JI PROJECT MONITORING REPORT
ANNUAL REPORT

 # UA1000157 / 03

Version 03

May 18, 2011

"Rehabilitation of the District Heating System in Luhansk City"

CONTENTS

ANNEXES

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:

ITL project ID - UA 1000157

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 "Rehabilitation of the District Heating System in Luhansk City" 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_2e	Project emissions, tCO_2e	Emission Reduction, tCO_2e
2010	**358737**	**290161**	**68576**

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 04* [1], the baseline shall be established on a project-specific basis, or where applicable, project participants may opt to apply approved clean development mechanism (CDM) baseline and monitoring methodologies.

In course of development of the project **"Rehabilitation of the District Heating System in Luhansk City"**, 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 System in Luhansk City"** 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 $EG_{PJ, i, y}$ – 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.

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[1] *http://ji.unfccc.int/Ref/Documents/Guidelines.pdf*
[2] *http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_L4AQZSBA770KNI0BUSG1JVIWCXIFU5*

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 $\varepsilon_{project,i,y}$ 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 report, the majority of boiler-houses in Ukraine are not equipped with devices for heat-carrier expenditure definition or heat meters. There is only one parameter that is regularly and with high precision defined in the boiler houses – fuel consumption.

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

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.

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[3] *http://cdm.unfccc.int/UserManagement/FileStorage/K4P3YG4TNQ5ECFNA8MBK2QSMR6HTEM*
[4] *http://cdm.unfccc.int/filestorage/EB52_repan06_AM0048_ver03.pdf?t=SHh8M0lHTFRBRkMxVlNZNEhRVU84V1pETjA2NTdFTVhKfDEyODgxNzIzNDEuNjc=|35jXwvrTnpGqUjSvdxUE9eB3Q6w=*

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

- It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95 % of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (CO_2) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as registration of residents' complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.
- Definition of the fuel consumption in base year (baseline) in view of the fact that in Ukraine at the majority of the municipal heat supply enterprises the natural gas is used as a fuel, which consumption is measured constantly by the counters with the high measurement accuracy, seems to be more exact, than definition of the fuel consumption with use of heat power, boiler efficiency and heat value of the fuel. This especially concerns the efficiency, which changes greatly depending on load of boilers, which also changes essentially, and often not automatically but manually, in the heat supply systems within a day and within a year. Averaging of such values 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 "Rehabilitation of the District Heating System in Donetsk Region", "District Heating System Rehabilitation of Chernihiv Region", "Rehabilitation of the District Heating System in Kharkiv City", "Rehabilitation of the District Heating System of Crimea", 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.

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

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 inflownce 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 CO_2e:

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

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

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

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

where:
E_{1i}^b and E_{1i}^r –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 $E_{gen\,i}^r$ –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), and generated by included into the project objects in the reported year, respectively, t CO_2e;
$E_{cons\,i}^b$ and $E_{cons\,i}^r$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year and in the reported year, respectively, t CO_2e.

For each (i) boiler-house:

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

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

$$E_{gen}^b = W_b*CEF_g + Q_b*f_b/1000*NCV_r*Cef \quad (6)$$

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

$$E_{cons}^b = P_b*CEF_c \quad (8)$$

$$E_{cons}^r = P_r*CEF_c \quad (9)$$

where:

NCV – Net Calorific value of a fuel, MJ/m^3 (MJ/kg);
Cef – Carbon emission factor for a fuel, kt CO_2/TJ;
B – amount of a fuel consumed by a boiler-house, ths m^3 or tonnes;
W_b – scheduled electricity production by the new CHP units at a boiler-house, MWh;
W_r – electricity production by the installed CHP units MWh;
CEF_g– Carbon emission factor for the Ukrainian grid, tCO_2e/MWh;
P_b – electricity consumption in the base year by a boiler-house where energy saving measures are scheduled to be implemented, MWh;
P_r – electricity consumption in the reported year by a boiler-house where energy saving measures are implemented, MWh;

CEF_c – Carbon emission factor for JI projects on 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 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/MWh;
B_g – amount of fuel (gas) consumed by the installed CHP units for heat and electricity 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:

$$E_{1i}^{b} = E_{hi}^{b}, + E_{wi}^{b}; \quad (10)$$

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

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

$$E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w], \quad (11)$$

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

For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is:

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

$$E_1^r = NCV_r* Cef_r*B_r \quad (13)$$

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

$$a_b = L_h^b*g*N_h^b / (L_h^b*g*N_h^b+L_w^b*N_w^b); \quad (14)$$

$$a_r = L_h^r*g*N_h^r / (L_h^r*g*N_h^r+L_w^r*N_w^r), \quad (15)$$

where:
L_h, L_w – maximum connected load to the boiler-house, that is required for heating and for hot water supply service, MW;
g – recalculating factor for average load during heating period (is determined for each boiler-house on historical base, usually is in the range 0.4 – 0.8);

N_h, N_w – duration of heating period and period of hot water supply service per year, hours.
[h] index – related to heating;
[w] index – related to hot water supply.

Adjustment factors:

1. K_1 (Net calorific value of a fuel change factor):

$$K_1 = NCV_b / NCV_r \tag{16}$$

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

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

$$B_h = B*a = Q_h / NCV*\eta_h, \tag{17}$$

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

$$Q_{h\,br} = Q_{h\,b}*K_h = Q_{h\,r} \tag{18}$$

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.

