

JI PROJECT MONITORING REPORT

Monitoring Report #04 “Rehabilitation of the District Heating Systems in Makiivka, Mariupol,
Artemivsk Cities of Donetsk Region”

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**“Rehabilitation of the District Heating Systems in Makiivka, Mariupol,
Artemivsk Cities of Donetsk Region”**

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SECTION A. General Project activity and monitoring information

A.1 Title of the project activity:

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

Sectoral scopes:

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

A.2. JI registration number:

State Environmental Investment Agency of Ukraine reference Number: 0139

A.3. Short description of the project:

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

Regional Municipal Enterprise (RME) “Donetskteplocomunenergo” is one of the main enterprises in field of production and distribution of the heat energy in Donetsk region. Municipal Enterprise (ME) “Makiivteplomerezha” is the main heat supply organization in Makiivka City. Municipal Commercial Enterprise (MCE) “Mariupolteplomerezha” is the main heat supply organization in Mariupol City. “Artemivsk-Energy”, Ltd. is one of the main heat supply organizations in Artemivsk City. They sell heat energy in forms of heat, hot water and steam, to local consumers, namely households, municipal consumers and state-owned organizations. Heat supply market in the region is stable for years.

The project «Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region» was initiated in 2006 to rehabilitate district heating systems in Cities of Donetsk Region, including boiler and distribution network equipment replacement and rehabilitation, and installation of cogeneration units as well as frequency controllers installation, heat exchangers and pumps replacement, transition from the existing central heat points (CHP) to individual heat points (IHP).

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

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

The common practice for the district heating enterprises in Ukraine including district heating enterprises that implement the project is to fulfil annual minimal repairing of the DH system to keep it working. Particularly it executes repairing of network’s parts and boilers that might cause accidents.

b) Baseline scenario:

For Baseline scenario, the economically feasible and realistic scenario with very slow rehabilitation activities was chosen. Tariffs for heat do not include the resources for prospective rehabilitation of the district heating system, only the resources for probable necessary repairing after possible accidents.

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Minimal annual repairing doesn't lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the same level. This scenario is not environmentally favorable for the near future (including first commitment period 2008-2012), since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is attractive.

c) Project scenario

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

The following activities will ensure fuel saving:

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

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

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

The PDD for this project Version 04 dated August 2, 2011 was determined by Bureau Veritas Certification Holding SAS (the Determination Report # UKRAINE-DET /0294/2011 dated 03.08.2011).

The State Environmental Investment Agency of Ukraine has issued the Letter of Approval for this project #2811/23/7 dated 28. 09.2011.

Letter of Approval from the Party of buyer - The Netherlands # 2011JI33 was issued on 14.09.2011.

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

Year	Baseline emissions, tCO ₂ e	Project emissions, tCO ₂ e	Emission Reduction, tCO ₂ e
2010	712173	607489	104684

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

A.4. Monitoring period:

- Monitoring period starting date: 01/01/2010
- Monitoring period closing date: 31/12/2010

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

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

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of direct monitoring devices for heat and heat-carrier expenditure in the municipal boiler-houses. Only such main characteristic as fuel consumption is registered on a regular basis. It makes practically impossible the application of AM0044 methodology, which basic moment is monitoring of the value $EG_{PI, i, y}$ – the thermal energy output of project boiler i in year y , that should be measured every month by flow-meters (the expenditure of heat-carrier) and thermal sensors (temperatures at the input and output of the boiler, etc.). This also concerns the definition of the average historical value of heat power generation per year $EG_{BL, his, i}$ (average historic thermal energy output from the baseline boiler “ i ”), etc.

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

Approved Consolidated Methodology ACM0009 “Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas” (version 03.2)³ proposes the dependences for baseline and reported year emissions quantity definition, that contain determination of Energy efficiency $\epsilon_{project, i, y}$ and $\epsilon_{baseline, i}$ for equipment. In the chapter “Baseline emissions” on the page 6 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.

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

² http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_LAAQZSBA770KNI0BUSG1JVIWCXIFU5

³ <http://cdm.unfccc.int/UserManagement/FileStorage/K4P3YG4TNO5ECFNA8MBK2QSMR6HTEM>

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

Approved Methodology AM0048 “New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels” (version 03)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 $SCPCSG_{i,y}$ (Total steam self-generated by project customer ‘i’ during year ‘y’ of the crediting period, TJ), measured by the steam meter at the customer ‘i’. Thus Methodology AM0048 couldn’t be implemented in original. In principle, it could be modified for conditions of hot water production for heating and hot water supply systems, but this will require modification of monitoring plan with introduction of other parameters that it is necessary to measure and register. But it would be the another methodology, that would require to measure such parameters as heat output, or hot water output with its temperature (in analogy with requirements of Methodology AM0048 to measure steam output, its pressure and temperature.

As it was already mentioned before, the majority of the heat supply enterprises and heat customers in Ukraine are not equipped with heat meters or devices for heat-carrier output (hot water for heating and hot water service) determination.

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

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

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

- It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95 % of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (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

⁴ <http://cdm.unfccc.int/methodologies/DB/Z4R6FBTQ5FMWU76ISIM5M5GJPN4F6Y>

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, this project specific approach, developed for “District Heating” projects in Ukrainian conditions and used in JI Projects “District Heating System Rehabilitation of Chernihiv Region”, “Rehabilitation of the District Heating System in Kharkiv City”, “Rehabilitation of the District Heating System in Donetsk Region”, “Rehabilitation of the District Heating System of Crimea”, “Rehabilitation of the District Heating System in Luhansk city”, etc. as well, is the most appropriate, precise, corresponding to the conservative approach, and in the most closely manner reflects the aims, goals and spirit of Kyoto Protocol.

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

A.5.2. Monitoring methodology:

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

For any project year, the baseline scenario may be different due to the influence of external factors such as weather conditions, possible changes of the Net Calorific Value of fuel(s), number of customers, heated 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:

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

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.

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

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;

$E_{gen\ i}^b$ – emissions due to electricity generation associated to the project for an (i) boiler-house in the base year (consumed from grid, amount to be substituted in the reported year), t CO₂e; $E_{gen\ i}^b = 0$, since no electricity generation associated to the project was provided in the base year;

$E_{cons\ (i)}^b$ –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:

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

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 E₁^b is:

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

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;

K₁, K_h = K₂ * K₃ * K₄; K_w = K₅ * K₆ * K₇ – 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.

