JI PROJECT MONITORING REPORT
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"Rehabilitation of District Heating Systems in Dnipropetrovsk Region"

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ANNEXES

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:

National Environmental Investment Agency of Ukraine reference Number: 0145

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 (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.

The following activities will ensure fuel and electricity saving:

- Replacement of out-of-date low efficient boilers by new highly efficient boilers;
- Boiler equipment rehabilitation,
- Burners replacement;
- Installation of heat utilizers;
- Network rehabilitation, including decreasing of 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 supply stations (CHSS);
- Technical re-equipment of central heat supply stations with new heat exchangers;
- Installation of frequency controllers at electric drives of draught-blowing and pump equipment;
- Use of modern devices for gas account; for control systems of heat networks; for control, management and automation of the heat generating objects;
- Installation of combined heat and power production equipment.

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

	Baseline emissions, tCO_2e	Project emissions, tCO_2e	Emission Reduction, tCO_2e
2008	308610	254968	53642

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 04* [1], 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 $\varepsilon_{project,i,y}$ and $\varepsilon_{baseline,i}$ for equipment. In the chapter "Baseline emissions" there is an explanation that: Efficiencies for the project activity ($\varepsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations, Efficiencies for the baseline scenario ($\varepsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations.

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

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

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-

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

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

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

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. 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 (CO_2) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as registration of residents' complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.

·   Definition of the fuel consumption in base year (baseline) in view of the fact that in Ukraine at the majority of the municipal heat supply enterprises the natural gas is used as a fuel, which consumption is measured constantly by the counters with the high measurement accuracy, seems to be more exact, than definition of the fuel consumption with use of heat power, boiler efficiency and heat value of the fuel. This especially concerns the efficiency, which changes greatly depending on load of boilers, which also changes essentially, and often not automatically but manually, in the heat supply systems within a day and within a year. Averaging of such values

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[4] *http://cdm.unfccc.int/filestorage/EB52_repan06_AM0048_ver03.pdf?t=SHh8M0lHTFRBRkMxVlNZNEhRVU84V1 pETjA2NTdFTVhKfDEyODgxNzIzNDEuNjc=|35jXwvrTnpGqUjSvdxUE9eB3Q6w=*

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 used 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.

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

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, t CO_2e:

$$ERUs = \sum [E_i^b - E_i^r] \qquad (1)$$

where:
E_i^b and E_i^r - GHG 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.

$$E_i^b = E_{1i}^b + E_{cons\,i}^b, \qquad (2)$$
$$E_i^r = E_{1i}^r + E_{cons\,i}^r, \qquad (3)$$

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;
$E_{cons\,i}^b$ and $E_{cons\,i}^r$ – GHG emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year and in the reported year, respectively, t CO_2e.

For each (i) boiler-house:

$$E_1^b = NCV_b * Cef_b * B_b \qquad (4)$$

$$E_1^r = NCV_r * Cef_r * B_r \qquad (5)$$

$$E_{cons}^b = P_b * CEF_c \qquad (6)$$

$$E_{cons}^r = P_r * CEF_c \qquad (7)$$

where:

NCV – Net Calorific value of a fuel, MJ/m^3 (MJ/kg);
Cef – carbon emission factor for a fuel, $kt\ CO_2/TJ$;
B – amount of a fuel consumed by a boiler-house, ths m^3 or tonnes;
P – electricity consumption by a boiler-house and heat supply stations associated with it, MWh;
CEF_c – Carbon Emission factors for JI projects on 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:

$$E_{1i}{}^b = E_{hi}{}^b, + E_{wi}{}^b; \tag{8}$$

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

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

$$E_1{}^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w], \tag{9}$$

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), the formulae for $E_1{}^b$ is:

$$E_1{}^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}] \tag{10}$$
$$E_1{}^r = NCV_r* Cef_r*B_r \tag{11}$$

where:
NCV – Net Calorific value of a fuel, MJ/m^3 (MJ/kg);
Cef – carbon emission factor for a fuel, $kt\ CO_2/TJ$;
B – amount of a fuel consumed by a boiler-house, ths m^3 or tonnes per year;
K_1, K_h, K_w, K_{w0} – adjustment factors;
a – portion of fuel (heat), consumed for heating purposes;
(1-a) – portion of fuel (heat), consumed for hot water supply services;
$[_h]$ index – related to heating;
$[_w]$ index – related to hot water supply.

$$a_b = L_h{}^b*g*N_h{}^b/ (L_h{}^b*g*N_h{}^b+L_w{}^b*N_w{}^b); \tag{12}$$
$$a_r = L_h{}^r*g*N_h{}^r/ (L_h{}^r*g*N_h{}^r+L_w{}^r*N_w{}^r), \tag{13}$$

where:
L_h, L_w – maximum connected load to a boiler-house, that is required for heating and for hot water supply service, MW;
g – recalculating factor for average load during heating period (is to be 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 (Net calorific value of a fuel change factor):

$$K_1 = NCV_b / NCV_r \tag{14}$$

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.

Amount of fuel consumed for heating is proportional to the required amount of heat during heating period, Q_h:

$$B_h = B*a = Q_h / NCV*\eta, \tag{15}$$

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:

$$Q_{h\,br} = Q_{h\,b}*K_h = Q_{h\,r} \tag{16}$$

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.

