

JI PROJECT MONITORING REPORT

UA1000254 / 06

Version 02

August 26, 2011

“Rehabilitation of District Heating Systems in Dnipropetrovsk Region”

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SECTION A. General Project activity and monitoring information

A.1 Title of the project activity:

“Rehabilitation of District Heating Systems in Dnipropetrovsk Region”

A.2. JI registration number:

ITL project ID: UA1000254

A.3. Short 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 (CO₂ 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 district heating systems in Dnipropetrovsk region, including boiler and distribution network equipment replacement and rehabilitation.

In 2011 the Municipal Enterprise “Teploenergo” of Dnipropetrovsk City Council, the City Municipal Enterprise “Dnipropetrovski miski teplovi merezhi” and Municipal Enterprise of Heat Supply Network “Kryvorizhteplomerzha” have joined the Project as partners.

The 570 boiler-houses with 1837 boilers (total maximal connected load 3640.58 Gcal/hour, baseline) and 1302.5 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 this project is to fulfil annual minimal repairing of the DH system to keep it working. Particularly it covers repairing of networks and boilers parts which failure might cause accidents.

b) Baseline scenario:

For Baseline scenario the economically feasible and realistic scenario with very slow rehabilitation activities was chosen. Tariffs for heat do not include the resources for prospective rehabilitation of the district heating system, only the resources for probable necessary repairing after possible accidents. Minimal annual repairing doesn’t lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the same level. This scenario is not environmentally favorable for the near future (including first commitment period 2008-2012), since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is attractive.

c) Project scenario

Project provides installation of 382 new highly efficient boilers, replacement of 333 boilers’ burners, installation of 74 heat utilizers, rehabilitation of by 393 km of heat distributing networks and other fuel and energy saving measures.

After complete project implementation about 304 million Nm³ of natural gas, 708 t of coal and 12.5 GWh 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 high efficient boilers;
- Boiler equipment rehabilitation:
 - Replacement of burners;
 - Replacement of convection parts and screen tubes;
 - Renovation of boiler lining, brickwork and termoinsulation;
 - Chemical flushing and cleaning;
- Installation of water treatment systems;
- Installation of heat utilizers;
- Rehabilitation of heat network equipment, including decreasing of pipelines length and replacing of the 4-pipe lines by 2-pipe lines, with implementation of the new heat insulation and the pre-insulated pipes.
- Construction of quarter boiler-houses on the basis of existing central heat supply stations (CHSS);
- Technical re-equipment of central heat supply stations with heat exchangers;
- Replacement of pumps;
- Installation of frequency controllers at electric drives of smoke exhausters, etc.;
- Installation of automatic system for electricity counting control (ASECC);
- Installation of combined heat and power production equipment;
- Implementation of modern devices for heat accounting; of systems for heat networks operation monitoring, for the control, management and automation of heat generating objects;
- Creation of optimized systems for monitoring and energy audit of heat energy objects.

According to the monitoring plan, section D of the PDD version 04, for the period 01.01.2008-31.12.2008 monitoring of the project activity was executed for the district heating enterprises ME “Teploenergo” of Dnipropetrovsk City Council, CME “Dnipropetrovski miski teplovi merezhi” and MEHSN “Kryvorizhteplomerzha”. In this Monitoring Report information on only these 3 district heating enterprises is provided.

According to collected data, the following amount of GHG emission reduction was achieved during the monitoring period (2008):

Year	Baseline emissions, tCO ₂ e	Project emissions, tCO ₂ e	Emission Reduction, tCO ₂ e
2008	1165670	935958	229712

Table 1. Amount of GHG emission reduction during the monitoring period.

A.4. Monitoring period:

- Monitoring period starting date: 01/01/2008
- Monitoring period closing date: 31/12/2008

A.5. Methodology applied to the project activity (incl. version number):**A.5.1. Baseline methodology:**

According to the “Guidelines for users of the JI PDD form” version 04¹, the baseline shall be established on a project-specific basis, or where applicable, project participants may opt to apply approved clean development mechanism (CDM) baseline and monitoring methodologies.

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

This project specific approach is partly similar to the Baseline and monitoring methodology AM0044 “Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors” (version 1)², however the AM0044 can not be used for the JI project “Rehabilitation of the District Heating Systems in Dnipropetrovsk Region” since this project has some differences from applicability conditions of this methodology.

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of 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 $EG_{PJ,i,y}$ (heat energy output of project boiler ‘i’ in year y), 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.).

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. Our project includes also some other kinds of modernization such as the replacement of burner equipment, installation of cogeneration units, etc.

Approved Consolidated Methodology ACM0009 “Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas” (version 03.2)³ proposes the dependences for calculation the amounts of baseline and reported year emissions that contain determination of Energy efficiency $\epsilon_{project,i,y}$ and $\epsilon_{baseline,i}$ for equipment. In the chapter “Baseline emissions” there is an explanation that: Efficiencies for the project activity ($\epsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations, Efficiencies for the baseline scenario ($\epsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations.

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

In additional, the proposition in ACM0009 to take 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 $\epsilon_{project,i,y}$.

The 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)⁴ 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.

¹ <http://ji.unfccc.int/Ref/Documents/Guidelines.pdf>

² http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_L4AOZSBA770KNI0BUSG1JVIWCXIFU5

³ <http://cdm.unfccc.int/UserManagement/FileStorage/K4P3YG4TNQ5ECFNASMBK2QSMR6HTEM>

⁴ http://cdm.unfccc.int/filestorage/EB52_repan06_AM0048_ver03.pdf?t=SHh8M0IHTRBRkMxVINZNEhRVU84V1pE TjA2NTdFTVhKfDEyODgxNzIzNDEuNjc=/35jXwvrTnpGqUjSvdXUE9eB3Q6w=

Beside this, in according to AM0048 and its monitoring plan, it is necessary to realize, among other measurements, monthly measurement of $SC_{PCSG,i,y}$ (Total steam self-generated by project customer ‘i’ during year ‘y’ of the crediting period, TJ), measured by the steam meter at the customer ‘i’. 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).

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

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

This developed project specific approach has two important advantages (at least for Ukrainian conditions):

- It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95% of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (CO₂) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as registration of residents’ complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.
- Definition of the fuel consumption in base year (baseline) in view of the fact that in Ukraine at the majority of the municipal heat supply enterprises the natural gas is used as a fuel, which consumption is measured constantly by the counters with the high measurement accuracy, seems to be more exact, than definition of the fuel consumption with use of heat power, boiler efficiency and heat value of the fuel. This especially concerns the efficiency, which changes greatly depending on load of boilers, which also changes essentially, and often not automatically but manually, in the heat supply systems within a day and within a year. Averaging of such values without having of the heat account system is fraught with serious discrepancies. Definition of the fuel consumption in the presence of counters requires only data collection and implementation of arithmetic actions.

Thus, in contrast to the methodologies AM0044, ACM0009 and AM0048, the specific project approach, developed for “District Heating” projects in Ukrainian conditions and applied in JI Projects “Rehabilitation of the District Heating System in Donetsk Region”, “District Heating System Rehabilitation of Chernihiv Region”, “Rehabilitation of the District Heating System in Crimea”, “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 conservative approach, and the most closely reflects the aims, goals and spirit of Kyoto Protocol.

This project specific approach is presented in section **A.5.2 (Monitoring methodology)**.

A.5.2. Monitoring methodology:

The JI project specific approach for monitoring 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 project specific approach is proposed to be used.

Amount of the Emission Reduction Units (ERUs), t CO₂e:

$$ERUs = \sum [E_{(i)}^b - E_{(i)}^r] \tag{1}$$

where:

$E_{(i)}^b$ and $E_{(i)}^r$ - GHG emissions for an (i) boiler-house in the reported year for the dynamic baseline and project scenarios, respectively, t CO₂e.