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

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, 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) in reported year with the renewed (improved) thermal insulation, m^2 ;

k_{hb} – average heat transfer factor of heated buildings in the base year, $kW/m^2 \cdot K$;

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

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

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

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

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.

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

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, tCO_2e/MWh ;

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

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, $t CO_2e$;

$E_{gen(i)}^r$ – emissions due to electricity generation by the new cogeneration units (due to fuel consumption) at an (i) boiler-house in the reported year, $t CO_2e$;

$E_{cons(i)}^r$ – emissions due to electricity consumption from grid by the (i) boiler-house and heat supply stations related to the i boiler-house in the reported year, $t CO_2e$.

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

where:

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

Cef – 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).

$$E_{gen(i)}^r = B_{g(i)} * NCV_r * Cef; \quad (18)$$

where:

B_g – natural gas consumption by installed cogeneration units, ths m³/MW;

NCV_r – average annual Net Calorific Value in reported year, GJ/ths m³ (GJ/t)

Cef – carbon emission factor, tCO₂/GJ.

$$E_{cons(i)}^r = P_r * CEF_c; \quad (19)$$

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: 15/03/2006.

The starting date of the crediting period is set to the date where the first emission reduction units were generated from the project, that is October 1, 2006. The end of the crediting period is the end of the lifetime of the main equipment, that is minimal 20 years, and correspondingly December 31, 2032.

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
Starting date of the project is: 15 March 2006							
Base year							
Boiler-houses equipment rehabilitation							
Network rehabilitation							
					CHP units installation		
				Frequency controllers installation			
Replacement of heat exchangers							
Replacement of pumps							
					Installation of IHSS		
1 st Kyoto commitment period							
		1 st Monitoring Period	2 nd Monitoring Period	3 rd Monitoring Period	4 th 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.

In 2010 implementation of CHP units has been started. But no CHP unit has been putted into operation yet.

Table of implemented energy saving measures is presented below.

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Implemented energy saving measures	Volume of performed works (number of boilers, length of network replacement, etc.)		
	2006-2009	2010	Total
ME “Makiivteplomerezha”			
Boilers replacement			
Super Rac 2330	5		5
KSVa-2	3		3
KSVa-0,63	2		2
KSVa -1,0	3		3
Kolvi-300	2		2
BGV-50E	12		12
Rac 1060	3		3
Sunier duval	3		3
REX-200	2		2
REX-100	7		7
Modul Bernard 120	10		10
Super Rac 465	2		2
Super Rac 2100	2		2
Super Rac 2910	3		3
Super Rac 345	4		4
KVT - 1	4		4
Total	67	0	67
Rehabilitation of network, m	6700	1312	8012
Switching of boiler-houses’ load to the more effective including the newly built ones	7		7
MCE “Mariupolteplomerezha”			
Boilers replacement			
PTVM-30	2		2
PTVM-50	3		3
TVG-8M	5	4	9
E-1-09	1		1
KVG-6,5	4		4
VPR-500	1		1
NIISTU-5M	2		2
KVGM -50	1		1
Total	19	4	23
Replacement of boiler burners			
SNG-33	81		81
MDGG 150	2		2
Total	83		83
Rehabilitation of network, m	92273	31595	123868

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Replacement of pumps	6		6
Switching of boiler-houses’ load to the more effective ones	3		3
Replacement of heat exchangers	2	12	14
Reconstruction of boilers	6		6
Chemical flushing of boilers	9		9
Replacement of boiler convection part pipes	0	5	5
Frequency controllers installation	81	35	116
Implementation of heat utilizers	3	1	4
“Artemivsk-Energy”, Ltd.			
Boilers replacement			
KVG-0,63	6		6
KV-GM-1,0	4		4
KV-GM-1,6	3		3
Viessmann	2		2
Riello	2	2	4
Total	17	2	19
Rehabilitation of network, m	4692	1903	6595
Frequency controllers installation	5		5
Replacement of pumps	22		22
Setting up of boilers	0	18	18
Switching of boiler-houses’ load to the more effective ones	1		1

Table 3. Implemented energy saving measures

For detailed information about implemented measures see Annex 2.



Fig.1 LOOS boilers, installed at the boiler-house Uvileyna str.,117 Artemivsk city (#152 in the project)

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

No intended deviations or revisions to the registered PDD are intended.

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

According to the conditions described in the monitoring plan, section D.1.1 of the PDD, because of lack of veracious data in the base year, the calculations for the following boiler-houses were not made, emission reductions for them are assumed equal to 0.

# in the project	Adress of boiler-houses
Mariupol	
71	Gretska str., 206
77	Gromovoi str., 1
83	Artema str., 66
99	Nove zhittia str., 3
109	Oktiabraska str., 25

A.9. Changes since last verification:

The 1st Monitoring Report was prepared for period October 1, 2006 - December 31, 2007 on September 5, 2011 (version 02).

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

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

The further implementation of fuel and energy saving measures within this project has led 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 to fuel consumption measurement. Other parameters are defined by calculations or taken from statistic data. Fuel consumption measurement is realized at the gas distributing units of the boiler-houses. Gas registration is caring out in volume units relate 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.