This averaged adjustment factor may be determined from the equation:

$$K_h = Q_{h\,r} / Q_{h\,b.} \tag{17}$$

Required amount of heat for heating of buildings during a year, according to the "Norms and instructions on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic needs in Ukraine. KTM 204 Ukraine 244-94"[5], is determined by (ibid, equation 2.17):

$$Q_h = F_h*k_h*(T_{in} - T_{out})*N_h, \tag{18}$$

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

Then:
$$k_h = (F_{h\,r}*k_{h\,r})*(T_{in\,r} - T_{out\,r})*N_{h\,r} / F_{h\,b}*k_{h\,b}*(T_{in\,b} - T_{out\,b})*N_{h\,b} \tag{19}$$

2.1. K_2 (temperature change factor):

$$K_2 = (T_{in\,r} - T_{out\,r}) / (T_{in\,b} - T_{out\,b}). \tag{20}$$

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

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[5] *Norms and instructions of rate setting for fuel and heat energy discharge for heating of dwelling and civil buildings, as well as social needs in Ukraine. KTM 204 Ukraine 244-94. Kyiv, 2001, 376 p.*

$$K_3 = (F_{hr}*k_{hr}) / F_{hb}*k_{hb} = [(F_{hr} - F_{htr} - F_{hnr})*k_{hb} + (F_{hnr} + F_{htr})*k_{hn}] / F_{hb}*k_{hb}, \qquad (21)$$

where:

F_{hb} – heated area of buildings in the base year, m^2;

F_{hr} – heated area of buildings 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) 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):

$$K_4 = N_{hr} / N_{hb} \qquad (22)$$

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,

$$K_h = K_2 * K_3 * K_4 \qquad (23)$$

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

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

$$B_w = B*(1-a) = Q_w / NCV*\eta_w, \qquad (24)$$

where:

Q_w - required amount of heat for the period of hot water supply service rendering;

η_w - overall efficiency of the hot water supply system.

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

$$Q_{wbr} = Q_{wb}*K_w = Q_{wr} \qquad (25)$$

where:

Q_{wbr} – required amount of heat for hot water supply service for Dynamic Baseline, is assumed equal to Q_{wr};

Q_{wr} – required amount of heat for hot water supply service in the reported year,

Q_{wb} – required amount of heat for hot water supply service in the base year,

K_w – averaged adjustment factor for hot water supply service.

This averaged adjustment factor may be determined from the equation:

$$K_w = Q_{wr} / Q_{wb}. \qquad (26)$$

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

$$Q_w = n_w*v_w*N_w, \qquad (27)$$

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:
$$K_w = n_{wr}*v_{wr}*N_{wr} / n_{wb}*v_{wb}*N_{wb} \tag{28}$$

3.1. K_5 (number of customers change factor):

$$K_5 = n_{wr} / n_{wb} \tag{29}$$

where;
n_r – number of consumers in the base year;
n_b – number of consumers in the reported year.

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

$$K_6 = v_{wr} / v_{wb} \tag{30}$$

where:
v_{wr} – standard specific discharge of hot water for the personal account in the base year, hour;
v_{wb} – standard specific discharge of hot water for the personal account in the reported year, hour.

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, thus $K_6 = 1$ and does not require special monitoring.

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

$$K_7 = N_{wr} / N_{wb} \tag{31}$$

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

Thus,
$$K_w = K_5 * K_6 * K_7. \tag{32}$$

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

Since in case when there was no hot water supply service in the base year, number of customers, standard specific discharge of hot water per personal account and duration of hot water supply service 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 **B.2.1.** and **Annex 1.**

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 rehabilitation and network rehabilitation is realized according to the project plan.

In several cases replacement of network pipes with different (from planned before) diameters takes place.

The table of implemented energy saving measures is presented below.

Implemented energy saving measures	Volume of performed works (number of boilers, etc.)		
	2003-2007	**2008**	**Total**
Replacement of boilers			
NIISTU-5	40	3	**43**
TVG-8M	3	1	**4**
VK-21	5		**5**
DKVR 4-13	3		**3**
Fakel	6	2	**8**
KVV-3.15	2		**2**
Nika-05	6		**6**
E-1/9 g	1		**1**
AOGV-96k	3		**3**
AOGV-50k	2		**2**
KOLVI 250	2		**2**
KOLVI 350		3	**3**
KOLVI 440		2	**2**
KSVa-1		1	**1**
KSVa-0.63	3	4	**7**
KSVa-0.25	5		**5**
Logano GE515		3	**3**
Buderus		3	**3**
Total	**81**	**22**	**103**
Reconstruction of boilers			
Replacement of boiler burners	82	59	**141**
Replacement of boiler screen pipes	85	1	**86**
Replacement of boiler convection part pipes	48	2	**50**
Replacement of boiler linings	26	1	**27**
Chemical flushing of boilers	154		**154**
Total	**395**	**63**	**458**
Construction / reconstruction of chemical water treatment system (CWT)	17		**17**
Load switch	1		**1**
Construction of quarter boiler-house	1		**1**
Implementation of heat utilizers	7		**7**
Replacement of heat exchangers	4		**4**
Replacement of pumps	6		**6**
Replacement of gas flow meters	5	1	**6**
Implementation of automation	2		**2**
Other	5	6	**11**
Network replacement, m	**21692,3**	**7651,7**	**29344**

Table 3. Implemented energy saving measures

For detailed information about implemented measures see Annex 2.