This averaged adjustment factor may be determined from the equation:

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

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

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

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

Then:

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

The components of K_h:

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[5] *Norms and instructions on rationing of fuel and heat energy for heating of residential and public buildings, as well as for communal and domestic needs in Ukraine. KTM 204 Ukraine 244-94. Kyiv, 2001, 376 p.*

2.1. K_2 (Temperature change factor):

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

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

$K_3 = (F_{h\ r} * k_{h\ r}) / F_{h\ b} * k_{h\ b} = [(F_{h\ r} – F_{h\ t\ r} – F_{h\ n\ r}) * k_{h\ b} + (F_{h\ n\ r} + F_{h\ t\ r}) * k_{h\ n}] / F_{h\ b} * k_{h\ b}$, (23)

where:
$F_{h\ b}$ – heated area of buildings in the base year, m^2;
$F_{h\ r}$ – heated area of buildings in the reported year, m^2;
$F_{h\ n\ r}$ – heated area of new buildings connected to DH system (assumed with the new (improved) thermal insulation) in the reported year, m^2;
$F_{h\ t\ r}$ – heated area of buildings (previously existed in the base year) in reported year with the renewed (improved) thermal insulation, m^2;
$k_{h\ b}$ – average heat transfer factor of heated buildings in the base year, kW/m^2*K;
$k_{h\ r}$ – average heat transfer factor of heated buildings in the reported year, kW/m^2*K;
$k_{h\ n}$ – heat transfer factor of heated buildings with the new thermal insulation (new buildings or old ones with improved thermal insulation), kW/m^2*K.

2.3. K_4 (Heating period duration change factor):

$K_4 = N_{h\ r} / N_{h\ b}$ (24)

where:
$N_{h\ b}$ – duration of the heating period in the base year, hours;
$N_{h\ r}$ – duration of the heating period in the reported year, hours.

Thus,

$K_h = K_2 * K_3 * K_4$ (25)

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

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

$B_w = B*(1-a) = Q_w / NCV*\eta_w$, (26)

where
Q_w - required amount of heat during the service rendered period
η_w - overall efficiency of the hot water supply system.

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

$Q_{w\ br} = Q_{w\ b} * K_w = Q_{w\ r}$ (27)

where:
$Q_{w\ br}$ – required amount of heat for hot water supply service for Dynamic Baseline, is assumed equal to $Q_{w\ r}$ – required amount of heat for hot water supply service in the reported year,
$Q_{w\ b}$ – required amount of heat for hot water supply service in the base year,
K_w – averaged adjustment factor for hot water supply service.

This averaged adjustment factor may be determined from the equation:

$K_w = Q_{w\ r} / Q_{w\ b}$. (28)

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

$Q_w = n_w * v_w * N_w$, (29)

where:
Q_w – required amount of heat for hot water supply service, kWh;
n_w – average number of service's customers, personal accounts;
v_w – standard specific discharge of hot water per personal account (in heat units, kWh/h);
N_w – duration of the service period per year, hours.

Then:
$K_w = n_{w\,r} * v_{w\,r} * N_{w\,r} / n_{w\,b} * v_{w\,b} * N_{w\,b}$ (30)

where;
$n_{w\,r}$ and $n_{w\,b}$ – number of consumers in the reported year and the base year, respectively;
$v_{w\,r}$ and $v_{w\,b}$ - standard specific discharge of hot water per personal account (in heat units, kWh/h) in the reported year and the base year, respectively;
$N_{w\,r}$ and $N_{w\,b}$– duration of the service period per year, in the reported year and the base year, respectively, hours.

The components of K_w:

3.1. K_5 (Number of of hot water supply service customers change factor):

$K_5 = n_{w\,r} / n_{w\,b}$ (31)

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

$K_6 = v_{w\,r} / v_{w\,b}$ (32)

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

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

$K_7 = N_{w\,r} / N_{w\,b}$ (33)

Thus,

$K_w = K_5 * K_6 * K_7$. (34)

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

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

$K_5 = K_6 = K_7 = 1$. (35)

Thus

$K_{w0} = 1$. (36)

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

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

The starting date of the project according to PDD is: 07/02/2006
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 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	3 rd Monitoring Period		

Table 2: Status of implementation (according to PDD)

Implementation of boiler houses rehabilitation and network rehabilitation are realized mainly according to project plan with some deviations from time-table. In several cases replacement of different (from planed before) diameters of network pipes takes place. Installation of frequency controllers is not finished yet. Implementation of CHP units and HPS unit is delayed due to lack of financing.

Table of implemented energy saving measures is presented bellow.

Implemented energy saving measures	**Volume of performed works (number of boilers, length of network replacement, etc.)**		
	2003-2009	**2010**	**Total**
Reconstruction of boiler	97	57	154
Replacement of boiler's convection part	21		21
Replacement of boiler's ceiling screens	6		6
Replacement of boiler's screen tubes	3	1	4
Replacement of boiler's heating surface	1		1
Switching boiler to water-heating mode	2		2
Reconstruction of setting	18	1	19
Replacement of boiler's burners	36	13	49
Installation of automatic system for boilers	20	6	26
Switching of boiler-houses' load to the more effective ones	6	4	10
Replacement of boilers:			
KSVa-3G	3		3
AOGV-100	3		3
KOLVI-500		2	2
KOLVI - 1000 - 2,6 MW	2		2
Vitomax 200 LW- 40 MW	4		4
MH120 EKO "Bernard" - 360 kW	2		2
IVAR Superac 290 2F - 600 KW	2		2
MH120 EKO "Bernard" - 420 kW	4		4
«Super Rac-2F-345»	6		6
KTN-50		2	2
KTN-100		2	2
Building of boiler-house	1		1
Replacement of tank-accumulators	1		1
Heat exchangers replacement	4	3	7
Pumps replacement		2	2
Frequency controllers installation	12		12
Replacement of capacitors	7		7
Reconstruction of chemical water treatment (CWT)		7	7
Reconstruction of filters		7	7
Network rehabilitation with pre-insulated pipes, m	41432	43044	84476
Network rehabilitation with usual pipes, m	87070		87070

Table 2: Table of implemented energy saving measures

For detailed information about implemented measures see Annex 2.

Fig.1. Boilers Kolvi-550 installed at boiler-house Artema, 449b (#102 in the Project)

Fig.1. Step-up pumping station Grundfos CRE1-15 G-A-A-E-HQQE installed at boiler-house Artema, 449b (#102 in the Project)

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 dated December 11, 2009 was determined by AIE "Bureau Veritas Certification Holding SAS" (Determination Report No: UKRAINE-0048/2009 dated 18.12.2009).