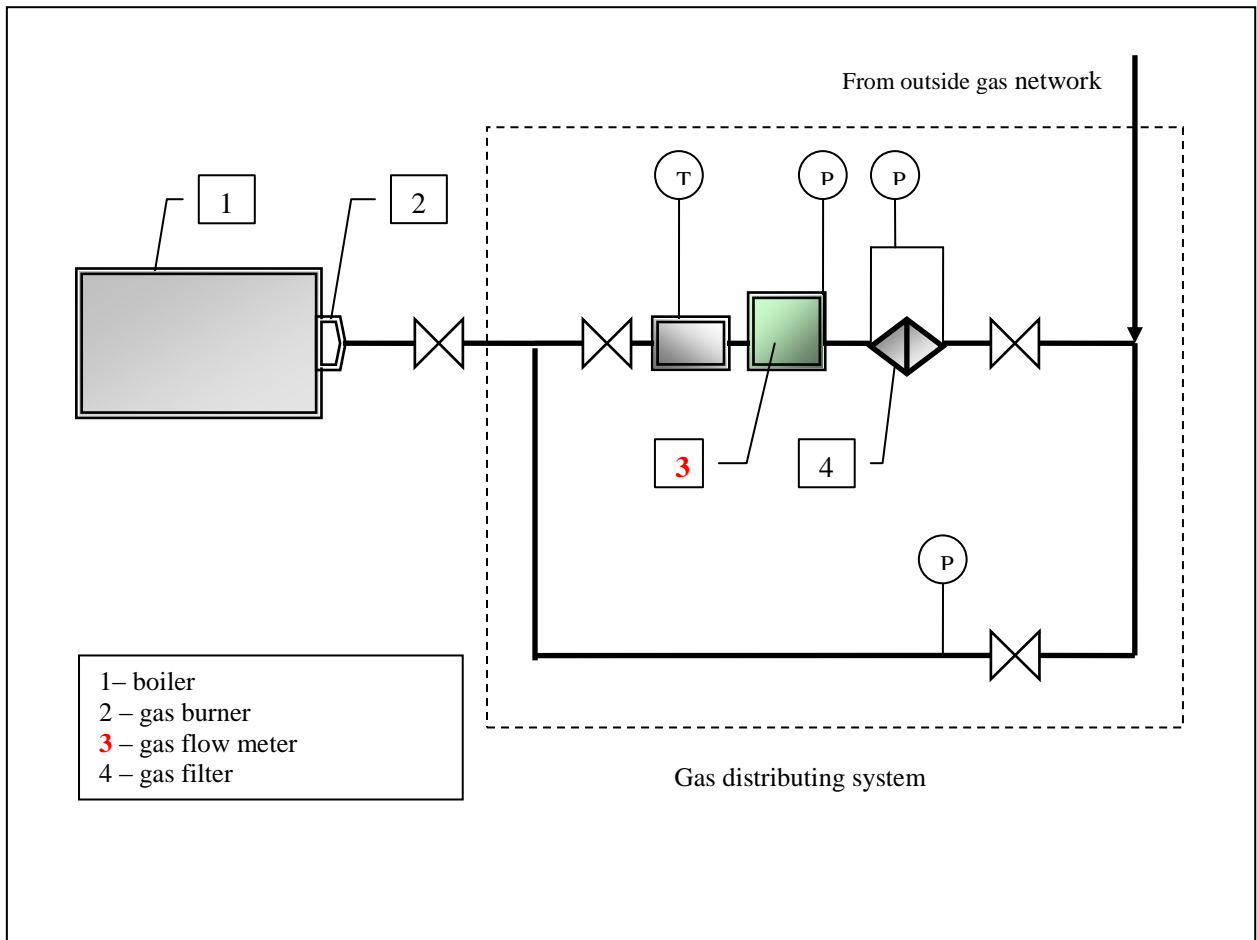
Fig. 2. Gas distribution unit



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. Scheme of the Gas distribution system

The typical scheme of monitoring system for boiler-house where the CHP unit is installed is shown at the Fig. 5. It consists of the following equipment:

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

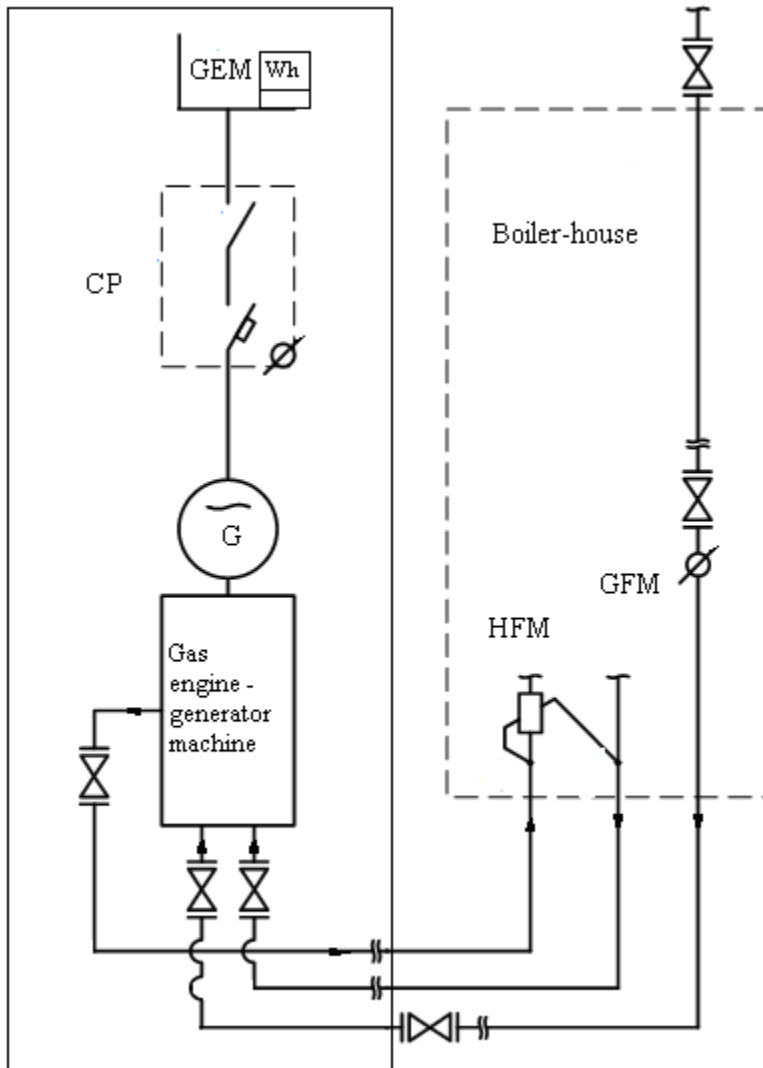


Fig. 5. Scheme of monitoring system for boiler-house where the CHP unit is installed

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B.1. Monitoring equipment types:

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

Type of gas flow meter	Manufacturer	Calibration interval (years)
G - 1600 -LGK – 200	OJSC "Pomprilad", Ivano-Frankivsk	2
G – 160- LGK - 80	OJSC "Pomprilad", Ivano-Frankivsk	2
G - 400 - LGK - 150	OJSC "Pomprilad", Ivano-Frankivsk	2
G - LGK - 80 – 650	OJSC "Pomprilad", Ivano-Frankivsk	2
G - RGK - 400 - 250	OJSC "Pomprilad", Ivano-Frankivsk	2
RGK -40 ... ПГK-1000	OJSC "Pomprilad", Ivano-Frankivsk	2
LGK -80 ... ЛГK-200	OJSC "Pomprilad", Ivano-Frankivsk	2
RGS-65-Ex	OJSC "Pomprilad", Ivano-Frankivsk	2
GMS- G16 ... G250	"Arsenal", Kiyv	2
Kurs G400 A2	PKF "KURS" Ltd., Dnipropetrovsk	2
Kurs -01 G16A1	PKF "KURS" Ltd., Dnipropetrovsk	2
SAMGAS VK-G10	"Samgaz" Ltd., Rivne	2
VRSG-1	"Irvis", Harkiv	2
AMG10	“Apator Metrix”, Poland	2
Diaphragm"Potik"	SPE "Measurement systems", Dnipropetrovsk	1

Table 4. Gas flow meters and their calibration

For electricity consumption measurement the following electricity meters are used:

Type of electricity meter	Manufacturer	Calibration interval (years)
NIK2303APK1	"Nik-elektronika" Ltd., Kiyv	6
NIK 2301, 2303	"Nik-elektronika" Ltd., Kiyv	6
Delta 8010-02	OJSC MITEL, Dnipropetrovsk	6
Delta 8010-08	OJSC MITEL, Dnipropetrovsk	6
Delta 8010-06	OJSC MITEL, Dnipropetrovsk	6
SA4Y - 196	"LEMZ" Ltd., Sankt-Peterburg	4
SA4Y - И672M	"LEMZ" Ltd., Sankt-Peterburg	4
SP4Y - И673M	"LEMZ" Ltd., Sankt-Peterburg	4
SA4 – И678	"LEMZ" Ltd., Sankt-Peterburg	4
Itron SL7000 Smart	DE "Aitron Ukraina", Kiyv	6
SL 761BO71	"Actaris", France	6
Mercuriy 230	"INKOTEKS" Ltd.,Moskva	8
EMS-135001... 134.10.1	OJSC "ELGAMA elektronika", Vilnus	6
LZQM	OJSC "ELGAMA elektronika", Vilnus	6
A1140 RAL	"Elster Metronik", Moskva	16
STK-3	OJSC "Elvin", Kiyv	6

Table 5. Electricity meters and their calibration

See Annex 4 and Annex 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”⁵, all measuring equipment in Ukraine should meet the specified requirements and is to be inspected (calibrated) periodically.

According to the conservative approach, the volumes of consumed natural gas and 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-house, correspondingly.

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

B.1.3. Involvement of Third Parties:

Measurement equipment calibration was carried out by:

SE “Donetskstandartmetrology”;
SE “Kharkivkstandartmetrology”;
«Apator Metrix», Poland;
PKF "KURS" Ltd.;
Artemivsk GPUА;
PJSC “Donetskoblenergo”;
PE Umantsev A.P.

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

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

Data used for monitoring 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), Annex 3 (GHG emission reduction due to reducing of 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 at boiler houses		m
1.1		Natural Gas	ths. m ³	
1.2		Coal	ton	
2	(NCV_b) and (NCV_r)	Average annual Net Calorific Value of fuels		m, c
2.1		Natural Gas	GJ/ths. m ³	
2.2		Coal	GJ/t	
3	($T_{out r}$) and ($T_{out b}$)	Average outside temperature during the heating period	⁰ C	m, c
4	($T_{in r}$) and ($T_{in b}$)	Average inside temperature during the heating period	⁰ C	m, c
5	(n_{wb} and (n_{wr})	Number of Customers of the hot water supply service		Statistics
6	(F_{hb} and (F_{hr})	Heated area (total)	m ²	Statistics
7	(k_{hb})	Average heat transfer factor of heated buildings in the base year	W/m ² *K	Statistics
8	(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
9	(F_{hnr})	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m ²	Statistics
10	(k_{hn})	Heat transfer factor of buildings with new thermal insulation	W/m ² *K	Statistics
11	(N_{hr}) and (N_{hb})	Heating period duration	hours	m
12	(N_{wr}) and (N_{wb})	Duration of period of hot water supply service	hours	m
13	(L_h^b) and (L_h^r)	Maximum connected load to a boiler- house, that is required for heating	MW	c

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14	(L_w^b) and (L_w^r)	Connected load to a boiler-house, that is required for hot water supply service	MW	c
15	(v_{wr}) and (v_{wb})	Standard specific discharge of hot water per personal account	kWh/h	Statistics
16	$(Cef_b, Cef_r, \text{ and } CEF_c)$	Carbon emission factor		c
16.1		Natural Gas	kt CO ₂ /TJ	
16.2		Coal	kt CO ₂ /TJ	
16.3		Reducing electricity consumption	t CO ₂ e/ MWh	
17	(P_b) and (P_r)	Electricity consumption	MWh	m
18	(B_g)	Fuel consumption by the cogeneration units	ths. m ³	m

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

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

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

See Annex 1, Annex 2 and Annex 3 of 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 the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region” has a positive effect on environment. Following points give detailed information on environmental benefits.

1. Project implementation allowed to save over 20 million Nm³ of natural gas, 1432.5 ton of coal and over 10214 MWh of electricity during 2010.
2. Due to fuel and electricity saving 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

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

Registration of Natural gas consumption at boiler houses of district heating enterprises that implement the project is carried out by the following scheme:

1. Natural gas consumption is measured by gas flow meter, installed at a boiler-house. All boiler-houses are equipped with gas flow meters.
2. The majority of boiler-houses are equipped with automatic correctors for temperature and pressure. Gas consumption is registered automatically. Every day operator of a boiler house makes registration of daily gas consumption in the special paper journal “Journal of registration of boiler-house’s operation parameters”, see Fig. 6.
3. At the boiler-houses that are not equipped with gas volume correctors, operator of a boiler house every 2 hours registers parameters of natural gas (temperature and pressure) in the paper journal “Journal of registration of boiler-house’s operation parameters”. These parameters are used to bring gas consumption to standard conditions.
4. Every day operators report values of gas consumption by phone to Production-Technical Department (PTD) of ME “Makiivteplomerezha”, MCE “Mariupolteplomerezha” and “Artemivsk-Energy”, Ltd., correspondingly, where they are storing and used for payments to gas suppliers.
5. Every month the account centers transfer data to gas suppliers.