Fig. 1. SNG burners

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

The PDD for this project Version 03 dated December 15, 2010 was determined by Bureau Veritas Certification Holding SAS (the Determination Report # UKRAINE-DET /0186/2010 dated 22.12.2010).

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.

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

A.10. Person(s) responsible for the preparation and submission of the monitoring report:

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SECTION B. Key monitoring activities

The control and monitoring system comes mainly to fuel and electicity 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 caring 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.
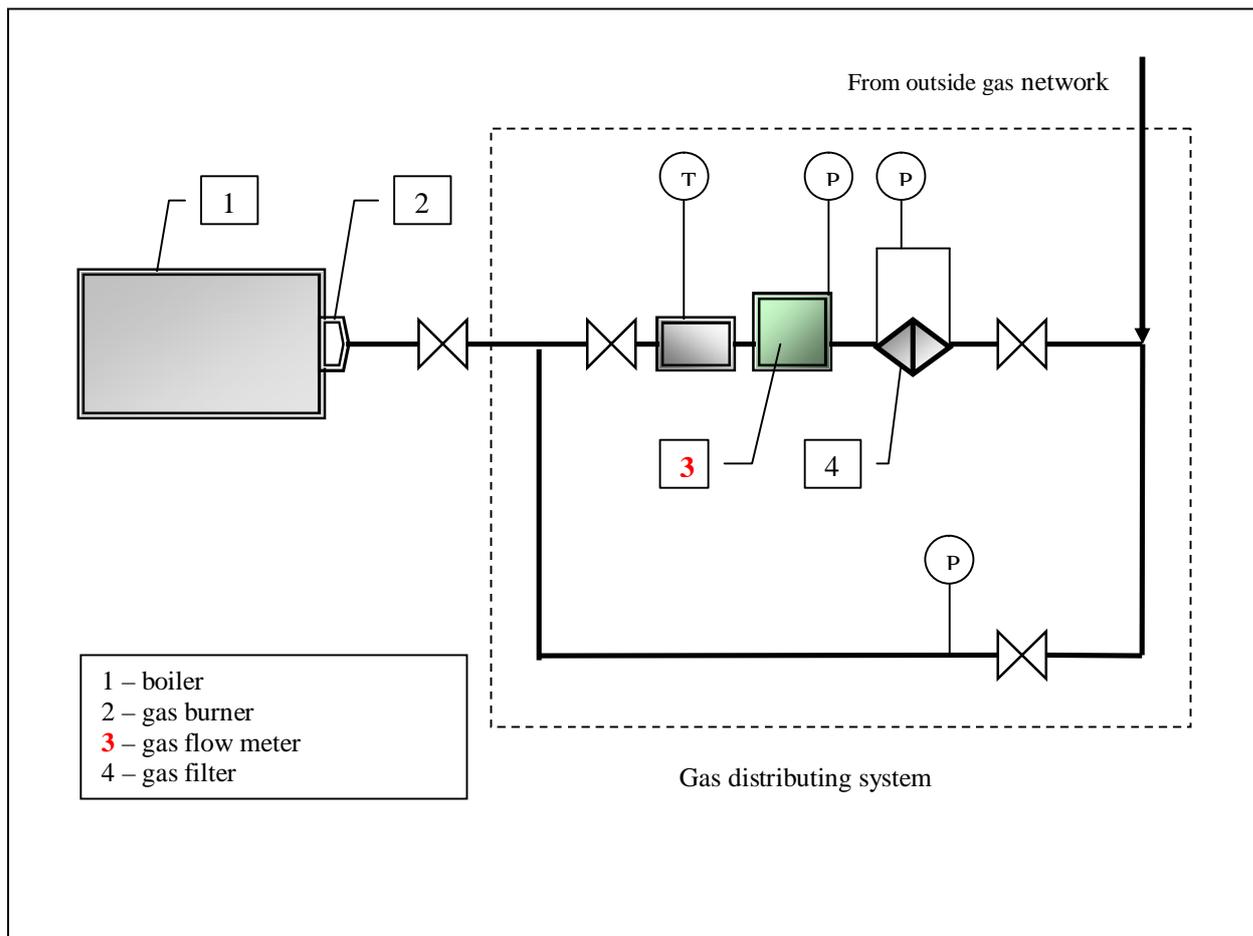
Fig. 4. Scheme of the Gas distribution system

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

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 a boiler-house gas-input. Natural gas consumption is measured by gas flow meters, installed at a boiler-house. Every day operator of a boiler house makes registration of daily gas consumption in the special paper journal.

B.1. Monitoring equipment types:

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

Type of Gas flow meter	Manufacturer
Курс-0,1 G25… G250	Dnipropetrovsk PKF "Kurs Ltd."
РГ-40 … РГ-600	Ivano-Frankivsk plant JSC "Promprylad"
РГ-К 40…1000	Ivano-Frankivsk plant JSC "Promprylad"
ЛГ-80-160, ЛГ-150-650	Ivano-Frankivsk plant JSC "Promprylad"
ЛГК-80 … ЛГК-200	Ivano-Frankivsk plant JSC "Promprylad"
G-40	Ivano-Frankivsk plant JSC "Promprylad"
СГ-80-100	Ivano-Frankivsk plant JSC "Promprylad"
GMS-G-65…GMS-G 100	Kyiv DE "Arsenal"
УНІВЕРСАЛ-01	Vinnytsya SPE "GREMPIS Ltd."
Ирвис К-300	Kharkiv "Irvis"
Д-10 METRIX 6-10	METRIX (Poland)
BK-G10T V6T	ELSTER (Slovakia, Old Tula city)
DELTA G – 40	Actaris, (France)

For more details See Annex 4.