The National Environmental Investment Agency of Ukraine has issued the Letter of Approval for this project #365/23/7 dated 16. 04.2010.
Letter of Approval from the Party of buyer - The Netherlands # 2010JI02 was issued on 03.03.2010.

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.

There are no deviations or revisions to the registered PDD.

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

There are no deviations or revisions to the registered monitoring plan.

A.9. Changes since last verification:

1 st Monitoring Report was made for the period January 1, 2008 - December 31, 2008 (Version 02 dated June, 02 2010).
2 nd Monitoring Report was made for the period January 1, 2009 - December 31, 2009 (Version 02 dated June, 03 2010).

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

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

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SECTION B. Key monitoring activities

The control and monitoring system comes 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. 3, typical gas flow meter is shown at the Fig. 4.

Fig. 3. Gas distribution unit

Fig. 4. Gas flow meter with corrector

The typical scheme of the gas distributing system is shown at the Fig. 5. Usually it consists of the following equipment:

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

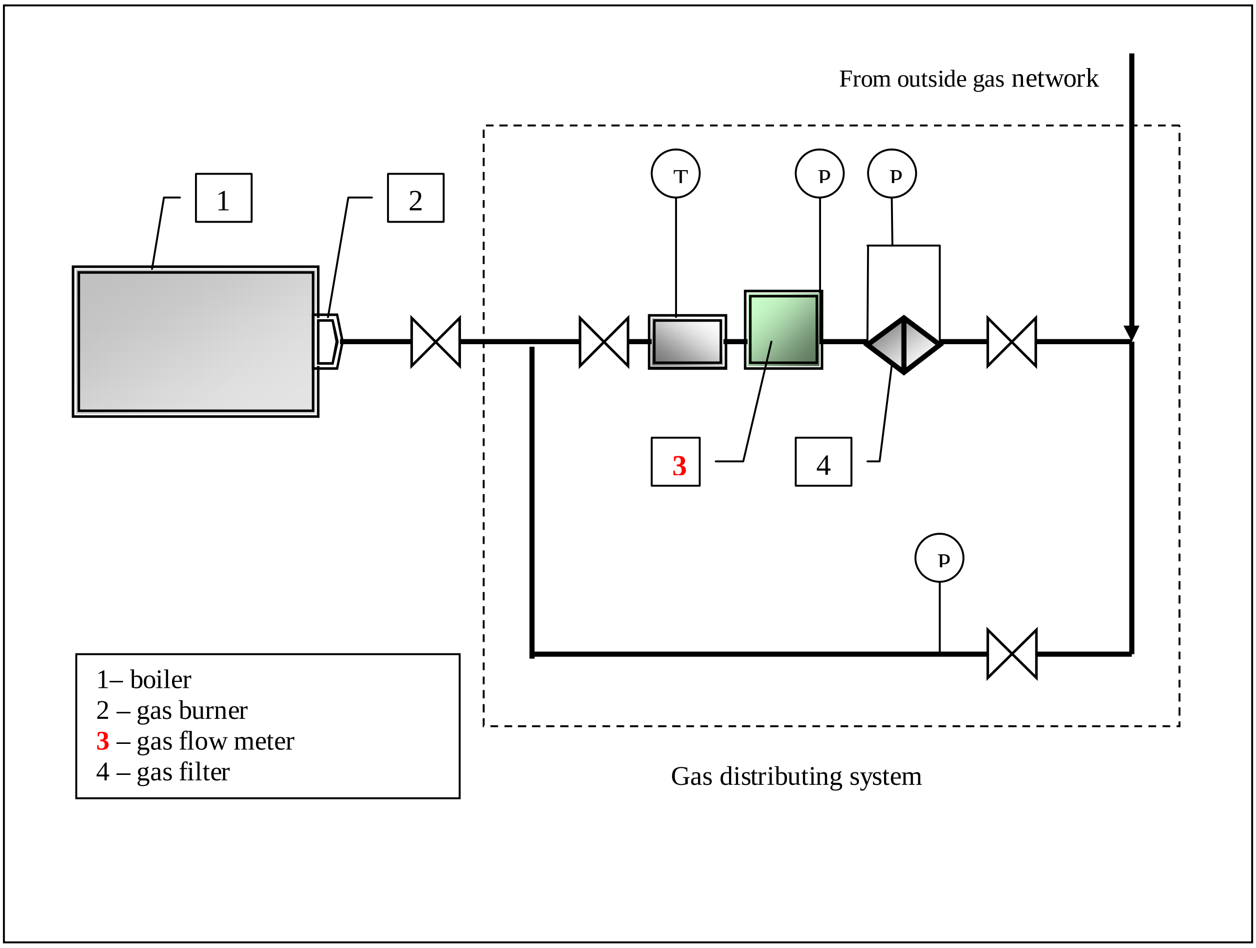

Fig. 5. Scheme of the gas distribution system

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

At the boiler-houses that are not equipped with gas volume correctors, operator of a boiler house every 2 hours reads the values of natural gas temperature and pressure at a boiler-house gas-input. Natural gas consumption is measured by gas flow meter, installed at a boiler-house. Every day operator of a boiler house makes registration of daily gas consumption in the special paper journal.