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

The image shows a handwritten registration journal for boiler-house operation parameters. The table is organized into several main sections:

- Header Section:** Includes fields for 'Date, month, year', 'Boiler house name', 'Shift', 'Operator', and 'Temperature of natural gas'.
- Gas Flow Section:** Contains columns for 'Gas flow (m³/h)', 'Gas flow (m³/day)', and 'Gas flow (m³/month)'. It also includes a section for 'Gas flow through meter' with sub-columns for different meters.
- Temperature Section:** Contains columns for 'Temperature of natural gas (°C)', 'Temperature of water (°C)', and 'Temperature of steam (°C)'. It also includes a section for 'Temperature of boiler' with sub-columns for different parts of the boiler.
- Pressure Section:** Contains columns for 'Pressure (atm)', 'Pressure (MPa)', and 'Pressure (bar)'. It also includes a section for 'Pressure of boiler' with sub-columns for different parts of the boiler.
- Data Rows:** The table contains multiple rows of numerical data, with some cells containing handwritten notes or corrections.
- Summary Section:** At the bottom of the page, there are several lines of handwritten text in Russian, likely summarizing the data or providing additional information.

Fig. 6. Journal of registration of boiler-house’s operation parameters

Scheme of data collection for Monitoring Report is presented at the Fig. 7.

B.4. Special event log:

n.a.

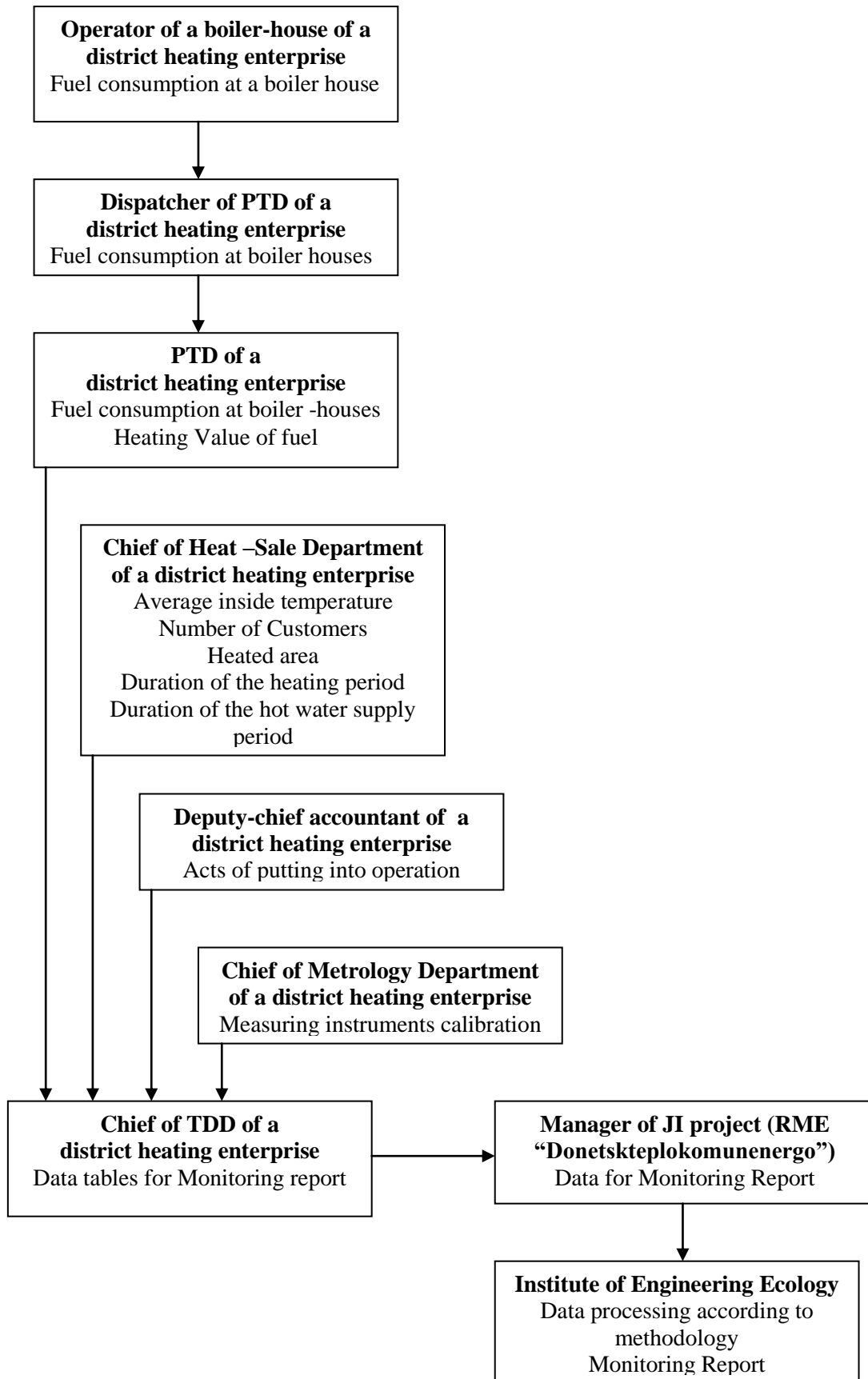


Fig. 7. Scheme of data collection for Monitoring Report

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

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

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

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

C.1.2. Trainings:

As far as the main activity of district heating enterprises that implement the project is not changed in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprises have sufficient knowledge and experience for implementation of the project activity and maintenance of the usual equipment.

In cases of the new (never used at this enterprise before, for example: cogeneration units, foreign produced boilers, etc.) equipment installation, the company - producer of this equipment should provide trainings for personnel.

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

In course of the JI project development (starting from 2006), specialists of Institute of Engineering Ecology carried out a comprehensive consultations and trainings for involved representatives of district heating enterprises on the necessary data collection according to Monitoring plan for the project.

The special training was held in June, 2010.

