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"Rehabilitation of the District Heating System in Luhansk City"

CONTENTS

SECTION A. General Project activity and monitoring information

A.1 Title of the project activity:

"Rehabilitation of the District Heating System in Luhansk City"

A.2. JI registration number:

National Environmental Investments Agency registration number #365/23/7 from 16.04.2010

A.3. Short description of the project:

The project main goal is fuel consumption reduction, in particular reduction of natural gas (which is imported to Ukraine) and coal consumption, by means of district heating system rehabilitation in Luhansk City, including boiler and distribution network equipment replacement and rehabilitation, installation of combined heat and power production plants and frequency controllers. Such reduction of fuel consumption will result in decrease of greenhouse gas emissions (CO_2 and N_2O). The purpose of the project is sustainable development of the region through implementation of energy saving technologies.

Luhansk City Municipal Enterprise (LCME) "Teplocomunenergo"is one of the main enterprises in field of production and distribution of the heat energy in Luhansk City. Its share in district heating system of the city is approximately 92%. It sells 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 was initiated in 2006 to rehabilitate Luhansk City's district heating system, including boiler and distribution network equipment replacement and rehabilitation, and installation of combined heat and power production plants (CHP) as well as frequency controllers. Project includes 135 boiler-houses with 344 boilers (total connected load 550 Gkal/hour, 2006) and 269 km of heat distributing networks, that are managed by LCME "Teplocomunenergo".
Project provides installation of cogeneration units at the three boiler houses - 11 gas engines, 1064 kW. Gas engines-generators machines "Jenbacher" JGS 320 GS (Austria) are considered as potential candidates for installation.

The project employs the increase in fuel consumption efficiency to reduce greenhouse gas emissions relative to current practice. Over 35.8 million Nm^3 of natural gas and 710 ton of coal will be saved annually starting from 2011. Such reduction of fuel consumption is based on increase of the boiler efficiencies, reduction of heat losses in networks and CHP and frequency controllers installation. The following activities will ensure fuel saving:
- Replacement of old boilers by the new highly efficient boilers;
- Switching of load from boiler-houses with obsolete equipment to modern equipped boiler houses;
- Switching of boiler-houses from coal to natural gas;
- Improving of the network organization;
- Application of the pre-insulated pipes;
- Installation of combined heat and power production units;
- Replacement of heat exchangers;
- Installation of heat pump station;
- Installation of frequency controllers at electric drives of draught-blowing equipment and hot water pumps motors.

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
2009	309354	268724	40630

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

A.4. Monitoring period:

- Monitoring period starting date: 01/01/2009

- Monitoring period closing date: 31/12/2009

A.5. Methodology applied to the project activity (incl. version number):

A.5.1. Baseline methodology:

In course of development of the project **"Rehabilitation of the District Heating System in Luhansk City"**, the **own-developed methodology** was used that is partly similar to "Baseline and monitoring methodology AM0044". The project "Rehabilitation of the District Heating System in Luhansk city" has some differences from applicability conditions of this methodology.

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

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

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

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

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

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

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

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

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

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

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

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

Approved Methodology AM0048 "New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels" already in its title shows the scope of applicability, that is different from the scope of the "District Heating" projects. In our projects, the cogeneration facilities produce hot water and not steam. Beside this, in according to AM0048 (page 22) and its monitoring plan (pages 23-30), it is necessary to realize, among other measurements, monthly measurement of $SC_{PCSG,i,y}$ (Total steam self-generated by project customer 'i' during year 'y' of the crediting period, TJ), measured by the steam meter at the customer 'i' (page 25). Thus Methodology AM0048 couldn't be implemented in original. In principle, it could be modified for conditions of hot water production for heating and hot water supply systems, but this will require modification of monitoring plan with introduction of other parameters that it is necessary to measure and register. But it would be the another methodology, that would require to measure such parameters as heat output, or hot water output with its temperature (in analogy with requirements of Methodology AM0048 to measure steam output, its pressure and temperature.

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

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

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

A.5.2. Monitoring methodology:

The monitoring methodology 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 lower heating 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 methodology is proposed to be used.

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

$$ERUs = \sum[E_i^b - E_i^r]$$

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

$$E_i^b = E_{1i}^b + E_{gen\,i}^b + E_{cons\,i}^b,$$
$$E_i^r = E_{1i}^r + E_{gen\,i}^r + E_{cons\,i}^r,$$

where:
E_{1i}^b and E_{1i}^r – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the base year and in the reported year, respectively, t CO_2e;
$E_{gen\,i}^b$ and $E_{gen\,i}^r$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year (consumed from greed, amount to be substituted in the reported year), and generated by included into the project objects in the reported year, respectively, t CO_2e;
$E_{cons\,i}^b$ and $E_{cons\,i}^r$ – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the base year and in the reported year, respectively, t CO_2e.

For each i boiler-house:

$$E_1^b = LHV_b * Cef_b * B_b$$

$$E_1^r = LHV_r * Cef_r * B_r$$

$$E_{gen}^b = W_b * CEF_g + Q_b * f_b / 1000 * LHV_r * Cef$$

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

$$E_{cons}^b = P_b * CEF_c$$

$$E_{cons}^r = P_r * CEF_c$$

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, kt CO_2/TJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tons;
W_b – scheduled electric power production by the new CHP units at a boiler-house, MWh;
W_r – electric power production by the installed new CHP units MWh;
CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;
P_b – electric power consumption by a boiler-house where energy saving measures are scheduled to be implemented, MWh;
P_r – electric power consumption by a boiler-house with energy saving measures implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

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

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

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

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

$[_b]$ 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:

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

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

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

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

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:

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

$E_1{}^r = LHV_r* Cef_r*B_r$

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);

Cef – carbon emission factor, kt CO_2/TJ;

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

K_1, K_h, K_w, K_{w0} – adjustment factors;

a – portion of fuel (heat), consumed for heating purposes;

(1-a) – portion of fuel (heat), consumed for hot water supply services;

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

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

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

$a_r = L_h{}^r*g*N_h{}^r/ (L_h{}^r*g*N_h{}^r + L_w{}^r*N_w{}^r)$,

where:

L_h, L_w – maximum connected load to the boiler-house, that is required for heating and for hot water supply service, MW;

g – recalculating factor for average load during heating period (is determined for each boiler-house on historical base, usually is in the range 0,4 – 0,8);

N_h, N_w – duration of heating period and period of hot water supply service per year, hours.

Adjustment factors:

1. K_1 (change in the lower heating value of fuel):

$K_1 = LHV_b / LHV_r$

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

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

$B_h = B*a = Q_h / LHV*\eta$,

where η is 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:

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

where:
$Q_{h\,br}$ – required heat for Dynamic Baseline, is assumed equal to Q_r – required heat in the reported year,
$Q_{h\,b}$ – required heat in the base year,
K_h – averaged adjustment factor for heating.