B.1. Monitoring equipment types:

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

Type of gas flow meter	Manufacturer
GMS G-160-80 GMS G-65/40 G-1601-100 G-250 … 1000 Б G-65 A1 G65 ТЕМП 1/50	"Slot" Ltd., Ivano-Frankivsk
3095 FE	"Izodrom" Ltd.
«Курс -01»	"Slot" Ltd., Ivano-Frankivsk
РГ-К-25…1000	"Tandem" Ltd., Vinnytsya
"ПМ-3В"	Kyiv city
ЛГК-650…1600	"Slot" Ltd., Ivano-Frankivsk
GMS 10…40	"Tandem" Ltd., Vinnytsya
Ж-650-ЛГК	Donetsk city
МБМ 6	"Premagas"
РЛ 4	DP "Arsenal" Kyiv
GMS-10…63	Kyiv city
G6 МКМ	Kyiv city
АМЖ-10	"Apator-metric" Poland
Type of corrector	
ОЕ -22 ЛА	"Slot" Ltd., Ivano-Frankivsk
ОЕ VPT	"Slot" Ltd., Ivano-Frankivsk
«Тандем»	"Tandem" Ltd., Vinnytsya
В - 25	Donetsk city

Table 3: Gas flow meters and correctors types

For electricity consumption measurement the following electricity meters are used:

Type of electricity flow meter	Manufacturer
СА4У-И672М СР4У-И673М СА4-И678	JSC "LEMZ", Russia
СА4-195, СА4-196, СА4-199 СА4-5001	SE "KhZE", Kharkiv city
СО-197, СО-446	SE "KhZE", Kharkiv city
ЦЭ-6803в, ЦЭ-6811	"Energomira", Russia
SL 7000	France
ACE 5000… 6000	France
СОЭ-1,02/2т	"Merydian", Kyiv city
EMT133106	"Elgama", Lithuania
СТК 3-10-Q	"Energomira", Russia

CP4-5002	"Rostok", Kyiv city
СТ-ЭА03	"Komunar"
Меркурий (А+Р)	JSC "LEMZ", Russia
СТК-3 (А+Р)	PKF "Telekart"
5CM-4	AEM-SA, Romania
NIK 2303	"Nik", Kyiv city

Table 4: 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 the requirements of the State Standard of Ukraine № 2708:2006 "Metrology. Calibration of measuring equipment. The organization and procedure"[6], all measuring equipment in Ukraine should meet the specified requirements and is to be inspected (calibrated) periodically.

Type of gas flow meter	Calibration interval
GMS G-160-80 GMS G-65/40 G-1601-100 G-250 … 1000 Б G-65 A1 G65 ТЕМП 1/50	2 years
3095 FE	1 years
«Курс -01»	2 years
РГ-К-25…1000	2 years
"ПМ-3В"	2 years
ЛГК-650…1600	2 years
GMS 10…40	2 years
Ж-650-ЛГК	2 years
МБМ 6	6 years
РЛ 4	6 years
GMS-10…63	2 years
G6 МКМ	2 years
АМЖ-10	5 years
Type of electricity flow meter	
СА4У-И672М СР4У-И673М СА4-И678	4 years
СА4-195, СА4-196, СА4-199 СА4-5001	4 years
СО-197, СО-446	8 years

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

ЦЭ-6803в, ЦЭ-6811	16 years
SL 7000	6 years
ACE 5000… 6000	6 years
СОЭ-1,02/2т	16 years
EMT133106	8 years
СТК 3-10-Q	4 years
СР4-5002	6 years
СТ-ЭА03	6 years
Меркурий (А+Р)	10 years
СТК-3 (А+Р)	6 years
5СМ-4	8 years
NIK 2303	6 years

Table 5: Measuring equipment calibration interval

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"Luhanskstandartmetrologiya" according to Agreement #48030-2009 from 12.01.2009.

Calibration of correctors type «Тандем» was carried out by “Bartosh AP” according to Agreement #183-У/28-2010 from 11.05.2010.

Daily outside temperature values are taken by dispatcher of LCME “Teplocomunenergo” from Luhansk Regional Gidrometerology Center every day of heating period. Luhansk Regional Gidrometerology Center sends the Report every month for every day of heating period according to Agreements # 3M from 09.10.2008 and # 3M from 03.10.2010.

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 at the LCME “Teplocomunenergo” due to reducing of fuel consumption) and Annex 3 (GHG emission reduction at the LCME “Teplocomunenergo” due to reducing electricity consumption) of this report. The table in Section B.2.1 contains all default values, variables and attached values that have been used in calculating emission reductions in this monitoring report.

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

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	(B_b) and (B_r)	Fuel consumption by boiler houses		m
1.1		Natural Gas	m^3	
1.2		Coal	ton	
2	(NCV_b) and (NCV_r)	Average annual Net Calorific Value of fuels		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 period	^0C (K)	m, c
4	($T_{in\ b}$) and ($T_{in\ r}$)	Average inside temperature during the heating period	^0C (K)	m, c
5	(n_{wb} and (n_{wr})	Number of customers of the hot water supply service		Statistics
6	($F_{h\ b}$ and ($F_{h\ r}$)	Heated area (total)	m^2	Statistics
7	(k_{hb})	Average heat transfer factor of heated buildings in the base year	W/m^2*K	Normative documents
8	($F_{h\ t\ r}$)	Heated area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year	m^2	Statistics
9	($F_{h\ n\ r}$)	Heated area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m^2	Statistics
10	($k_{h\ n}$)	Heat transfer factor of buildings with the new thermal insulation	W/m^2*K	Normative documents
11	($N_{h\ b}$) and ($N_{h\ r}$)	Duration of the heating period	Hours	m
12	($N_{w\ b}$) and ($N_{w\ r}$)	Duration of the hot water supply period	Hours	m
13	(L_h^b) and (L_h^r)	Maximum connected load to a boiler-house, that is required for heating	MW	c
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	($v_{w\ r}$) and ($v_{w\ b}$)	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	
16.3		For JI projects on reducing electricity consumption in Ukraine	t CO_2e/ MWh	

16.4		For the Ukrainian grid	t CO_2e/ MWh	
17	**g**	Recalculating factor for average load during heating period		Statistics
18	(**W_b**) and (**W_r**)	Scheduled electricity production by the new CHP units and electricity production by the installed CHP units in the reported year, MWh	MWh	c/m
19	(**Q_b**) and (**Q_r**)	Scheduled heat energy production by the new CHP units and heat energy production by the installed CHP units in the reported year, MWh	MWh	c/m
20	(**P_b**) and (**P_r**)	Electricity consumption by the boiler-houses	MWh	m

Table 6: List of fixed default values, variables and attached values

Parameters 18, 19 associated with installation of CHP units are not applicable in this Monitoring report due to non-implementation of these measures.