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

$$E_{(i)}^b = E_{1(i)}^b + E_{cons(i)}^b; \tag{2}$$

where:

$E_{(i)}^b$ – baseline emissions (dynamic for a reported year), t CO₂e;

$E_{1(i)}^b$ – emissions due to fuel consumption for heating and hot water supply service for an (i) boiler-house in the base year in terms of a reported year, t CO₂e;

$E_{cons(i)}^b$ – emissions due to electric power consumption by an (i) boiler-house and heat supply stations related to the (i) boiler-house in the base year in terms of a reported year, t CO₂e.

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:

$$E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w], \tag{3}$$

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:

$$E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_r * (1-a_r) * K_1 * K_{w0}]. \tag{4}$$

where:

NCV_b – average annual net calorific value of fuel in the base year, GJ/ ths m³ (GJ/t);

Cef – carbon emission factor of fuel, tCO₂/GJ;

B_b – amount of fuel consumed by a boiler-house in the base year, ths m³ or tons;

$K_1, K_h = K_2 * K_3 * K_4; K_w = K_5 * K_6 * K_7$ – adjustment factors;

a_b – portion of fuel (heat), consumed for heating purposes in the base year;

$(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year;

a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

$$a_b = L_h^b * g^b * N_h^b / (L_h^b * g^b * N_h^b + L_w^b * N_w^b); \tag{5}$$

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^b – recalculating factor for average load during heating period in the base year;
 N_h^b – duration of heating period in the base year, hours;
 N_w^b – duration of hot water supply service in the base year, hours.

$$a_r = L_h^r * g^r * N_h^r / (L_h^r * g^r * N_h^r + L_w^r * N_w^r) \quad (6)$$

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^r – recalculating factor for average load during heating period in the reported year;
 N_h^r – duration of heating period in the reported year, hours,
 N_w^r – duration of hot water supply service in the reported year, hours.

$$g^{b,r} = F_h^{b,r} * k_h^{b,r} * (T_{in}^{b,r} - T_{out av}^{b,r}) / F_h^{b,r} * k_h^{b,r} * (T_{in}^{b,r} - T_{out min}^{b,r}) = (T_{in}^{b,r} - T_{out av}^{b,r}) / (T_{in}^{b,r} - T_{out min}^{b,r}) \quad (7)$$

where:

$F_h^{b,r}$ – heated area of buildings, m²;
 $k_h^{b,r}$ – average heat transfer factor of heated buildings, kW/m²*K;
 $T_{in}^{b,r}$ – average inside temperature for the heating period, K (or °C);
 $T_{out av}^{b,r}$ – average outside temperature for the heating period, K (or °C);
 $T_{out min}^{b,r}$ – minimal outside temperature for the heating period, K (or °C).

$$K_1 = NCV_b / NCV_r; \quad (8)$$

where:

NCV_b – average annual net calorific value of fuel in the base year, GJ/ ths m³ (GJ/t);
 NCV_r – average annual net calorific value of fuel in the reported year, GJ/ ths m³ (GJ/t).

$$K_2 = (T_{in r} - T_{out r}) / (T_{in b} - T_{out b}); \quad (9)$$

where:

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

$$K_3 = [(F_{hr} - F_{htr} - F_{hnr}) * k_{hb} + (F_{hnr} + F_{htr}) * k_{hn}] / F_{hb} * k_{hb}; \quad (10)$$

where:

F_{hb} – heated area in the base year, m²;
 F_{hr} – heated area in the reported year, m²;
 F_{hnr} – heated area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m²;
 F_{htr} – heated area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m²;
 k_{hb} – average heat transfer factor of heated buildings in the base year, kW/m²*K;
 k_{hn} – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), kW/m²*K.

$$K_4 = N_{hr} / N_{hb}; \quad (11)$$

where:

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

$$K_5 = n_{wr} / n_{wb}; \quad (12)$$

where:

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

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

At the MEHSN “Kryvorizhteplomerzha”, statistics on the number of the hot water supply service customers is provided only for inhabitants and not for other consumers, thus adjustment factor K_5 for boiler-houses of this enterprise is calculated as the ratio of connected loads for the hot water supply service in the reported and in the base years, which correctly reflects the change in the number of the hot water supply service customers:

$$K_5^r = L_w^r / L_w^b \quad (12')$$

$$K_6 = v_{wr} / v_{wb}; \quad (13)$$

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).

$$K_7 = N_{wr} / N_{wb}; \quad (14)$$

where:

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

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

$$E_{cons}^b = P_b * CEF_c; \quad (15)$$

where:

P_b – electric power consumption by the boiler-houses and heat supply stations, MWh;

CEF_c – Carbon Emission factors for projects on reducing electricity consumption in Ukraine, tCO₂e/MWh;

$$E_{(i)}^r = E_{1(i)}^r + E_{cons(i)}^r; \quad (16)$$

where:

$E_{1(i)}^r$ – emissions due to fuel consumption for heating and hot water supply service for an (i) boiler-house in the reported year, t CO₂e;

$E_{cons(i)}^r$ – emissions due to electric power consumption from grid by the (i) boiler-house and heat supply stations related to the i boiler-house in the reported year, t CO₂e.

$$E_{1(i)}^r = NCV_r * Cef_r * B_{r(i)}, \quad (17)$$

where:

$NCV_{r(i)}$ – average annual net calorific value of (i) fuel, GJ/ ths m³ (GJ/t)

Cef_r – carbon emission factor of (i) fuel, tCO₂/GJ;

$B_{r(i)}$ – amount of fuel consumed by a boiler-house in the reported year, ths m³ (t).

$$E_{cons(i)}^r = P_r * CEF_c; \quad (18)$$

where:

P_r – electric power consumption by the boiler-houses and heat supply stations, MWh;

CEF_c – Carbon Emission factors for JI projects on reducing electricity consumption in Ukraine, tCO₂e/MWh;

[_b] index – related to the base year;

[_r] index – related to the reporting year.

The table of parameters included in the process of monitoring and verification for ERUs calculation is represented in the Section **B.2.1.** and **Annex 1.**

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A.6. Status of implementation including time table for major project parts:

The starting date of the project according to PDD is: 20.06.2002.

The starting date of the crediting period is set to the date when the first emission reduction units were 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, and is correspondingly December 31, 2030.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	1st Jan - 31st Dec	
Base year	Starting date of the project is: 20 June 2002										
	Boiler equipment rehabilitation (replacement and rehabilitation of boilers, burners, etc.)										
	Network rehabilitation (replacement and rehabilitation of pipes, heat supply stations, heat exchangers, etc.)										
	Installation of heat utilizers										
	Electricity saving measures (Installation of frequency controllers, replacement of pumps, etc.)										
	Construction of quarter gas boiler-houses										
									Installation of CHP		
							1 st Kyoto commitment period				
		1 st Monitoring Period				2 nd Monitoring Period					

Table 2. Status of implementation (according to PDD)

Implementation of boiler houses equipment rehabilitation and network rehabilitation are realized mainly according to project plan with some deviations from time-table.

Reconstruction of boiler-houses sometimes has insignificant deviations from the project particularly in changes of installed boilers capacity. It was dictated by changes in heat energy demand. In several cases replacement of different (from planned before) diameters of network pipes takes place.

Table of implemented energy saving measures is presented below.