From this equation it is possible to determine the averaged adjustment factor:
$K_h = Q_{h\,r} / Q_{h\,b.}$

Required amount of heat for heating of buildings during a year, according to the "Codes and regulations on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic requirements in Ukraine. KTM 204 Ukraine 244-94"[1], is determined by [ibid, equation 2.17]:

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

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

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

2.1. K_2 (temperature change factor):

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

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

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

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

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

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

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

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

k_{hr} – average heat transfer factor of heated buildings in the reported year, (W/m^2*K);

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

2.4. K_4 (heating period duration change factor):

$$K_4 = N_{hr} / N_{hb}$$

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,

$$K_h = K_2 * K_3 * K_4$$

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

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

$$B_w = B*(1-a) = Q_w / LHV*\eta,$$

where η is overall hot water supply system efficiency.

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

$$Q_{wbr} = Q_{wb}*K_w = Q_{wr}$$

where:

Q_{wbr} – required heat for hot water supply service for Dynamic Baseline, is assumed equal to Q_{wr} – required heat for hot water supply service in the reported year,

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

K_w – averaged adjustment factor for hot water supply service.

From this equation it is possible to determine the averaged adjustment factor:
$$K_w = Q_{wr} / Q_{wb.}$$

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

$$Q_w = n_w * v_w * N_w,$$

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

3.1. K_5 (number of customers change factor):

$$K_5 = n_{wr} / n_{wb}$$

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

$$K_6 = v_{wr} / v_{wb}$$

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

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

$$K_7 = N_{wr} / N_{wb}$$

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

Thus,

$$K_w = K_5 * K_6 * K_7.$$

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

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

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

Thus

$$K_{w0} = 1.$$

The table of parameters included in the process of monitoring and verification for ERUs calculation, is represented in the Section **D.1.1.1, D.1.1.3** and **Monitoring plan**.

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

The starting date of the project according to PDD is: 07/02/2006
The starting date of the crediting period is set to the date where the first emission reduction units are expected to be generated from the project, that is January 1, 2007. 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, 2026.

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
Base year						
Starting date of the project is: 07 February 2006						
	Boiler houses rehabilitation					
	Network rehabilitation					
	Heat exchangers replacement					
				Frequency controllers installation		
				CHP units installation		
				Installation of HPS		
		1 st Kyoto commitment period				
		1 st Monitoring Period	2 nd Monitoring Period			

Fig 1: Status of implementation (according to PDD)

Implementation of boiler houses rehabilitation and network rehabilitation are realized according to project plan. In several cases replacement of different (from planed before) diameters of network pipes takes place.
Table of implemented energy saving measures is presented bellow.

Implemented energy saving measures	Volume of performed works (number of boilers, etc.) 2006-2008	Volume of performed works (number of boilers, etc.) 2009	Total
Complete overhaul	71	26	97
Replacement of convection part	21		21
Replacement of ceiling screens	6		6
pipe part	3		3
Replacement of heating surface	1		1
Complete overhaul, switch boiler to water-heating mode	2		2
Overhaul of setting	18		18
replacement of the burners	16	20	36
Installation of automatic system of regulation on boilers	9	11	20
Switch to boiler-house	3	3	6
Replacement of boilers			
KSVa-3G	3		3
AOGV-100	3		3
KOLVI - 1000 - 2,6 MW	2		2
Vitomax 200 LW- 40 MW	4		4
МН120 ЕКО "Бернард" - 360 kW		2	2
IVAR Superac 290 2F - 600 KW		2	2
МН120 ЕКО "Бернард" - 420 kW		4	4
«Super Rac-2F-345», pumps with FC, Grundfos та Wilo		6	6
building of boiler-house	1		1
Replacement of tank-accumulators	1		1
Heat exchangers replacement	0	4	4
Frequency controllers installation	0	12	12
Replacement of capacitors	1	6	7
Pre-insulated network replacement, m	24609	16823	41432
Usual pipe network replacement, m	70323	16747	87070

Table 2: Table of implemented energy saving measures

For detailed information about implemented measures see Annex 2.

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

PDD for this project - "Rehabilitation of the District Heating System in Luhansk City", - version 06 from December 11, 2009 was determined by Bureau Veritas Certification Holding SAS (Final Determination Report No: UKRAINE-0048/2009 from 18.12.2009).

The National Enviromental Investment Agency of Ukraine has confirmed this JI project under Track 1 procedure by the Order No. 72 dated June 02, 2010.

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

There are no deviations or revisions to the registered monitoring plan in general.
Parameter 18 (Scheduled electric power production by the all new CHP units and electric power generation by the installed new CHP units in reported year) and Parameter 19 (Scheduled heat power production by the all new CHP units and heat power generation by the installed new CHP units in reported year) were not take into consideration because CHP units has not been implemented.

A.9. Changes since last verification:

1 st Monitoring Report was prepared for period January 1, 2008 - December 31, 2008 on June, 02 2010 (Version 02).
Additional fuel and energy saving measures were realized at the LCME "Teplocomunenergo" within this project that 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 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 with corrector