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

1. Project implementation allowed saving over 37 million Nm^3 of natural gas, over 222 ton of coal and about 6782 MWh of electricity during 2010.

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

3. Project implementation allows to decrease the water consumption and as a result – to decrease the amount of waste water. The evidences for these statements can be acts of water consumption with RME "Luhanskvoda" for 2006-2010 years.

4. Impact on the land medium is not present.

5. Impact on biodiversity is not present.

6. Waste generation is increased over the project implementation after disassembling of physically and

morally obsolete equipment, burners, pipes, etc. Also some construction waste are occurred 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" # СП-457 from 29.12.2009 and # С-51-У/15-2009-1384 from 29.12.2009 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 the LCME "Teplocomunenergo" is carried out by the following scheme:

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

2. Most of boiler-houses equipped with automatic corrector for temperature and pressure. Gas consumption registered automatically. Beside this operator of a boiler-house registers the instrument readings in the paper journal "Journal of registration of boiler-house's operation parameters" every day, see Fig.6.

3. At the boiler-houses that are not equipped with gas volume correctors (at present about 2% of the total number of boiler-houses), 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" (Fig.6) every 2 hours. These parameters are used to bring gas consumption to normal conditions.

4. Every day operators transfer values of energy sources (fuel and electricity) consumption to dispatcher of the regional branch of the LCME "Teplocomunenergo" by phone. Monthly they transfer the paper report.