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Implemented energy saving measures	Volume of performed works (number of boilers, etc.)		
	2004-2007	2008	Total
Replacement of boilers			
NIISTU-5	4	15	19
KSV-3/15 (VK-22)	2		2
VK-32	1		1
KVG-4	3		3
KVG-4.65	2		2
E-1/9 g	3		3
KOLVI 600	4		4
KOLVI 650	2	1	3
KOLVI 1300	0	2	2
Prextherm N 500	15		15
Prextherm RSV240	1		1
Prextherm RSW 300	2		2
Prextherm RSW 350	5		5
Prextherm RSW 500	4		4
Prextherm RSW 600	5		5
Prextherm RSW 720	13		13
RTQ900	5		5
RTQ1000	6		6
RTQ1250	3		3
VPM 192	14		14
KT MONO	6		6
Total	100	18	118
Reconstruction of boilers			
Replacement of boiler burners	88		88
Replacement of boiler convection part, screen pipes	106	59	165
Replacement of boiler linings	640	288	928
Chemical flushing of boilers	477	24	501
Cleaning of boilers	44	6	50
Total	1355	377	1732
Construction / reconstruction of chemical water treatment system (CWT)	12	3	15
Pumps replacement	2	14	16
Implementation of frequency controllers	7		7
Replacement of gas flow meters	0	8	8
Length of rehabilitated pipelines, m	84727.2	19 157.0	103884.2

Table 3. Implemented energy saving measures

For detailed information about implemented measures see Annexes 2, 6, 10.



Fig. 1. Reconstruction of boiler-house City Hospital # 6 (#519 in the project) with Kolvi boilers

A.7. Intended deviations or revisions to the registered PDD:

The PDD for this project Version 04 dated July 18, 2011 was determined by Bureau Veritas Certification Holding SAS (the Determination Report # UKRAINE-DET /0229/2011 dated 26.07.2011).

The National Environmental Investment Agency of Ukraine has issued the Letter of Approval for this project #569/23/7 dated 16.03.2011.

The Federal Office for the Environment (FOEN), Switzerland (Party of Buyer), has issued the Letter of Approval for this project No. J294-0485 dated 24.01.2011.

No deviations or revisions to the registered PDD are intended.

A.8. Intended deviations or revisions to the registered monitoring plan:

No deviations or revisions to the registered monitoring plan are intended.

A.9. Changes since last verification:

The 1st Monitoring Report was prepared for period January 1, 2003 - December 31, 2007 on April 5, 2011 (version 02).

The 2nd Monitoring Report was prepared for period January 1, 2008 - December 31, 2008 on April 5, 2011 (version 02).

The 3rd Monitoring Report was prepared for period January 1, 2009 - December 31, 2009 on April 5, 2011 (version 02).

The 4th Monitoring Report was prepared for period January 1, 2010 - December 31, 2010 on April 5, 2011 (version 02).

The above Monitoring Reports were prepared for the district heating enterprises RME “Dniproteploenergo” including 9 daughter enterprises: DE “Novomoskovskteploenergo”, DE “Petrykivkateploenergo”, DE “Vasylkivkateploenergo”, DE “Pokrovkateploenergo”, DE “Pyatyhatkyteploenergo”, DE “Verhnedniprovskeploenergo”, DE “Sofiivkateploenergo”, DE “Pereschepynoteploenergo”, DE “Soloneteploenergo”; and ME “Dniprodzerzhinskteploenergo”, NME “Nikopolteploenergo”, ME “Pavlogradteploenergo”, OCME “Ordzhonikidzeteploenergo”.

The 5th Monitoring Report was prepared for period January 1, 2004 - December 31, 2007 on August 26, 2011 (version 02).

This Monitoring Report was prepared for the district heating enterprises ME “Teploenergo” of Dnipropetrovsk City Council, CME “Dnipropetrovski miski teplovi merezhi” and MEHSN “Kryvorizhteploenergo”.

The further implementation of fuel and energy saving measures within this project has led to additional GHG emissions reduction.

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SECTION B. Key monitoring activities

The control and monitoring system comes mainly to fuel and electricity consumption measurements. Other parameters are defined by calculations or are taken from statistic data. Fuel consumption measurements are realized at the Gas distributing units of the boiler-houses. Gas registration is carrying out in volume units reduced to standard conditions by means of automatic correction for temperature and pressure. The typical Gas distribution unit is shown at the Fig. 2, typical Gas flow meter is shown at the Fig. 3.



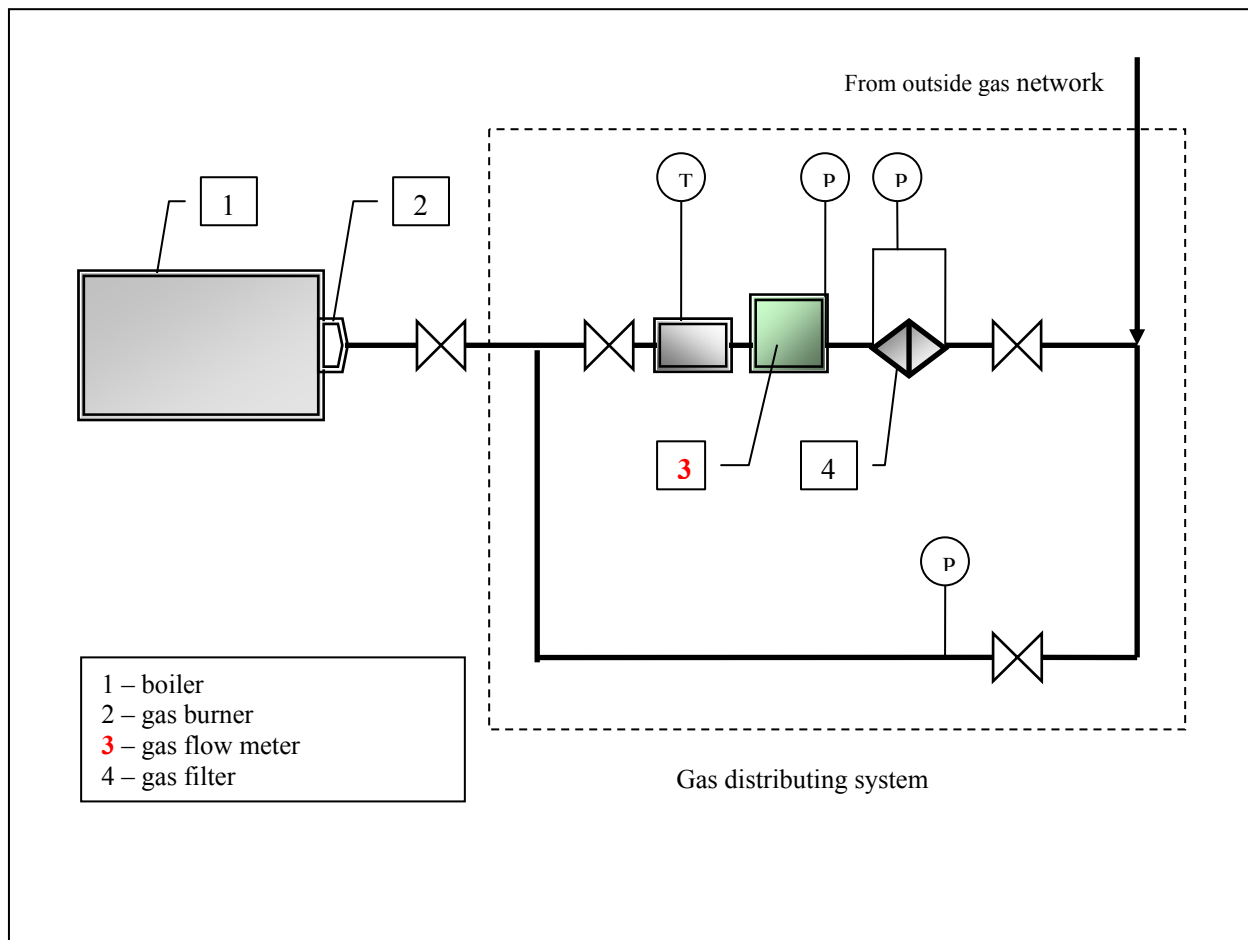
Fig. 2. Gas distribution unit



Fig. 3. Gas flow meter

The typical scheme of the Gas distributing system is shown at the Fig. 4. Usually it consists of the following equipment:

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



T –temperature of the natural gas;
 P - natural gas pressure at a boiler-house gas-input

Fig. 4. Typical scheme of the Gas distribution system

B.1. Monitoring equipment types:

The following Gas flow meters are used for gas consumption measurements:

Type of gas flow meter	Manufacturer	Інтервал повірки, років
Kurs -01 G-16	OJSC "Kurs", Kharkiv, Ukraine	2
Kurs -01 G-25	OJSC "Kurs", Kharkiv, Ukraine	2
Kurs -01 G-40	OJSC "Kurs", Kharkiv, Ukraine	2
Kurs -01 G65	OJSC "Kurs", Kharkiv, Ukraine	5
BKT G-10	“Premagas”, Lubny, Ukraine	5
G 10 BK	“Premagas”, Lubny, Ukraine	5
G-10 PJ	PA "Novator", Kharkiv, Ukraine	5
G-6	“Premagas”, Lubny, Ukraine	5
SM-RA-X-LG-40	"Promprylad", Ivano-Frankivsk, Ukraine	5

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ЛГ-80-160	"Promprylad", Ivano-Frankivsk, Ukraine	2
ЛГ-100-250	"Promprylad", Ivano-Frankivsk, Ukraine	2
ЛГ-150-400	"Promprylad", Ivano-Frankivsk, Ukraine	2
ЛГ-К-100-250	"Promprylad", Ivano-Frankivsk, Ukraine	2
ЛГ-К-200-100	"Promprylad", Ivano-Frankivsk, Ukraine	2
ЛГ-К-200-150	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-40	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-100	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-250	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-400	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-К-40	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-К-100	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-К-250	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-К-400	"Promprylad", Ivano-Frankivsk, Ukraine	2
ПГ-К-600	"Promprylad", Ivano-Frankivsk, Ukraine	2
G-16	"Promprylad", Ivano-Frankivsk, Ukraine	2
G-40	"Promprylad", Ivano-Frankivsk, Ukraine	2
G-65	"Promprylad", Ivano-Frankivsk, Ukraine	2
G-250	"Promprylad", Ivano-Frankivsk, Ukraine	2
G-400	"Promprylad", Ivano-Frankivsk, Ukraine	2
Delta 100	"Promprylad", Ivano-Frankivsk, Ukraine	2
Itabar-zond	"Isodorm" Ltd., Kyiv, Ukraine	-
Diafragm	MEHSN “Kryvorizhteplomerzha”, Kryvyi Rih, Ukraine	1

For more details See Annexes 4, 8, 12.

The following electricity meters are used for electricity consumption measurements:

Type of electricity meter	Manufacturer	Інтервал повірки, років
CP4Y-И672M	OJSC "LEMZ", Russia	4
CA4Y-И673M	OJSC "LEMZ", Russia	4
CA4Y-И678M	OJSC "LEMZ", Russia	4
CP4Y-И673	OJSC "LEMZ", Russia	4
CA4Y-И674	OJSC "LEMZ", Russia	4
CA4-И678	OJSC "LEMZ", Russia	4
CA3Y-И670M	OJSC "Merydian", Kharkiv, Ukraine	4
CA3Y-И670	OJSC "Merydian", Kharkiv, Ukraine	4
COE-5028MHB	OJSC "Prylad", Kharkiv, Ukraine	8
COE-5026	OJSC "Prylad", Kharkiv, Ukraine	8
COE-5028	OJSC "Prylad", Kharkiv, Ukraine	8
ЦЭ-6811	OJSC "Koncern Energomira", Russia	6

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ЦЭ6803B	OJSC "Koncern Energomira", Russia	6
LZQM.131.02	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
LZQM.321	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
LZQM.211.02	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
LZQV.411.02-534	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
Delta 8010-01	CJSC "Mitel", Dnipropetrovsk, Ukraine	6
Delta 8010-02	CJSC "Mitel", Dnipropetrovsk, Ukraine	6
Delta 8010-08	CJSC "Mitel", Dnipropetrovsk, Ukraine	6
Delta 8010-10	CJSC "Mitel", Dnipropetrovsk, Ukraine	6
CA4-195	OJSC "LEMZ", Russia	4
CA4-198	OJSC "LEMZ", Russia	4
CA4-199	OJSC "LEMZ", Russia	4
CA4Y-195	OJSC "LEMZ", Russia	4
CA4Y-196	OJSC "LEMZ", Russia	4
EMS-132.00.1	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT-132.02.6	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT-132.10.6	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT 132.12.6	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT 133.10	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT.-133.10.6	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMS 134.001	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
EMT-136-126	CJSC "ELGAMA-ELEKTRONIKA", Lithuania	6
CA4-5001	"Modul", Kharkiv, Ukraine	4
CT-ЭАО1	"Modul", Kharkiv, Ukraine	4
CT-ЭАО2	"Modul", Kharkiv, Ukraine	4
CT-ЭАО5	"Komunar", Kharkiv, Ukraine	4
CT-ЭАО8	"Komunar", Kharkiv, Ukraine	4
CTK3 10Q	"Telekart-Prylad", Odesa, Ukraine	6
CTK3 10Q244KH	"Telekart-Prylad", Odesa, Ukraine	6
CTK3-05Q2H4M	"Telekart-Prylad", Odesa, Ukraine	6
HIK 2301AΠ1	"NIK-ELEKTRONIKA" Ltd., Kyiv, Ukraine	16
HIK 2301AK1	"NIK-ELEKTRONIKA" Ltd., Kyiv, Ukraine	16
ЛЮ-3Т5-4М1	"Oblik", Dnipropetrovsk, Ukraine	6
A05RAL-P2B-3	"Elster-Metronika" Ltd., Russia	6

For more details See Annexes 5, 9, 13.

B.1.2. Calibration procedures:

According to the requirements of the State Standard of Ukraine № 2708:2006 “Metrology. Calibration of measuring equipment. The organization and procedure”⁵, all measuring equipment in Ukraine should meet the specified requirements and is to be inspected (calibrated) periodically.

According to the conservative approach, the volume of consumed natural gas amount of consumed electricity were corrected by measurement error. Amounts of consumed natural gas and electricity in the reported year that were used for Project emissions calculations were increased by the portion proportional to the level of accuracy of gas flow meter or electricity meter installed at a boiler-houses, correspondingly.

See Annexes 2-13.

B.1.3. Involvement of Third Parties:

Periodical calibration of the measurement equipment was made with involvement of the following Third Parties.

- PE “Atamanchuk” Dnipropetrovsk city;
- OJSC “Dniprooblenergo” Dnipropetrovsk city;
- JEV “Olefrenko S.V.” Dnipropetrovsk city;
- PJSC “Energy saving company “Dniprooblenergo” DPUEN” Dnipropetrovsk city;
- SE “Kryvbasstandartmetrologiya” Kryvyi Rih;
- "Yurfactoring-servis" Ltd., Kirovograd.

B.2. Data collection (accumulated data for the whole monitoring period):

Data used for monitoring of the emission reductions are presented in the table in Section B.2.1 (List of fixed default values, variables and attached values) and in Annexes 1-13 of this monitoring report.

The table in Section B.2.1 contains all default values, variables and attached values that have been used in calculating emission reductions in this monitoring report.