The following electricity meters are used for electricity consumption measurements:

Type of electricity meter	Manufacturer
СА-4УИ 672, СА4У-И672М, СР4У-И673М	JSC "LEMZ" Russia
СА4-И678, СА4-И679, СА4-И680	JSC "LEMZ" Russia
СА4-195	SE "KhZE", Kharkiv city
СТК3 10А1Р, СТК3-02Q2Т3Р	"Teklekart Prylad" Ltd., Odessa city
ЕМТ 132.02.6, ЕМТ 133.10.6, ЕМТ-132.12.6	"ELGAMA-ELEKTRONIKA", Lithuania
НІК 2301АП3, НІК 2303 АПР3	"Nik", Kyiv city
СТ-ЭАО8, СТ-ЭА 05, СТ-ЭА01	"Komunar", Kharkiv city
ЛТЕ 1.03 "Мерідіан"	"Meridian", Kyiv city
Дельта 8010-05, Дельта 8010-06, Дельта 8010-08, Дельта 8010-02	"Mitel" Dnipropetrovsk
ЦЭ 6803 В	"Energomira", Russia,
ЛЕ 1101	"Dnista", Dnipropetrivsk city
EA05RAL-B-4	"Elster Metronika", Russia
Ф68700В	"Koncern Energomira", Russia
A1R-4-00-C22-T	"Mitronika", Russia
EPQS 122.21.17LL	"ELGAMA-ELEKTRONIKA", Lithuania
LZQM 321.02.534	"ELGAMA-ELEKTRONIKA", Lithuania
EMS132.10.1	"ELGAMA-ELEKTRONIKA", Lithuania

For more details See Annex 5.

B.1.1. Table providing information on the equipment used:

See Annexes 4 and 5.

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"[6], all measuring equipment in Ukraine should meet the specified requirements and is to be inspected (calibrated) periodically.

Type of Gas flow meter	Calibration interval
Курс-0,1 G25… G250	2 years
РГ-40 … РГ-600, РГ-К 40…1000	2 years
ЛГ-80-160, ЛГ-150-650, ЛГК-80 … ЛГК-200	2 years
G-40	2 years
СГ-80-100	5 years
GMS-G-65…GMS-G 100	2 years
УНІВЕРСАЛ-01	2 years
Ирвис К-300	2 years
Д-10 METRIX 6-10	2 years
BK-G10T V6T	2 years
DELTA G – 40	2 years
Type of electricity meter	
СА-4УИ 672, СА4У-И672М, СР4У-И673М, СА4-И678, СА4-И679, СА4-И680, СА4-195	4 years
СТКЗ 10А1Р, СТК3-02Q2Т3Р	6 years
ЕМТ 132.02.6, ЕМТ 133.10.6, ЕМТ-132.12.6	6 years
НІК 2301АП3	16 years
НІК 2303 АПР3	6 years
СТ-ЭАО8, СТ-ЭА 05, СТ-ЭА01	6 years
ЛТЕ 1.03 "Мерідіан"	12 years
Дельта 8010-05, Дельта 8010-06, Дельта 8010-08, Дельта 8010-02	16 years
ЦЭ 6803 В	6 years
ЛЕ 1101	16 years
EA05RAL-B-4	8 years
Ф68700В	6 years
A1R-4-00-C22-T	6 years
EPQS 122.21.17LL	8 years
LZQM 321.02.534	6 years
EMS132.10.1	6 years

Table 4. Calibration interval of meters

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 Annex 2, Annex 3, Annex 4 and Annex 5.

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

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;
DE "Dniprostandartmetrologiya";
OJSC "Dniprogas";
"Sicheslavagromontag Ltd." Dnipropetrovsk city;
Dnipropetrovsk PKF "Kurs Ltd.";
PSPE "Tehkompleks" Dnipropetrovsk city;
"Center of standardization, metrology and certification";
SPE Kharkiv Ltd.;
OJSC Oblenergo;
Center of standardization, metrology and certification, Dnipropetrovsk city;
"Nik" Kyiv.

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 Annex 1 (Data), Annex 2 (GHG emission reduction due to reducing of fuel consumption) and Annex 3 (GHG emission reduction due to reducing electricity consumption) of this 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	m^3	m
1.2		Coal	tonn	m
2	(NCV_b) and (NCV_r)	Average annual Calorific Value		m, c
2.1		Natural Gas	MJ/m^3	m, c
2.2		Coal	MJ/kg	m, c
3	$(T_{out\ b})$ and $(T_{out\ r})$	Average outside temperature during the heating period	^0C (K)	m, c
4	$(T_{in\ b})$ and $(T_{in\ r})$	Average inside temperature during the heating period	^0C (K)	c
5	$(n_{wb}$ and (n_{wr})	Number of Customers of hot water supply service		Statistics
6	$(F_{h\ b}$ and $(F_{h\ r})$	Heated area (total)	m^2	Statistics
7	(k_{hb})	Average heat transfer factor of heated buildings in the base year	W/m^2*K	Normative document

