JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

“Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region”

Sectoral scopes:

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

PDD Version: 03, dated March 14, 2012.

A.2. Description of the project:

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

Municipal Enterprise “Kharkivski teplovi merezhi” (further mentioned as ME “KhTM”) is the main heat supply organization in Kharkiv City. Other project partners are:

- Kharkiv Regional Municipal Enterprise “Dyrektsiya rozvytku infrastruktury terytorii” (further mentioned as KhRME “Dyrektsiya RIT”);
- Izium Heat Supply Networks Municipal Enterprise (further mentioned as Izium HSNME);
- Krasnohrad Heat Supply Networks Enterprise (further mentioned as Krasnohrad HSNE);
- Novovodolaha Heat Supply Networks Enterprise (further mentioned as Novovodolaha HSNE);
- Pervomais’kyi Municipal Enterprise “Teplomerezhi” (further mentioned as Pervomais’kyi ME “Teplomerezhi”);
- Municipal Enterprise of Balakliia District Council “Balakliyski teplovi merezhi” (further mentioned as MEBDC “BTM”);
- Municipal Enterprise “Teplovi merezhi” of Lozova City Council of Kharkiv Region (further mentioned as ME “Teplovi merezhi” of Lozova CC);
- “Kotelni likarnyanogo kompleksu” Ltd. (further mentioned as “KLK” Ltd.);
- Intersectoral Regional Corporation “Teploenergiya” (further mentioned as IRC “Teploenergiya”);
- Municipal Enterprise “Chuhuivteplo” (further mentioned as ME “Chuhuivteplo”);
- Kharkiv District Heat Supply Networks Municipal Enterprise of Kharkiv District State Administration (further mentioned as Kharkiv District HSNME);
- Borova Heat Supply Networks Municipal Enterprise (further mentioned as Borova HSNME).

Project includes 248 boiler-houses with 703 installed boilers and 278.5 km in the 2-pipe calculation of heat distribution networks, see Appendixes 1 and 2.

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

The common practice for the district heating enterprises in Ukraine including municipal enterprises that implement the project is to fulfil annual minimal repairing of the DH system to keep it working. In fact, mainly repairing of network’s parts and boilers which might cause accidents are commonly executed.

b) Baseline scenario:

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

Minimal annual repairing doesn't lead to reduction of baseline emissions, because along with degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay at approximately the same level. This scenario is not environmentally favorable for the near future, since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is attractive.

c) Project scenario

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

The following activities will ensure fuel and electricity saving:

- liquidation of low efficient boiler-houses with:
  - ✓ switching load to high efficient boiler-houses;
  - ✓ construction of modular mini- boiler-houses;
- replacement of obsolete boilers with highly efficient ones;
- modernization of boilers:
  - ✓ replacement of boilers burners;
  - ✓ replacement of boilers heated surfaces;
  - ✓ implementation of control automatics;
- implementation of technology for utilization of the exhaust gases heat;
- optimization of network organization;
- gradual shift of heat distribution networks to preliminary isolated pipes;
- technical re-equipment of heat supply stations with high efficient heat exchangers;
- installation of frequency controllers at electric drives of pumps, blow fans and smoke exhausters;
- replacement of pumps;
- optimization of load allocation;
- implementation of control and monitoring systems;
- implementation of other energy saving measurements.

Estimated project annual reductions of GHG emissions, mainly CO_2, are 112 861 tons per year after project complete implementation comparing to business-as-usual or baseline scenario.

Implementation of the project will provide substantial economic, environmental, and social benefits to the Kharkiv Region. Social impact of the project is positive since after project implementation the heat supply service will be improved.

The brief history (the main milestones) of the project (including its JI component):

The project was initiated in 2004.

September, 2004 – Agreement was signed between the Institute of Engineering Ecology and IRC "Teploenergiya" on the preparation of the initial data for claim for the project on CO_2 emission reductions due to fuel saving in system of IRC "Teploenergiya" (No.523 dated 14.09.2004);

December, 2006 – Agreement on implementation of organizational and technical measures to achieve reduction of greenhouse gases emissions to the environment according to the Kyoto Protocol was signed between the ME "KhTM" and KhRME "Dyrektsiya RIT", Izium HSNME, Krasnohrad HSNE, Nova Vodolaha HSNE, Pervomais'kyi ME "Teplomerezhi", MEBDC "BTM", ME "Teplovi merezhi" of Lozova CC, "KLK" Ltd., IRC "Teploenergiya" (No. 221308 dated 29.12.2006);

August, 2008 – The supplementary agreement No.2 dated 11.08.2008 on joining to Agreement No. 221308 dated 29.12.2006 was signed between the ME "KhTM" and ME "Chuhuivteplo";

December, 2008 – The supplementary agreement No.4 dated 30.12.2008 on joining to Agreement No. 221308 dated 29.12.2006 was signed between the ME "KhTM" and Kharkiv District HSNME;

May, 2009 – The supplementary agreement No.6 dated 06.05.2009 on joining to Agreement No. 221308 dated 29.12.2006 was signed between the ME "KhTM" and Borova HSNME;

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host Party)	ME "Kharkivski teplovi merezhi"	No
The Netherlands	"E – energy B.V."	No

- ***ME "Kharkivski teplovi merezhi":*** organization acting as Project Applicant and **Supplier** of GHG emission reductions on behalf of all partners of the Agreement on implementation of organizational and technical measures to achieve reduction of greenhouse gases emissions to the environment according to the Kyoto Protocol (No. 221308 dated 29.12.2006). It represents the interests of partners of the Agreement and is responsible for the organizational aspects of JI project.

Historical details:

At the beginning of 1930, the Chief engineering department of Kharkiv city council together with "Heat and power" enterprise have developed the project for district heating of Kharkiv City. In frames of this project, the engineering solution about future heat supply of Kharkiv City was set.

In 1932 Kharkiv city celebrated the event that started development of the biggest district heating system in the USSR. Start of operation of the first heat supplying pipe-line in Ukraine, which length was 5.5 km, was celebrated as an outstanding achievement in developing of municipal engineering.

The huge building of heat supply networks in the city was started since 1934-1935, the enterprise "Teplomerezha" has built the hot-water supply systems and steam pipelines from CHP-3 to industrial enterprises.

At the end of 1937 the total length of main lines was 42 km and their heat load was 185 Gcal per hour.

In the post-war period, not only the half-destroyed stations and heat distribution networks were renewed, but development of the heat supply system in the city had been continued.

In 1960 the intensive development of residential area near the Selektsiyna station was started. For the purpose of its heat supply, building of a new pipeline with 600 mm diameter was started in October, 1960.

Intensive development of residential areas required further developing of the heat sources. Necessity of construction of the district boiler-houses in the places of advanced house building such as Selektsiyniy district, Pavlovo Pole and Saltivskiy district, was adopted by the city council.

At the end of 70-th and at the beginning of 80-th, the development of construction activity in Kharkiv City was continued.

Existed DH facilities didn't cover needs of city, there was necessity in increasing of heat and electric power production. For compensation of deficit of heat power and covering heat loads of Kharkiv City, construction of the CHP-5 was provided, as well as construction of two heat pipelines at the same time.

The general dynamic of heat distribution networks development was the following:

- 1932 – the length of main and heat distribution networks was 5.5 km, maximum load – 25 Gcal per hour;
- 1935 – accordingly, 12.5 km and 35 Gcal per hour;
- 1940 – 42 km, 226 Gcal per hour;
- 1950 – 54 km, 295 Gcal per hour;
- At the end of 50-th, at the beginning of intensive development of residential area, intensive implementation of the Central Heat supply stations was started, which were connected to the main heat distribution networks and from which heat was distributed by branch pipelines to the houses in the middle of the residential areas.
- 1967 – the length of heat distribution networks was 780 km and heat load was 1201.2 Gcal per hour;
- 1975 – 1052 km;
- 1980 – 1231 km;
- 1993 – 1556 km, and head load reached 5390.3 Gcal per hour.

But at the beginning of 90-th, the disastrous reduction of load has happened, which had been caused by stoppage of many industrial enterprises and plants.

At the end of 90-th - beginning of 2000-th, heat supply in Kharkiv city was provided by ME “Kharkivski teplovi merezhi”, OJSC “Kharkivska CHP-5”, CJSC “CHP-3” and departmental boiler-houses.

Today ME “Kharkivski teplovi merezhi” is the heat power enterprise which produces, transports and distributes heat to all groups of consumers in Kharkiv City.

Municipal Enterprise “Kharkivski teplovi merezhi” is one of the most powerful enterprises of municipal heat supply in Ukraine. Its 6888 qualified specialists operate 1647 km of pipelines in the 2-pipe calculation, 285 heat supply stations (HSS), 11 pump stations, 252 boiler-houses and combined heat and power stations CHP-3 and CHP-4. 95 % of Kharkiv’s inhabitants use services of the enterprise.

For effective use of power resources, ME “Kharkivski teplovi merezhi” implements measures for reconstruction and technical re-equipment of the heat energy sources and heat distribution networks.

The program-technical complex of automation and dispatching is successfully used at the enterprise, that leads to increasing of the operational efficiency of district heating system in Kharkiv city. Automatic dispatcher control system covers three CHPs, the whole old city district and partly quarter boiler-houses, main networks with all pump stations, as well as some HSSs.

Also, specialists of the enterprise develop energy saving competitive equipment and automatic systems. For example, electronic water counter CV-4T; system of remote measurement of data from consumers’ water meters, universal temperature regulator “TUR-04”; temperature regulation and indication units “BRIT-2”.

Described above measures improve quality of ME “Kharkivski teplovi merezhi” service to population. In addition, solving of energy saving problems enables to reduce the cost of energy sources in prime cost structure of heating service.

Enterprise characteristics:

	2005	2011
Total amount of objects (boiler-houses, CHSSs)	261	254
Length of the heat supply networks in the 2-pipe calculation, km	1550.5	1647.8
Total enterprise capacity, Gcal per hour	3006.8	4514.0
Connected heat load, Gcal per hour	3441.6	3872.2
Heated area , ths m^2	27551.2	31099.9

The heated area for the population makes 79.8% of the total heated area, for the legal entities – 20.2%.

- ***"E-Energy B.V.":*** is the purchaser of the emission reduction units generated from this Project. It is a company registered in the Netherlands, and is one of subsidiaries belonging to the **"**E energija**"** group.

Having started its activity in 1994, **"**E energija**"** group has expanded from its first established company "Energijos taupymo centras" (Energy saving center).

The rising work range and economical-social conditions caused the creation of vertically integrated company's structure, with the separation of group's operation fields. For this purpose, the company **"**E energija UAB", which now is the management company of the whole **"**E energija**"** group, was established. **"**E energija UAB" is an energy planning and management company, which implements turnkey projects from conceptual development, as well as owns companies generating and supplying energy for industrial and residential object of the cities.

One of key aims of **"**E energija**"** specialists is to prepare energy plans to meet energy needs with subsistence and development of alternative energy sources and increase of energy comsumption efficiency for improving the economy and environment.

Since 2005 **"**E energija**"** group, one of the first companies in the Baltic countries, has been involved in the project development under Kyoto Protocol flexible mechanisms and started trading activities with EU allowances as specified by EU Emission Trading Scheme.

"E-Energy B.V." is a company responsible for **"**E energija**"** group carbon credit procurement for its own purposes and for all business related with carbon credit trading. "E-Energy B.V." is an active investor in the market of Eastern European countries in a number of JI projects.

A.4. Technical description of the project:

A.4.1. Location of the project:

The Project is located in Kharkiv Region in the North-Eastern part of Ukraine (Fig.1).

Fig. 1. The map of Ukraine with administrative division and neighboring countries

A.4.1.1. Host Party(ies):

The project is located in Ukraine.

Ukraine is an Eastern European country that ratified the Kyoto Protocol to UN FCCC on February 4th, 2004, it enters into the list of the countries of the Annex I and is eligible for the Joint Implementation projects.

A.4.1.2. Region/State/Province etc.:

Kharkiv region[1] is located in the North-Eastern part of Ukraine.

The centre of the region is Kharkiv Citiy (49°59' N   36°13' E)

The climate is temperate. The average temperatures are +21 ^{0}C in summer and -7 ^{0}C in winter. Average annual rainfall is 540 mm.

Kharkiv region borders to the north and north-west with Belgorod region of Russia, to the east – with Luhansk region, to the south-east – with Donetsk region, to the south-west - with Dnipropetrovsk region, to the west and north-west – with Poltava and Sumy regions of Ukraine.

The region territory is 31.4 ths km^2 (about 5.2% of the total area of Ukraine).

Population of the region is about 2895.8 ths. (about 6 % of the total population of Ukraine).

Number of settlements is 1761, including 78 urban ones and 1683 rural ones.

The Project includes almost all districts of the Kharkiv region.

---

[1] *http://kharkivoda.gov.ua/uk*

A.4.1.3. City/Town/Community etc.:

Cities, towns and villages in Kharkiv region.

Districts: Izium, Balakliia, Barvinkove, Blyzniuky, Bohodukhiv, Borova, Valky, Velykyi, Burluk, Derhachi, Zachepylivka, Zmiiv, Zolochiv, Krasnohrad, Krasnokutsk, Kupians'k, Lozova, Nova Vodolaha, Pervomais'kyi, Kharkiv, Chuhuiv, Shevchenkove.

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

Location of the office: Kharkiv City, 49° 59' N, 36° 13' E;

The centers of the districts involved in the project are marked with blue circles (Fig. 2).