B.2.1. List of fixed default values, variables and attached values:

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	(B_b) and (B_r)	Fuel consumption by boiler houses		m
1.1		Natural Gas	ths m ³	m
1.2		Coal	ton	m
2	(P_b) та (P_r)	Electricity consumption	MWh	m
3	(NCV_b) and (NCV_r)	Average annual Calorific Value		m, c
3.1		Natural Gas	MJ/m ³	m, c
3.2		Coal	MJ/kg	m, c
4	(Cef_b) and (Cef_r)	Carbon emission factor		Normative document
4.1		Natural Gas	t CO ₂ /GJ	

⁵ <https://oscill.com/files/27082006.pdf>

4.2		Coal	t CO ₂ /GJ	
4.3		For JI projects on reducing electricity consumption in Ukraine	t CO ₂ e/MWh	
5	(T _{out b}) and (T _{out r})	Average outside temperature during the heating period	⁰ C (K)	m, c
6	(T _{in b}) and (T _{in r})	Average inside temperature during the heating period	⁰ C (K)	c
7	(n _{wb} and (n _{wr})	Number of Customers of hot water supply service		Statistics
8	(F _{hb} and (F _{hr})	Heated area (total)	m ²	Statistics
9	(k _{hb})	Average heat transfer factor of heated buildings in the base year	W/m ² *K	Normative document
10	(F _{htr})	Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year	m ²	Statistics
11	(F _{hnr})	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m ²	Statistics
12	(k _{hn})	Heat transfer factor of buildings with the new thermal insulation	W/m ² *K	Normative document
13	(N _{hb}) and (N _{hr})	Duration of the heating period	Hours	Statistics
14	(N _{wb}) and (N _{wr})	Duration of the hot water supply period	Hours	Statistics
15	(L _{hb} ^b) and (L _{hr} ^r)	Maximum connected load to the boiler-house, that is required for heating	MW	Statistics
15	(L _{wb} ^b) and (L _{wr} ^r)	Connected load to the boiler-house, that is required for hot water supply service	MW	Statistics
17	(v _{wb}) and (v _{wr})	Standard specific discharge of hot water per personal account	kWh/h	Statistics

Table 5. Monitoring parameters

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

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

In this Monitoring report the last assumption was used (See Annexes 2, 3, 6, 7, 10, 11).

B.2.2. Data concerning GHG emissions by sources according to the project activity:

See Annexes 1, 2, 3, 6, 7, 10 and 11 to this monitoring report.

B.2.3. Data concerning GHG emissions by sources according to the baseline:

See Annexes 1, 2, 3, 6, 7, 10 and 11 to this monitoring report.

B.2.4. Data concerning leakage:

There is no leakage effects associated with this project. Therefore monitoring of leakage is not required.

B.2.5. Data concerning environmental and social impacts:

Implementation of project “Rehabilitation of District Heating Systems in Dnipropetrovsk Region” at the district heating enterprises ME “Teploenergo” of Dnipropetrovsk City Council, CME “Dnipropetrovski miski teplovi merezhi” and MEHSN “Kryvorizhtepplomerezha” has a positive effect on environment. Following points give detailed information on environmental benefits:

1. Project implementation allowed saving over 163 million Nm³ of natural gas and 39 GWh of electricity during 2008.
2. Due to fuel and electricity consumption reduction and implementation of new environmentally friendlier technologies of fuel combustion, project activity has reduced emissions of SO_x, NO_x, CO and particulate matter (co-products of combustion).

There are no negative social impacts associated with the project.

B.3. Data processing and archiving (including software used):

Registration of Natural gas consumption at boiler houses is carried out by the following scheme:

1. All boiler-houses are equipped with gas flow meters.
2. Operator of a boiler-house registers 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, operator of a boiler house every 2 hours reads the values of temperature and pressure of the natural gas at the boiler-house gas-input. These parameters are used to bring gas consumption to standard 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.

Monthly they transfer the paper report to gas supplying company.

Collected data are to be submitted for verification, and are to be storied during two years after the end of the crediting period, according to the Order #14a dated 04.10.2010, on formation of the operational team and storage term of documents.

Scheme of data collection for Monitoring Report is shown at the Fig. 5.

B.4. Special event log:

No extraordinary events were registered during the reported period.

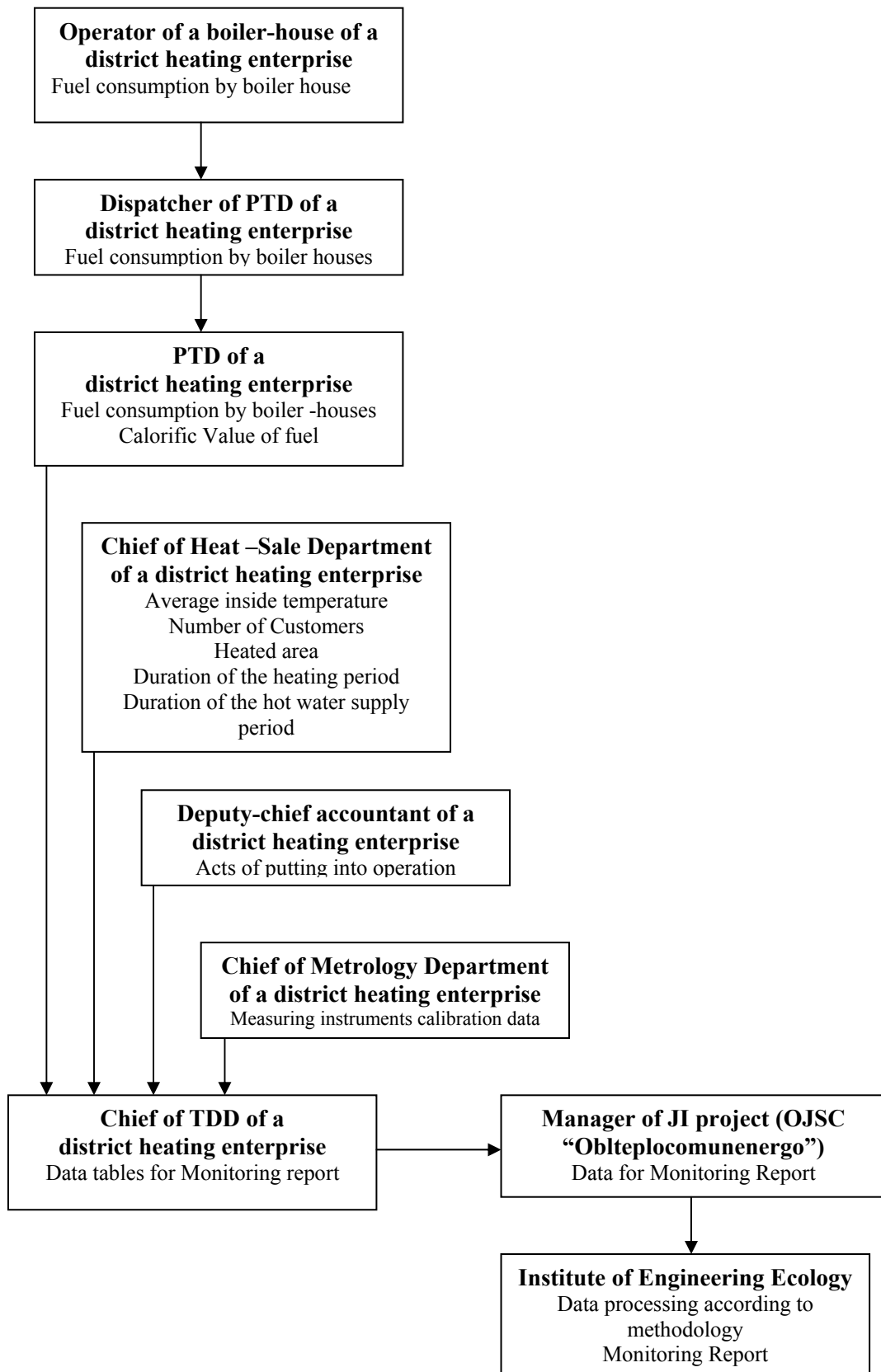


Fig.5. Scheme of data collection for Monitoring Report

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

The chairman of OJSC “Oblteplocmunenergo”, Mr. Yuriy Barbarov, appointed the responsible persons, Mr. Valeriy Derevianko and Ms. Olena Bardina, for the implementation and management of the monitoring process at the district heating enterprises that implement the project.

Ms. Olena Bardina, Head of the Legal security of economic activity Department of OJSC “Oblteplocmunenergo”, is responsible for supervising data collection.

Mr. Valeriy Derevianko, Director General of RME “Dniproteploenergo” is responsible for data recording and storage.

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

Dr. Nonna Pavlyuk, senior scientific researcher of the Institute of Engineering Ecology, is responsible for data processing.