8	$(F_{h\,t\,r})$	Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year	m^2	Statistics
9	$(F_{h\,n\,r})$	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m^2	Statistics
10	$(k_{h\,n})$	Heat transfer factor of buildings with the new thermal insulation	$W/m^2{*}K$	Normative document
11	$(N_{h\,b})$ and $(N_{h\,r})$	Duration of the heating period	Hours	Statistics
12	$(N_{w\,b})$ and $(N_{w\,r})$	Duration of the hot water supply period	Hours	Statistics
13	(L_h^b) and (L_h^r)	Maximum connected load to the boiler-house, that is required for heating	MW	Statistics
14	(L_w^b) and (L_w^r)	Connected load to the boiler-house, that is required for hot water supply service	MW	Statistics
15	$(v_{w\,b})$ and $(v_{w\,r})$	Standard specific discharge of hot water per personal account	kWh/h	Statistics
16	(Cef_b) and (Cef_r)	Carbon emission factor		Normative document
16.1		Natural Gas	$t\,CO_2/GJ$	Normative document
16.2		Coal	$t\,CO_2/GJ$	Normative document
16.3		For JI projects on reducing electricity consumption in Ukraine	$t\,CO_2e/MWh$	Normative document
17	**g**	Recalculating factor for average load during heating period		c
18	(P_b) та (P_r)	Electricity consumption	MWh	m

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 Annex 2 and Annex 3).

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

See Annex 1, Annex 2 and Annex 3 to this monitoring report.

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

See Annex 1, Annex 2 and Annex 3 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" has a positive effect on environment. Following points give detailed information on environmental benefits:

1. Project implementation allowed saving over 41.71 million Nm^3 of natural gas, 708 tonnes of coal, 3.54 GWh of electricity during 2008 year.

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 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.

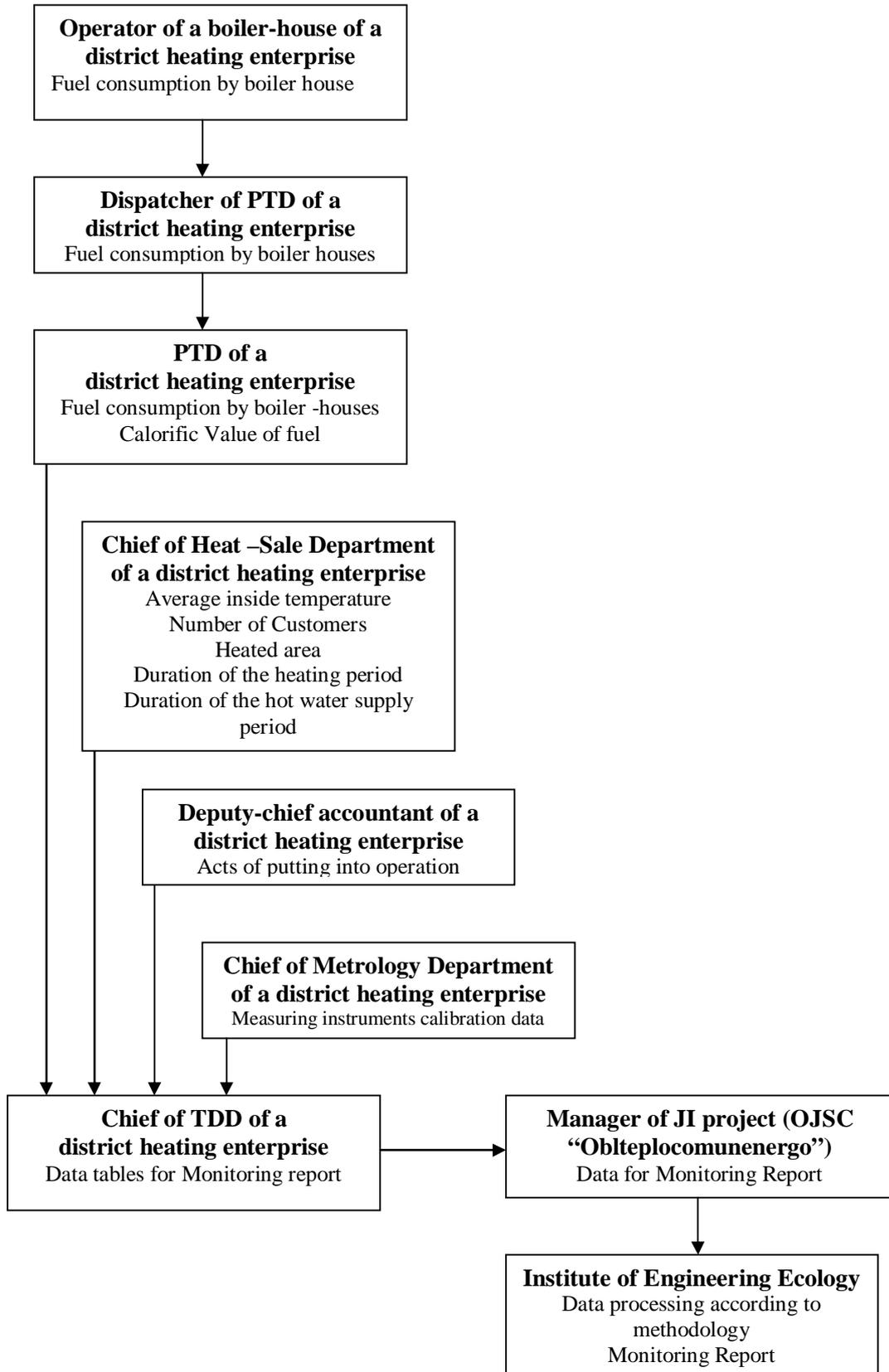Monthly they transfer the paper report to gas supplying company.