The special group was organized consisted of representatives of RME “Donetskteplokomunenergo”, ME “Makiivteplomerezha”, MCE “Mariupolteplomerezha”, “Artemivsk-Energy”, Ltd. and Institute of Engineering Ecology, in particular:

Vasyl Vorotyntsev - RME “Donetskteplokomunenergo”, the General Director;

Viktoriya Kucherenko - RME “Donetskteplokomunenergo”, Deputy General director on investments and strategic development;

Kateryna Pahomova - RME “Donetskteplokomunenergo”, the first category engineer of the Prospective development department;

Natalia Ryazantseva - ME “Makiivteplomerezha”, senior engineer of exploitation service;

Tetyana Shabanova - MCE “Mariupolteplomerezha”, head of the Production-Technical Department;

Lubov Kravtsova - “Artemivsk-Energy”, Ltd., head of the Production-Technical Department;

Dmytro Paderno - Institute of Engineering Ecology, Deputy director;

Kateryna Korinchuk - Institute of Engineering Ecology, engineer.

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:

SE “Donetskstandartmetrology”;
SE “Kharkivstandartmetrology”;
«Apator Metrix», Poland;
PKF "KURS" Ltd.;
Artemivsk GPUUA;
PJSC “Donetskoblenergo”;
PE Umantsev A.P.

C.3. Internal audits and control measures:

Manager of the JI project, Deputy General director on investments and strategic development Ms. Victoriya Kucherenko 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 reduction	
	$ERUs = \sum [E_{(i)}^b - E_{(i)}^r]$
	ERUs – total annual emission reduction, t CO ₂ e E _(i) ^b – dynamic baseline emissions, t CO ₂ e E _(i) ^r – 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)	
	$E_{(i)}^r = E_{1(i)}^r + E_{gen (i)}^r + E_{cons (i)}^r$
	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 _{gen (i)} ^r – emissions due to electricity generation by the new cogeneration units (due to fuel consumption) at an (i) boiler-house in the reported year, t CO ₂ e; E _{cons (i)} ^r – emissions due to electricity consumption from grid by the (i) boiler-house and heat supply stations related to the i boiler-house 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

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Formula 4 – Emissions due to electricity generation by the new cogeneration units (due to fuel consumption) at an (i) boiler-house in the reported year, ($E_{gen(i)}^r$)

	$E_{gen(i)}^r = B_{g(i)} * NCV_r * Cef$
	B_g – natural gas consumption by installed cogeneration units at an (i) boiler-house in the reported year, ths m ³ /MW; NCV_r – average annual Net Calorific Value in reported year, GJ/thm ³ (GJ/t) Cef – carbon emission factor, tCO ₂ /GJ.

Formula 5 – Emissions due to electricity consumption from grid by the (i) boiler-house and heat supply stations related to the (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 6 – Dynamic baseline emissions (E_b)

	$E_{(i)}^b = E_{1(i)}^b + E_{cons(i)}^b$
	$E_{1(i)}^b$ – 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; $E_{cons(i)}^b$ – 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 7 – Baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the base year in terms of a reported year, ($E_{1(i)}^b$)

	<p>For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$):</p> $E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w],$ <p>where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply service.</p> <p>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):</p> $E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_r * (1-a_r) * K_1 * K_{w0}].$
	<p>NCV_b – average Net Calorific Value of a fuel in the base year, GJ/thm³ (GJ/t); Cef_b – Carbon emission factor for a 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.</p>

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

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

Formula 10 – Recalculating factor for average load during heating period (g)	
	$g^{b,r} = (T_{in}^{b,r} - T_{out av}^{b,r}) / (T_{in}^{b,r} - T_{out min}^{b,r})$
	$T_{in}^{b,r}$ – 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 11 – Net calorific value of a fuel change factor (K_1)	
	$K_1 = NCV_b / NCV_r$
	NCV_b – average Net Calorific Value in the base year, GJ/th s m 3 (GJ/t); NCV_r – average Net Calorific Value in the reported year, GJ/th s m 3 (GJ/t).

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Formula 12 – Temperature change factor (K_2)	
	$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$
	$T_{in\ r}$ – average inside temperature for the heating period in the reported year, °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 13 – 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 14 – Heating period duration change factor (K_4)	
	$K_4 = N_{hr} / N_{hb}$
	N_{hb} – duration of heating period in the base year, hours N_{hr} – duration of heating period in the reported year, hours

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

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Formula 16 – 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 17 – Hot water supply period duration change factor (K_7)	
	$K_7 = N_{wr} / N_{wb}$
	N_{wr} – duration of hot water supply service in the reported year, hours. N_{wb} – duration of hot water supply service in the base year, hours.

Formula 18 – Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house with heat supply stations in the base year ($E_{cons(i)}^b$)	
	$E_{cons}^b = P_b * CEF_c$
	P_b – electricity consumption by a boiler-house with heat supply stations in the base year, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, t CO ₂ e/MWh

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

D.2.1. Project emissions:

Project emissions consist of:

1. Emissions due to fuel and electricity consumption for heating and hot water supply service at the ME “Makiivteplomerezha” in the reported year.
2. Emissions due to fuel and electricity consumption for heating and hot water supply service at the MCE “Mariupolteplomerezha” in the reported year.
3. Emissions due to fuel and electricity consumption for heating and hot water supply service at the “Artemivsk-Energy”, Ltd. in the reported year.

Project emissions, tCO ₂ e	2010
ME “Makiivteplomerezha”	155958
MCE “Mariupolteplomerezha”	394220
“Artemivsk-Energy”, Ltd	57311
Total	607489

Table 4: Project emissions

See Annex 6.

D.2.2. Baseline emissions:

Baseline emissions consist of:

1. Emissions due to fuel and electricity consumption for heating and hot water supply service at the ME “Makiivteplomerezha” in the base year, corrected according to the actual conditions in the reported year (the dynamic baseline).
2. Emissions due to fuel and electricity consumption for heating and hot water supply service at the MCE “Mariupolteplomerezha” in the base year, corrected according to the actual conditions in the reported year (the dynamic baseline).
3. Emissions due to fuel and electricity consumption for heating and hot water supply service at the “Artemivsk-Energy”, Ltd in the base year, corrected according to the actual conditions in the reported year (the dynamic baseline).

Baseline emissions, tCO ₂ e	2010
ME “Makiivteplomerezha”	191266
MCE “Mariupolteplomerezha”	441736
“Artemivsk-Energy”, Ltd	79171
Total	712173

Table 5: Baseline emissions

See Annex 6.

D.2.3. Leakage:

There is no leakage associated with the project.

D.2.4. Summary of the emissions reductions during the monitoring period:

Emission Reduction, tCO₂e	2010
ME “Makiivteplomerezha”	35308
MCE “Mariupolteplomerezha”	47516
“Artemivsk-Energy”, Ltd	21860
Total	104684

Table 6: Total Emission Reductions

See Annex 6.