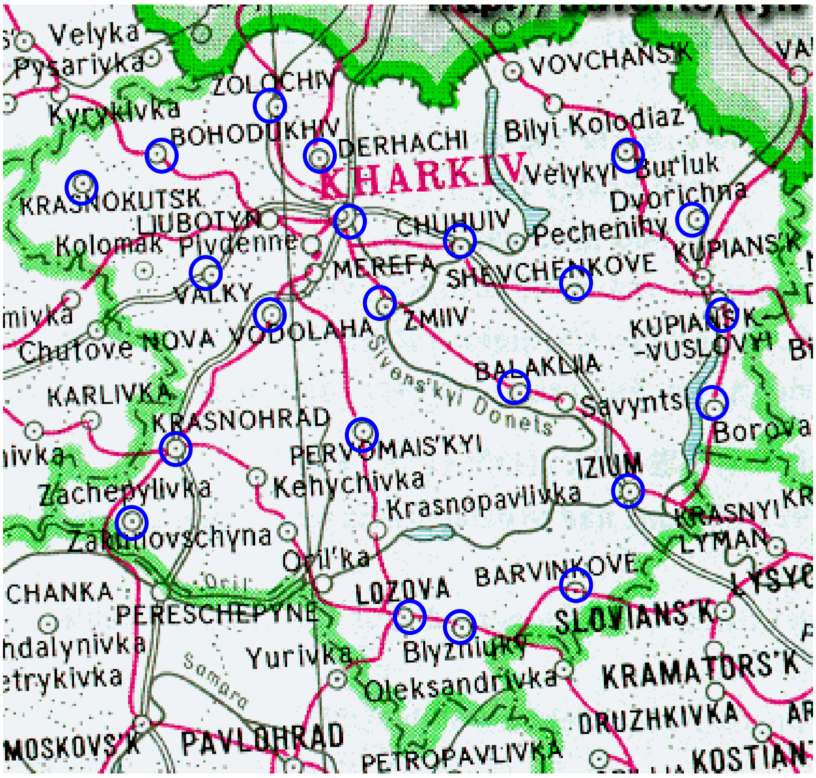


Fig. 2. Location of the districts of Kharkiv region where project will be implemented

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

The main measures planned to be implemented by the project for improving the efficiency of municipal enterprises that implement the project are the following:

- Liquidation of low efficient boiler-houses with switching of load to highly efficient boiler-houses, including to the newly constructed modular mini-boiler-houses.
- Replacement of old operating boilers with low efficiency by the new highly efficient ones, that will result in efficiency increase from 50-87% up to 92-95%. Technical characteristics of new boilers scheduled to be installed are presented at the producer's websites that are listed in Table 1 below.

Type of boiler	Website of boiler producer
Kolvi	www.kolvi.com
Riello	www.riello.su
Hotwell	http://www.hot-well.com/
Viessmann	http://viessmann.com.ua/
Ferroli	www.ferroli.ru
Protherm	www.protherm.com.ua
KVG	www.tekom.com.ua/kotel/kvg.html
KSVa	www.eco-boilers.com.ua/kotel/vodogrejnij/index.htm
VK	www.tekom.com.ua/kotel/vk.html
Stankinprom	http://www.users.kharkiv.com/stankinprom/stankinprom.com.ua/products/products.php/Id_5/index.html
Majak	www.majak.com.ua/products/majak12ks.html
AOGV	www.majak.com.ua/products/majak12ks.html
ROSS	www.ross.com.ua
Fakel	http://kotloenergo.com.ua/kotly-vodogreynye/2011-02-23-14-57-41
Topaz	http://agrotorg.net/companies/c-210/goods/g-1630/gazovye-promyshlennye-kotly-topaz/

Table 1. Boilers producer's web sites

- Modernization of obsolete but able to work boilers with using various technologies, including replacement of boilers burners, replacement of boilers heated surfaces, implementation of technology for utilization of the exhaust gases heat, implementation of control automatics, etc., will lead to 5-20% increase in efficiency.
- The efficiency of heat distribution networks system will be considerably increased by:
  - optimization of network organization: decreasing pipelines length (moving heat generating source closer to consumer, etc.), replacement of 4-pipe lines by 2-pipe ones with simultaneous installation of heat exchangers directly at the consumers, etc.;
  - gradual shift of heat supply networks to preliminary isolated pipes, including produced by "Transprogres" Ltd. (http://www.transprogress.com.ua/products.htm) and "Polimerteplo-Ukraine" Ltd. (http://polymerteplo.com.ua/). These pipes are presented at the Fig. 3;
  - decreasing of losses in pipelines (renovation of heat insulation, packing of controlling and locking elements, etc.).

Fig.3. Pre-insulated pipes.

- Replacement of old heat exchangers by the high efficient plate-type ones. This will enable to reduce electric power consumption and heat losses. Technical characteristics of new heat exchangers (Fig. 4) are presented at the producer's website http://teploenergo.com.ua.

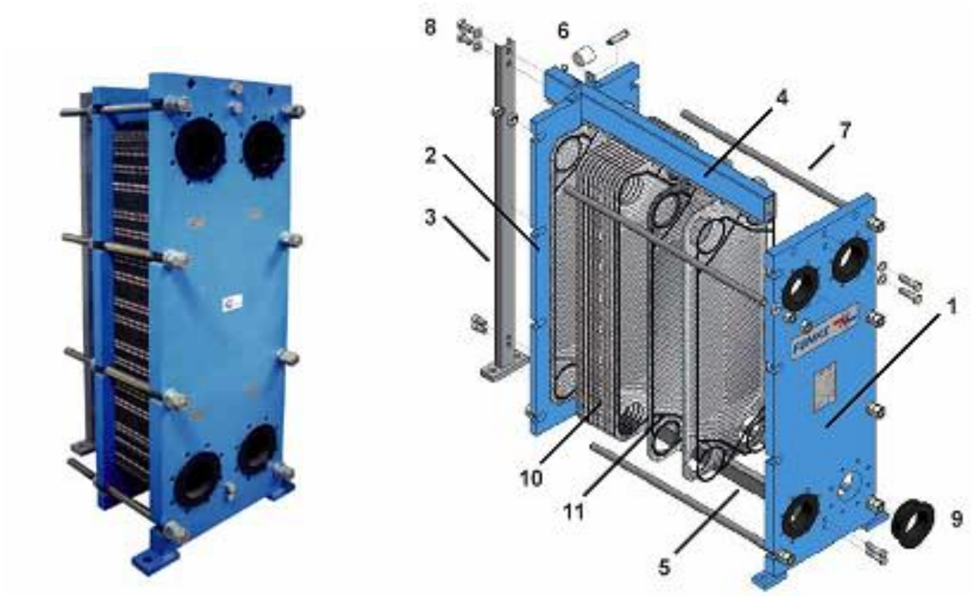


Fig.4.Heat exchangers produced by "Ukrteploenergo" corporation.

- Installation of frequency controllers at hot water pump motors' electric drives will result in electricity saving. Such regulators enable to change the actual capacity of the motors in dependence on connected load, both during a day when water consumption is changed, and during a year when in summer motors work only for hot water supply.

  Installation of frequency controllers at smoke exhausters' electric drives will result in considerable electricity saving in dependence on a boiler operation mode.

  Technical characteristics of frequency converters are presented at the website of "Danfoss" company: www.danfoss.com.
- Replacement of old pumps by the new ones will enable to considerably reduce power consumption for water pumping.
- Optimization of load allocation, in particular during intermediary period, will enable to considerably reduce fuel consumption for supplying required heat energy to consumers.
- Implementation of modern control and monitoring systems will allow increasing efficiency of a whole boiler-house system.

The generalized planned schedule of their implementation will be the following:

#	Project stages	Period
1	Liquidation of low efficient boiler-houses	2006-2012
2	Construction of modular mini- boiler-houses	2006-2012
3	Replacement of low efficient boilers with high efficient ones	2006-2012
4	Rehabilitation of boilers (with replacement of burners, installation of heat-recovery apparatuses, etc.)	2007-2012
5	Replacement of heat exchangers	2011-2012
6	Network rehabilitation	2006-2012
7	Installation of frequency controllers	2011-2012
8	Replacement of pumps	2006-2012
9	Organizational and operational measures	2006-2012

Table 2. Schedule of the Project implementation

At the beginning of the project, specialists of the Institute of Engineering Ecology (project developer) had analyzed the current state of the heat supply systems of the district heating enterprises that implement the project. Based on experience of developing and implementing the JI projects for rehabilitation of the district heating systems in Ukrainian conditions ("District Heating System Rehabilitation of Chernihiv Region", "Rehabilitation of the District Heating System in Kharkiv City", "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Crimea"), a set of recommendations to implement the low-cost, mainly organizational and operational measures, were issued by the Institute and were implemented under the supervision of ME "KhTM" at objects of enterprises involved in the project.

Such measures, in particular, include:

- technical servicing and operational adjustment of boiler equipment (additional extraordinary);
- optimization of operational mode of the equipment:
    - providing of the correspondence of the quantity of heat supplied to consumers to that is determined by need to satisfy normative requirements in specific conditions depending on outside temperature, day time, etc., i. e. avoiding of the so-called "excess heating",
    - providing of the operational mode of the equipment at maximum efficiency according to the regime cards or specifications of equipment;
- reduction of operational time of boiler equipment (pumps, smoke exhausters, fans, etc.) at idle running;
- identifying and removing of the small leakages of heat-carrying agent (nonhermeticity) and heat (heat insulation defects);
- mechanical and / or chemical cleaning of heating surfaces of boilers;
- adjustment of automatic control devices at the heat supply stations (HSS) to the economic mode, which also favours to reduce "excess heating";
- improving the quality of water for feeding of boilers by optimizing of water treatment systems operation.

In addition, in connection with participation in the JI project, during the process of project implementation at enterprises that implement the project the responsibility of each employee for the optimal consumption of energy resources is set, under which the unscheduled on-site monitoring of all key parameters of system as a whole are conducted.

These measures have provided achieving of the average fuel saving up to 15% and of electricity saving up to 7%, depending on capacity of facilities and state of the boiler-house system. Sometimes the energy saving due to implementing of organizational and operational measures achieves up to 30% or more.

Estimated prognostic results of implementation of the above technologies and measures are listed in the Appendices 1 – 4.

These technologies are already approved but some of them are not widespread. Therefore, there might be some bottlenecks, which are typical when implementing the new technologies and equipment.

These technologies are the most up-to-date thus it is ensured that there is no risk that they will be substituted by any other technologies during at least the first commitment period up to 2012, and most probably in near future during the upcoming second commitment period. As to the last one, the project activity can be extended with further implementation of the abovementioned measures and technologies at the objects included in the project. Detailed information about types and amounts of project activity will be included in the periodic monitoring reports.

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

In cases of the new (never used at this enterprise before), equipment installation, the company - producer of this equipment should provide trainings for personnel.

Municipal enterprises that implement the project provide personnel retraining according to the labour protection norms. The enterprises have the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

The special training on the data collection according to Monitoring plan for this project was hold by the Institute of Engineering Ecology (IEE), and the special group that consisted of representatives of district heating enterprises and IEE was organized.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

The project activities including rehabilitation of boiler-houses and heat distribution networks will increase energy efficiency of the district heating (DH) systems in Kharkiv region, thus enabling them to produce the same amount of heat energy with less fuel and power consumption. Reduced fuel and power consumption will lead to reduction of GHG emissions.

In the absence of the proposed project, all equipment, including the old low efficient but still workable for a long life period one, will operate in as-usual mode, and any emission reductions will not occur.

Ukraine has claimed district heating and municipal energy sector as a priority of the national energy-saving development. This is pointed out in the State Program for Reformation and Development of municipal economy for 2004-2010 (Law of Ukraine dated 24.06.2004 № 1869-IV), The Law of Ukraine dated 01.07. 1994 № 74/94-VR "On energy saving" and The Law of Ukraine dated 22.12.2005 №3260-IV "On changes to The Law of Ukraine "On energy saving". The law of Ukraine "On heat energy supply" (№ 2633-IV dated 02.06.2005) regulates all relations in the heat supply market. It does not considerably change the previously existing practices in the market, but stimulates the more rigid energy saving and implementation of energy efficient technologies.

A.4.3.1. Estimated amount of emission reductions over the crediting period:

In course of project implementation, the following emission reductions will be achieved, at the stages of project implementation:

Period before January 1, 2008:

	Years
Length of the crediting period	1
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2007	30618
Total estimated emission reductions over the early crediting period (tonnes of CO_2 equivalent)	**30618**
Annual average of estimated emission reductions over the early crediting period (tonnes CO_2 equivalent)	**30618**

Table 3. Estimated emission reductions for early crediting period before January 1, 2008 (2007)

The First Kyoto Commitment period 2008 – 2012:

	Years
Length of the crediting period	5
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2008	43741
2009	63327
2010	67650
2011	83550
2012	112861
Total estimated emission reductions over the first commitment period (tonnes of CO_2 equivalent)	**371129**
Annual average of estimated emission reductions over the first commitment period (tonnes CO_2 equivalent)	**74226**

Table 4. Estimated emission reductions during the first commitment period (2008 – 2012)

The Post-first commitment period 2013 – 2032:

	Years
Length of the crediting period	20
Year	**Estimate of annual emission reductions in tonnes of CO_2 equivalent**
2013	112861
2014	112861
2015	112861
2016	112861
2017	112861
2018	112861
2019	112861
2020	112861
2021	112861
2022	112861
2023	112861
2024	112861
2025	112861
2026	112861
2027	112861
2028	112861
2029	112861
2030	112861
2031	112861
2032	112861
Total estimated emission reduction over the post-first commitment period (tonnes of CO_2 equivalent)	**2257220**
Annual average of estimated emission reduction over the post- first commitment period (tonnes CO_2 equivalent)	**112861**

Table 5. Estimated emission reductions during the post- first commitment period (2013 – 2032)

Total amount of Emission Reductions over the crediting period:

	Years
Length of the crediting period	26
	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**2658967**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**102268**

Table 6. Estimated emission reductions during the crediting period (2007 – 2032)

A.5. Project approval by the Parties involved:

The project has been already approved by local authorities (see Section G.1) and representative of the Government of Ukraine - the State Environmental Investment Agency of Ukraine (responsible authority for the Kyoto Protocol activity in Ukraine). Therefore, organizational risks are minimized.

Ukrainian DFP – the State Environmental Investment Agency of Ukraine has issued the Letter of Endorsement for this project (# 3801/23/7 dated 30.12.2011).

According to the adopted procedure, the LoAs by Parties involved will be issued after the project determination.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

According to the “Guidelines for users of the JI PDD form” version 04[2], the baseline shall be established on a project-specific basis, or where applicable, project participants may opt to apply approved clean development mechanism (CDM) baseline and monitoring methodologies.