Collected data are to be submitted for verification, and are to be storaged 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:

n.a.

**Operator of a boiler-house of a
district heating enterprise**
Fuel consumption by boiler house

**Dispatcher of PTD of a
district heating enterprise**
Fuel consumption by boiler houses

**PTD of a
district heating enterprise**
Fuel consumption by boiler -houses
Calorific Value of fuel

**Chief of Heat –Sale Department
of a district heating enterprise**
Average inside temperature
Number of Customers
Heated area
Duration of the heating period
Duration of the hot water supply
period

**Deputy-chief accountant of a
district heating enterprise**
Acts of putting into operation

**Chief of Metrology Department
of a district heating enterprise**
Measuring instruments calibration data

**Chief of TDD of a
district heating enterprise**
Data tables for Monitoring report

**Manager of JI project (OJSC
"Oblteplocomunenergo")**
Data for Monitoring Report

Institute of Engineering Ecology
Data processing according to
methodology
Monitoring Report

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 "Oblteplocomunenergo", Mr. Yuriy Barbarov, appointed the responsible persons, Mr. Valeriy Derevianko and Ms. Elena Bardina, for the implementation and management of the monitoring process at the district heating enterprises that implement the project.
Ms. Elena Bardina, Head of the Legal security of economic activity Department of OJSC "Oblteplocomunenergo", is responsible for supervising data collection.
Mr. Valeriy Derevianko, Director General of RME "Dniproteploenergo" is responsible for data recording and storage.
Dr. Dmitri Paderno, Deputy director of Institute of Engineering Ecology, is responsible for baseline and monitoring project specific approach development.
Ms. Kateryna Korinchuk, engineer of 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 Institute of Engineering Ecology 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 was held before the development of the Monitoring report of period 2003-2007 in September, 2010.

The group consisted of representatives of district heating enterprises, that implement the project, and representatives of JSC "Oblteplocomunenergo" and Institute of Engineering Ecology, in particular:
Valeriy Derevianko - RME "Dniproteploenergo", General director;
Ruslan Severin - RME "Dniproteploenergo", Engineer;
Elena Bardina - OJSC "Oblteplocomunenergo", Head of the Legal security of economic activity Department;
Kateryna Korinchuk - Institute of Engineering Ecology, Engineer;
Dmitri Paderno - Institute of Engineering Ecology, Deputy director.

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

C.2. Involvement of Third Parties:

No third parties involved for quality assurance and quality control measures.

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

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

Formula 1 – Total emission reductions (ERUs)
$ERUs = \sum[E_i^b - E_i^r]$;   [t CO2e.]
ERUs - total annual emission reduction, t CO2e E_i^b - baseline emissions, t CO2e E_i^r - 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$_2$e]
E_{1i}^r – 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; $E_{cons\ i}^r$ – emissions due to electricity generation to the grid which is consumed by an i boiler-house and heat supply stations related to it in the reported year, t CO$_2$e.

Formula 3 – 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 of a fuel, MJ/m^3 (MJ/kg) Cef – carbon emission factor of a fuel, ktCO$_2$/TJ; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tonnes;

Formula 4 – Emissions due to electricity generation to the grid which is consumed by an i boiler-house and heat supply stations related to it in the reported year ($E_{cons\ i}^r$)
$E_{cons\ i}^r = P_r*CEF_c$
P_r – electricity consumption by a boiler-house and heat supply stations in the reported year, MWh; CEF_c – Carbon Emission factors for JI projects on reducing electricity consumption in Ukraine, tCO$_2$e/MWh;

Baseline emissions

Formula 5 – Baseline emissions (E_b)
$E_i^b = E_{1i}^b + E_{cons\ i}^b$; [t CO_2e]
E_{1i}^b – baseline emissions due to fuel consumption for heating and hot water supply service for an i boiler-house, t CO_2e; $E_{cons\ i}^b$ – emissions due to electricity generation to the grid which is consumed by an i boiler-house and heat supply stations related to it in the base year, t CO_2e.

Formula 6 – Baseline 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 (independently 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; 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; 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 – 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, MJ/m^3 (MJ/kg); NCV_r – average 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 – Heated area and building thermal insulation change factor (K_3)
$K_3 = [(F_{h\ r} - F_{h\ t\ r} - F_{h\ n\ r}) * k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r}) * k_{h\ n}] / F_{h\ b} * k_{h\ b}$,
$F_{h\ b}$ – heated area in the base year, m^2; $F_{h\ r}$ – heated area in the reported year, m^2; $F_{h\ n\ r}$ – heated area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2; $F_{h\ t\ r}$ – heated area of buildings (previously existed in the base year) 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_{wb} – standard specific discharge of hot water per personal account in the base year, (in heat units, kWh/h). v_{wr} – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h);

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

Formula 16 – Emissions due to electricity generation to the grid which is consumed by an i boiler-house and heat supply stations related to it in the base year ($E_{cons\,i}^{b}$)	
	$E_{cons}^{b} = P_b * CEF_c$
	P_b – electricity consumption by a boiler-house and heat supply stations related to it in the base year, MWh; CEF_c – Carbon Emission factors for JI projects on reducing electricity consumption in Ukraine, tCO_2e/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:

- RME "Dniproteploenergo"
- DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"
- ME «Pavlogradteploenergo»
- DE RME "Dniproteploenergo" "Pokrovkateploenergo"
- DE RME "Dniproteploenergo" "Sofiivkateploenergo"
- DE RME "Dniproteploenergo" -"Vasylkivkateploenergo"
- DE RME "Dniproteploenergo" "Pereschepynoteploenergo"
- DE RME "Dniproteploenergo" "Verhn'odniprovskteploenergo"
- Nikopol municipal enterprise "Nikopolteploenergo"
- DE RME "Dniproteploenergo" "Soloneteploenergo"
- DE RME "Dniproteploenergo" "Petrykivkateploenergo"
- OCME "Ordzhonikidzeteploenergo"
- DE RME "Dniproteploenergo" "Novomoskovskteploenergo"
- ME "Dniprodzerzhinskteplomerezha"

Project emissions, tCO$_2$e	2008
RME "Dniproteploenergo"	18278
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	1113
ME «Pavlogradteploenergo»	72789
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	2323
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	1127
DE RME "Dniproteploenergo" - "Vasylkivkateploenergo"	2577
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	1876
DE RME "Dniproteploenergo" "Verhn'odniprovskteploenergo"	4186
Nikopol municipal enterprise "Nikopolteploenergo"	40538
DE RME "Dniproteploenergo" "Soloneteploenergo"	571
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	1282
OCME "Ordzhonikidzeteploenergo"	23449
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	32544
ME "Dniprodzerzhinskteplomerezha"	52315
Total	**254968**

Table 6. Project emissions

See Annex 7.

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:
- RME "Dniproteploenergo"
- DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"
- ME «Pavlogradteploenergo»
- DE RME "Dniproteploenergo" "Pokrovkateploenergo"
- DE RME "Dniproteploenergo" "Sofiivkateploenergo"
- DE RME "Dniproteploenergo" -"Vasylkivkateploenergo"
- DE RME "Dniproteploenergo" "Pereschepynoteploenergo"
- DE RME "Dniproteploenergo" "Verhn'odniprovskteploenergo"
- Nikopol municipal enterprise "Nikopolteploenergo"
- DE RME "Dniproteploenergo" "Soloneteploenergo"
- DE RME "Dniproteploenergo" "Petrykivkateploenergo"
- OCME "Ordzhonikidzeteploenergo"
- DE RME "Dniproteploenergo" "Novomoskovskteploenergo"
- ME "Dniprodzerzhinskteplomerezha"

Baseline emissions, tCO$_2$e	2008
RME "Dniproteploenergo"	21216
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	1642
ME «Pavlogradteploenergo»	103233
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	3792
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	1706
DE RME "Dniproteploenergo" - "Vasylkivkateploenergo"	3673
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	2571
DE RME "Dniproteploenergo" "Verhn'odniprovskteploenergo"	5984
Nikopol municipal enterprise "Nikopolteploenergo"	47298
DE RME "Dniproteploenergo" "Soloneteploenergo"	1707
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	2208
OCME "Ordzhonikidzeteploenergo"	24372
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	34232
ME "Dniprodzerzhinskteplomerezha"	54976
Total	**308610**

Table 7. Baseline emissions

See Annex 7.

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, tCO$_2$e	2008
RME "Dniproteploenergo"	2938
DE RME "Dniproteploenergo" "Pyatyhatkyteploenergo"	529
ME «Pavlogradteploenergo»	30444
DE RME "Dniproteploenergo" "Pokrovkateploenergo"	1469
DE RME "Dniproteploenergo" "Sofiivkateploenergo"	579
DE RME "Dniproteploenergo" - "Vasylkivkateploenergo"	1096
DE RME "Dniproteploenergo" "Pereschepynoteploenergo"	695
DE RME "Dniproteploenergo" "Verhn'odniprovskteploenergo"	1798
Nikopol municipal enterprise "Nikopolteploenergo"	6760
DE RME "Dniproteploenergo" "Soloneteploenergo"	1136
DE RME "Dniproteploenergo" "Petrykivkateploenergo"	926
OCME "Ordzhonikidzeteploenergo"	923
DE RME "Dniproteploenergo" "Novomoskovskteploenergo"	1688
ME "Dniprodzerzhinskteplomerezha"	2661
Total	**53642**

Table 8. Total Emission Reductions

See Annex 7.

Annex 1 – Data

The data in this Annex are presented in accordance with Parameter 1-18 in the Monitoring plan.

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

Parameter number and name	**1.1.** Natural gas consumption a by boiler houses
Description	Natural gas consumption by boiler houses.
Value in monitoring period	2008 – 116921.86 ths. m^3 The detailed data of natural gas consumption by boiler-houses are presented in Annex 2.
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.
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 Annex 2 and Annex 4.