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 flue meter;
- stop valve;
- bypass facility.
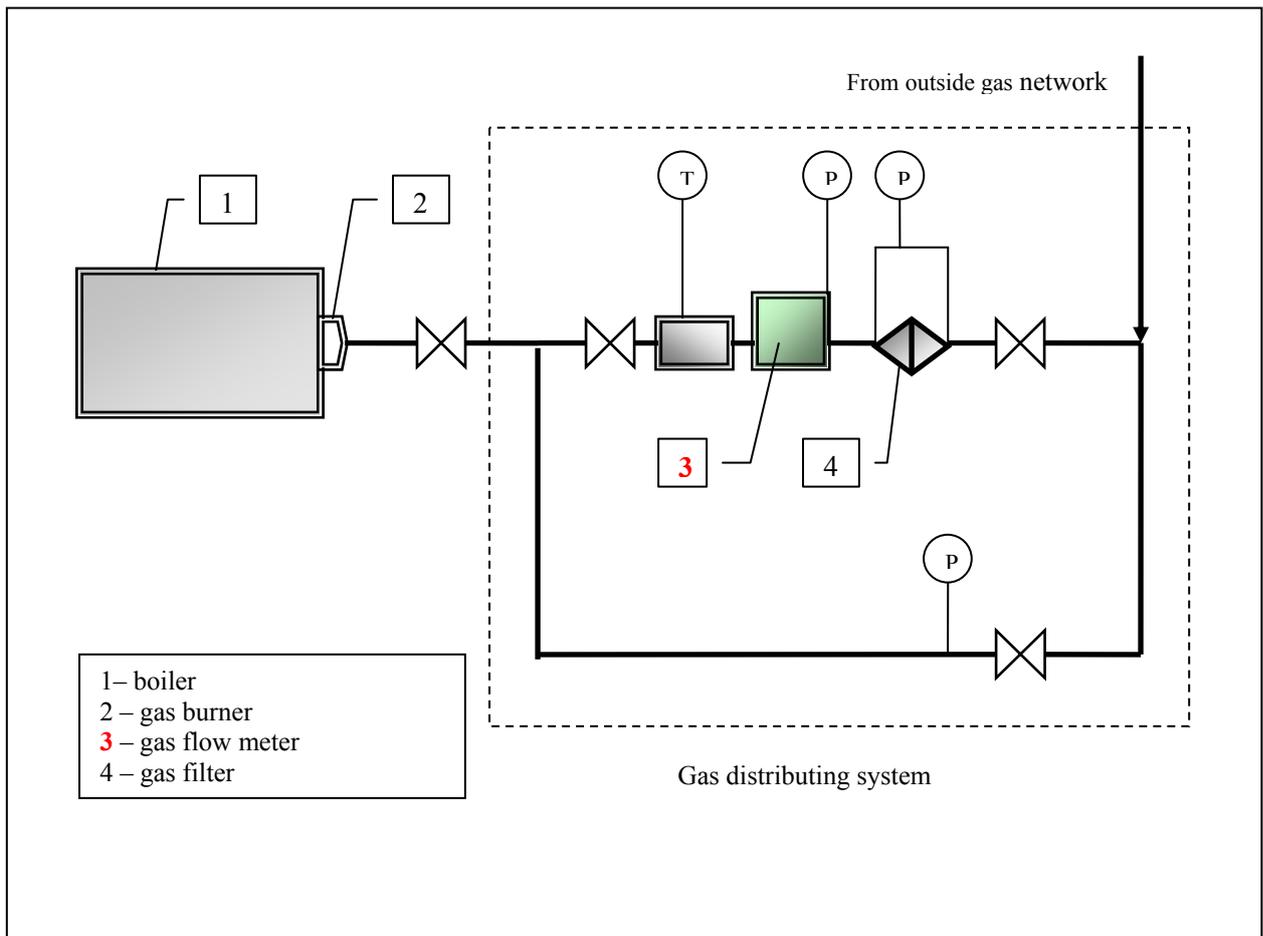
Fig. 4. Scheme of the Gas distribution system

T – outside air temperature and temperature of the natural gas;
P - gas pressure at the entrance to the boiler-house.

Every hour operator of a boiler house read the values of outside air temperature, temperature of the natural gas and gas pressure at the entrance to the boiler-house. Natural gas consumption is measured by gas flow meters, installed at the every boiler-house. Every day operator of a boiler house make registration of daily gas consumption in the special paper journal.

B.1. Monitoring equipment types:

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

Type of Gas flue meters	Producer
3095 FE	Ltd. "Slot"
Ж-650-ЛГК	Donetsk city
GMS	Ltd. "Slot"
G-160-80	Produced by Ivano-Frankivsk plant JSC "Promprylad"
«Курс -01»	Ltd. "Slot"
ЛГК-650	Ltd. "Slot"
ЛГК-1600	Produced by Ivano-Frankivsk plant JSC "Promprylad"
G-250 Б	Produced by Ivano-Frankivsk plant JSC "Promprylad"
РГ-К-40….1000	Produced by Ltd. "Tandem" Vinnitsa city
Gms g-65/40	Ltd. "Slot"
С.У. ; 3095 FE	Ltd. "Izodrom"
«Курс -01»	Ltd. "Slot"
G-400 Б	Produced by Ivano-Frankivsk plant JSC "Promprylad"
G-650 Б	Produced by Ivano-Frankivsk plant JSC "Promprylad"
GMS 100-80	Ltd. "Slot"
G1000 Б	Produced by Ivano-Frankivsk plant JSC "Promprylad"
G-1601-100	Produced by Ivano-Frankivsk plant JSC "Promprylad"
ОЕ- 22ДМ	Ltd. "Izodrom"
ОЕ VPT	Produced by Ivano-Frankivsk plant JSC "Promprylad"
«Тандем» РТ	Produced by Ltd. "Tandem" Vinnitsa city

Table 3: Table of Gas flow meters and correctors types

For power measurement the following are used:

Type of electricity flue meters	Producer
СА4У-И672М	Produced by Leningrad "LEMZ";
Меркурий (А+Р)	Produced by Leningrad "LEMZ";
СА4-195	Produced by GE "ХЗЭ" , Kharkiv city
СТК-3 (А+Р)	PKF "Telecart"
SL - 7000 (А+Р)	France
ЦЭ-6811	Produced by "Energomera";
СР4-5002	JSC "Rostok", Kiev
СОЭ-1,02/2т	LE "Meredian" Kiev
ЕМТ133106	Elgama Litva

Table 3: Table of electricity meters types

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

See Annex 4 and Annex 5.

B.1.2. Calibration procedures:

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

Type of Gas flue meters	Calibration interval
3095 FE	2 years
Ж-650-ЛГК	2 years
GMS	1 years
G-160-80	2 years
«Курс -01»	2 years
ЛГК-650	2 years
ЛГК-1600	2 years
G-250 Б	2 years
РГ-К-40….1000	2 years
Gms g-65/40	2 years
С.У. ; 3095 FE	2 years
«Курс -01»	2 years
G-400 Б	2 years
G-650 Б	2 years
GMS 100-80	2 years
G1000 Б	2 years
G-1601-100	2 years
ОЕ- 22ДМ	1 years
ОЕ VPT	2 years
«Тандем» РТ	2 years
Electricity meters	
СА4У-И672М	4 years
Меркурий (А+Р)	10 years
СА4-195	4 years
СТК-3 (А+Р)	6 years
SL - 7000 (А+Р)	6 years
ЦЭ-6811	16 years
СР4-5002	6 years
СОЭ-1,02/2т	16 years
EMT133106	8 years

Table 4: Table of measuring equipment calibration interval

According to the Monitoring Plan the volume of consumed natural gas and consumed power was corrected by measurement error using the principle of conservatism. Natural gas consumption and power consumption in the reported year that used for Project emissions calculations were increased on the level of accuracy of gas flue meters and electricity meters installed at the every boiler-house.

See Annex 2 and Annex 3.

B.1.3. Involvement of Third Parties:

Measurement equipment calibration was carried out by GB "Luhanskstandartmetrologiya" for gas flow meters and for electricity meters according to Agreement #48030-2009 from 12.01.2009. Calibration of gas flow meters produced by plant "Arsenal" was carried out by Subdivision "Warranty supervision and testing center – Arsenal" of GB plant "Arsenal" according to Agreements #И/75-29-08/081-Y/31-2008 from 18.02.2008, #И/75-239-08 from 21.07.2008 and #И/75-119-09 from 03.09.2009.
Calibration of gas flow meters types: ЛГ , РГ, РГ-К and membrane type was carried out by JSC "Luganskgas" according to Agreements #179 from 10.09.2009 and #267 from 20.08.2009
Calibration of gas flow meters types: GSM G-25 #028722 was carried out by GB "Donetskstandartmetrologiya" according to Agreements #114-P/31-2008 from 07.03.2008.
Daily outside temperature values taken by dispatcher of LCME "Teplocomunenergo" from Luhansk Regional Gidrometerology Center from 10 to 11 a.m. every day of heating season. Luhansk Regional Gidrometerology Center sends the Report every month for every day of heating season according to Agreements # 3M from 09.10.2008.