In course of development of this JI project **“Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region”**, in accordance with paragraph 9(a) of the “Guidance on criteria for baseline setting and monitoring”, the project specific approach was used, developed in accordance with appendix B “Criteria for baseline setting and monitoring” of the JI guidelines.

This project specific approach is partly similar to the Baseline and monitoring methodology AM0044 “Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors” (version 1)[3],, however the AM0044 can not be used for the JI project “Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region” since this project has some differences from applicability conditions of this methodology.

The main complication for implementation of the JI projects on district heating in Ukraine is the practical absence of direct monitoring devices for heat and heat-carrier expenditure in the municipal boiler-houses. Only such main characteristic as fuel consumption is registered on a regular basis. It makes practically impossible the application of AM0044 methodology, which basic moment is monitoring of the value $EG_{PJ,\ i,\ y}$ – the heat energy output of project boiler i in year y, that should be measured every month by flow-meter (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 production per year $EG_{BL,\ his,\ i}$ (average historic heat 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. At the same time this project includes also some others kinds of modernization such as the replacement of burner and network equipment, etc.

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 consumers, etc. Taking into account only equipment efficiency change does not eliminate the possibilities of undersupply of heat to consumers (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 emission reductions amount. The developed project specific approach eliminates any possibility to depreciate fuel consumption and correspondingly to underestimate GHG emissions due to underdelivery of heat to consumers.

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

- It takes into account the quality of heat supply (heating and hot water supply). Almost every year 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

---

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

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

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 excess reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of excess increasing of generation of emission reductions 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 methodology AM0044, this project specific approach, developed for "District Heating" projects in Ukrainian conditions and used in JI Projects "District Heating System Rehabilitation of Chernihiv Region", "Rehabilitation of the District Heating System in Kharkiv City", "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Crimea", "Rehabilitation of the District Heating System in Luhansk city", etc. as well, is the most appropriate, precise, corresponding to the conservative approach, and in the most closely manner reflects the aims, goals and spirit of Kyoto Protocol.

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

This project specific approach is presented in **paragraph D.1.**

There were three different versions of Baseline scenario that were discussed before starting this project.

The first version of Baseline scenario was a business-as-usual scenario with minimum rehabilitation works balanced by overall degradation of the DH system. For this Baseline scenario there are no barriers (no investment barrier since this scenario doesn't require the attraction of additional investments, and no technological barrier since the equipment is operated by existing skilled personnel, and additional re-training is not required), and it represents the common practice in Ukraine.

The second version of Baseline scenario was to make rehabilitation works without JI mechanism. In this case there exist both investment barrier since this scenario requires the attraction of large additional investments, and due to very large payback time and high risks it is not attractive for investments, and as well the technological barrier since operation of the new modern equipment will require additional re-training of personnel. Rehabilitation of heat supply equipment in order to improve its efficiency is not a common practice in Ukraine.

The third version of Baseline scenario was the shortened project activity, without any of the non-key type of activity, for example elimination of frequency controllers installation, etc., from the project. This makes project economically less attractive, with the longer pay back period.

Thus, the first version was chosen for Baseline scenario.

Status and adequacy of the current heat delivery system

Current heat supply by DH systems of Kharkiv Region is primarily based on Ukrainian and Russian made gas fired boilers, including: E-1/9; AOGV-23; AOGV-100; AOT-50; Bratsk-1G; VK-21; D-900; D-7/21; DE-16/14GM; DKVR-2,5; DKVR-4/13; DKVR-6,5/13; DKVR-10/13; DKVR-20/13; ELGA-0,5; K50/14; KBNG-2,4; KBNG-2,5; KBNG-3,15; KVAS-0,8; KVG-4; KVG-4,65; KVG-6,5; KVG-7,56; KVGM-10; KVGM-20; KVGM-100; KGSM-1/18; KIMAK; KSVa-0,63; KSVa-1,25; KSVa-2,0; KT-75; KChM-2; KEPR-160; MZK-7; MTV-200; Nadtochiya, NIISTU-5; NIKA-0,5; STV-100; Strebelya; TVG-8; TG-3-95; Universal-5; Universal-6; Fakel; Energiya-3. Detailed information is presented in **Appendix 1.** Current efficiencies of those boilers are in the range of 50-87%.

Current distribution networks are characterized by heat losses up to 35%. Detailed information is presented in **Appendix 2.**

Construction of the Baseline Scenario

Current operation of DH systems of Kharkiv Region results in continuous deterioration of the heat-generating and distribution equipment, followed by continuous slight efficiency droop. However, at the same time operative maintenance increases efficiency, which substantially compensates deterioration, and makes annual total emissions level (the Baseline) about the same for years.

Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2005 was taken as the Base year. This year is one of the typical years concerning conditions of production and consumption of the heat.

The baseline fuels and electricity consumptions are represented in Table 7.

	Baseline Natural Gas consumption, ths m^3/yr	Baseline electricity consumption, MWh
ME “KhTM”	183.80	16.27
KhRME “Dyrektsiya RIT”	43944.55	9530.57
Izium HSNME	12821.00	2250.00
Krasnohrad HSNE	4362.27	677.25
Nova Vodolaha HSNE	2081.10	373.90
Pervomais’kyi ME “Teplomerezhi”	19300.00	0.00
MEBDC “BTM”	17695.33	4502.56
ME «Teplovi merezhi» of Lozova CC	27200.70	7453.11
“KLK” Ltd.	21996.93	3880.07
ME “Chuhuivteplo”	13757.84	2493.57
Kharkiv District HSNME	9259.69	1553.32
Borova HSNME	2559.80	501.90
Total	**175163.01**	**33232.52**

Table 7. Baseline fuel and electricity consumption

Detailed information is presented in **Appendix 1.**

Calculation of Baseline Carbon Emissions

There are two kinds of GHG emissions which are included in the baseline:

1) GHG emissions from boilers which are operated by the DH systems of Kharkiv region.
2) GHG emissions from current electricity consumption from the state grid which will be reduced due to implementation of energy saving measures at boiler-houses and heat supply stations. Thus:

$E^b = E1^b + E2^b$ (B.1-1)

where:
$E1^b$ – emissions from heat production sources operated by the heat supply systems of Kharkiv region, t CO_2e;
$E2^b$ – emissions due to electricity production to the grid that is consumed by boiler houses and heat supply stations, t CO_2e;

1) Emissions from heat production sources:

$E1^b = \sum (B_{(i)}^b * NCV^b * Cef)$, (B.1-2)

where:
$B_{(i)}^b$ – fuel (natural gas) consumption by an (i) boiler-house in the baseline scenario, ths m^3;
NCV^b – averaged calorific value of natural gas, GJ/ths m^3;
Cef – carbon emission factor for natural gas, t CO_2/GJ.

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

2) GHG emissions due to electricity production to the grid that is consumed by boiler houses and heat supply stations.

$E2^b = \sum (P_{(i)}^b * CEF_c)$, (B.1-3)

where:
$P_{(i)}^b$ – electricity consumption by an (i) boiler house and heat supply stations related to it in the baseline scenario, MWh;
CEF_c – carbon emission factor for electricity consumption, tCO_2e/MWh.

Baseline calculations were based on the assumption that baseline emissions from boilers operated during any reported year remain the same as in the base year 2005.

Detailed information is presented in **Appendix 1.**

Calculation of resulting annual Baseline Carbon Emissions, that would take place during typical year if DH systems of Kharkiv region remain unchanged, see in **Appendix 6 (Baseline)**.

The key information and data used to establish the baseline are provided in tables below:

Data / Parameter	**B^b**
Data unit	ths. m^3
Description	Fuel (natural gas) consumption by a boiler house
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	Municipal enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	175163.01
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measurements are taken by gas meters at each boiler-house.
QA/QC procedures (to be) applied	Equipment is inspected and calibrated according to the the State Standard of Ukraine № 2708:2006 "Metrology. Calibration of measuring equipment. The organization and procedure"[4].
Any comment	Fuel consumption by the boiler-houses is the basic data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

Data / Parameter	**P^b**
Data unit	MWh
Description	Electricity consumption
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	Municipal enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	33232.52
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measurement by electricity meters
QA/QC procedures (to be) applied	Equipment is inspected and calibrated according to the the State Standard of Ukraine № 2708:2006 "Metrology. Calibration of measuring equipment. The organization and procedure"
Any comment	This is the basic data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

[4] *http://oscill.com/files/27082006.pdf*

Data / Parameter	**NCV**[b]
Data unit	MJ/m^3
Description	Averaged calorific value of a fuel (natural gas)
Time of determination/monitoring	Once after the end of the base year
Source of data (to be) used	Municipal enterprises that implement the project
Value of data applied (for ex ante calculations/determinations)	34.5
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Fuel Supplier's Report
QA/QC procedures (to be) applied	N/A
Any comment	Data allowing calculation of GHG emissions in base year; information shall be archived in paper and electronic form

Data / Parameter	**Cef**
Data unit	t CO_2/GJ
Description	Carbon emission factor for natural gas
Time of determination/monitoring	Once per year
Source of data (to be) used	Normative documents
Value of data applied (for ex ante calculations/determinations)	The following Cef values are used in calculations in PDD: Year — Cef, t CO_2/GJ 2005 — 0.0555 2007 — 0.0554 2008 — 0.0554 2009-2012 — 0.0554
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The National inventory report of Ukraine for 1990 – 2009, Table P2.6,[5]
QA/QC procedures (to be) applied	N/A
Any comment	Auxiliary data allowing adjustment of baseline. In course of development of the Monitoring reports for this project, the valid values for corresponding period will be used.

[5] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2011-nir-08jun.zip

Data / Parameter	**CEFc**
Data unit	t CO_2e/MWh
Description	Carbon emission factor for electricity consumption
Time of determination/monitoring	Once per year
Source of data (to be) used	Normative documents
Value of data applied (for ex ante calculations/determinations)	The following CEF values are used in calculations in PDD: Year — CEFc, t CO_2e/MWh 2005 — 0.896 2007 — 0.896 2008 — 1.219 2009 — 1.237 2010 — 1.225 2011-2012 — 1.227
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption" of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines. Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004[6]; Table 8 "Emission Factors for the Ukrainian grid 2006-2012" of Annex 2 "Standardized Emission Factors for the Ukrainian Electricity Grid" to "Ukraine - Assessment of new calculation of CEF", confirmed by TUV SUD Industrie Service GmbH 17.08.2007[7]; Orders of the National Environmental Investment Agency of Ukraine: # 62 dated 15.04.2011[8]; # 63 dated 15.04.2011[9]; # 43 dated 28.03.2011[10]; # 75 dated 12.05.2011[11].
QA/QC procedures (to be) applied	N/A
Any comment	Auxiliary data allowing adjustment of baseline. In course of development of the Monitoring reports for this project, the valid values for corresponding period will be used.

[6] http://ji.unfccc.int/CallForInputs/BaselineSettingMonitoring/ERUPT/GuidVol2.doc

[7] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

[8] http://www.neia.gov.ua/nature/doccatalog/document?id=127171

[9] http://www.neia.gov.ua/nature/doccatalog/document?id=127172

[10] http://www.neia.gov.ua/nature/doccatalog/document?id=126006

[11] http://www.neia.gov.ua/nature/doccatalog/document?id=127498

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

The anthropogenic emissions of GHG in the project scenario will be reduced due to comprehensive modernization of heat generating and distributing equipment with application of the technologies proposed in the project activities and described in **paragraph A.4.2.**

The more obvious description of how the anthropogenic emissions of GHG are reduced below those that would have occurred in the absence of the JI project may be represented with dynamic baseline, which is the function of the stage of project implementation (see Fig. 5).

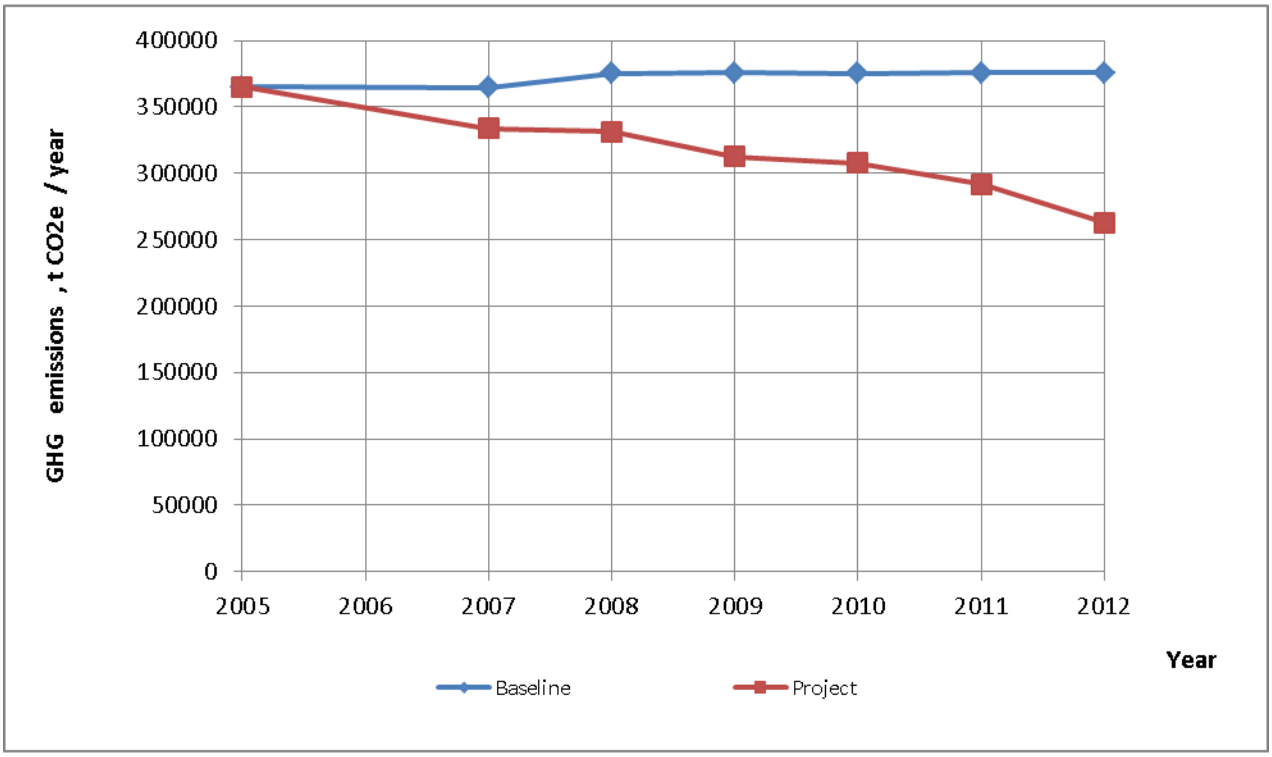


Fig. 5. Dynamic baseline and project GHG emissions

Additionality of the project

The additionality of the project activity is demonstrated and assessed below with using the "Tool for the demonstration and assessment of additionality" (Version 6.0)[12] (see Fig. 6). This tool was originally developed for CDM projects but may be applied to JI projects as well.