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

C.1.2. 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 (from 2003), specialists of the Institute of Engineering Ecology carried out a comprehensive consultations and trainings for involved representatives of the OJSC “Oblteplocmunenergo” and other enterprises on the necessary data collection according to Monitoring plan for the project.

The special training was held before the development of the Monitoring report of period 2004-2007 in September, 2010.

The group consisted of representatives of district heating enterprises, that implement the project, and representatives of JSC “Oblteplocmunenergo” and Institute of Engineering Ecology, in particular:

Valeriy Derevianko - RME “Dniproteploenergo”, General director;

Ruslan Severin - RME “Dniproteploenergo”, Engineer;

Olena Bardina - OJSC “Oblteplocmunenergo”, Head of the Legal security of economic activity Department;

Kateryna Korinchuk - Institute of Engineering Ecology, Engineer;

Dmytro Paderno - Institute of Engineering Ecology, Deputy director.

The additional training was held 24.06.2011 for enlisted personnel of enterprises: ME “Teploenergo” DCC, CME “DTM” and MEHSN “Kryvorizhtplomerezh”.

The group consisted of representatives of above mentioned enterprises, that implement the project, and representatives of JSC “Oblteplocmunenergo” and Institute of Engineering Ecology, in particular:

Volodymyr Bilan – ME “Teploenergo” DCC, chief of PTD;

Evhen Puha - ME “Teploenergo” DCC, engineer;

Oleh Zheleznyakov - CME “DTM”, chief of PTD;

Viktoriya Reznichenko - CME “DTM”, chief of ESD;

Olha Babenko - CME “DTM”, engineer;
Valentyna Kuzmenko - MEHSN “Kryvorizhteplomerzha”, chief of PTD;
Tetyana Lazareva - MEHSN “Kryvorizhteplomerzha”, chief of EMD;
Olena Bardina - OJSC “Oblteplocmunenergo”, Head of the Legal security of economic activity Department;
Oleksiy Teterya - OJSC “Oblteplocmunenergo”, Deputy chairman;
Nonna Pavlyuk - Institute of Engineering Ecology, senior scientific researcher;
Kateryna Korinchuk - Institute of Engineering Ecology, Engineer;
Dmytro Paderno - Institute of Engineering Ecology, Deputy director.

The responsible staff of the Production-Technical Department of district heating enterprises are involved in this process.

C.2. Involvement of Third Parties:

According to the requirements of the State Standard of Ukraine № 2708:2006 “Metrology. Calibration of measuring equipment. The organization and procedure”, all measuring equipment in Ukraine should meet the specified requirements and is to be inspected (calibrated) periodically.

Periodical calibration of the measurement equipment was made with involvement of the following Third Parties.

PE “Atamanchuk” Dnipropetrovsk city;
OJSC “Dniprooblenergo” Dnipropetrovsk city;
JEV “Olefirenko S.V.” Dnipropetrovsk city;
PJSC “Energy saving company “Dniprooblenergo” DPUEN” Dnipropetrovsk city;
SE “Kryvbasstandartmetrologiya” Kryvyi Rih city;
"Yurfactoring-servis" Ltd., Kirovograd city.

C.3. Internal audits and control measures:

Manager of the JI project Mr. Valeriy Derevianko controls and checks up the adequacy of the data collection mechanism and the reliability of parameters of the Monitoring plan and other information on project implementation.

C.4. Troubleshooting procedures:

Any problem occurring that concerns this project is to be reported immediately to the project manager, who takes the appropriate measures.

SECTION D. Calculation of greenhouse gas emission reductions

D.1. Formulae used:

In this section the formulae used for computing project emissions, baseline emissions and the total emission reduction are documented.

Total emission reduction

Formula 1 – Total emission reduction	
	$ERUs = \sum [E_{(i)}^b - E_{(i)}^r]$
	ERUs - total annual emission reduction, t CO ₂ e E ^b _(i) – dynamic baseline emissions, t CO ₂ e E ^r _(i) – emissions in the reported year, t CO ₂ e
	The sum is taken over all boiler-houses (i) which are included into the project

Project emissions

Formula 2 –Emissions in the reported year (E^r)	
	$E_{(i)}^r = E_{1(i)}^r + E_{cons(i)}^r$
	E _{1(i)} ^r – emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, t CO ₂ e; E _{cons(i)} ^r – emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with the related heat supply stations in the reported year, t CO ₂ e.

Formula 3 –Emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, (E_{1(i)}^r)	
	$E_{1(i)}^r = NCV_r * Cef_r * B_{r(i)}$
	NCV _{r(i)} – average annual Net Calorific Value of a fuel, GJ/th _s m ³ (GJ/t); Cef – Carbon emission factor for a fuel, tCO ₂ /GJ; B _{r(i)} – amount of fuel consumed by a boiler-house in the reported year, th _s m ³ or tons

Formula 4 – Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the reported year (E_{cons(i)}^r)	
	$E_{cons(i)}^r = P_r * CEF_c$
	P _r – electricity consumption in the reported year by a boiler-house, MWh; CEF _c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, tCO ₂ e/MWh.

Baseline emissions

Formula 5 – Dynamic baseline emissions (E_b)	
	$E_{(i)}^b = E_{1(i)}^b + E_{\text{cons}(i)}^b$
	$E_{1(i)}^b$ – baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the base year in terms of a reported year, t CO ₂ e; $E_{\text{cons}(i)}^b$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year in terms of a reported year, t CO ₂ e.

Formula 6 – Baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the base year in terms of a reported year, ($E_{1(i)}^b$)	
	For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$): $E_1^b = \text{NCV}_b * \text{Cef}_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w]$, where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply service. For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population): $E_1^b = \text{NCV}_b * \text{Cef}_b * [B_b * a_b * K_1 * K_h + B_r * (1-a_r) * K_1 * K_{w0}]$.
	NCV_b – average Net Calorific Value of a fuel in the base year, GJ/th _s m ³ (GJ/t); Cef – Carbon emission factor for a fuel, tCO ₂ /GJ; B_b – amount of fuel consumed by a boiler-house in the base year, th _s m ³ or tons; $K_1, K_h = K_2 * K_3 * K_4; K_w = K_5 * K_6 * K_7$ – adjustment factors; a_b – portion of fuel (heat), consumed for heating purposes in the base year; $(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year; a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

Formula 7 – Portion of fuel (heat), consumed for heating purposes in the base year (a_b)	
	$a_b = L_h^b * g^b * N_h^b / (L_h^b * g^b * N_h^b + L_w^b * N_w^b)$;
	L_h^b – maximum connected load required for heating in the base year, MW; L_w^b – connected load required for hot water supply service in the base year, MW; g^b – recalculating factor for average load during heating period in the base year; N_h^b – duration of heating period in the base year, hours; N_w^b – duration of hot water supply service in the base year, hours.

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

Formula 9 – Recalculating factor for average load during heating period (g)	
	$g^{b,r} = (T_{in}^{b,r} - T_{out\ av}^{b,r}) / (T_{in}^{b,r} - T_{out\ min}^{b,r})$
	$T_{in}^{b,r}$ – average inside temperature for the heating period, °C; $T_{out\ av}^{b,r}$ – average outside temperature for the heating period, °C; $T_{out\ min}^{b,r}$ – minimal outside temperature for the heating period, °C.

Formula 10 – Net calorific value of a fuel change factor (K_1)	
	$K_1 = NCV_b / NCV_r$
	NCV_b – average Net Calorific Value in the base year, GJ/th $s\ m^3$ (GJ/t); NCV_r – average Net Calorific Value in the reported year, GJ/th $s\ m^3$ (GJ/t).