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

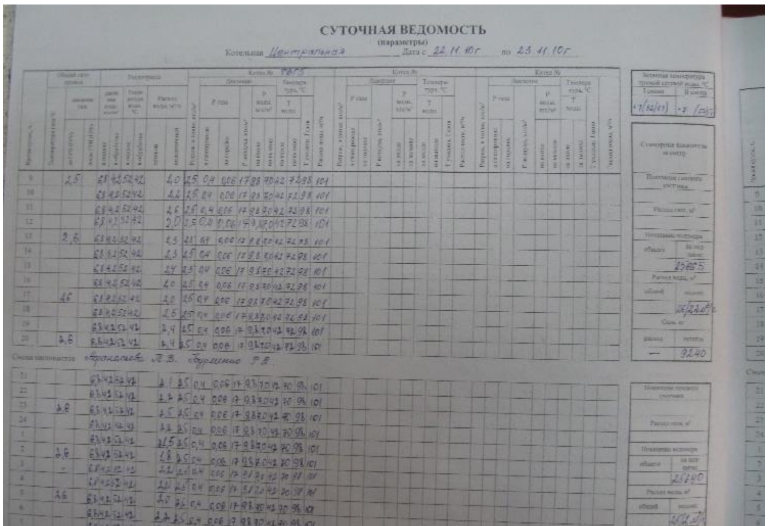

Fig. 6 Paper journal for registration of boiler-house's operation parameters

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

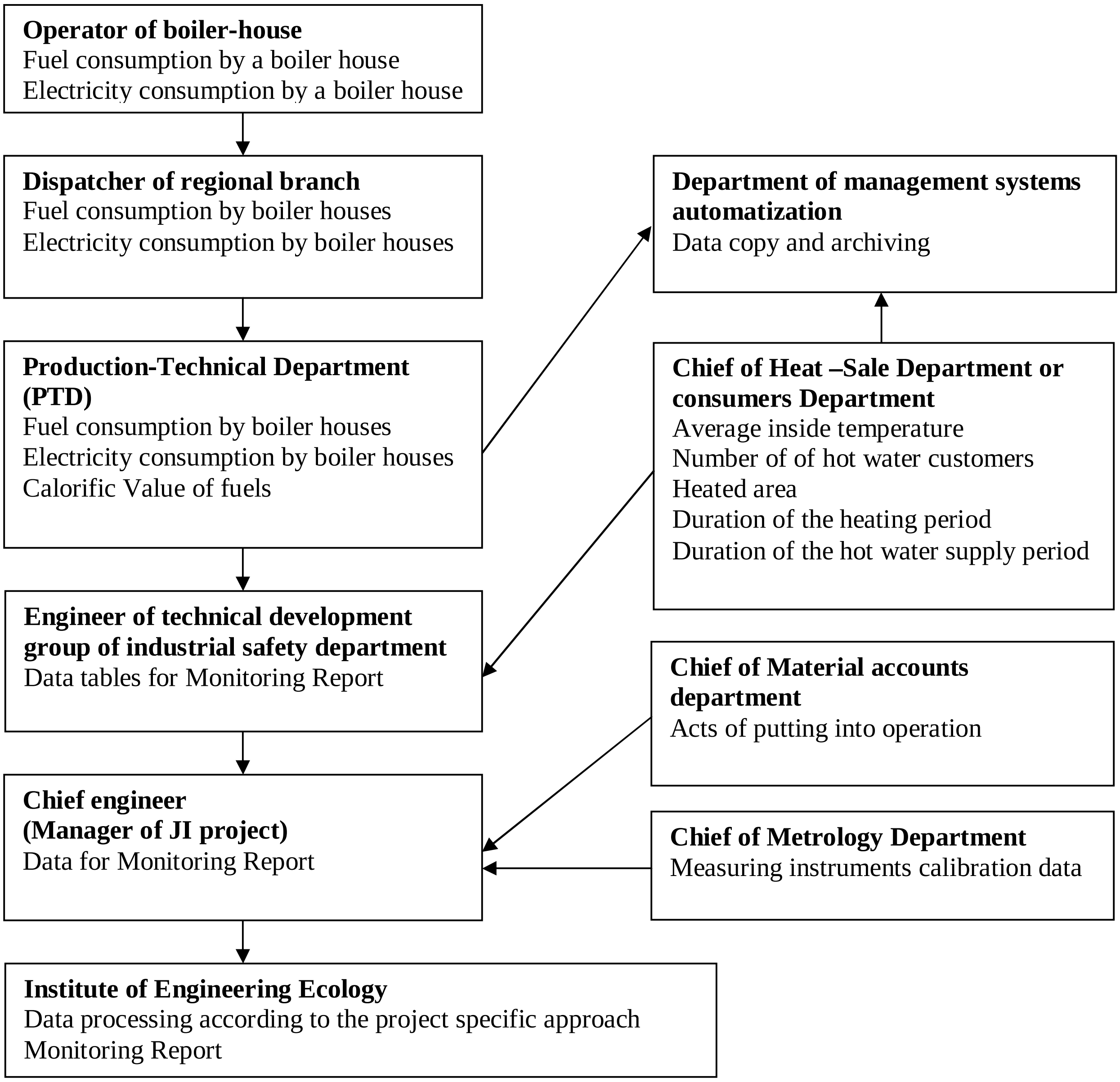

Fig.7. Scheme of data collection for Monitoring Report

B.4. Special event log:

n.a.

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

The director of the LCME "Teplocomunenergo", Mr. Oleksiy Rusakov, appointed the responsible person, Mr. Yuriy Negrey, for the implementation and management of the monitoring process at the LCME "Teplocomunenergo". Mr. Yuriy Negrey is responsible for supervising of data collection, measurements, calibration, data recording and storage.

Dr. Dmitri Paderno, Deputy director of Institute of the 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.

Responsibilities for data management are presented in Table 7.

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	Lidia Fomenko	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	Senior engineer of technical development group of industrial safety department of LCME "Teplocomunenergo"
Data monitoring and reporting, coordination of verification process	Yuriy Negrey	Chief engineer of LCME "Teplocomunenergo"
Data processing according to JI project specific approach, development of Monitoring Report	Kateryna Korinchuk	Engineer of the Institute of Engineering Ecology, Ltd
Support in coordination of verification process	Dmitri Paderno	Deputy Director of the Institute of Engineering Ecology, Ltd

Table 7: Responsibilities for data management

C.1.2. Trainings:

As far as the main activity of the LCME "Teplocomunenergo" is not changed in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprise have sufficient knowledge and experience for implementation of the project activity and maintenance of the usual equipment.

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

The LCME "Teplocomunenergo" provides personnel retrainings 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 the Institute of Engineering Ecology carried out a comprehensive consultations and trainings for involved representatives of the LCME "Teplocomunenergo" on the necessary data collection according to Monitoring plan for the project.

The special training was held before preparing of 1st Monitoring report, in October, 2009. The special group consisted of representatives of the LCME "Teplocomunenergo" and the 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, Deputy director.

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

C.2. Involvement of Third Parties:

There were no third parties involved for quality assurance and quality control measures.

C.3. Internal audits and control measures:

Manager of the JI project Mr. Yuriy Negrey 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, Mr. Yuriy Negrey - Chief engineer of LCME "Teplocomunenergo", 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)	
	$ERUs = \sum[E_i^b - E_i^r]$; [t CO_2e]
	ERUs - total annual emission reduction, t CO_2e E^b_i - baseline emissions, t CO_2e E^r_i - 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 –emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, t CO_2e; $E_{gen\ i}^r$ –emissions due to electricity generation by included into the project objects in the reported year, t CO_2e; $E_{cons\ i}^r$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the reported year, t CO_2e.

Formula 3 –Emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house in the reported year, (E_{1i}^r)	
	$E_{1i}^r = NCV_r * Cef_r * B_{ri}$, [t CO_2e]
	NCV_{ri} – average annual Net Calorific Value of a fuel, MJ/m^3 (MJ/kg) Cef – Carbon emission factor for a fuel, ktCO_2/TJ; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons

Formula 4 – Emissions due to electricity generation by included into the project objects in the reported year ($E_{gen\ i}^{r}$)	
	$E_{gen}^{r} = (W_b - W_r)*CEF_g + [(Q_b - Q_r)*f_b/1000 + B_g]* NCV_r * Cef$
	W_b – scheduled electric power production by the new CHP units, MWh; W_r – electricity production by the installed CHP units in reported year, MWh; CEF_g – Carbon emission factor for the Ukrainian grid, t CO_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 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/MWh; B_g – amount of fuel (gas) consumed by the installed CHP units for heat and electricity generation, ths m^3; Cef – Carbon emission factor for natural gas, ktCO_2/TJ;

Formula 5 – Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the reported year ($E_{cons\ i}^{r}$)	
	$E_{cons\ i}^{r} = P_r * CEF_c$
	P_r – electricity consumption in the reported year by a boiler-house where energy saving measures are implemented, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, tCO_2e/MWh;

Baseline emissions

Formula 6 – Dynamic baseline emissions **(**E_b)	
	$E_i^b = E_{1i}^b + E_{gen\ i}^b + E_{cons\ i}^b$; [t CO_2e]
	E_{1i}^b – baseline emissions due to fuel consumption for heating and hot water supply service by an (i) boiler-house, t CO_2e; $E_{gen\ i}^b$–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 CO_2e; $E_{cons\ i}^b$ –emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year, t CO_2e.

Formula 7 – Baseline emissions due to fuel consumption for heating and hot water supply service by 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, $(1-a_b) \neq 0$): $E_1^b = NCV_b * Cef_b * [B_b * a_b * K_1 * K_h + B_b * (1-a_b) * K_1 * K_w]$, where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply service.

	For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population): $E_1^b = NCV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.
	NCV_b – average Net Calorific Value of a fuel in the base year, MJ/m^3 (MJ/kg); Cef – Carbon emission factor for a fuel, $KtCO_2/TJ$; 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)	
	$a_b = L_h^b*g*N_h^b / (L_h^b*g*N_h^b+L_w^b*N_w^b)$;
	L_h^b – maximum connected load required for heating in the base year , MW; L_w^b – connected load required for hot water supply service in the base year , MW; g – recalculating factor for average load during heating period; N_h^b – duration of heating period in the base year, hours; N_w^b – duration of hot water supply service in the base year, hours.