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 (CO2 emissions reduction calculations at the LCME "Teplocomunenergo") and Annex 3 (CO2 emissions reduction due to power saving at the LCME "Teplocomunenergo") 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	m^3	
1.2		Coal	ton	
2	(LHV_b) and (LHV_r)	Average annual Heating Value of a fuel calculated by Lower Heating Value		m, c
2.1		Natural Gas	MJ/m^3	
2.2		Coal	MJ/kg	
3	$(T_{out\ b})$ and $(T_{out\ r})$	Average outside temperature during the heating season	^0C (K)	m, c
4	$(T_{in\ b})$ and $(T_{in\ r})$	Average inside temperature during the heating season	^0C (K)	m, c
5	$(n_{wb}$ and (n_{wr})	Number of Customers		Statistics

6	(F_{hb}) and (F_{hr})	Heating area (total)	m^2	Statistics
7	(k_{hb})	Average heat transfer factor of heated buildings in the base year	$W/m^2{*}K$	c
8	(F_{htr})	Heating 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})	Heating 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 the new thermal insulation	$W/m^2{*}K$	Normative documents
11	(N_{hb}) and (N_{hr})	Duration of the heating period	Hours	m
12	(N_{wb}) and (N_{wr})	Duration of the hot water supply period	Hours	m
13	(L_h^b) and (L_h^r)	Maximum connected load to the boiler-house, that is required for heating	MW	c
14	(L_w^b) and (L_w^r)	Connected load to the 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	Normative documents
16	(Cef_r) and (Cef_b)	Carbon emission factor		Normative documents
16.1		Natural Gas	kt CO_2/TJ	
16.2		Coal	kt CO_2/TJ	
17	**g**	Recalculating factor for average load during heating period		Statistics
18	(W_b) and (W_r)	Scheduled electric power production by the all new CHP units and electric power generation by the installed new CHP units in reported year, MWh	MWh	c/m
19	(Q_b) and (Q_r)	Scheduled heat power production by the all new CHP units and heat power generation by the installed new CHP units in reported year, MWh	MWh	c/m
20	(P_b) and (P_r)	Electric power consumption by the boiler-houses and heating points where energy saving measures are scheduled to be implemented	MWh	m

Table5: List of fixed default values, variables and attached values

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 are 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 System in Luhansk City"
has a positive effect on environment. Following points give detailed information on environmental benefits.

1. Project implementation allowed to save over 36 million Nm^3 of natural gas, over 294 ton of coal and 10364 ths. kWh of power during 2009.

2. Due to fuel economy and new environmentally friendlier technologies of fuel combustion, project implementation reduced emissions of SO_x, NO_x, CO and particulate matter (co-products of combustion).

3. Project implementation allow to decrease the water consumption and as a result – to decrease the amount of waste water. The evidences for this statements can be acts of water consumption with RME "Luhanskvoda" for 2006-2009 years.

4. Impact on the land medium is not present.

5. Impact on biodiversity is not present.

6. Waste generation increased over the project implementation after disassembling of physically and morally obsolete equipment, burners, pipes, etc. Also occured some construction waste due to destruction of boiler settling, boiler house foundations, etc.
According to the "Law on waste products", (article 17) "Obligations of economical activity subjects in sphere of waste treatment" LCME "Teplocomunenergo" delivers old equipment to metal recycling
Therefore LCME "Teplocomunenergo" has Agreements with ME "Luhansk center of waste utilization" #CP 052-Y/15-2008 from 11.02.2008 and #CP 17-Y/15-2009 from 04.01.2009 for waste burial at city landfill in t. Alecsandrovska.

LCME "Teplocomunenergo" has the appropriately approved Environmental Impact Assessments (EIA)
for all capital constructions.

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 of LCME "Teplocomunenergo" is carried out by the following scheme:

1. All boiler-houses are equipped with gas flow meters, installed at gas distributing units of the boiler-houses.

2. Most of boiler-houses equipped with automatic corrector for temperature and pressure. Gas consumption registered automatically. Beside this operators of all boiler-houses register the instrument readings in the paper journals "Journal of registration of boiler-house's operation parameters" every day, see Fig.5.

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

4. Every day operators transfer values of gas consumption to dispatcher of the regional branch of LCME "Teplocomunenergo" by phone. Monthly they transfer the paper report.

5. Regional branches transfer data to Production-Technical Department (PTD) of LCME "Teplocomunenergo" where they are storing and used for payments with gas suppliers.

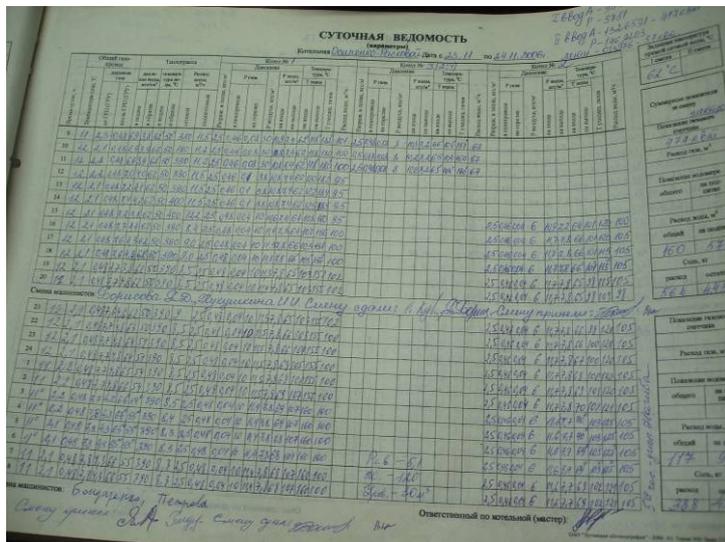Scheme of data collection for Monitoring Report is shown at the Fig. 6.

Fig. 5 Paper journal for natural gas consumption registration

B.4. Special event log:

n.a.