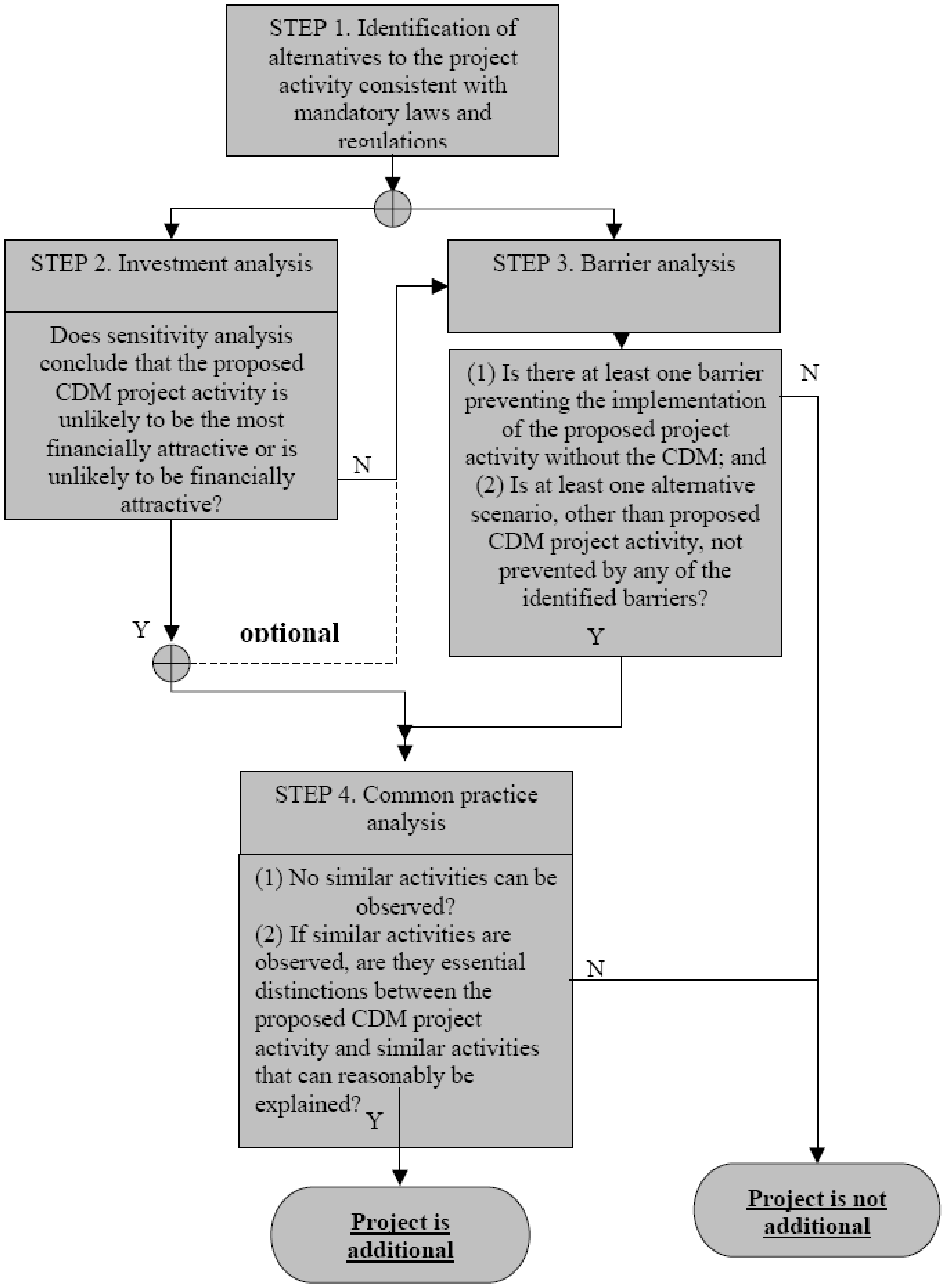


Fig.6. Steps for demonstration of additionality

[12] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v6.0.0.pdf

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity:

There are three alternatives to this project (as was already discussed in section **B1**).

1. The first alternative is continuation of the current situation (no project activity or other alternatives undertaken), i.e. business-as-usual scenario with minimum rehabilitation works, approximately balanced by overall degradation of the DH systems.

It should be noted that there is no local legislation regarding the time of boilers replacement and maximum lifetime permitted for boilers. It is common practice in Ukraine to exploit boilers which were installed in 70^{th} and even in $50\text{-}60^{th}$ and earlier, if they pass the technical examination by the authorized body ("Derzhnagliadohoronpratsi").

2. The second alternative is to make rehabilitation works (the proposed project activity) without JI mechanism.

3. The third alternative is the shortened project activity, without any of the non-key type of activity, for example elimination of frequency controllers installation, etc., from the project.

Outcome of Step 1a: Three realistic and credible alternative scenarios to the project activity are identified.

Sub-step 1b. Consistency with mandatory laws and regulations:

According to The Laws of Ukraine "On licensing of the separate types of activity" № 1775-III, dated June 01, 2000 and "On heat energy supply" № 2633-IV dated 02.06.2005; Ukrainian Government Regulation "On introduction of changes to the Government Regulations №1698 dated 14.11.2000 and №756 dated 04.07.2001" №549 dated 19.04.2006 and "On approval of the list of licensing bodies" №1698 dated 14.11.2000, execution of economic activity in fields of heat energy production, distribution and supply require a license that is issued by Ministry of Housing and Municipal Economy of Ukraine.

Municipal enterprises that implement the project have such licenses:

- ME "KhTM" - AB # 345059;
- "Dyrektsiya RIT" - AB # 345056;
- Izium HSNME - AB # 345122;
- Krasnohrad HSNE - AB # 331341;
- Nova Vodolaha HSNE - AB # 331344;
- Pervomais'kyi ME "Teplomerezhi"- AB # 368502; AB # 368507; AB # 368503;
- MEBDC "BTM" - AB # 345086;
- ME «Teplovi merezhi» of Lozova CC - AB # 345125;
- "KLK" Ltd. - AB # 345160;
- ME "Chuhuivteplo" - AB # 368505;
- Kharkiv District HSNME - AG # 500130; AG # 500132; AG # 500131;
- Borova HSNME - AG # 500126; AG # 500128; AG # 500127.

The Project "Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region" has been prepared according to The Law of Ukraine dated 01.07.1994 №74/94-VR "On energy saving" and The Law of Ukraine dated 22.12.2005 №3260-IV "On changes in The Law of Ukraine "On energy saving".

Outcome of Step 1b: The alternatives, which are: to continue business-as-usual scenario, to make rehabilitation works without JI mechanism and to implement shortened project activity without any of the non-key type of project activity, are in compliance with the mandatory laws and regulations.

Hence, the Step 1 is satisfied.

According to the "Tool for the demonstration and assessment of additionality" (Version 6.0), for further additionality analysis it is possible to follow the Step 2 or Step 3 (or both).

Step 2. Investment analysis.

Sub-step 2a: Determine appropriate analysis method

The appropriate analysis method is to be chosen in dependence of generating of financial or economic benefits by the project. If project activity generates no financial or economic benefits other than JI related income, then the simple cost analysis (Option I) may be applied, otherwise the investment comparison analysis (Option II) or the benchmark analysis (Option III) should be used.

The main source of income of the district heating enterprises in Ukraine are payments from consumers according to the tariffs that are regulated by the "Procedure of setting tariffs for production, transportation and supply of heat energy and for centralized heating and hot water supply services"[13].

According to this Procedure tariffs are to be set on the base of the scheduled prime cost and doesn't allow to obtain benefit from reduction of fuel, power, raw materials, etc. consumption. Any reduction of expenses for these raw inputs should result in decrease of tariffs for the end consumers and corresponding decrease of an enterprise's revenue, thereby the enterprise doesn't obtain additional revenue.

Thus, the simple cost analysis (Option I) may be applied.

Sub-step 2b: Option I. Apply simple cost analysis

Implementation of the project activity will require substantial additional investments – about **24** million EUR only for the main equipment installation / rehabilitation. The required investments for implementation of the project "Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region" include the costs of the main equipment installation / rehabilitation, as well as the auxiliary costs such as personnel training, maintenance control, systematic data collection and archiving, etc.

For more detailed information see **Financing plan of JI project.**

Estimated costs for implementation of the defined above alternatives to the project activity:

1. For the first alternative (continuation of the current situation, business-as-usual scenario) no additional investments are required.

2. For the second alternative (the proposed project activity without JI mechanism) the required additional investments are the same as for the project activity.

3. For the third alternative (shortened project activity) the required additional investments are less then the ones required for the project activity.

Outcome of Step 2: There is at least one alternative which is less costly than the project activity.

Hence, the Step 2 is satisfied.

Step 3: Barrier analysis

Sub-step 3a: Identification of barriers that would prevent the implementation of the proposed project activity

Investment barriers

The general situation in District Heating sector in Ukraine may be characterized as quite insufficient, and is analyzed and described in several available reviews and reports. Some citations, especially describing technical and financial situation, are given below.

[13] *http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=955-2006-%EF*

"The existing district heating systems suffer from the same, well-known problems as those in other Central and European Countries. Old-fashioned Russian technology, oversized equipment, neglected maintenance and repairs, have resulted in increasing inefficiency. Typically, the overall efficiency of the DH systems (from fuel consumption in boilers to heat supplied to the building entrance) is about 50%. Including the losses within the buildings, it is estimated that only one third of the energy of the fuel is useful heat for the final consumers.

The bad technical state of the DH systems has its counterpart in the bad financial state. Non cost-covering tariffs can not meet the revenue requirements and subsidy payments are too small to cover all costs and are often delayed. In addition, collection rates are going in line with increasing tariffs" [Report: Market Potential for District Heating Projects in the Ukraine and their Modernization with Austrian Technology, Vienna, 2004, p.3][14]

"The current regulatory framework and tariff policy makes it difficult to attract private investors to district heating. Yet the main stakeholders, *e.g.* municipalities and residents, in most cases lack the necessary financing capacity. (P. 324).

District heating in Ukraine suffers from inefficiency and urgently needs investment in refurbishment and modernization. … Yet, the current policy framework does not make district heating attractive for investment, which undermines its sustainability. Barriers to investment and efficiency improvements include (but are not limited to): the current pricing policy; lack of metering; the focus on heat production, not consumption; unclear ownership and management of buildings; and difficult access to financing for interested parties. It is vital to create adequate policy and regulatory conditions for attracting private investments in the sector." (P. 328). [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006[15].

"District heating suffers from inefficiency and low level of investment. The major impediments for investment include the unclear pricing policy, unregulated management and ownership conditions, the accumulated debt of heat producers" [Overview of Heating Sector in Ukraine, CASE, 2007][16].

The energy efficiency projects in the district heating sector in Ukraine could not be implemented at the expense of tariffs for heat energy, since the innovative constituent in tariffs is usually absent, and even "In some regions of Ukraine heat tariffs are below the cost coverage level, which results in debt accumulation of heat producers to the creditors (fuel supply companies, staff etc.)" [Overview of Heating Sector in Ukraine, CASE, 2007[17].].

Moreover, no bank gives credits without the proper guarantees. Municipal enterprises that implement the project are communal ownership enterprises, and all theirs main funds belong to territorial population. For this reason the property of enterprises can not be a credit mortgage. Thus, the DH system rehabilitation without additional external investments (grants, subsidy, subvention, etc.) practically isn't possible, and in current situation practically only municipal or state financing might be used for this purposes. But Ukrainian government does not have enough funds for this, and insufficiency and delay of the budget financing of activity in this sector is the main its problem.

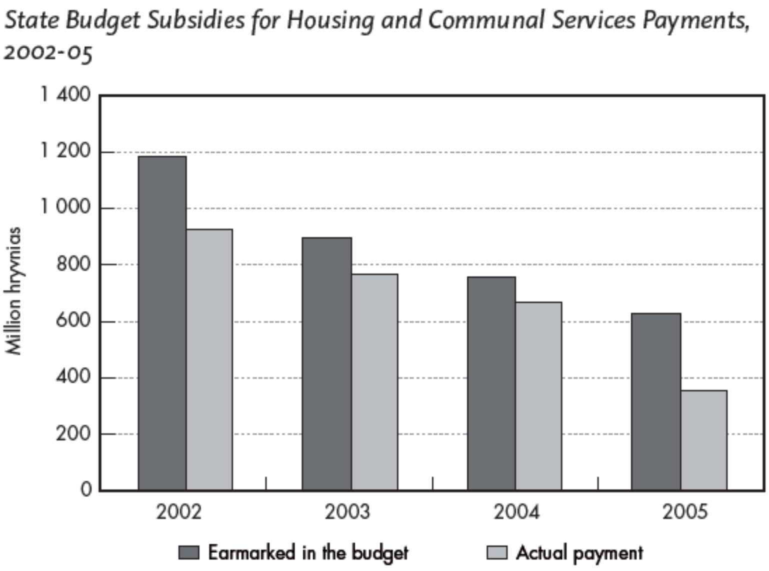
Moreover, the real budget financing is usually significantly lower than scheduled (see diagram below, [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006].