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

Formula 10 – Net calorific value of a fuel change factor (K_1)	
	$K_1 = NCV_b / NCV_r$
	NCV_b – average Net Calorific Value in the base year, MJ/m^3 (MJ/kg); NCV_r – average Net Calorific 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, ^0C; $T_{in\,b}$ – average inside temperature for the heating period in the base year, ^0C; $T_{out\,r}$– average outside temperature for the heating period in the reported year, ^0C; $T_{out\,b}$– average outside temperature for the heating period in the reported year, ^0C

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

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

Formula 14 – Number of customers of the hot water supply service change factor (K_5)	
	$K_5 = n_{wr} / n_{wb}$
	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

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

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

Formula 17 –Emissions due to electricity generation associated to the project for an (i) boiler-house in the base year ($E_{gen\,i}^{b}$)	
	$E_{gen}^{b} = W_b{*}CEF_g + Q_b{*}f_b/1000{*}\ NCV_r{*}\ Cef$
	W_b – scheduled electricity production by the new CHP units at a boiler-house, MWh; CEF_g – Carbon emission factor for the Ukrainian grid, tCO_2e/MWh; Q_b – scheduled heat energy production by the new CHP units at a boiler-house, MWh; f_b – specific natural gas consumption by a boiler-house, where CHP units are scheduled to be installed, m^3/MWh; NCV_r – average annual Net Calorific Value of a fuel in reported year, MJ/m^3 (MJ/kg) Cef – Carbon emission factor for a fuel, $ktCO_2/TJ$;

Formula 18 –Emissions due to electricity generation to the state grid in amount consumed by an (i) boiler-house in the base year ($E_{cons\,i}^{b}$)	
	$E_{cons}^{b} = P_b{*}CEF_c$
	P_b – electricity consumption in the base year by a boiler-house where energy saving measures are scheduled to be implemented, MWh; CEF_c – Carbon emission factor for JI projects on reducing electricity consumption in Ukraine, tCO_2e/MWh

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

D.3.1. Project emissions:

Project emissions consist of GHG emissions due to fuel and electricity consumption for heating and hot water supply service at the LCME "Teplocomunenergo" in the reported year.

Project emissions, tCO_2e	**2010**
Emissions due to fuel consumption	232948
Emissions due to electricity consumption	57213
Total	**290161**

Table 8: Project emissions

See Annex 6.

D.3.2. Baseline emissions:

Baseline emissions consist of GHG emissions due to fuel and electricity consumption for heating and hot water supply service at the LCME "Teplocomunenergo" in the base year, corrected according to the actual conditions in the reported year (the dynamic baseline).

Baseline emissions, tCO_2e	**2010**
Emissions due to fuel consumption	293215
Emissions due to electricity consumption	65522
Total	**358737**

Table 9: Baseline emissions

See Annex 6.

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_2e	**2010**
Emissions due to fuel consumption	60267
Emissions due to electricity consumption	8309
Total	**68576**

Table 10: Total Emission Reductions

See Annex 6.

According to the results of the Monitoring Report for 2010, the actual achieved GHG emission reductions are larger than it was indicated as prognosis estimation in the PDD.

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 are:

1) Application of the principally different approaches and methods 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.;
2) Application of the strictly conservative approach for estimation of emission reductions in the PDD: the minimum assured (on the basis of the known results of similar measures) effect from implementation of all energy saving measures was accepted, and in some cases, when it was impossible to define it concretely in numbers, was not taken into account in the calculations in the PDD, although it obviously must be positive;
3) Implementation in the first place the measures which favour achievement of the maximal emission reductions;
4) In connection with participation in the JI project, in the course of the project realization the system of responsibility of every employee for optimum consumption of fuel and energy resources at the enterprise was established, as a result of which the off-scheduled monitoring of all key parameters of work of the system as a whole is conducted at the objects of the enterprise, as well as additional and concomitant measures for emission reduction are implemented.

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

Annex 1 – Data

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

Parameter Number	Parameter Name
1	Fuel consumption by boiler house
1.1	Natural Gas
1.2	Coal
2	Average annual Calorific Value of a fuel
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	Duration of the heating period
12	Duration of the hot water supply service period
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	For JI projects on reducing electricity consumption in Ukraine
16.4	For the Ukrainian grid
17	Recalculating factor for average load during heating period
18	Scheduled electricity production by the new CHP units and electricity production by the installed CHP units in the reported year
19	Scheduled heat energy production by the new CHP units and heat energy production by the installed CHP units in the reported year
20	Electricity consumption by the boiler-houses

Parameter number and name	**1.1** Natural gas consumption by boiler houses
Description	Natural gas consumption by boiler houses
Value in monitoring period	2010 – 127116.36 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 hour
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	2010 - 466.7 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	

Parameter number and name	**2.1** Average annual Calorific Value of natural gas
Description	Average annual Calorific Value of natural gas calculated by Net Calorific Value
Value in monitoring period	2010 – 33.21 MJ/m^3
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	**2.2** Average annual Calorific Value of Coal
Description	Average annual Calorific Value of Coal calculated by Net Calorific Value
Value in monitoring period	2010 – 17.6 MJ/kg
Monitoring method	Accepted in accordance with quality certificate from coal supplier's or independent chemical lab analysis report. Independent chemical lab analysis is used in contentious cases. It is used rarely
Recording frequency	Quality certificate is given by coal supplier's for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value

Parameter number and name	**3.** Average outside temperature during the heating 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 LCME "Teplocomunenergo" from the daily outside temperatures, that are taken by dispatcher of the enterprise from Luhansk Meteorological Centre at 10 to 11 a.m. every day of heating period.
Recording frequency	Once per year. Daily temperatures are registered 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

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	2010 - 18 ^{o}C
Monitoring method	Sum of returned payments
Recording frequency	Once per heating period
Background data	Accounting documents
Calculation method	According to "Rules of rendering of heat and hot water supply service to population" № 1497 from 30.12.1997, enterprise makes the return payment of: – 5% from payment for every degree from 18 to 12 ^{o}C; – 10% from 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 conservative approach, R < 0.05 is assumed for the baseline): $\mathbf{T}_{\mathbf{in\ b}}$ = 18 ^{o}C.