LCME "Teplocomunenergo"
Operator of boiler-house
Fuel consumption at boiler house

LCME "Teplocomunenergo"
Dispatcher of regional branch
Fuel consumption at boiler houses

LCME "Teplocomunenergo"
Production-Technical
Department (PTD)
Fuel consumption at boiler houses
Power consumption at boiler
houses
Heating Value of fuel

LCME "Teplocomunenergo"
Department of management
systems automatization
Data copy and archiving

LCME "Teplocomunenergo"
Chief of Heat –Sale Department
or consumers Department
Average inside temperature
Number of Customers
Heating area
Duration of the heating period
Duration of the hot water supply
period

LCME "Teplocomunenergo"
Engineer of technical
development group of industrial
safety department
Data tables for Monitoring Report

LCME "Teplocomunenergo"
Chief of Material accounts
department
Acts of putting into operation

LCME "Teplocomunenergo"
Chief engineer (Manager of JI
project)
Data for Monitoring Report

LCME "Teplocomunenergo"
Chief of Metrology Department
Measuring instruments calibration
data

Institute of Engineering Ecology
Data processing according to
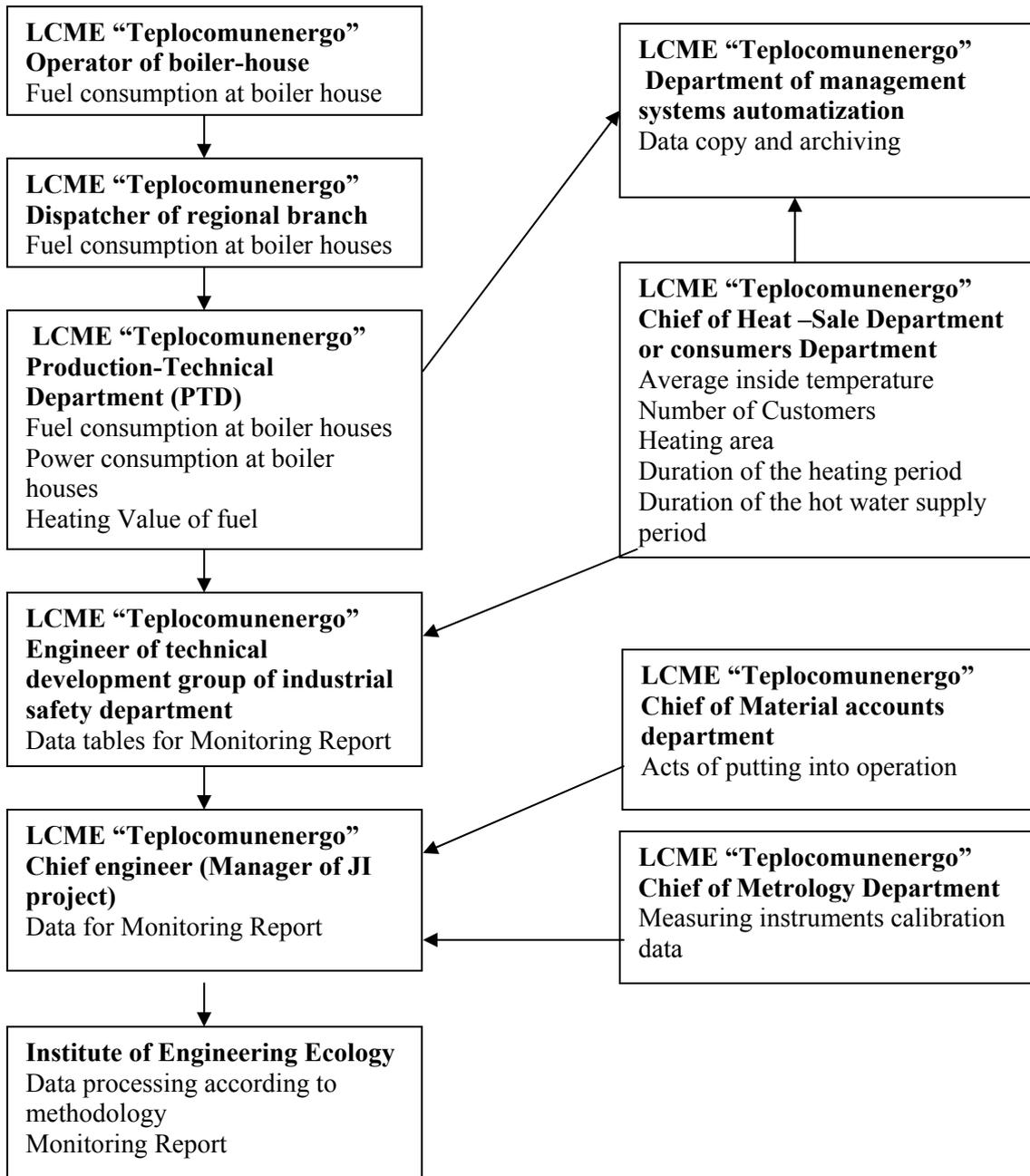methodology
Monitoring Report

Fig.6. 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 director of LCME "Teplocomunenergo", Mr. Oleksiy Rusakov, appointed the responsible person, Mr. Yuriy Negriy, for the implementation and management of the monitoring process at the LCME "Teplocomunenergo". Mr. Yuriy Negriy is responsible for supervising of data collection, measurements, calibration, data recording and storage.
Dr. Dmitri Paderno, vice director of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development.
Ms. Tetiana Grechko, senior engineer of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development and data processing.

Responsibilities for data management are presented in Table 6.

Activity	Responsible person	
	Name	Position and department
Data storage and archiving	Natalia Balalaeva	chief of PTD of LCME "Teplocomunenergo"
Data storage and archiving	Oksana Konstantinenko	Chief of Heat –Sale Department of LCME "Teplocomunenergo"
Data storage and archiving	Ekaterina Scherbakova	Chief of consumers Department of LCME "Teplocomunenergo"
Data storage and archiving	Andriy Ulchenko	Chif of Metrology department of LCME "Teplocomunenergo"
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Eleonora Schigoleva	Engineer of technical development group of industrial safety department of LCME "Teplocomunenergo"
Eelectronic data copy and archiving	P. Levitan	Chif of department of management systems automatization of LCME "Teplocomunenergo"
Data monitoring and reporting, coordination of verification process	Yuriy Negriy	Chief engineer of LCME "Teplocomunenergo"
Data processing according to methodology, development of Monitoring Report	Tetiana Grechko	Senior engineer of Institute of Engineering Ecology, Ltd
Support in coordination of verification process	Dmitri Paderno	Vice Director of Institute of Engineering Ecology, Ltd

Table 6: Responsibilities for data management

C.1.2. Trainings:

As far as the main activity of LCME "Teplocomunenergo" 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 implmentation 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.

LCME "Teplocomunenergo" provides personnel retraining according to protection of labour norms. The enterprise has the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

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

The special training was held before preparing of Monitoring report for 2008 year, in October, 2009.

The special group was organized consisted of representatives of LCME "Teplocomunenergo" and Institute of Engineering Ecology, in particular:

Oleksiy Rusakov - LCME "Teplocomunenergo", Director;

Yuriy Negriy - LCME "Teplocomunenergo", Chief engineer;

Eleonora Schigoleva - LCME "Teplocomunenergo", Engineer of technical development group of industrial safety department;

Tetiana Grechko - Institute of Engineering Ecology, senior engineer;

Dmitri Paderno - Institute of Engineering Ecology, vice director.

The responcible stuff of the Production-Technical Service of LCME "Teplocomunenergo" is involved in this process.