[14] *http://www.energyagency.at/(publ)/themen/elektrizitaet_index.htm*

[15] *http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1819*

[16] *www.case-ukraine.com.ua*

[17] *www.case-ukraine.com.ua*



Source: Ministry of Construction, Architecture, Housing and Communal Services.

Fig.7. Diagram of the real State budget subsidies for Housing and communal services payments

Also, as discussed earlier, "district heating tariffs do not cover costs and the difference must be covered by direct subsidies to heat providers, which come from local or state budgets". But even these payments are often delayed or even not paid: "Budget payments, however, are often delayed, which results in significant accumulated debt to district heating companies" [UKRAINE ENERGY POLICY REVIEW 2006, OECD/IEA, 2006].

From the other side, the additional financing of the project activity from JI mechanism is not only important for project financing, but also is a very positive factor that even can allow shifting the priorities of budget financing, thus decreasing the investment barrier. The evidence for this, in particular for the very similar JI project on rehabilitation of the heat supply system of Chernihiv region, is available in the letter from the local authority – the Chernihiv Regional State Administration #01.04-05/1554 from 03.06.2008.

For this project, also the fact of signing of the external economic contract between ME "KhTM" and the purchaser of the Emission reduction units provides the priority for distribution of funds from the state and local budgets to the rehabilitation of the district heating systems of Kharkiv Region, thus to provide fulfillment of international liabilities on the joint implementation project.

Technological barriers

1. Not all proposed technologies are widely approved already. Qualification of operational personal for implementation of the new technologies may be not sufficient to provide project implementation properly and in time.

Most of communal heating enterprisers in Ukraine fulfill annual minimal repairing of the DH system to keep it working. Particularly they execute repairing of network's parts and boilers that might cause accidents. The most economically feasible and realistic scenario without carbon credits sales is a very slow rehabilitation activity, instead of making a major overhaul of the heating system.

Most of proposed technologies are widely used in Ukraine namely for the similar JI projects. For example boilers replacement, network replacement with pre-insulated pipes, installation of frequency controllers, etc.

2. Efficiency of installed equipment could be lower than was claimed by producers or equipment may have substantial defects.

3. Available amount of natural gas since Ukraine is dependent on Russian natural gas delivery. Ukrainian Government makes attempts to reduce this dependence.

Organizational barriers

The management experience in implementation of JI projects is absent, including international collaboration, validation, verification, registration, monitoring of similar projects and so on.

Outcome of Step 3a: Identified barriers would prevent the implementation of the proposed project activity as well as of the other alternatives - to make rehabilitation works without JI mechanism and to realize shortened project activity, without any of the non-key type of project activity.

Sub-step 3b: Explanation that the identified barriers would not prevent the implementation of at least one of the alternatives

One of the alternatives is to continue business-as-usual scenario. Therefore, as the barriers mentioned above are directly related to investing into upgrading of the district heating systems of Kharkiv Region, there is no impediment for municipal enterprises that implement the project to operate the district heating systems at its present level.

Outcome of Step 3b: The identified barriers would not prevent the implementation of at least one of the alternatives – the business-as-usual scenario.

Hence, the Step 3 is satisfied.

Step 4: Common practice analysis

Sub-step 4a. Analysis of other activities similar to the proposed project activity.

The common practice for district heating enterprises in Ukraine without JI mechanism is only a necessary repair of the old equipment, mainly in emergency cases, and not the renewal. Only with the JI component it is possible to obtain the necessary additional funds for real rehabilitation of the district heating system.

This is confirmed by the present situation that the real comprehensive rehabilitation of the district heating systems in Ukraine is performed only by the enterprises participating in JI projects. There are at least 9 District Heating Rehabilitation Projects with JI mechanism in Ukraine at advanced stages beside this project: for DH systems in Chernihiv region, Donetsk region, AR Crimea, Kharkiv city, Rivne region, Dnipropetrovsk Region, Luhansk city, Zaporizhzhia City, Sevastopol city. But other JI project activities are not to be included in Common practice analysis.

Outcome of Step 4a: Since the similar projects (being implemented without JI mechanism, since the projects implemented with JI mechanism are not to be taken into account) are not observed in the region, there is no basis for analysis of similar activities.

Sub-step 4b. Discuss any similar Options that are occurring

All District Heating Rehabilitation Projects in Ukraine are being implemented only within the framework of the Kyoto Protocol JI mechanism. In the absence of additional financing (such as grants, other non-commercial finance terms, carbon credits, etc) implementation of these projects would be impossible. Application of the JI mechanism is the only incentive to implement such projects.

Outcome of Step 4b: Based on the available facts, the following conclusions may be made:

- Activities similar to this Project are not widespread in the housing and utilities sector of the Ukraine.
- These activities are not a result of national policy being pursued in respect to promoting the utilization of gas as a fuel in municipal heat supply systems.

Thus, the Project activities do not fall under the category of *common practice.*

Hence, the Step 4 is satisfied.

Conclusion

The results of the above assessment lead to the conclusion that the project activity is additional.

B.3. Description of how the definition of the project boundary is applied to the project:

Boundaries for **Baseline scenario** are represented by dotted black line rectangle at the graphical representation (Fig.8).

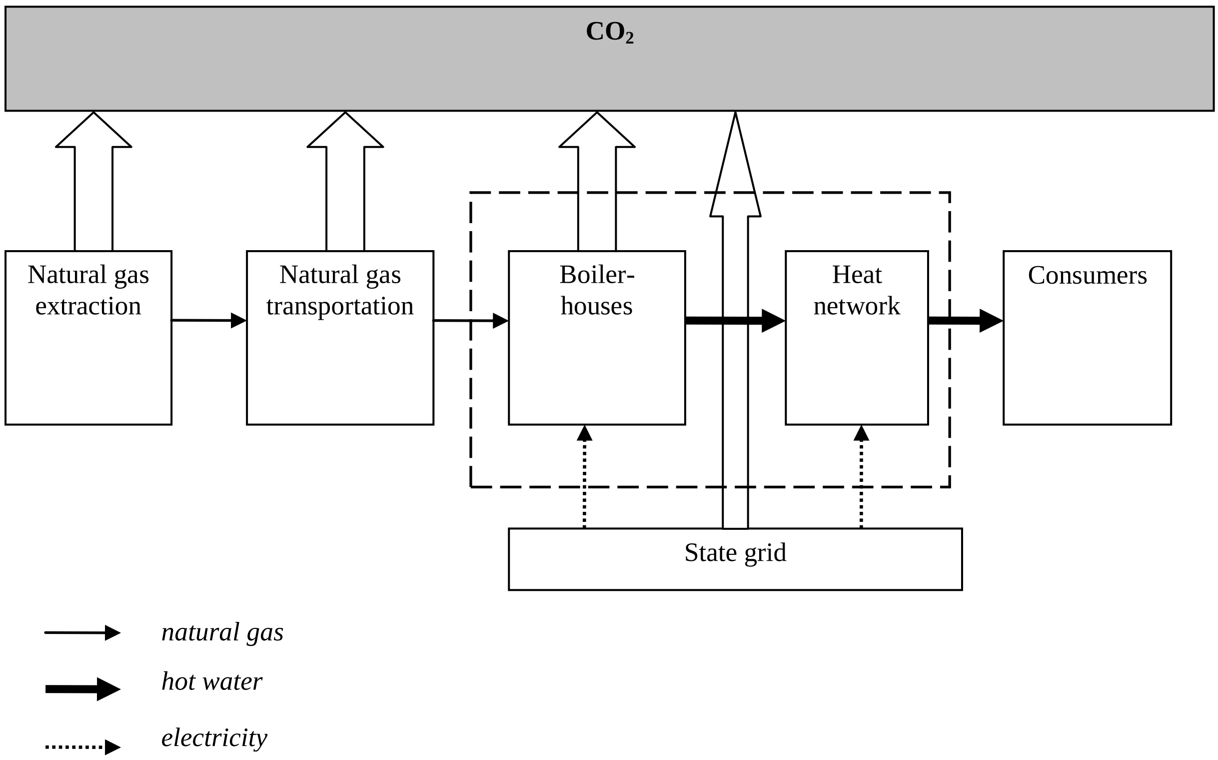


Fig.8. Boundaries for Baseline scenario

Project boundaries for **Project scenario** are represented by dotted black line rectangle at the graphical representation (Fig.9).

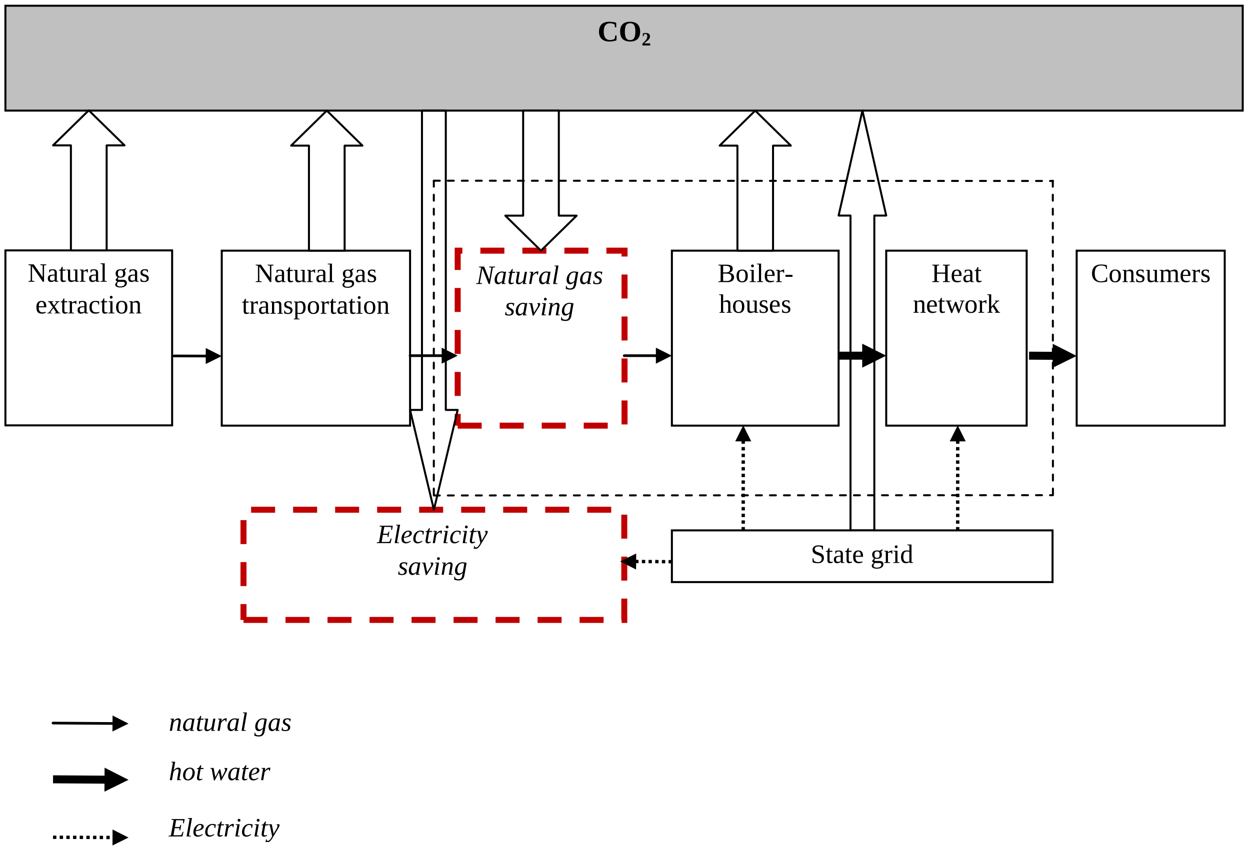


Fig.9. Project boundaries for Project scenario

Direct and Indirect Emissions

Direct on-site emissions: CO_2 emissions from natural gas combustion in boilers, NO_x and CO emission from combustion in the existing boilers/ burners, additional CO_2 emissions from natural gas combustion in boilers at the boiler houses due to the too large (exceeding normative) heat losses in the distribution networks.

CH_4 and N_2O emissions from fuel combustion are negligible minor sources, and are excluded from considerations for simplification.

Direct off-site emissions: GHG emissions from power station(s) due to electricity production to the grid that is consumed by boiler houses.

GHG emissions from power plants due to electricity production to the grid that is consumed for heating of consumers of Kharkiv region. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of power heaters is quite typical and widespread.

Indirect on-site emissions: none.

Indirect off-site emissions: CO_2 emissions from fuel extraction and transportation.

On-site emissions			
Current situation	Project	Direct or indirect	Included or excluded
CO_2 emissions from fuel (natural gas) combustion in boilers	Reduced CO_2 emissions from fuel (natural gas) combustion in boilers due to increased efficiency and fuel saving.	Direct	Included
NO_x and CO emission from fuel combustion in existing boilers/ burners	Reduced NO_x and CO emissions from fuel combustion after boiler / burners' replacement	Direct	Excluded. NO_x and CO are not GHGs
CO_2 emissions from fuel combustion in boilers at the boiler houses due to the too large heat losses in the networks	Reduced CO_2 emissions from boiler houses due to decreasing of heat losses in the network pipes due to replacement pipes with the pre-insulated ones, implementation of new heat exchangers, re-equipment of HSS	Direct	Included
Off-site emissions			
Current situation	Project	Direct or indirect	Included or excluded
CO_2 emissions from power plant(s) due to electricity production to the grid, that is consumed by boiler houses	Reduced CO_2 emissions from power plant(s) due to reduction of electricity consumption by boiler houses due to implementation of energy saving measurements	Direct	Included
CO_2 emissions from power plant(s) due to electricity consumption used for heating by consumers of Kharkiv region. It takes place due to inefficiencies of heat supply service quality for many consumers in the current situation. Exploitation of power heaters is quite typical and widespread.	Reduced CO_2 emissions from power plant(s) due to reduction of electricity consumption for heating by consumers of Kharkiv region. This will take place after project implementation when heat supply service will become more efficient. Exploitation of electric heaters will be decreased substantially	Direct	Excluded, not under control of project developer
CO_2 emissions from fuel extraction and transportation.	Reduced CO_2 emissions from fuel extraction and transportation due to fuel saving	Indirect	Excluded, not under control of project developer

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

Date of baseline setting: 26/05/2011.