Parameter number and name	**1.2** Coal consumption by boiler houses
Description	Coal was consumed only by Petrivka town in 2002
Value in monitoring period	2008 – 0 t
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.
Comment	

Parameter number and name	**2.1.** Average Calorific Value of Natural Gas
Description	Average Calorific Value of Natural Gas calculated by Net calorific Value for every town
Value in monitoring period	See Annex 2.
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
Comment	

Parameter number and name	**2.2** Average Calorific Value of Coal
Description	There was no coal consumption in 2008.
Value in monitoring period	
Monitoring method	
Recording frequency	
Background data	
Calculation method	
Comment	

Parameter number and name	**3.** Average outside temperature during the heating period
Description	Average outside temperature during the heating period
Value in monitoring period	See Annex 2.
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. Daily temperature is registered every day of heating period
Background data	Monthly Reports of Meteorological Centre.
Calculation method	Average value
Comment	

Parameter number and name	**4.** Average inside temperature during the heating period
Description	Average inside temperature during the heating period is calculated from the sum of returned payments caused by insufficient heating (in case of normative level ($18\,^0C$) is not satisfied) Above $18\,^0C$ – is treated as $18\,^0C$ (according to the conservative approach) and as meeting the normative level. Below $18\,^0C$ – is treated as not meeting the normative level, and is calculated as below.
Value in monitoring period	See Annex 6
Monitoring method	Sum of returned payments
Recording frequency	Once per heating period
Background data	Account documents
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 $18\,^\circ C$. Amount of the return payment is: – 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. Therefore the inside temperature will be calculated by formulae: If R = 0 (according to conservative approach, R < 0.05 is assumed

	for the baseline): $T_{in\,b} = 18\ ^{o}C$. If $0.05 < R \leq 0.3$: $T_{in\,b} = 18 - (R/0,05)\ [^{o}C]$ If $0.3 < R < 1$: $T_{in\,b} = 12 - [(R - 0.3)/0,1]\ [^{o}C]$ where: R - portion of returned payment of NP; NP – amount of normative payment. Thus if the inside temperature will be $18\,^{o}C$ or higher, we will accept it as $18\,^{o}C$ according to conservative approach; if it will be lower than $18\,^{o}C$ it will be calculated from return payments by the methodology presented before.
Comment	

Parameter number and name	**5.** Number of Customers for hot water supply service
Description	Number of Customers for hot water supply service for a boiler house
Value in monitoring period	See Annex 2.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Contracts with population, organizations and legal entities are concluded 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	
Comment	

Parameter number and name	**6.** Heated area (Total)
Description	Heated area for boiler houses
Value in monitoring period	2008 – 6942.82 ths. m^{2} The detailed data are presented in Annex 2.
Monitoring method	Statistics of district heating enterprises
Recording frequency	The revise is made in case of making the 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 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 for every year
Comment	

Parameter number and name	**7.** Heat transfer factor of buildings
Description	Heat transfer factor of buildings
Value in monitoring period	See Annex 2.
Monitoring method	Statistics of district heating enterprises
Recording frequency	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any heated area to boiler-houses included in project.
Background data	
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 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/m2*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/m2*K.
Comment	

Parameter number and name	**8.** Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Value in monitoring period	There was no improving of buildings thermal insulation in the monitoring period.
Description	Heated 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	
Comment	

Parameter number and name	**9.** Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Value in monitoring period	There was no connecting of new buildings in the monitoring period.
Description	Heated 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	
Comment	

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
Value in monitoring period	0.36 W/m2*K
Monitoring method	According to State Buildings Norms (B.2.6-31:2006)
Recording frequency	It is recorded once per year and is subject to change upon ratification of any other value in normative documents.
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/m2*K)and is general for all country.
Calculation method	
Comment	

Parameter number and name	**11.** Heating period duration
Description	Heating period duration for a boiler-house
Value in monitoring period	See Annex 2.
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.
Calculation method	
Comment	

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for a boiler house.
Value in monitoring period	See Annex 2.
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	
Comment	

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.
Value in monitoring period	See Annex 2.
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 period. It is calculated according to heat demand at following outside temperatures [KTM 204 Ukraine 244-94, Annex 1]: Dnipropetrivsk – (-23) ^{o}C Pyatyhatky - (-24) ^{o}C Pavlograd - (-24) ^{o}C Pokrovka - (-23) ^{o}C Sofiivka - (-23) ^{o}C Vasylkivka - (-24) ^{o}C Pereschepyno - (-24) ^{o}C Verhnedniprovsk - (-22) ^{o}C Nikopol - (-23) ^{o}C Solone - (-23) ^{o}C Petrykivka - (-23) ^{o}C Ordzhonikidze - (-23) ^{o}C Novomoskovsk - (-23) ^{o}C Dniprodzerzhinsk - (-24) ^{o}C
Calculation method	
Comment	

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
Value in monitoring period	See Annex 2.
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	
Comment	

Parameter number and name	**15.** Standard specific discharge of hot water per personal account
Description	Standard specific discharge of hot water per personal account
Value in monitoring period	The standard specific discharge of hot water is valid in Ukraine was established by the "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	
Comment	

Parameter number and name	**16.** 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 = 0,896 tCO_2e/MWh
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. For calculations the values of the carbon emission factors for JI projects on reducing electricity consumption in Ukraine, 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", validated by TUV SUD Industrie Service GmbH 17.08.2007[7] was used.
Calculation method	
Comment	

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

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
Value in monitoring period	See Annex 2.
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	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min}) = (T_{in} - T_{out\ av}) / (T_{in} - T_{out\ min})$ where: g – recalculating factor for average load during heating period; F_h – heated 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, ^0C ; $T_{out\ av}$ – average outside temperature for the heating period, ^0C; $T_{out\ min}$ – minimal outside temperature for the heating period, ^0C.
Comment	

Parameter number and name	**18.** Electricity consumption
Description	Electricity consumption by the boiler-houses
Value in monitoring period	2008 – 35883.57MWh The detailed data of electricity consumption by every boiler-house are presented in Annex 3.
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	
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 Annex 3 and Annex 5.