C.2. Involvement of Third Parties:

Measurement equipment calibration was carried out by GB "Luhanskstandartmetrologiya" for gas flow meters and for electricity meters according to Agreement #48030-2009 from 12.01.2009. Calibration of gas flow meters produced by plant "Arsenal" was carried out by Subdivision "Warranty supervision and testing center – Arsenal" of GB plant "Arsenal" according to Agreements #И/75-29-08/081-Y/31-2008 from 18.02.2008, #И/75-239-08 from 21.07.2008 and #И/75-119-09 from 03.09.2009.

Calibration of gas flow meters types: ЛГ , РГ, РГ-К and membrane type was carried out by JSC "Luganskgas" according to Agreements #179 from 10.09.2009 and #267 from 20.08.2009

Calibration of gas flow meters types: GSM G-25 #028722 was carried out by GB "Donetskstandartmetrologiya" according to Agreements #114-P/31-2008 from 07.03.2008.

Daily outside temperature values taken by dispatcher of LCME "Teplocomunenergo" from Luhansk Regional Gidrometerology Center from 10 to 11 a.m. every day of heating season. Luhansk Regional Gidrometerology Center sends the Report every month for every day of heating season according to Agreements # 3M from 09.10.2008.

For reconstructed objects that require Environmental Impact Assessment according to Ukrainian legislation PE "Firma Priroda" has developed EIA as a separate section of the project.

C.3. Internal audits and control measures:

Internal Audits of monitoring activities haven't been undertaken because of the absence of energy manager position at the LCME "Teplocomunenergo". "The analyze of energy indicators of LCME "Teplocomunenergo" operation " was developed by PE "Metalod" for tariffs establishing on Ministry Resolution #955 from 10.07.2006.

C.4. Troubleshooting procedures:

All boiler-houses has a Plan of localization and liquidation of accidents. For any types of accidents and places of there appearance measures of there liquidation has been developed. There are following types of accidents: stopping of gas supply, stopping of power supply, stopping of water supply, damage of pipe line inside boiler-house, leakage on the heating surface of boiler, break gas pipe line inside boiler-house, abrupt dropping of water pressure in heat network, gas explosion in furnace and gas flue, absolute interruption of flame torch from burner, fire in boiler-house, flood of gas flue, flood of equipment room, flood of entrance room, damage of power equipment, breakage of all pumps, breakage smoke exhaust or ventilator, breakage of chemical cleaning water filter, dropping of outside temperature lower than -20 $^{\circ}$C.

In any case troubleshooting procedure includes immediately reporting to master of boiler-house, dispatcher, manager of filial and direction. As far as Chief engineer of LCME "Teplocomunenergo" is a JI project manager, he takes the appropriate measures.

Any of listed above problems can have influence for the JI project. Due to "SVT e.V." (Germany) and Institute of Engineering Ecology (Ukraine) invented the special methodology, that consider such monitoring parameters as: Average inside temperature during the heating season, Heating period duration, Duration of the hot water supply period – calculation of GHG emission reduction   takes into account all accidents concerning heat production and distribution that can occur at the enterprise.

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 (BE) and the project emissions (PE).

Formula 1 – Total emission reduction (ERUs)
$ERUs = [E_i^b - E_i^r]; \quad [t\ CO_2e]$
ERUs - Total annual emission reduction [t CO_2e] E_i^b - Baseline CO_2 emissions [t CO_2e] E_i^r - CO_2 emissions in the reported year [t CO_2e]
The sum is taken over all boiler-houses (i) which are included into the project

Project emissions

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

Formula 3 – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, (E_{1i}^r)
$E_{1i}^r = LHV_r * Cef_r * B_{ri} , [tCO2\text{-}eq.]$
LHV_{ri} – Average annual lower heating value, MJ/m^3 (MJ/kg)   Average annual Heating Value is calculated for every town;   Cef – carbon emission factor, ktCO$_2$/TJ; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons;

Formula 4 – CO$_2$ emissions due to electric power generated by included into the project objects in the reported year ($E_{gen\,i}^{\,r}$)
$E_{gen}^{\,r} = (W_b - W_r)*CEF_g + [(Q_b-Q_r)*f_b/1000 + B_g]* LHV_r* Cef$
W_b – scheduled electric power production by the all new CHP units, MWh; W_r – electric power production by the installed new CHP units, and additional power production by the CHP at the HPS (that is not used for Heat Pump) in reported year, MWh; CEF_g – Carbon Emission factor for electricity generation in Ukraine, t CO$_2$e/MWh; Q_b – scheduled heat energy production by the all new CHP units, MWh; Q_r – heat energy production by the installed new CHP units, MWh; f_b – specific natural gas consumption by the boiler-house, where CHP units are scheduled to be installed, m^3/MW; B_g – amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;

Formula 5 – CO$_2$ emissions due to electric power consumption from greed by the i boiler-house in the reported year ($E_{cons\,i}^{\,r}$)
$E_{cons\,i}^{\,r} = P_r*CEF_c$
P_r – electric power consumption by the boiler-houses with energy saving measures implemented, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO$_2$e/MWh;

Baseline emissions

Formula 6 – Annual baseline emissions (E_b)
$E_i^{\,b} = E_{1i}^{\,b} + E_{gen\,i}^{\,b} + E_{cons\,i}^{\,b}$; [t CO$_2$e]
$E_{1i}^{\,b}$ – baseline CO$_2$ emissions due to fuel consumption for heating and hot water supply service for an i boiler-house , t CO$_2$e; $E_{gen\,i}^{\,b}$ – CO$_2$ emissions due to electric power generation associated to the project for an i boiler-house in the base year (consumed from greed, amount to be substituted in the reported year), t CO$_2$e; $E_{cons\,i}^{\,b}$ – CO$_2$ emissions due to electric power consumption from greed by the i boiler-house in the base year, t CO$_2$e.

Formula 7 – Baseline CO$_2$ emissions due to fuel consumption for heating and hot water supply service for an i boiler-house, ($E_{1i}^{\,b}$)
For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for $E_1^{\,b}$ is: $E_1^{\,b} = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$, 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: $E_1^{\,b} = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.

	LHV_b – Average annual lower heating 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 tons; K_1, $K_h = K_2 * K_3 * K_4$; $K_w = K_5 * K_6 * K_7$ – adjustment factors; a_b – portion of fuel (heat), consumed for heating purposes in the base year; $(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year; a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

Formula 8 – Portion of fuel (heat), consumed for heating purposes in the base year (a_b)
$a_b = L_h^b * q * N_h^b / (L_h^b * g * N_h^b + L_w^b * N_w^b)$;
L_h^b – maximum connected load required for heating in the base year, MW; L_w^b – connected load required for hot water supply service in the base year, MW; g – recalculating factor for average load during heating period (usually 0.4-0.8); N_h^b – duration of heating period in the base year , hours; N_w^b – duration of hot water supply service in the base year, hours.