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

Formula 12 – Heated area and building thermal insulation change factor (K_3)	
	$K_3 = [(F_{hr} - F_{htr} - F_{hnr}) * k_{hb} + (F_{hnr} + F_{htr}) * k_{hn}] / F_{hb} * k_{hb}$
	F_{hb} – heated area in the base year, m 2 ; F_{hr} – heated area in the reported year, m 2 ; F_{hnr} – heated area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m 2 ; F_{htr} – heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in reported year, m 2 ; k_{hb} – average heat transfer factor of heated buildings in the base year, kW/m 2 *K; k_{hn} – average heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), kW/m 2 *K.

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

Formula 14 – Number of customers of the hot water supply service change factor (K_5)	
	$K_5 = n_{wr} / n_{wb}$ For the MEHSN “Kryvorizhtplomerezha”: $K_5 = L_w^r / L_w^b$
	N_{wb} – average number of customers of the hot water supply service in base year; N_{wr} – average number of customers of the hot water supply service in the reported year; L_w^b – connected load required for hot water supply service in the base year, MW; L_w^r – connected load required for hot water supply service in the reported year, MW.

Formula 15 – 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 16 – Hot water supply period duration change factor (K_7)	
	$K_7 = N_{wr} / N_{wb}$
	N_{wr} – duration of hot water supply service in the reported year, hours. N_{wb} – duration of hot water supply service in the base year, hours.

Formula 17 – Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with heat supply stations in the base year ($E_{cons(i)}^b$)	
	$E_{cons}^b = P_b * CEF_c$
	P_b – electricity consumption by a boiler-house with heat supply stations in the base year, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, t CO ₂ e/MWh

D.3. GHG emission reductions (referring to B.2 of this document):

D.3.1. Project emissions:

Project emissions consist of emissions due to fuel and electricity consumption for heating and hot water supply service in the reported year at:

- ME “Teploenergo” DCC
- CME “Dnipropetrovski miski teplovi merezhi”
- MEHSN “Kryvorizhtplomerezha”

Project emissions, tCO₂e	2008
ME “Teploenergo”	78411
CME “Dnipropetrovski miski teplovi merezhi”	457920
MEHSN “Kryvorizhtplomerezha”	399627
Total	935958

Table 6. Project emissions

See Annex 14.

D.3.2. Baseline emissions:

Baseline emissions consist of emissions due to fuel and electricity consumption for heating and hot water supply service according to the Dynamic baseline at:

- ME “Teploenergo” DCC
- CME “Dnipropetrovski miski teplovi merezhi”
- MEHSN “Kryvorizhtplomerezha”

Baseline emissions, tCO₂e	2008
ME “Teploenergo”	115731
CME “Dnipropetrovski miski teplovi merezhi”	545544
MEHSN “Kryvorizhtplomerezha”	504395
Total	1165670

Table 7. Baseline emissions

See Annex 14.

D.3.3. Leakage:

There is no leakage associated with the project.

D.3.4. Summary of the emissions reductions during the monitoring period:

Emission Reductions, tCO₂e	2008
ME “Teploenergo”	37320
CME “Dnipropetrovski miski teplovi merezhi”	87624
MEHSN “Kryvorizhteplomerzha”	104768
Total	229712

Table 8. Total Emission Reductions

See Annex 14.

According to the results of the Monitoring Report, the actual achieved GHG emission reductions differ from indicated as prognostic estimation in the PDD.

The main reason of the difference between the prognostic estimation of emission reductions in the PDD and the actual emission reductions in the Monitoring Report is application of the principally different approaches and algorithms for prognostic estimation of GHG emission reductions in the PDD and for calculation of the actually achieved GHG emission reductions in the Monitoring Report (both approaches are described in details in the PDD), in particular impossibility of taking into account in the PDD of the actual conditions in reported period (heating period duration, calorific value of fuels, outside temperature, number of customers, etc.).

It should be noted that in the PDD projected GHG emission reductions for the entire project, which includes 17 district heating enterprises of Dnipropetrovsk region, are given. As it is mentioned in Section D of the PDD and Section A.9 of this Monitoring Report, this Monitoring Report is prepared for only 3 enterprises. For comparison of the achieved actual GHG emission reductions with estimated reductions in the PDD, the actual overall GHG emission reductions (for all project partners) should be taken into account, i. e. with taking into account the GHG emission reductions according to the results of the monitoring report #UA1000254 / 02 Version 02 dated April 5, 2011.

	GHG emission reductions, t CO ₂ e	
	Prognosis estimation in the PDD	The results of the Monitoring Reports (## 02, 06)
2008	387089	283354

According to the results of the Monitoring Report, the actual achieved GHG emission reductions for 2008 are less than it was indicated as prognostic estimation in the PDD (see table above) due to decreasing of actual heat energy output comparison with planed in the PDD mainly as a result of changing of customers of heating service as well as changing of actual conditions (heating period duration, outside temperature, etc.).

Thus, the actually achieved GHG emission reductions, under compliance with all proper conditions of the heat supply services, practically always will be different from the prognostic estimations.

Annex 1 – Data

The data in this Annex are presented in accordance with Parameter 1-17 in the Monitoring plan.

Parameter Number	Parameter Name
1	Fuel consumption by boiler houses
1.1	Natural Gas
1.2	Coal
2	Electricity consumption
3	Average annual Heating Value
3.1	Natural Gas
3.2	Coal
4	Carbon emission factor
4.1	Natural Gas
4.2	Coal
4.3	For JI projects on reducing electricity consumption in Ukraine
5	Average outside temperature during the heating period
6	Average inside temperature during the heating period
7	Number of Customers of hot water supply service
8	Heated area (total)
9	Heat transfer factor of buildings
10	Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
11	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
12	Heat transfer factor of new buildings and buildings with new thermal insulation
13	Heating period duration
14	Duration of the hot water supply period
15	Maximum connected load to the boiler-house. that is required for heating
16	Connected load to the boiler-house. that is required for hot water supply service
17	Standard specific discharge of hot water per personal account

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Parameter number and name	1.1. Natural gas consumption a by boiler houses
Description	Natural gas consumption by boiler houses.
Value in monitoring period	The detailed data of natural gas consumption by boiler-houses are presented in Annexes 2, 6, 10.
Monitoring method	Measurement by 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.
Comment	According to the conservative approach, the volume of consumed natural gas was corrected by measurement error. Amount of natural gas consumed in the reported year that was used for Project emissions calculations was increased by the portion proportional to the level of accuracy of gas flow meter installed at a boiler-houses. See Annexes 2, 4, 6, 8, 10, 12.

Parameter number and name	1.2 Coal consumption by boiler houses
Description	Coal consumption by boiler houses
Value in monitoring period	0 t
Monitoring method	n.a.
Recording frequency	n.a.
Background data	n.a.
Calculation method	n.a.
Comment	Coal was not consumed

Parameter number and name	2. Electricity consumption
Description	Electricity consumption by the boiler-houses
Value in monitoring period	The detailed data of electricity consumption by every boiler-house are presented in Annexes 3, 7, 11.
Monitoring method	Measurement by electricity meters
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	n.a.
Comment	According to the conservative approach, the volume of consumed electricity was corrected by measurement error. Amount of electricity consumed in the reported year that was used for Project emissions calculations was increased by the portion proportional to the level of accuracy of electricity meter installed at a boiler-houses. See Annexes 3, 5, 7, 9, 11, 13.

Parameter number and name	3.1. Average Calorific Value of Natural Gas
Description	Average Calorific Value of Natural Gas calculated by Net calorific Value for every boiler-house
Value in monitoring period	See Annexes 2, 6, 10.
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	Once per year
Background data	Registered in the paper journal
Calculation method	Weighted average value
Comment	Data is provided by natural gas suppliers usually 3 times per month

Parameter number and name	3.2 Average Calorific Value of Coal
Description	Average Calorific Value of Coal calculated by Net calorific Value boiler-house
Value in monitoring period	n.a.
Monitoring method	n.a.
Recording frequency	n.a.
Background data	n.a.
Calculation method	n.a.
Comment	Coal was not consumed

Parameter number and name	4. Carbon emission factor
Description	Carbon emission factors
Value in monitoring period	Cef (natural gas) = 0.0561 tCO ₂ /GJ; Cef (coal) = 0.0946 tCO ₂ /GJ; (taken as “Other bituminous coal”). CEF _c = 1.219 tCO ₂ e/MWh
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	For all fuels, the data from the Table 1-2 of Volume 2, “Energy” of the IPCC 1996 Guidelines for National Greenhouse Gas Inventories ⁶ were used. The value of the carbon emission factor for JI projects reducing electricity consumption in Ukraine was taken according to the Order of the National Environmental Investment Agency of Ukraine # 62 dated 15.04.2011 ⁷ .
Calculation method	n.a.
Comment	n.a.