D.3. Deviation of the actual emissions reductions from estimated in the registered PDD, if any:

According to the results of the Monitoring Report for the project “Rehabilitation of the District Heating Systems in Makiivka, Mariupol, Artemivsk Cities of Donetsk Region” for 2010, the actual achieved GHG emission reductions are less than it was indicated as prognosis estimation in the PDD for this monitoring period (110 078 t CO₂e).

The main reasons of the difference between the prognosis 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 prognosis 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, etc.

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

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Annex 1 – Data

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

Parameter Number	Parameter Name
1	Fuel consumption at boiler house
1.1	Natural Gas
1.2	Coal
2	Average annual Calorific Value of a fuels
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 the hot water supply service
6	Heated area (total)
7	Average heat transfer factor of heated buildings in the base year
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 buildings with new thermal insulation
11	Heating period duration
12	Duration of period of hot water supply service
13	Maximum connected load to a boiler-house, that is required for heating
14	Connected load to a 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	Reducing electricity consumption
17	Electricity consumption
18	Fuel consumption by the cogeneration units

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Parameter number and name	1.1 Natural gas consumption at boiler houses
Description	Natural gas consumption by boiler houses
Value in monitoring period	268277.66 ths. m ³ . The detailed data of natural gas consumption by every boiler-house 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. Natural gas consumption in the reported year that used for Project emissions calculations was increased proportionally to the level of accuracy of gas flow meters installed at the every boiler-house. See Annex 2 and Annex 4.

Parameter number and name	1.2 Coal consumption by boiler houses
Description	Coal consumption by boiler houses
Value in monitoring period	1804.45 t. The detailed data of coal consumption by every boiler-house are presented in Annex 2.
Monitoring method	Purchasing of coal is realized in accordance with invoices. Amount of coal is measured by wheelbarrows and pails, and then is converted to weight
Recording frequency	Every day
Background data	Coal consumption is registered in the paper journals at every boiler-house. Invoices are filed in special journals.
Calculation method	n.a.
Comment	n.a.

Parameter number and name	2.1 Annual Calorific Value of natural gas
Description	Average annual Calorific Value of natural gas calculated by Net Calorific Value
Value in monitoring period	The detailed data for every city are presented in 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	n.a.

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Parameter number and name	2.2 Annual Calorific Value of Coal
Description	Average annual Calorific Value of Coal calculated by Net Calorific Value
Value in monitoring period	The detailed data for every city are presented in Annex 2.
Monitoring method	Accepted in accordance with quality certificate from coal supplier's or independent chemical lab analysis report. Independent chemical lab analysis is used in contentious cases. It is used rarely
Recording frequency	Quality certificate is given by coal supplier's for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value
Comment	n.a.

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 Annex2
Monitoring method	Average outside temperature during the heating period is calculated by district heating enterprises that implement the project from the values of daily outside temperature taken by dispatchers of district heating enterprises from Donetsk Meteorological Centre at 10 to 11 a.m. every day of heating period.
Recording frequency	Average outside temperature is calculated once per year. Daily outside temperature is recorded every every day of heating period
Background data	Meteorological Centre every month sends the Report for every day of heating period. Reports are filed in special journals
Calculation method	Average value
Comment	n.a.

Parameter number and name	4. Average inside temperature during the heating period
Description	Average inside temperature in the heated buildings during the heating period.
Value in monitoring period	Makiivka - 18 °C; Mariupol - 18 °C; Artemivsk - 18 °C.
Monitoring method	Sum of returned payments
Recording frequency	Once per heating period
Background data	Accounting documents
Calculation method	According to item 24 of “Rules of rendering of heat and hot water supply service to population” № 1497 from 30.12.1997 ⁶ , enterprise makes the return payment of: – 5% from payment for every degree from 18 to 12 °C; – 10% from payment for every degree from 12 to 5 °C; – when inside temperature is lower than 5 °C, the payment is to

⁶ <http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1497-97-%EF>

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	<p>be returned completely.</p> <p>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 $0.3 < R < 1$: $T_{in b} = 12 - [(R - 0.3)/0.1] \text{ } [^{\circ}\text{C}]$</p> <p>where: R - portion of returned payment of NP; NP – amount of normative payment.</p> <p>Thus if the inside temperature will be $18 \text{ }^{\circ}\text{C}$ or higher we will accept it as $18 \text{ }^{\circ}\text{C}$ according to conservative approach, if it will be lower than $18 \text{ }^{\circ}\text{C}$ it will be calculated from return payments by the methodology presented before.</p> <p>The total sum of charge for population of Makiivka city was 89.03 mln UAH, the sum of returned payment was 2.80 mln UAH Percentage of returned payment is 3.15% that corresponds to inside temperature $18 \text{ }^{\circ}\text{C}$.</p> <p>The total sum of charge for population of Mariupol city was 350.14 mln UAH, the sum of returned payment was 1.18 mln UAH Percentage of returned payment is 0.34% that corresponds to inside temperature $18 \text{ }^{\circ}\text{C}$.</p> <p>The total sum of charge for population of Artemivsk city was 29.09 mln UAH, the sum of returned payment was 0.48 mln UAH Percentage of returned payment is 1.64% that corresponds to inside temperature $18 \text{ }^{\circ}\text{C}$.</p>
Comment	n.a.

Parameter number and name	5. Number of Customers of hot water supply service
Description	Number of Customers of hot water supply service for every boiler house
Value in monitoring period	218686. The detailed data are presented in Annex 2.
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Customers update the contracts for hot water supply service with balance-owners (ZhEK) once per year. ZhEKs give to district heating enterprises personal accounts of customers once per year. Contracts with organizations and legal entities are concludes directly with district heating enterprises .
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	n.a.
Comment	n.a.

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Parameter number and name	6. Heated area (Total)
Description	Heated area for every boiler house
Value in monitoring period	12220888.50 m ² The detailed data are presented in Annex 2.
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	The revise is made in case of new contracts with Customers or in case of contracts break.
Background data	The information is collected at the sales departments of district heating productive units of district heating enterprises in every city by the certificates of owners or balance-owners (ZhEK) in accordance with technical passport of building Total area with balconies and stairs and heated area are displayed in the special journal
Calculation method	The data is taken for January, 01 for every year
Comment	n.a.