Formula 9 – Portion of fuel (heat), consumed for heating purposes in the reported year (a_r)
$a_r = L_h^r * q * N_h^r / (L_h^r * g * N_h^r + L_w^r * N_w^r)$
L_h^r – maximum connected load required for heating in the reported year, MW; L_w^r – connected load required for hot water supply service in the reported year, MW; g – recalculating factor for average load during heating period (usually 0.4-0.8); N_h^r – duration of heating period in the reported year, hours; N_w^r – duration of hot water supply service in the reported year, hours.

Formula 10 – Change in the lower heating value (K_1)
$K_1 = LHV_b / LHV_r$
LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg); LHV_r – Average annual lower heating value in the reported year, MJ/m^3 (MJ/kg)

Formula 11 – Temperature change factor (K_2)
$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$
$T_{in\ r}$ – average inside temperature for the heating period in the reported year, 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 12 – Heating 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} – heating area in the base year, m^2; F_{hr} – heating area in the reported year, m^2; F_{hnr} – heating area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2; F_{htr} – heating area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2; k_{hb} – average heat transfer factor of heated buildings in the base year, (W/m^2*K); k_{hn} – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), (W/m^2*K).

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

Formula 14 – Number of customers 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 15 – Standard specific discharge of hot water per personal account change factor (K_6)	
	$K_6 = v_{wr} / v_{wb}$
	v_{wr} – standard specific discharge of hot water per personal account in the reported year, (in heat units, kWh/h); v_{wb} – standard specific discharge of hot water per personal account in the base year, (in heat units, kWh/h).

Formula 16 – Hot water supply period duration change factor (K_6)
$K_7 = N_{wr}/ N_{wb}$
N_{wr}– duration of hot water supply service in the reported year, hours. N_{wb} – duration of hot water supply service in the base year, hours.

Formula 17 – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year ($E_{gen\,i}^{b}$)
$E_{gen}^{b} = W_b*CEF_g + Q_b*f_b/1000* LHV_r* Cef$
W_b – scheduled electric power production by the all new CHP units, MWh; CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh; Q_b – scheduled heat energy production by the all new CHP units, MWh; f_b – specific natural gas consumption by the boiler-house, where CHP units are scheduled to be installed, m^3/MW; LHV_r – Average annual lower heating value in reported year, MJ/m^3 (MJ/kg) Cef – carbon emission factor, $ktCO_2$/TJ;

Formula 18 – CO_2 emissions due to electric power consumption for an i boiler-house in the base year ($E_{cons\,i}^{b}$)
$E_{cons}^{b} = P_b*CEF_c$
P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented in the base year, MWh; CEF_c – Carbon Emission factors for 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 CO_2 emissions due to fuel consumption for heating and hot water supply service at LCME "Teplocomunenergo" and of CO_2 emissions due to electric power consumption from the greed in the reported year.

Project emissions, tCO$_2$e	2009
CO_2 emissions due to fuel consumption	230018,2
CO_2 emissions due to electric power consumption	38706,0
Total	268724,2

Table 7: Project emissions

D.3.2. Baseline emissions:

Baseline emissions consist of Baseline CO_2 emissions due to fuel consumption for heating and hot water supply service at LCME "Teplocomunenergo"and of CO_2 emissions due to electric power consumption from the greed.

Baseline emissions, tCO$_2$e	2009
CO_2 emissions due to fuel consumption	262115,2
CO_2 emissions due to electric power consumption	47239,2
Total	309354,4

Table 8: Baseline emissions

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 Reduction, tCO$_2$e	2009
CO_2 emissions reduction due to fuel saving	32097,1
CO_2 emissions due to electric power saving	8533,1
Total	40630,2

Table 9: Total Emission Reductions

Annex 1 – Data

The data in this Annex are presented in accordance with Parameter 1-20 in the Monitoring plan.

Parameter Number	Parameter Name
1	Fuel consumption at boiler houses
1.1	Natural Gas
1.2	Coal
2	Average annual Heating Value of a fuel calculated by Lower Heating Value
2.1	Natural Gas
2.2	Coal
3	Daily outside temperature during the heating season
4	Average inside temperature during the heating season
5	Number of Customers
6	Heating area (total)
7	Heat transfer factor of buildings
8	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
9	Heating 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
17	Recalculating factor for average load during heating period
18	Scheduled electric power production by the all new CHP units and electric power generation by the installed new CHP units in reported year, (was not take into consideration)
19	Scheduled heat power production by the all new CHP units and heat power generation by the installed new CHP units in reported year (was not take into consideration)
20	Electric power consumption by the boiler-houses and heating points where energy saving measures are scheduled to be implemented

Parameter number and name (according to PDD monitoring plan)	**1.1** Natural gas consumption at boiler houses
Description	Consumption of fuel is the main parameter affecting greenhouse gas emissions. The most objective and accurate indicator of project performance will therefore be the changes in fuel consumption. Changes in fuel consumption in result of the project implementation, when compared to baseline fuel consumption, will integrate all other relevant indicators such as improvement of boiler efficiency, reduction of network losses, etc.
Value in monitoring period	2009 – 126913,6 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 Monitoring Plan the volume of consumed natural gas was corrected by measurement error using the principle of conservatism. Natural gas consumption in the reported year that used for Project emissions calculations was increased on the level of accuracy of gas flue meters installed at the every boiler-house. See Annex 2 and Annex 3.

Parameter number and name (according to PDD monitoring plan)	1.2 Coal consumption at boiler houses
Description	Coal consumption at 4 boiler houses
Value in monitoring period	2009 – 395,7 ton
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	The detailed data of Coal consumption by every boiler-house are presented in Annex 2.

Parameter number and name (according to PDD monitoring plan)	**2.1** Average annual Heating Value of Natural Gas
Description	Average annual Heating Value of Natural Gas calculated by Lower Heating Value
Value in monitoring period	Average annual Heating Value of Natural Gas was approximately 33,0 MJ/m3 during 2009 year.
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 monthly
Background data	Registered in the paper journal
Calculation method	Weighted average value
Comment	

Parameter number and name (according to PDD monitoring plan)	**2.2** Average annual Heating Value of Coal
Description	Average annual Heating Value of Coal
Value in monitoring period	Average annual Heating Value of Coal was approximately 17,6 MJ/t during 2009 year.
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 heavy oil supplier for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value

Parameter number and name (according to PDD monitoring plan)	**3.** Daily outside temperature during the heating season
Description	Average daily outside temperature during the heating season
Value in monitoring period	During the heating season 2009 - +0,8ºC
Monitoring method	Average outside temperature during the heating season is calculated by LCME "Teplocomunenergo" from the daily outside temperature values taken by dispatcher of LCME "Teplocomunenergo" from Luhansk Meteorological Centre from 10 to 11 a.m. every day of heating season.
Recording frequency	Every day of heating season

Background data	Meteorological Centre sends the Report every month for every day of heating season. Reports are filed in special journals
Calculation method	Average value