⁶ <http://www.ipcc-nggip.iges.or.jp/public/gl/pdffiles/rusch1-1.pdf>

⁷ <http://www.neia.gov.ua/nature/doccatalog/document?id=127171>

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Parameter number and name	5. Average outside temperature during the heating period
Description	Average outside temperature during the heating period
Value in monitoring period	See Annexes 2, 6, 10.
Monitoring method	Average outside temperature during the heating period 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 period.
Recording frequency	Once per heating period.
Background data	Monthly Reports of Meteorological Centre.
Calculation method	Average value
Comment	Average outside temperature is calculated once per heating period. Daily outside temperature is recorded every every day of heating period

Parameter number and name	6. Average inside temperature during the heating period
Description	Average inside temperature during the heating period is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 °C) is not satisfied) Above 18 °C – is treated as 18 °C (according to the conservative approach) and as meeting the normative level. Below 18 °C – is treated as not meeting the normative level, and is calculated as below.
Value in monitoring period	18 °C
Monitoring method	Sum of returned payments
Recording frequency	Once per heating period
Background data	Accounting documents
Calculation method	According to “Rules of rendering of heat and hot water supply service to population” № 1497 from 30.12.1997 ⁸ , 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 °C. Amount of the return payment is: – 5% from normative payment for every degree from 18 to 12 °C; – 10% from normative payment for every degree from 12 to 5 °C; – when inside temperature is lower than 5 °C the payment is to be returned completely. Therefore the inside temperature will be calculated by formulae: If $R = 0$ (according to conservative approach, $R < 0.05$ is assumed for the baseline): $T_{in b} = 18 \text{ }^{\circ}\text{C}$. If $0.05 < R \leq 0.3$: $T_{in b} = 18 - (R/0.05) \text{ }^{\circ}\text{C}$ If $0.3 < R < 1$: $T_{in b} = 12 - [(R - 0.3)/0.1] \text{ }^{\circ}\text{C}$ where: R - portion of returned payment of NP;

⁸ <http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1497-97-%EF>

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	NP – amount of normative payment. Thus if the inside temperature will be 18 °C or higher, we will accept it as 18 °C according to conservative approach; if it will be lower than 18 °C it will be calculated from return payments by the methodology presented before.
Comment	n.a.

Parameter number and name	7. Number of customers of hot water supply service
Description	Number of customers of hot water supply service for a boiler house
Value in monitoring period	See Annexes 2, 6, 10.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	The information is collected in special electronic journals “Registration of income from population” (for inhabitants). For organizations and legal entities such information is taken from contracts concluded with them
Calculation method	The data is taken for January, 01 of the year next to the reported year
Comment	Contracts with population, organizations and legal entities are concluded directly with district heating enterprises. They are updated once per year.

Parameter number and name	8. Heated area (Total)
Description	Heated area for boiler houses
Value in monitoring period	See Annexes 2, 6, 10.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	The information is collected at the sale departments of district heating enterprises by the certificates of owners in accordance with technical passports of buildings. Total area with balconies and stairs and heated area are displayed in the special journal
Calculation method	The data is taken for January, 01 of the year next to the reported year
Comment	The revise is made in case of making the new contracts with Customers or in case of contracts break.

Parameter number and name	9. Heat transfer factor of buildings
Description	Heat transfer factor of buildings
Value in monitoring period	0.63 W/m ² *K
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	SNiP 2-3-79 (1998) ⁹ , State Buildings Norms B.2.6-31:2006 ¹⁰
Calculation method	For calculation of Heat transfer factor of buildings for every

⁹ http://www.snip-info.ru/Snip_ii-3-79_%281998%29.htm

¹⁰ <http://dbn.at.ua/load/1-1-0-13>

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	boiler-house, the method of Weighted average value was used, that depends on heated area of existing buildings and heated area of the new buildings. Values of the heat transfer factor for existing buildings were taken from SNiP 2-3-79 (1998) - not higher than 0.63 W/m ² *K. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms (B.2.6-31:2006) - not higher than 0.36 W/m ² *K.
Comment	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any heated area to boiler-houses included in project.

Parameter number and name	10. Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heated area of reconstructed buildings with application of new insulations for walls
Value in monitoring period	There was no improving of buildings thermal insulation in the monitoring period.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	The information is collected at the sale departments of district heating enterprises by the certificates of owners in accordance with technical passports of buildings. Total area with balconies and stairs and heated area are displayed in the special journal
Calculation method	The data is taken for January, 01 of the year next to the reported year
Comment	The revise is made in case of making the new contracts with Customers or in case of contracts break.

Parameter number and name	11. Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heated area of newly connected buildings with application of the new insulation for walls
Value in monitoring period	There was no connecting of new buildings in the monitoring period.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	The information is collected at the sale departments of district heating enterprises by the certificates of owners in accordance with technical passports of buildings. Total area with balconies and stairs and heated area are displayed in the special journal
Calculation method	The data is taken for January, 01 of the year next to the reported year
Comment	The revise is made in case of making the new contracts with Customers or in case of contracts break.

Parameter number and name)	12. Heat transfer factor of new buildings and buildings with new thermal insulation
Description	Heat transfer factor of buildings with new thermal insulation
Value in monitoring period	0.36 W/m ² *K
Monitoring method	According to State Buildings Norms B.2.6-31:2006

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Recording frequency	Once per year
Background data	It is taken as the maximum one specified in State Buildings Norms B.2.6-31:2006 (not higher than 0.36 W/m ² *K) and is general for all country.
Calculation method	n.a.
Comment	It is recorded once per year and is subject to change upon ratification of any other value in normative documents.

Parameter number and name	13. Heating period duration
Description	Heating period duration for a boiler-house
Value in monitoring period	See Annexes 2, 6, 10.
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” ¹¹ . 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 °C or lower during 3 days, and finishes if average daily outside temperature is 8 °C or higher during 3 days.
Calculation method	n.a.
Comment	n.a.

Parameter number and name	14. Duration of the hot water supply period
Description	Duration of the period of hot water supply service for a boiler house.
Value in monitoring period	See Annexes 2, 6, 10.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Hot water supply service is realized by hot water delivery schedule for every boiler house in a town.
Calculation method	n.a.
Comment	n.a.

Parameter number and name	15. 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.
Value in monitoring period	See Annexes 2, 6, 10.
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

¹¹ <http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?page=6&nreg=z0197-07>

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	heating period. It is calculated according to heat demand at following outside temperatures [KTM 204 Ukraine 244-94 ¹² , Annex 1]: Dnipropetrovsk – (-23)°C Kryvyi Rih - (-23)°C
Calculation method	n.a.
Comment	n.a.

Parameter number and name	16. 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
Value in monitoring period	See Annexes 2, 6, 10.
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	n.a.
Comment	n.a.

Parameter number and name	17. Standard specific discharge of hot water per personal account
Description	Standard specific discharge of hot water per personal account
Value in monitoring period	See Table 2.10 of “KTM 204 Ukraine 244-94”
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	At present the standard specific discharge of hot water is valid in Ukraine that was established by the “KTM 204 Ukraine 244-94”, and no information is available on any propositions to change it.
Calculation method	n.a.
Comment	n.a.

¹² <http://www.twirpx.com/file/153194/>