The baseline is determined by the Institute of Engineering Ecology (IEE), the project developer (is not the project participant), and ME "KhTM", Project Participant and project supplier.

IEE:
Institute of Engineering Ecology
Kyiv, Ukraine.
Dmytro Paderno,
Deputy director, PhD.
Phone: +38 044 453 28 62
Fax: +38 044 456 92 62
e-mail: engeco@kw.ua

ME "KhTM":
ME "Kharkivski teplovi merezhi"
Kharkiv, Ukraine.
Andriy Repin,
Chief of PTS
Phone: +38 057-758-84-61
Fax: +38 057-736-09-31
e-mail: ji.project@hte.vl.net.ua

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

The starting date of the project is: 29/12/2006.

The date 29/12/2006 was accepted as the project's starting date because on this date the Agreement on implementation of organizational and technical measures to achieve reduction of greenhouse gases emissions to the environment according to the Kyoto Protocol was signed between the ME "KhTM" and KhRME "Dyrektsiya RIT", Izium HSNME, Krasnohrad HSNE, Nova Vodolaha HSNE, Pervomais'kyi ME "Teplomerezhi", MEBDC "BTM", ME «Teplovi merezhi» of Lozova CC, "KLK" Ltd., IRC "Teploenergiya" (No. 221308 dated 29.12.2006).

C.2. Expected operational lifetime of the project:

The minimal nominal lifetime of the new boilers is 20 years. The real average lifetime of the new network equipment is estimated to be up to 30 – 40 years, therefore the expected operational lifetime of the project may be at least 30 years. For further calculations the end of the operational lifetime for the project is assumed equal to 20 years, or 240 months, since implementation of the last project activity (31.12.2012).

Thus, the expected operational lifetime of the project is 26 years (312 months), from 01.01.2007 till 31.12.2032.

C.3. Length of the crediting period:

Earning of the ERUs corresponds to the first commitment period of 5 years (January, 1, 2008 – December, 31, 2012).

The starting date of the crediting period is set to the date when 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 December 31, 2032. Thus the length of the crediting period is 26 years (312 months), from 01.01.2007 till 31.12.2032.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

Indicator of project performance

The most objective and cumulative factor that will give a clear picture of whether emission reductions really took place – are *fuel and electricity consumption reduction*. It can be identified as a difference between baseline consumption and consumption after project implementation. If boilers consume fuel at the projected level, than all other relevant indicators such as efficiencies of new boilers, burners and heat utilizers, as well as heat losses in pre-insulated pipes are adequate.

Monitoring of project performance indicators

Municipal enterprises that implement the project collect data on fuel and electricity purchasing and consumption for heat supply activity in form of fuel and electricity bills as well as input meters records. Information on actual fuel and electricity consumption will be used in course of preparation of monitoring reports mainly on a yearly basis (as a rule till April 1st for every year following the reported one), with all relevant grounding documentation and historical information.

Monitoring of Emission Reductions and Baseline Scenario

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

For any project year, the baseline scenario may be different due to the influence of external factors such as weather conditions, possible changes of the net calorific value of fuel(s), number of consumers, etc. The Baseline (and correspondingly the amount of emission reductions) for each project year should be corrected with taking into account these and some other factors (the Dynamic Baseline).

The following specific project approach is proposed to be used.

Amount of the Emission Reductions (ERs), t CO_2e:

$$ERs = \sum[E_{(i)}^{b} - E_{(i)}^{r}] \qquad (D.1.1\text{-}1)$$

where:
$E_{(i)}^{b}$ and $E_{(i)}^{r}$ - baseline and project emissions for an (i) boiler-house in the reported year, t CO_2e.

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

For each boiler-house:

$$E^{b} = E_{1}^{b} + E_{gen}^{b} + E_{cons}^{b}, \qquad (D.1.1\text{-}2)$$

$E^r = E_1{}^r + E_{gen}{}^r + E_{cons}{}^r$, (D.1.1-3)

where:
$E_1{}^b$ and $E_1{}^r$ – emissions due to fuel consumption for heating and hot water supply service by a boiler-house that would be in the base year in terms of the reported year and in the reported year, respectively, t CO_2e;
$E_{gen}{}^b$ and $E_{gen}{}^r$ – emissions due to electricity generation associated to the project for a boiler-house in the base year (consumed from grid, amount to be substituted in the reported year), and due to electricity generation by cogeneration units (due to fuel consumption) at a boiler-house in the reported year, respectively, t CO_2e;
$E_{cons}{}^b$ and $E_{cons}{}^r$ – emissions due to electricity consumption by a boiler-house and heat supply stations related to it that would be in the base year in terms of the reported year and in the reported year, respectively, t CO_2e.

$E_1{}^b = NCV^b*Cef*B^b$ (D.1.1-4)

$E_1{}^r = NCV^r* Cef*B^r$ (D.1.1-5)

$E_{gen}{}^b = W^b*CEF_c+ Q^b*f^b* NCV^r* Cef$ (D.1.1-6)

$E_{gen}{}^r = (W^b - W^r)*CEF_g+ [(Q^b-Q^r)*f^b+ B_g]* NCV^r* Cef$ (D.1.1-7)

$E_{cons}{}^b = P^b*CEF_c$ (D.1.1-8)

$E_{cons}{}^r = P^r*CEF_c$ (D.1.1-9)

where:
NCV – averaged calorific value of a fuel, GJ/ ths m^3 (GJ/t);
Cef – carbon emission factor for a fuel, t CO_2/GJ;
B – fuel consumption by a boiler-house, ths m^3 (t);
W^b – scheduled electricity generation by the new CHP units at a boiler-house, MWh;
W^r – electricity generation by the installed CHP units, MWh;
CEF_g – carbon emission factor for electricity generation, tCO_2e/MWh;
P – electricity consumption by a boiler-house and heat supply stations related to it, MWh;
CEF_c – carbon emission factor for electricity consumption, tCO_2e/MWh;
Q^b – scheduled heat energy generation by the new CHP units at a boiler-house, MWh;
Q^r – heat energy generation 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, ths m^3/MWh;
B_g – amount of fuel (gas) consumed by the installed CHP units, 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.

The value of E_1^b consists of the two components:

$E_1^b = E_h^b + E_w^b$; (D.1.1-10)

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

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

$E_1^b = NCV^b*Cef*[B^b*a^b*K_1*K_h + B^b*(1-a^b)*K_1*K_w]$, (D.1.1-11)

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:

$E_1^b = NCV^b*Cef*[B^b*a^b*K_1*K_h + B^r *(1-a^r)*K_1*K_{w0}]$ (D.1.1-12)

where:
NCV – averaged calorific value of a fuel, GJ/ ths m^3 (GJ/t);
Cef – carbon emission factor for a fuel, t CO_2/GJ;
B – fuel consumption by a boiler-house, ths m^3 (t);
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 service;
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

$a^b= L_h^b*g^b*N_h^b/ (L_h^b*g^b*N_h^b+L_w^b*N_w^b)$; (D.1.1-13)

$a^r= L_h^r*g^r*N_h^r/ (L_h^r*g^r*N_h^r+L_w^r*N_w^r)$, (D.1.1-14)

where:
L_h, L_w – maximum connected load to a boiler-house, that is required for heating and for hot water supply service, respectively, MW;
g – recalculation factor for average heat load during heating period;
N_h, N_w – duration of heating period and period of hot water supply service, hours.
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year;

[h] – index related to heating;
[w] – index related to hot water supply.

$$g^{b,r} = F_h^{b,r} * k_h^{b} * (T_{in}^{b,r} - T_{out\,av}^{b,r}) / F_h^{b,r} * k_h^{b} * (T_{in}^{b,r} - T_{out\,min}^{b,r}) = (T_{in}^{b,r} - T_{out\,av}^{b,r}) / (T_{in}^{b,r} - T_{out\,min}^{b,r}) \quad \text{(D.1.1-15)}$$

where:
F_h – heated area, m^2;
k_h – averaged heat transfer factor of heated buildings, $kW/(m^2*K)$;
T_{in} – average inside temperature during the heating period, K (or ^0C);
$T_{out\,av}$ – average outside temperature during the heating period, K (or ^0C);
$T_{out\,min}$ – minimal outside temperature during the heating period, K (or ^0C).
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

Adjustment factors:

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

$$K_1 = NCV^b / NCV^r \quad \text{(D.1.1-16)}$$

where
NCV – averaged calorific value of a fuel, GJ/ ths m^3 (GJ/t);
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

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:

$$B_h = B*a = Q_h / NCV*\eta_h, \quad \text{(D.1.1-17)}$$

where
B – fuel consumption by a boiler-house, ths m^3 (t);
a – portion of fuel (heat), consumed for heating purposes;
Q_h - required amount of heat during heating period, GJ,
NCV – averaged calorific value of a fuel, GJ/ ths m^3 (GJ/t);
η_h – 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:

$Q_h^{br} = Q_h^{b} * K_h = Q_h^{r}$ (D.1.1-18)

where:
Q_h^{br} – required amount of heat for Dynamic Baseline, is assumed equal to Q^r – required amount of heat in the reported year, GJ,
Q_h^{b} – required amount of heat in the base year, GJ,
K_h – averaged adjustment factor for heating.

This averaged adjustment factor may be determined from the equation:

$K_h = Q_h^{r} / Q_h^{b}$. (D.1.1-19)

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"[18], is determined by [ibid, equation 2.17]:

$Q_h = F_h * k_h * (T_{in} - T_{out}) * N_h$, (D.1.1-20)

where:
Q_h – required amount of heat for heating, kWh;
F_h – heated area, m^2;
k_h – averaged heat transfer factor of heated 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:
$K_h = (F_h^{r} * k_h^{r}) * (T_{in}^{r} - T_{out}^{r}) * N_h^{r} / F_h^{b} * k_h^{b} * (T_{in}^{b} - T_{out}^{b}) * N_h^{b}$ (D.1.1-21)

The components of K_h:

2.1. K_2 (Temperature change factor):

$K_2 = (T_{in}^{r} - T_{out}^{r}) / (T_{in}^{b} - T_{out}^{b})$. (D.1.1-22)

[18] http://www.twirpx.com/file/153194/

where:
T_{in} – average inside temperature for the heating period, K (or ^0C);
T_{out} – average outside temperature for the heating period, K (or ^0C);
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

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

$$K_3 = F_h^{\ r} * k_h^{\ r} / F_h^{\ b} * k_h^{\ b} = [(F_h^{\ r} – F_{h\,t}^{\ r} – F_{h\,n}^{\ r}) * k_h^{\ b} + (F_{h\,n}^{\ r} + F_{h\,t}^{\ r}) * k_{h\,n}] / F_h^{\ b} * k_h^{\ b}, \quad \text{(D.1.1-23)}$$

where:
F_h – heated area of buildings, m^2;
$F_{h\,n}$ – heated area of newly connected buildings (assumed with the new (improved) heat insulation), m^2;
$F_{h\,t}$ – heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation, m^2;
k_h – average heat transfer factor of heated buildings, $kW/(m^2*K)$;
$k_{h\,n}$ – heat transfer factor of heated buildings with new heat insulation, $kW/(m^2*K)$.
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

2.3. K_4 (Heating period duration change factor):

$$K_4 = N_h^{\ r} / N_h^{\ b} \quad \text{(D.1.1-24)}$$

where:
$N_h^{\ b}$ – heating period duration in the base year, hours;
$N_h^{\ r}$ – heating period duration in a reported year, hours.

Thus,

$$K_h = K_2 * K_3 * K_4 \quad \text{(D.1.1-25)}$$

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 consumers, 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:

$$B_w = B*(1-a) = Q_w / NCV*\eta_w, \quad \text{(D.1.1-26)}$$

where
B – fuel consumption by a boiler-house, ths m^3 (t);

(1 – a) – portion of fuel (heat), consumed for hot water supply service purposes;
Q_w - required amount of heat for hot water supply service during period of hot water supply service, GJ;
NCV – averaged calorific value of a fuel, GJ/ ths m^3 (GJ/t);
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 actual conditions (external to the project) in a reported year:

$$Q_w^{br} = Q_w^{b} * K_w = Q_{w\,r} \qquad \text{(D.1.1-27)}$$

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 a reported year, GJ,
Q_w^{b} – required amount of heat for hot water supply service in the base year, GJ,
K_w – averaged adjustment factor for hot water supply service.

This averaged adjustment factor may be determined from the equation:

$$K_w = Q_w^{r} / Q_w^{b}. \qquad \text{(D.1.1-28)}$$

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

$$Q_w = n_w * v_w * N_w, \qquad \text{(D.1.1-29)}$$

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

Then:

$$K_w = n_w^{r} * v_w^{r} * N_w^{r} / n_w^{b} * v_w^{b} * N_w^{b} \qquad \text{(D.1.1-30)}$$

where;
n_w – number of hot water supply service consumers;
v_w - standard specific discharge of hot water per personal account (in heat units, kWh/h);
N_w – duration of the hot water supply service period per year, hours.
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

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

$K_5 = n_w^{r} / n_w^{b}$ (D.1.1-31)

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

$K_6 = v_w^{r} / v_w^{b}$ (D.1.1-32)

At present the standard specific discharge of hot water is valid in Ukraine that was established by the "KTM 204 Ukraine 244-94"[19], and no information is available on any proposals 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):

$K_7 = N_w^{r} / N_w^{b}$ (D.1.1-33)

Thus,

$K_w = K_5 * K_6 * K_7$. (D.1.1-34)

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 consumers, 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,

$K_5 = K_6 = K_7 = 1$. (D.1.1-35)

Thus

$K_{w0} = 1$. (D.1.1-36)

For calculation the dynamic baseline emissions due to electricity consumption by a boiler-house, the same approach and the same adjustment factors are used as for calculation the dynamic baseline emissions due to fuel consumption. Thus, formula (D.1.1-8) becomes:

[19] http://www.twirpx.com/file/153194/

$E_{cons}{}^{b} = [P^{b}*a^{b}*K_{h} + P^{b}*(1-a^{b})*K_{w}] * CEF_{c}$, (D.1.1-37)

where:
P^{b} – electricity consumption by a boiler-house and heat supply stations related to it, MWh;
K_{h}, K_{w}, – adjustment factors;
a – portion of fuel (heat), consumed for heating purposes;
(1-a) – portion of fuel (heat), consumed for hot water supply service;
CEF_{c} – carbon emission factor for electricity consumption in Ukraine, $tCO_{2}e$/MWh.
[^{b}] – index related to the base year;
[^{r}] – index related to the reported year.

