in calculation of the baseline and project line emissions are taken as statistic data. Furthermore, they are used for adjustment factors calculation. Calculations of adjustment factors are based on reported and base year parameters ratio. For example, temperature change factor is calculated as ratio of inside and outside temperature differences in reported and base years: $K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$. Therefore any error in statistic data will be cancelled.

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

ID number and data variable	Measurement error (maximal)	Comment
1.1 Natural Gas consumption	± 1.0%	Accuracy of data is high due to necessity of information for commercial account purposes.
18. Power consumption	± 0.5%	Accuracy of data is high due to necessity of information for commercial account purposes.

Table 2: Measurement errors

Monitoring of environmental impacts

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

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

Project management planning

The overall responsibility for the project management and implementation is carried out by the Head of the Board of OJSC "Oblteplocomunenergo", Mr. Yuriy Barbarov, and appointed responsible persons leaded by Mr. Valeriy Derevianko, General director of RME "Dniproteploenergo". The stuff of PTD of district heating enterprises that implement the project is responsible for project activity.
Compliance of the project activity with the operational requirements is constantly controlled by responsible stuff of a boiler-house, and according to their reports – by PTD.
Possible bottlenecks and mistakes in project implementation should be identified and solved by responsible stuff of PTD.

Responsibilities for data collection

The chairman of OJSC "Oblteplocomunenergo", Mr. Yuriy Barbarov, appointed a responsible person, Ms. Elena Bardina, for the implementation and management of the monitoring process at the district heating enterprises that implement the project. Ms. Elena Bardina is responsible for supervising data collection, measurements, data recording and storage.
Dr. Dmitri Paderno, vice director of Institute of Engineering Ecology, is responsible for baseline and monitoring specific project approach development.
Ms. Kateryna Korinchuk, engineer of Institute of Engineering Ecology, is responsible for data processing.

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

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

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

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

4. Every day operators transfer values of gas consumption to Production-Technical Department (PTD) by phone, where they are storing and used for payments with gas suppliers.

Data monitored and required for determination according to paragraph 37 of the JI guidelines are to be kept for two years after the last transfer of ERUs for the project.

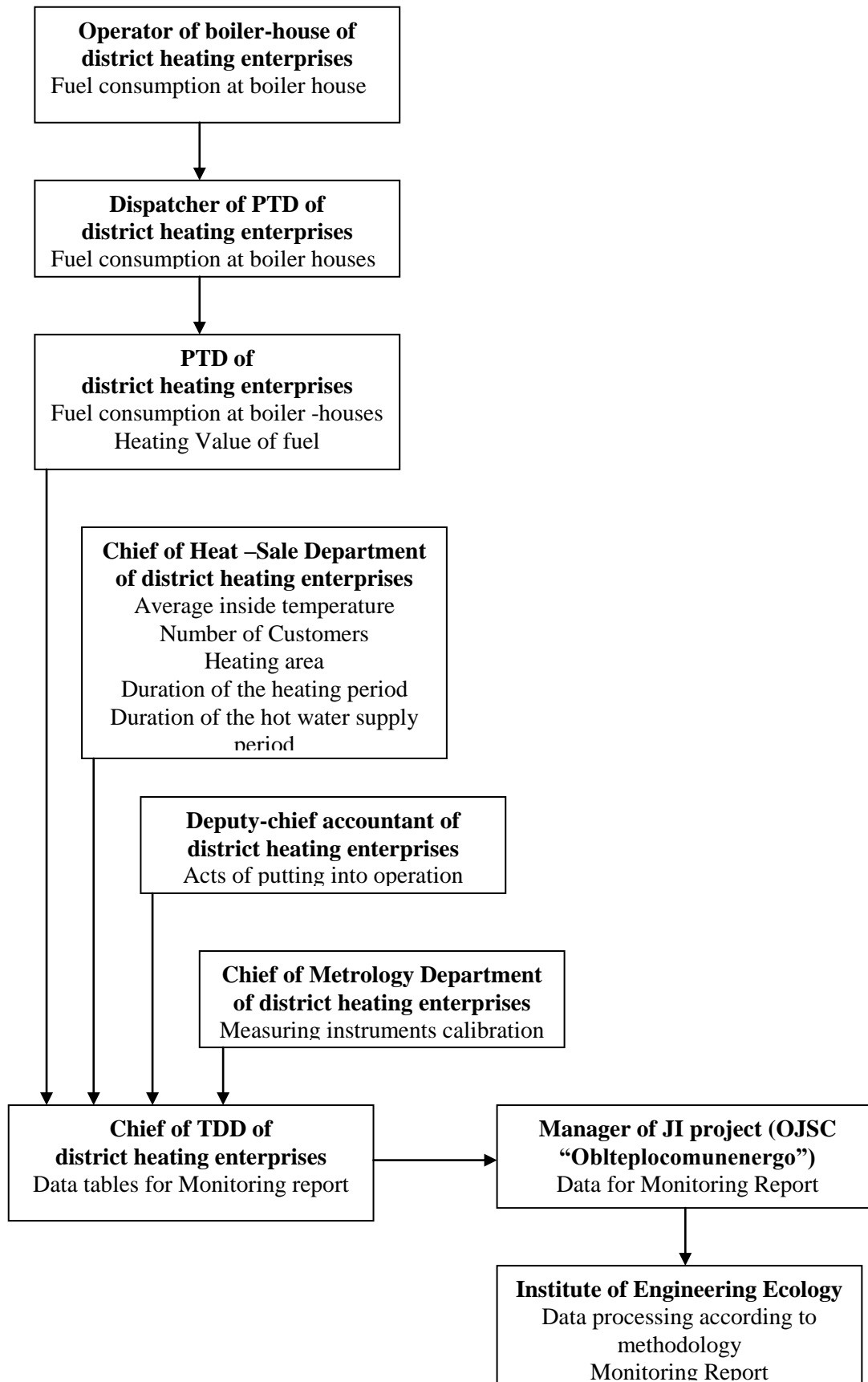Scheme of data collection for Monitoring Report is shown at the Fig. 2.

Fig.2. Scheme of data collection for Monitoring Report

Trainings

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.

District heating enterprises that implement the project provide personnel retraining according to protection of labour norms. The enterprises have the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

In course of the JI project development, specialists of Institute of Engineering Ecology and carried out a comprehensive consultations and trainings for involved representatives of OJSC "Oblteplocomunenergo" and other enterprises on the necessary data collection according to Monitoring plan for the project.
The special training is scheduled to be held before the development of the Monitoring report.

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

Responsibilities for data management

All collected data will be transferred to Elena Bardina, who will be responsible for data monitoring and reporting. Kateryna Korinchuk will be responsible for the data processing according to specific project approach and for development of Monitoring Report. Support in coordination of verification process will be undertaken by Dmitry Paderno. Responsibilities for data management are presented in Table 3.

Activity	Responsible person	
	Name	Position and department
Data monitoring and reporting, coordination of verification process	Elena Bardina	Head of the Legal security of economic activity Department of OJSC "Oblteplocomunenergo"
Data monitoring and reporting, coordination of verification process	Valeriy Derevianko	General director of RME "Dniproteploenergo"
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Ruslan Severin	Engineer of RME "Dniproteploenergo"
Data processing according to methodology, development of Monitoring Report	Kateryna Korinchuk	Engineer of Institute of Engineering Ecology, Ltd
Support in coordination of verification process	Dmitri Paderno	Vice Director of Institute of Engineering Ecology, Ltd

Table 3: Responsibilities for data management