Parameter number and name	7. Heat transfer factor of buildings
Description	Heat transfer factor of buildings for every boiler-house
Value in monitoring period	See Annex 2
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any heated area to boiler-houses included in project.
Background data	SNiP 2-3-79 (1998) ⁷ , State Buildings Norms B.2.6-31:2006 ⁸
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) (Table 1a) - not higher than 0.63 W/m ² *K. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms B.2.6-31:2006 (Table 1) - not higher than 0.36 W/m ² *K.
Comment	n.a.

⁷ http://www.snip-info.ru/Snip_ii-3-79_%281998%29.htm

⁸ <http://dbn.at.ua/load/1-1-0-13>

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Parameter number and name	8. Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heated area of reconstructed buildings with application of new thermal insulation
Value in monitoring period	There were no reconstructed buildings with application of new thermal insulation in the operation area of boiler-houses of district heating enterprises that implement the project
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year
Background data	Statistics of district heating enterprises
Calculation method	n.a.
Comment	n.a.

Parameter number and name	9. Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heated area of newly connected buildings with application of the new thermal insulation
Value in monitoring period	There were no new buildings connected to boiler-houses of district heating enterprises that implement the project
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year
Background data	Statistics of district heating enterprises
Calculation method	n.a.
Comment	n.a.

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	Not higher than $0.36 \text{ W/m}^2 \cdot \text{K}$
Monitoring method	According to State Buildings Norms B.2.6-31:2006, Table 1
Recording frequency	Once per year
Background data	State Buildings Norms B.2.6-31:2006 ⁸
Calculation method	n.a.
Comment	n.a.

Parameter number and name	11. Heating period duration
Description	Heating period duration for every boiler house
Value in monitoring period	The detailed data of Heating period duration are presented in Annex 2.
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year
Background data	The nominal duration (beginning and ending) of the heating

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	<p>period is defined for every town separately, in accordance with item 7.9.4 of “Rules of technical exploitation of heating equipment and networks. 2007”⁹. 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.</p> <p>The actual duration of the heating period is taken from statistics of district heating enterprises that implement the project.</p>
Calculation method	Sum of durations from the beginning of the calendar year till data of ending of the heating season, and from data of beginning of the new heating season till ending of this calendar year
Comment	n.a.

Parameter number and name	12. Duration of the hot water supply period
Description	Duration of the period of hot water supply service for every boiler house.
Value in monitoring period	The detailed data on Duration of the period of hot water supply service are presented in Annex 2
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year
Background data	Hot water supply service is realized by hot water delivery schedule for every boiler house.
Calculation method	Total duration of the hot water supply time per the calendar year
Comment	In Mariupol city hot water supply service is realized by boiler houses, where load required for hot water supply service is foreseen, 24 hours per day for children's communities and hospitals and 17 hours per day for other costumers during all year or just during heating period duration. Plan of disconnection of hot water supply service and preventing works is available.

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	The detailed data of maximum connected load to the boiler-house, that is required for heating for every boiler-house, are presented in Annex 2
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year .
Background data	Maximum connected load to a boiler-house, that is required for heating, is calculated by District heating enterprises for every heating period. It is calculated according to heat demand at

⁹ <http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?page=6&nreg=z0197-07>

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	nominal minimum outside temperatures [KTM 204 Ukraine 244-94 ¹⁰ , Annex 1]: Makiivka city – (-26) °C Mariupol city - (-23) °C Artemivsk city - (-25) °C.
Calculation method	n.a.
Comment	n.a.

Parameter number and name	14. Connected load to a boiler-house, that is required for hot water supply service
Description	Connected load to a boiler-house, that is required for providing the hot water supply service
Value in monitoring period	The detailed data of connected load that is required for hot water supply service for every boiler-house are presented in Annex 2
Monitoring method	Statistics of district heating enterprises that implement the project
Recording frequency	Once per year
Background data	Connected load to a boiler-house, that is required for hot water supply service, is calculated by district heating enterprises that implement the project every year according to contracts with consumers.
Calculation method	n.a.
Comment	In Makiivka city hot water supply service is not available. In Mariupol and Artemivsk cities hot water supply service is realized by boiler houses, where load required for hot water supply service is foreseen.

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	Standard specific discharges of hot water per personal account for different types of consumers are presented in Table 2.10 of “KTM 204 Ukraine 244-94” ¹⁰ .
Monitoring method	Regulatory 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” ¹⁰ , and no information is available on any propositions to change it. Thus it is not subject to special monitoring
Calculation method	n.a.
Comment	n.a.

¹⁰ <http://www.twirpx.com/file/153194/>

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Parameter number and name	16. Carbon emission factor
Description	Carbon emission factor for different fuels and for JI projects on reducing electricity consumption in Ukraine
Value in monitoring period	Cef (natural gas) = 0.0561 tCO ₂ /GJ; Cef (coal) = 0.0946 tCO ₂ /GJ (taken as “Other bituminous coal”); CEFc = 1.225 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 IPCC 1996 Guidelines for National Greenhouse Gas Inventories ¹¹ were used. The values of the carbon emission factors for JI projects on reducing electricity consumption in Ukraine was taken according to the Order of the National Environmental Investment Agency of Ukraine # 43 dated 28.03.2011 ¹² .
Calculation method	n.a.
Comment	n.a.

Parameter number and name	17. Electricity consumption
Description	Electricity consumption by boiler-houses
Value in monitoring period	74339.14 MWh. The detailed data on electricity consumption by every boiler-house are presented in Annex 3.
Monitoring method	Electricity meter
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. Electricity consumption in the reported year that used for Project emissions calculations was increased proportionally to the level of accuracy of electricity meters installed at the every boiler-house. See Annex 3 and Annex 5.

¹¹ <http://www.ipcc-nggip.iges.or.jp/public/gl/invs5a.html>

¹² <http://www.neia.gov.ua/nature/doccatalog/document?id=126006>.

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Parameter number and name	18. Fuel consumption by the cogeneration units
Description	Fuel (natural gas) consumption by the new cogeneration units
Value in monitoring period	0 ths. m ³ .
Monitoring method	Gas flow meters
Recording frequency	Every day
Background data	Instrument readings are registered in the paper journals at boiler-house.
Calculation method	n.a.
Comment	Cogeneration units have not been installed in 2010.