The tables of parameters included in the process of monitoring and verification for ERs calculation, are represented in the Sections **D.1.1.1** and **D.1.1.3.** Every year the table with foregoing factors will be updated with account for possible change of these factors, and the dynamic baseline will be developed as well as the amount of ERs will be calculated**.**

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

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

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel (natural gas) consumption by a boiler house (**B^r**)	Every boiler house	ths m^3	m	Every day	100%	Registered in the journal (paper and/or electronic)	Fuel consumption at boiler houses is the main data which allows to calculate GHG emissions in the reported year
2	Electricity consumption (**P^r**)	Every boiler house and heat supply stations related to it	MWh	m	Once per month	100%	Registered in the journal (paper and/or electronic)	Electricity consumption at boiler houses is the main data which allows to calculate GHG emissions in the reported year
3	Averaged calorific value of fuel (natural gas) (**NCV^r**)	Fuel Supplier's Report or Chem. Lab Analysis Report	MJ/m^3	m, c	Once per year (reported period)	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate GHG emissions in the reported year

4	Carbon emission factor for:	Normative documents		c	Once per year (reported period)	100%		Data which allows to calculate GHG emissions in the reported year
4.1	Natural gas (**Cef**)		kt CO_2/TJ					
4.2	Electricity consumption (**CEF_c**)		t CO_2e/ MWh					

All the data above are monitored throughout the crediting period.

According to valid legislation[20], all measuring equipment in Ukraine should meet the specified requirements of corresponding standards and is subject to the periodical calibration.

In case of failure of measurement equipment, it should be replaced or repaired as soon as possible. Such cases should be noted in monitoring reports.

[20] *http://oscill.com/files/27082006.pdf*

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

GHG emissions in the reported year for the project scenario is sum taken over all boiler-houses (i) which are included into the project. For each boiler-house:

The component $E_{gen}{}^{r}$ = 0, since no electricity production associated to this project is provided, thus formula (D.1.1-3) comes to:

$E^r = E_1{}^r + E_{cons}{}^r$; (D.1.1.2-1)

where:
$E_1{}^r$ – emissions due to fuel consumption for heating and hot water supply service by a boiler-house in the reported year, t CO_2e;
$E_{cons}{}^r$ – emissions due to electricity consumption by a boiler-house and heat supply stations related to it in the reported year, t CO_2e.

$E_1{}^r = NCV^r * Cef * B^r$, (D.1.1.2-2)

where:
B^r – fuel (natural gas) consumption by a boiler-house in the reported year, ths m^3;
NCV^r – averaged calorific value of a fuel (natural gas) in the reported year, GJ/ ths m^3;
Cef – carbon emission factor for a fuel (natural gas), tCO_2/GJ.

$E_{cons}{}^r = P^r * CEF_c$; (D.1.1.2-3)

where:
P^r – electricity consumption by a boiler-house and heat supply stations related to it in the reported year, MWh;
CEF_c – carbon emission factor for electricity consumption, tCO_2e/MWh.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Fuel (natural gas) consumption by a boiler house (**B^b**)	Every boiler-house	ths. m^3	m	Every day	100%	Registered in the journal (paper and/or electronic)	Fuel consumption at boiler houses is the main data which allows to calculate the baseline GHG emissions
2	Electricity consumption (**P^b**)	Boiler houses and heat supply stations	MWh	m	Every month	100%	Data journal, (paper and electronic file)	Data which allows to calculate the baseline GHG emissions due to power consumption from the grid
3	Averaged calorific value of fuel (natural gas) (**NCV^b** and **NCV^r**)	Fuel Supplier's Report or Chem. Lab Analysis Report	MJ/m^3	m, c	Once per year (reported period)	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate the baseline GHG emissions
4	Carbon emission factor for:	Normative documents		c	Once per year	100%	Special Reports (paper and/or electronic)	Data which allows to calculate the baseline GHG emissions

4.1	Natural Gas **(Cef)**		kt CO_2/TJ					
4.2	Electricity consumption **(CEF_c)**		t CO_2e/ MWh					
5	Average outside temperature during the heating period ($\mathbf{T_{out}}^{\mathbf{b}}$ and $\mathbf{T_{out}}^{\mathbf{r}}$)	Meteorological Service	^{0}C	m, c	Once per heating period. Daily temperature is registered every day	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
6	Average inside temperature during the heating period ($\mathbf{T_{in}}^{\mathbf{b}}$ and $\mathbf{T_{in}}^{\mathbf{r}}$)	Municipal enterprises that implement the project	^{0}C	m, c	Once per heating period	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
7	Number of consumers of hot water supply service ($\mathbf{n_w}^{\mathbf{b}}$ and $\mathbf{n_w}^{\mathbf{r}}$)	Municipal enterprises that implement the project	unit	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
8	Heated area (total) ($\mathbf{F_h}^{\mathbf{b}}$ and $\mathbf{F_h}^{\mathbf{r}}$)	Municipal enterprises that implement the project	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
9	Averaged heat transfer factor of buildings in the base year ($\mathbf{k_h}^{\mathbf{b}}$)	Municipal enterprises that implement the project	W/(m^2*K)	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline

10	Heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation in the reported year (**$F_{h\,t}^{\,r}$**)	Municipal enterprises that implement the project	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
11	Heated area of newly connected buildings (assumed with the new (improved) heat insulation) in the reported year (**$F_{h\,n}^{\,r}$**)	Municipal enterprises that implement the project	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
12	Heat transfer factor of buildings with new heat insulation (**$k_{h\,n}$**)	Municipal enterprises that implement the project, Normative documents	$W/(m^2*K)$	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
13	Heating period duration (**$N_h^{\,b}$** and **$N_h^{\,r}$**)	Municipal enterprises that implement the project	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline

14	Duration of period of hot water supply service (**N_w** ^{b} and **N_w** ^{r})	Municipal enterprises that implement the project	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
15	Maximum connected load to a boiler-house, that is required for heating (**L_h**^{b} and **L_h**^{r})	Municipal enterprises that implement the project	Gcal/h	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
16	Connected load to a boiler-house, that is required for hot water supply service (**L_w**^{b} and **L_w**^{r})	Municipal enterprises that implement the project	Gcal/h	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
17	Standard specific discharge of hot water per personal account (**v_w**^{b} and **v_w**^{r})	Municipal enterprises that implement the project, Normative documents	kWh/h	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline

For the base year (2005) all parameters (with [^{b}] index) presented above excluding parameters 10-12 are not monitored throughout the crediting period, are determined only once after the end of the base year and thus remain fixed throughout the crediting period. These data are available already at the stage of determination.

For any reported year (2007-2012 and later) all parameters (with [^{r}] index) presented above excluding parameters 1, 2, 9 are monitored throughout the crediting period.

See **Annex 3.**

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

GHG emissions in the reported year for the dynamic baseline scenario is sum taken over all boiler-houses (i) which are included into the project. For each boiler-house:

The component $E_{gen}^b = 0$, since no electricity generation associated to the project is provided, thus formula (D.1.1-2) comes to:

$E^b = E_1^b + E_{cons}^b$; (D.1.1.4-1)

where:
E_1^b – emissions due to fuel consumption for heating and hot water supply service by a boiler-house that would be in the base year in terms of the reported year, t CO_2e;
E_{cons}^b –emissions due to electricity consumption by a boiler-house and heat supply stations related to it that would be in the base year in terms of the reported year, t CO_2e.

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

$E_1^b = NCV^b*Cef*[B^b*a^b*K_1*K_h + B^b*(1-a^b)*K_1*K_w]$, (D.1.1.4-2)

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

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

$E_1^b = NCV^b*Cef*[B^b*a^b*K_1*K_h + B^r *(1-a^r)*K_1*K_{w0}]$. (D.1.1.4-3)

where:
B^b – fuel (natural gas) consumption by a boiler-house in the base year, ths m^3;
B^r – fuel (natural gas) consumption by a boiler-house in the reported year, ths m^3;
NCV^b – averaged calorific value of a fuel (natural gas) in the base year, GJ/ ths m^3;
Cef – carbon emission factor for a fuel (natural gas), tCO_2/GJ;
K_1, $K_h = K_2* K_3* K_4$; $K_w = K_5 * K_6 * K_7$, K_{w0} – 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 service in the base year;
a^r – portion of fuel (heat), consumed for heating purposes in the reported year;
$(1- a^r)$ – portion of fuel (heat), consumed for hot water supply service purposes in the reported year.

$a^b = L_h^b * g^b * N_h^b / (L_h^b * g^b * N_h^b + L_w^b * N_w^b)$; (D.1.1.4-4)

where:
L_h^b – maximum connected load to a boiler-house, that is required for heating in the base year, MW;
L_w^b – connected load to a boiler-house, that is required for hot water supply service in the base year, MW;
g^b – recalculation factor for average heat load during heating period in the base year;
N_h^b – heating period duration in the base year, hours;
N_w^b – duration of period of hot water supply service in the base year, hours.

$a^r = L_h^r * g^r * N_h^r / (L_h^r * g^r * N_h^r + L_w^r * N_w^r)$ (D.1.1.4-5)

where:
L_h^r – maximum connected load to a boiler-house, that is required for heating in the reported year, MW;
L_w^r – connected load to a boiler-house, that is required for hot water supply service in the reported year, MW;
g^r – recalculation factor for average heat load during heating period in the reported year;
N_h^r – heating period duration in the reported year, hours,
N_w^r – duration of period of hot water supply service in the reported year, hours.

$g^{b,r} = (T_{in}^{b,r} - T_{out}^{b,r}) / (T_{in}^{b,r} - T_{out\ min})$ (D.1.1.4-6)

where:
$T_{in}^{b,r}$ – average inside temperature during the heating period in the base and reported year, respectively, K (or ^0C);
$T_{out}^{b,r}$ – average outside temperature during the heating period in the base and reported year, respectively, K (or ^0C);
$T_{out\ min}$ – minimal outside temperature during the heating period, K (or ^0C).

$K_1 = NCV^b / NCV^r$; (D.1.1.4-7)

where:
K_1 –calorific value of a fuel change factor;
NCV^b – averaged calorific value of a fuel (natural gas) in the base year, GJ/ ths m^3;
NCV^r – averaged calorific value of a fuel (natural gas) in the reported year, GJ/ ths m^3.

$K_2 = (T_{in}^r - T_{out}^r) / (T_{in}^b - T_{out}^b)$; (D.1.1.4-8)

where:
K_2 – temperature change factor;
T_{in}^r – average inside temperature during the heating period in the reported year, K (or ^0C);
T_{in}^b – average inside temperature during the heating period in the base year, K (or ^0C);
T_{out}^r – average outside temperature during the heating period in the reported year, K (or ^0C);

T_{out}^{b} – average outside temperature during the heating period in the reported year, K (or ^{0}C)

$K_3 = [(F_h^{r} - F_{h\,t}^{r} - F_{h\,n}^{r})*k_h^{b} + (F_{h\,n}^{r} + F_{h\,t}^{r})*k_{h\,n}] / F_h^{b}*k_h^{b}$; (D.1.1.4-9)

where:
K_3 – heated area and building heat insulation change factor;
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 newly connected buildings (assumed with the new (improved) heat insulation) in the reported year, m^2;
$F_{h\,t}^{r}$ – heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation in reported year, m^2;
k_h^{b} – averaged 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 heat insulation, $kW/(m^2*K)$.

$K_4 = N_h^{r} / N_h^{b}$; (D.1.1.4-10)

where:
K_4 – heating period duration change factor;
N_h^{b} – heating period duration in the base year, hours
N_h^{r} – heating period duration in the reported year, hours

$K_5 = n_w^{r} / n_w^{b}$; (D.1.1.4-11)

where:
K_5 – number of consumers of hot water supply service change factor;
n_w^{b},– number of consumers of hot water supply service in the base year;
n_w^{r} – number of consumers of hot water supply service in the reported year

$K_6 = v_w^{r} / v_w^{b}$; (D.1.1.4-12)

where:
K_6 – standard specific discharge of hot water per personal account change factor;
v_w^{r} – standard specific discharge of hot water per personal account in the reported year, kWh/h (or heat units);
v_w^{b} – standard specific discharge of hot water per personal account in the base year, kWh/h (or heat units).

$K_7 = N_w^{r} / N_w^{b}$; (D.1.1.4-13)

where:
K_7 – duration of period of hot water supply service change factor;
N_w^{r} – duration of period of hot water supply service in the reported year, hours.

N_w^b – duration of period of hot water supply service in the base year, hours.

For the case when in the base year the hot water supply service was absent at all, and in the reported year this service was provided (due to improvement of heat supply service quality for population), number of consumers, standard specific discharge of hot water per personal account and duration of period of hot water supply service for baseline are assumed equal to these values in the reported year, and then:

$K_5 = K_6 = K_7 = 1.$

Thus
$K_{w0} = 1.$

$$E_{cons}^b = [P^b * a^b * K_h + P^b * (1-a^b) * K_w] * CEF_c, \quad (D.1.1.4\text{-}14)$$

where:
P^b – electricity consumption by a boiler-house and heat supply stations related to it in the base year, MWh;
K_h, K_w – 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 service in the base year;
CEF_c – carbon emission factor for electricity consumption in Ukraine, tCO_2e/MWh.
$[^b]$ – index related to the base year;
$[^r]$ – index related to the reported year.