	If 0.05 < R ≤ 0.3: $\mathbf{T}_{\mathbf{in\ b}}$ = 18 – (R/0.05) [^{o}C] If 0.3 < R < 1: $\mathbf{T}_{\mathbf{in\ b}}$ = 12 – [(R – 0.3)/0.1] [^{o}C] where: R - portion of returned payment of NP; NP – amount of normative payment. Thus if the inside temperature will be 18 ^{o}C or higher we will accept it as 18 ^{o}C according to conservative approach, if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented before. The total sum of charge for population of Luhansk city in 2010 was 166.5 mln UAH the sum of returned payment was 4.7 mln UAH. Percentage of returned payment is 2.8% that corresponds to inside temperature 18 ^{o}C.

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	See Annex2
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	**6.** Heated area (Total)
Description	Heated area for every boiler house
Value in monitoring period	2010 – 6044.64 ths m^2 The detailed data of heated area for every boiler-house are presented in Annex 2.
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 sales departments of LCME "Teplocomunenergo" by the certificates of owners 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	

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 LCME "Teplocomunenergo"
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), State Buildings Norms (B.2.6-31:2006)
Calculation method	For calculation of Heat transfer factor of buildings for every boiler-house, the method of Weighted average value was used, that depends on heated area of existing buildings and heated area of the new buildings. Values of the heat transfer factor for existing buildings were taken from SNiP 2-3-79 (1998) - not higher than 0.63 W/m^2*K. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms (B.2.6-31:2006) - not higher than 0.36 W/m^2*K.

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 LCME "Teplocomunenergo"
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	
Calculation method	

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 LCME "Teplocomunenergo"
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name	**10.** Heat transfer factor of new buildings and buildings with new thermal insulation
Description	Heat transfer factor of buildings with new thermal insulation
Value in monitoring period	Not higher than 0.36 W/m^2*K
Monitoring method	According to State Buildings Norms (B.2.6-31:2006)
Recording frequency	
Background data	
Calculation method	

Parameter number and name	**11.** Heating period duration
Description	Heating period duration for every boiler house
Value in monitoring period	The detailed data of heating period duration are presented in Annex 2.
Monitoring method	Statistics of LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	The nominal duration (beginning and ending) of the heating 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". The heating period begins if the average daily outside temperature is 8 ^oC or lower during 3 days, and finishes if average daily outside temperature is 8 ^oC or higher during 3 days. The actual duration of the heating period is taken from statistics of LCME "Teplocomunenergo"
Calculation method	

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for every boiler house.
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 LCME "Teplocomunenergo"
Recording frequency	Once per year
Background data	Hot water supply service is realized by hot water delivery schedule for every boiler house.
Calculation method	

Parameter number and name	**13.** Maximum connected load to the boiler-house, that is required for heating
Description	Maximum connected load to the boiler-house that is required for heating.
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 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 period. It is calculated according to heat demand at outside temperature -25 ^{o}C [KTM 204 Ukraine 244-94, Annex 1].
Calculation method	

Parameter number and name	**14.** Connected load to the boiler-house, that is required for hot water supply service
Description	Connected load to the boiler-house, that is required for providing the hot water supply service
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 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	**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 244-94".
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", and no information is available on any propositions to change it. Thus it is not subject to special monitoring
Calculation method	

Parameter number and name	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels, for JI projects on reducing electricity consumption in Ukraine, for the Ukrainian grid
Value in monitoring period	Cef (natural gas) = 0.0561 ktCO_2/TJ; Cef (coal) = 0.0946 ktCO_2/TJ (taken as "Other bituminous coal"); CEF_g = 1.055 t CO_2/ MWh CEF_c = 1.162 t CO_2/ MWh
Monitoring method	Normative documents
Recording frequency	Once per year.
Background data	For all fuels the Carbon emission factors are used from the data provided in the *IPCC 1996 Guidelines for National Greenhouse Gas Inventories*[7] The values of the carbon emission factors for generation of electricity in Ukraine and for JI projects on reducing of electricity consumption in Ukraine were taken according to the Order of the National Environmental Investment Agency of Ukraine # 43 dated 28.03.2011.[8]
Calculation method	

Parameter number and name	**17.** Recalculating factor for average load during heating period
Description	Recalculating factor for determination of the average load during heating period
Value in monitoring period	See Annex 2
Monitoring method	Statistics
Recording frequency	Once per year.
Background data	Recalculating factor for average load during heating period (is determined for each boiler-house on historical base)
Calculation method	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min}) = (T_{in} - T_{out\ av}) / (T_{in} - T_{out\ min})$ where: g – recalculating factor for average load during heating period; F_h – heated area of buildings, m^2; k_h – average heat transfer factor of heated buildings, kW/m^2*K; T_{in} – average inside temperature for the heating period, ^{0}C ; $T_{out\ av}$ – average outside temperature for the heating period, ^{0}C; $T_{out\ min}$ – minimal outside temperature for the heating period, ^{0}C.

[7] http://www.ipcc-nggip.iges.or.jp/public/gl/pdffiles/rusch1-1.pdf
[8] http://www.neia.gov.ua/nature/doccatalog/document?id=126006

Parameter number and name	**20.** Electricity consumption by the boiler-houses
Description	Electricity consumption by the boiler-houses and heat supply stations related to them.
Value in monitoring period	2010 – 49527.34 MWh The detailed data on electricity consumption consumption by every boiler-house are presented in Annex 3.
Monitoring method	Electricity consumption by a boiler-house and heat supply stations related to it is measured by electricity meters.
Recording frequency	Every day.
Background data	Electricity consumption is registered in the paper journal at every boiler-house.
Calculation method	
	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.