Parameter number and name (according to PDD monitoring plan)	**4.** Average inside temperature during the heating season
Description	Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied) Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative. Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.
Value in monitoring period	The inside temperature at the consumer's houses in Luhansk city was 17,9 ^{o}C during 2009 year.
Monitoring method	Sums of return payment
Recording frequency	Once per heating season
Background data	Sums of return payment
Calculation method	According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, the enterprises must make the return payments to population for delivery less than necessary amount of heat. The normative inside temperature should be not lower than 18 ^{o}C. Amount of the return payment is: – 5% from normative payment for every degree from 18 to 12 ^{o}C; – 10% from normative payment for every degree from 12 to 5 ^{o}C; – when inside temperature is lower than 5 ^{o}C the payment is to be returned completely. Therefore the inside temperature will be calculated by formulae: If R = 0 (according to conservatism principle for the baseline assume R < 0.05): $T_{in\,b} = 18$ ^{o}C. If $0.05 < R \leq 0.3$ NP: $T_{in\,b} = 18 - (R/5)$ [^{o}C] If 0.3 NP $< R <$ NP: $T_{in\,b} = 12 - [(R - 0.3\,NP)/10]$ [^{o}C] where: R - % of return payment from NP; NP – amount of normative payment.

	The total sum of charge for population of Luhansk city in 2009 was 271,2 mln hrn. the sum of returned payment was 0,7 mln hrn. Percentage of returned payment is 0,3 % that corresponds to inside temperature 17,9 $^{\circ}$ C.

Parameter number and name (according to PDD monitoring plan)	**5.** Number of Customers for hot water supply service
Description	Number of Customers for hot water supply service for every boiler houses
Value in monitoring period	See Annex 2
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Contracts with population, organizations and legal entities are concludes directly with LCME "Teplocomunenergo". They are updated once per year.
Background data	The information is collected in special electronic journals "Registration of income from population" (for inhabitants). For organizations and legal entities such information is taken from contracts concluded with them
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**6.** Heating area (Total)
Description	Heating area for every boiler houses
Value in monitoring period	The detailed data of heating area for every boiler-house are presented in Annex 2. Heating areas connected to LCME "Teplocomunenergo" were 6058,5 ths m^2 in 2009.
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	The revise is made in case of new contracts with Customers or in case of contracts break.
Background data	The information is collected at the sale departments of LCME "Teplocomunenergo" by the certificates of owners in accordance with technical passport of building. Total area with balconies and stairs and Heating area are displayed in the special journal
Calculation method	The data is taken for January, 01 for every year
Comment	

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

Parameter number and name (according to PDD monitoring plan)	**8.** Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heating area of reconstructed buildings with application of new insulations for walls
Value in monitoring period	There were no reconstructed buildings with application of new insulations for walls in the operation area of boiler-houses LCME "Teplocomunenergo"
Monitoring method	Statistics LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**9.** Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heating area of newly connected buildings with application of the new insulation for walls
Value in monitoring period	There were no new buildings connected to boiler-houses of LCME "Teplocomunenergo"
Monitoring method	Statistics LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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
Monitoring method	According to State Buildings Norms (B.2.6-31:2006)
Recording frequency	
Background data	
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**11.** Heating period duration
Description	Heating period duration in every town
Value in monitoring period	Heating period duration was different for boiler-houses. Values in monitoring period are presented in Annex 2.
Monitoring method	Measured by LCME "Teplocomunenergo"
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 °C or lower during 3 days, and finishes if average daily outside temperature is 8 °C or higher during 3 days. According to SNiP 2.01.01-84 (Climatology in heating engineering) the duration of heating period for project development is to be taken as 183 days, and usually it is from October,15, till April 15.
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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 for every boiler-house are presented in Annex 2.
Monitoring method	Measured by LCME "Teplocomunenergo"
Recording frequency	Once per day
Background data	Hot water supply service is realized by hot water delivery schedule. There are two types of Hot water supply service schedule in Luhansk city - 24 hours per day throughout the year and 24 hours per day only in the heating period. Most of boiler-houses have the second type of schedule. Hot water supply service is foreseen. There is a plan of disconnection of load for Hot water supply service for maintenance and preventive measures for

	every boiler-house.
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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	Calculated by LCME "Teplocomunenergo"
Recording frequency	Once per year.
Background data	Maximum connected load to the boiler-house, that is required for heating, is calculated by LCME "Teplocomunenergo" for every heating season. It is calculated according to heat demand at outside temperature - 25 $^{\circ}$C.
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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	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	Calculated by LCME "Teplocomunenergo"
Recording frequency	Once per year.
Background data	Connected load to the boiler-house, that is required for hot water supply service, is calculated by LCME "Teplocomunenergo" every year according to contracts with consumers.
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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 "KTM 204 Ukraine 244-941".
Monitoring method	Statistics
Recording frequency	Once per year .
Background data	At present the standard specific discharge of hot water is valid in Ukraine that was established by the "KTM 204 Ukraine 244-94"

	in 1993, and no information is available on any propositions to change it.
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels
Value in monitoring period	Cef (natural gas) = 0.0561 $ktCO_2$/TJ; Cef (coal) = 0.0946 $ktCO_2$/TJ; (taken as "Other bituminous coal").
Monitoring method	Normative documents
Recording frequency	Once per year .
Background data	For all fuels we used CO_2 emission factors from the data table provided in Annex C of the Operational Guidelines for Project Design Documents of Joint Implementation Projects [Volume 1: General guidelines; Version 2.2].
Calculation method	

Parameter number and name (according to PDD monitoring plan)	**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	Recalculating factor is 0.4
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	Recalculating factor for average load during heating period is determined for each boiler-house on historical base, usually it is in the range (0,4 – 0,8)
Calculation method	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min})$ where: g – recalculating factor for average load during heating period; F_h – heating area of buildings, m^2; k_h – average heat transfer factor of heated buildings,(W/m^2*K); T_{in} – average inside temperature for the heating period, K ; $T_{out\ av}$ – average outside temperature for the heating period, K (or ^{0}C); $T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^{0}C).

Parameter number and name	**20.** Electric power consumption
Description	Electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented
Value in monitoring period	Electric power consumption in 2009 – 42358,4 ths.kWh
Monitoring method	Measurement by Electricity supply meters
Recording frequency	Every day
Background data	Electric power consumption were measured at the boiler-houses where energy saving measures are scheduled to be implemented, for example:: 1. Boiler-houses, in the heating area of which, installation of heat exchangers will be take place. 2. Boiler-houses where replacement of pumps will be take place. 3. Boiler-houses, where frequency controllers will be installed 4. Boiler-houses, in the heating area of which, network replacement will be take place.
Calculation method	According to the Monitoring Plan the volume of consumed electric power was corrected by measurement error using the principle of conservatism. Electric power consumption in the reported year that used for Project emissions calculations was increased on the level of accuracy of electricity meters installed at the every boiler-house. See Annex 5.