The Specific project approach for "District Heating system rehabilitation" projects in Ukrainian conditions was developed for application in different regions of Ukraine. In some regions the consumers receive less than necessary amount of heat, in result of which the temperature inside the buildings is much lower than normative one (18^0C), and hot water supply is insufficient or absent. Therefore this Specific project approach allows taking into account improving of the heat supply quality for the consumers, and excludes deliberate excess reduction of heat delivery, and, in such a way, of fuel consumption with the purpose of excess increasing of generation of GHG emissions reductions (ERs) at the project activity.

Delivery of the less than necessary amount of heat and hot water really took place previously in a number of cities and regions in Ukraine (and takes place even now in some cities and regions where situation business-as-usual is continued), and is reflected for example in JI Projects "Rehabilitation of the District Heating System in Donetsk Region", "Rehabilitation of the District Heating System of Chernihiv Region", etc.

According to "Rules of rendering of heat and hot water supply service to population" confirmed by the Order of Cabinet of Ministries of Ukraine No. 1497 dated 30.12.1997[21] (valid till 21.07.2005, but the below recalculation order was valid till 17.02.2010), the heat supply enterprises must make the return payments to population for delivery less than necessary for providing normative heating level amount of heat. The normative inside temperature should be not lower than

[21] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1497-97-%EF

$18^{o}C$.

Amount of such return payment is the following:
– 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.

Average inside temperature during the heating period is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied).

Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservative approach) and as meeting the normative.
Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.

The average inside temperature is calculated by formulae: (D.1.1.4-15)

If R = 0 (according to conservative approach, R < 0.05 is assumed for the baseline):
$\mathbf{T_{in\ b}} = 18\ ^{o}C$.
If $0.05 < R \leq 0.3$:
$\mathbf{T_{in\ b}} = 18 - (R/0.05)\ [^{o}C]$;
If $0.3 < R < 1$:
$\mathbf{T_{in\ b}} = 12 - [(R - 0.3)/0.1]\ [^{o}C]$

where:
R **-** portion of returned payment of NP – amount of normative payment.

Since 17.02.2010, the new “Order for recalculation of payment for rendering the centralized heating, cold and hot water supply services in cases of their non-rendering or non-full rendering, quality decrease” confirmed by the Order of Cabinet of Ministries of Ukraine No. 151 dated 17.02.2010[22], is valid, according to which the amount of such return payment is the following:
– 5% from normative payment for every degree from 18 to 12 ^{o}C;
– when inside temperature is lower than 12 ^{o}C, the payment is to be returned completely.

Thus, the average inside temperature since 17.02.2010 is calculated by formulae: (D.1.1.4-16)

If R = 0 (according to conservative approach, R < 0.05 is assumed for the baseline):
$\mathbf{T_{in\ b}} = 18\ ^{o}C$.
If $0.05 < R \leq 0.3$:

---

[22] *http://zakon2.rada.gov.ua/laws/show/151-2010-%D0%BF*

$\mathbf{T_{in\ b}}$ = 18 – (R/0.05) [^{o}C];
If 0.3 < R < 1:
$\mathbf{T_{in\ b}}$ = 12 ^{o}C is accepted.

Thus if the inside temperature will be 18 ^{o}C or higher, it will be accepted as 18 ^{o}C according to conservative approach, and if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented above.

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

This section is left blank for purpose. Option 1 is chosen.

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

This section is left blank for purpose. Option 1 is chosen.

D.1.3. Treatment of leakage in the monitoring plan:

No leakage is expected. Dynamic baseline (based on collected monitoring data) will exclude all possible leakages.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Any occasional leakage emissions (for example, caused by pipes' leakages, etc.) should be eliminated as soon as possible.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

No leakages are expected.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

Formulae presented in sections D.1.1. - D.1.3. will be used for monitoring of the emissions in the project scenario and in the baseline scenario, in particular in course of preparation of Monitoring reports. The baseline is dynamic and depends on conditions of every reported year. Therefore it is impossible to use these formulae in PDD to estimate emission reductions because there are no data (whether conditions, net calorific value of fuels, etc.) available for any reported year yet.

Formulae presented in this section D.1.4. are used to estimate emission reductions in PDD. Results of the corresponding calculations made with using of these formulae are listed in **Appendices 1 - 4**. These calculations are based on planned equipment efficiency increasing. Parameters' names corresponding to these formulae are pointed out in **Appendices 1 - 4**.

Every Appendix contains calculations of GHG emission reductions that correspond to specified technology used in the JI project.

Appendix 1 - Boiler -houses equipment modernization.
Replacement of old operating boilers with low efficiency by the new highly efficient ones, switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment.
Appendix 2 - Network rehabilitation.
Partial replacement of the main and distribution networks' pipes by the pre-insulated ones.
Appendix 3 - Installation of frequency controllers.
Installation of frequency controllers at electric drives of pumps and draw-blowing equipment.
Appendix 4 – Replacement of pumps.
Replacement of pumps by the new ones with less capacity and better efficiency.
Appendix 5 - Contains total sums of emission reductions, fuel and electricity savings for every year for each technology.
Appendix 6 - Contains calculations of baseline emissions and project emissions as well as GHG emission reductions for every project year, based on formulae presented in D.1.4.

Appendices 5 and **6** contain links with all **Appendices 1 - 4**.

GHG emission reductions from the project are estimated by means of the following formulae:

$$ERs = E^b - E^r \quad (D.1.4\text{-}1)$$

where:
ERs – emission reductions, t CO_2e;
E^r – project emissions, t CO_2e;
E^b – baseline emissions, t CO_2e.

Baseline emissions

Baseline emissions consist of two types of GHG emissions:

1) GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region;
2) GHG emissions from current electricity consumption from the state grid which will be reduced due to implementation of energy saving measures at boiler-houses and heat supply stations.

$$E^b = E1^b + E2^b \quad (D.1.4\text{-}2)$$

where:
$E1^b$ – emissions from heat production sources operated by the heat supply systems of Kharkiv region, t CO_2e;
$E2^b$ – emissions due to electricity production to the grid that is consumed by boiler houses and heat supply stations, t CO_2e;

1) Emissions from heat generating sources:

$$E1^b = \sum (B_{(i)}^b * NCV^b * Cef), \quad (D.1.4\text{-}3)$$

where:
$B_{(i)}^b$ – fuel (natural gas) consumption by (i) boiler house in the baseline scenario, ths m^3;
NCV^b – averaged calorific value of a fuel (natural gas), GJ/ths m^3;
Cef – carbon emission factor for a fuel (natural gas), t CO_2/GJ.

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

For more detailed information see **Appendix 1.**

2) Emissions due to electricity production to the grid that is consumed by boiler houses and heat supply stations.

$E2^b = \sum (P_{(i)}^b * CEF_c)$, (D.1.4-4)

where:
$P_{(i)}^b$ – electricity consumption by (i) boiler house and heat supply stations related to it in the baseline scenario, MWh;
CEF_c – carbon emission factor for electricity consumption, tCO_2e/MWh.

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

For more detailed information see **Appendix 1.**

Project emissions

There are two kinds of emissions which are included in the project scenario:

1) GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region;
2) GHG emissions from the electricity consumption from the state grid.

$E^r = E1^r + E2^r$, (D.1.4-5)

where:
$E1^r$ – emissions from heat production sources operated by the heat supply systems of Kharkiv region in a reported year, t CO_2e;
$E2^r$ – emissions due to electricity production to the grid, that consumed by boiler houses and heat supply stations in a reported year, t CO_2e;

Project scenario emissions from boiler-houses are a sum of prognostic fuel amounts to be consumed in any reported year multiplied by corresponding conversion factors. Prognostic – means estimated fuel consumption in the project scenario after rehabilitation of boiler equipment, with subtracted fuel saving due to improving of the network efficiency, re-equipment of heat supply stations.

$E1^r = \sum [(B_{(i)}^r – V_{(i)}^r) *NCV^r *Cef]$; (D.1.4-6)

where:
$B_{(i)}^r$ – fuel (natural gas) consumption by (i) boiler house in the project scenario, ths m^3;

$V_{(i)}^{r}$ – fuel saving due to rehabilitation of network and heat supply stations related to (i) boiler-house, ths m^3;
NCV^r – averaged calorific value of a fuel (natural gas), GJ/ ths m^3;
Cef. – carbon emission factor for a fuel (natural gas), t CO_2/GJ.

$B_{(i)}^{r} = (B_{(i)}^{b} * NCV^{b} * BBE_{(i)}) / (NCV^{r} * PBE_{(i)})$, (D.1.4-7)

where:
$BBE_{(i)}$ - Baseline Boilers Efficiency, %;
$PBE_{(i)}$ - Project Boilers Efficiency, %.

$V_{(i)}^{r} = B_{(i)}^{b} - B_{(i)}^{b} * (100 - L1^{b})/(100 - L1^{r})$, (D.1.4-8)

where:
$L1^b$ – heat losses in the network in the baseline scenario, %;
$L1^r$ – heat losses in the network in the project scenario, %.

$E2^r = \sum [(P_{(i)}^{b} - P1_{(i)}^{r} - P2_{(i)}^{r}) * CEF_c]$ (D.1.4-9)

where:
$P1_{(i)}^{r}$ – calculated electricity saving due to frequency controllers' installation at (i) boiler house and heat supply stations related to it, MWh;
$P2_{(i)}^{r}$ - calculated electricity saving due to replacement of pumps at (i) boiler house and heat supply stations related to it, MWh.
CEF_c – carbon emission factor for electricity consumption, tCO_2e/MWh;

$P1^r = N^b * (1-\psi) * t$ (D.1.4-10)

where:
N^b – capacity of draw-blowing equipment and/or pumps where frequency controllers are scheduled to be implemented, MW;
ψ – engine loading factor;
t - working period duration, hours per year.

$P2^r = (N^b - N^r) * t$ (D.1.4-11)

where:
N^b and N^r – capacity of pumps that are scheduled to be replaced and of new pumps to be installed, respectively, MW;
t - working period duration, hours per year.

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

For more detailed information see **Appendices 1-4.**

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

According to the common Ukrainian practice for such type projects, the environmental impact of the project will be estimated by fuel consumption and combustion.

- Law of Ukraine # 1264-XII "On environmental protection" dated 25.06.1991[23];
- Law of Ukraine # 2707-XII "On atmospheric air protection" dated 16.10.1992[24];
- Valid rules on emissions limitation: "Norms of limit admissible emissions of pollution agents from stationary sources" – adopted by Ministry for Environmental Protection of Ukraine on 27.06.2006, #309 and registered by Ministry of Justice of Ukraine on 01.09.2006, #912/12786[25].

[23] *http://zakon2.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1264-12*

[24] *http://zakon2.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=2707-12*

[25] *http://zakon2.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=z0912-06*

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
D.1.1.1; D.1.1.3 **1**. Fuel (natural gas) consumption by a boiler house **(B)**	Low	Measuring instruments must be calibrated according to national regulations
D.1.1.1; D.1.1.3 **2**. Electricity consumption **(P)**	Low	Measuring instruments must be calibrated according to national regulations
D.1.1.1; D.1.1.3 **3**. Averaged calorific value of fuel (natural gas) **(NCV)**	Low	Even though there is no need to mistrust fuel suppliers, the Supplier may periodically check the data provided by fuel suppliers through performing chemical analysis of supplied fuel (usually once per heating period)
D.1.1.1; D.1.1.3 **4**. Carbon emission factors **(Cef**, **CEF_c)**	Low	Normative documents data. No QA/QC procedures are necessary
D.1.1.3 **5**. Average outside temperature during the heating period **(T_{out})**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **6**. Average inside temperature during the heating period **(T_{in})**	Low	Statistic data. No QA/QC procedures are necessary

D.1.1.3 **7**. Number of Consumers of hot water supply service **(n_w)**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **8**. Heated area (total) **(F_h)**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **9**. Averaged heat transfer factor of buildings in the base year **(k_h)**	Low	Normative documents data. No QA/QC procedures are necessary
D.1.1.3 **10**. Heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation in the reported year **($F_{h\ t}$)**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **11**. Heated area of newly connected buildings (assumed with the new (improved) heat insulation) in the reported year **($F_{h\ n}$)**	Low	Statistic data. No QA/QC procedures are necessary.

D.1.1.3 **12**. Heat transfer factor of buildings with new heat insulation **($k_{h\ n}$)**	Low	Normative documents data. No QA/QC procedures are necessary
D.1.1.3 **13**. Heating period duration **(N_h)**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **14**. Duration of period of hot water supply service **(N_w)**	Low	Statistic data. No QA/QC procedures are necessary
D.1.1.3 **15**. Maximum connected load to a boiler-house, that is required for heating **(L_h^b)**	Low	Calculated data (data are calculated taking into account connected Heated area by methodology of normative documents). No QA/QC procedures are necessary
D.1.1.3 **16**. Connected load to a boiler-house, that is required for hot water supply service **(L_w)**	Low	Calculated data (data are calculated taking into account number of connected consumers of hot water supply service by methodology of normative documents). No QA/QC procedures are necessary
D.1.1.3 **17**. Standard specific discharge of hot water per personal account **(v_w)**	Low	Normative documents data. No QA/QC procedures are necessary

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

The scheme identifying the responsibilities and the authority regarding the monitoring activity as to the parameters to be monitored is presented in **Annex 3**.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

The monitoring plan is determined by the Institute of Engineering Ecology (IEE), the project developer (is not the project participant), and ME "KhTM", project participant and project supplier.

IEE:
Institute of Engineering Ecology
Kyiv, Ukraine.
Dmytro Paderno,
Deputy director, PhD.
Phone: +38 044 453 28 62
Fax: +38 044 456 92 62
e-mail: engeco@kw.ua

ME "KhTM":
ME "Kharkivski teplovi merezhi"
Kharkiv, Ukraine.
Andriy Repin,
Chief of PTS
Phone: +38 057 758 84 61
Fax: +38 057 736 09 31
e-mail: ji.project@hte.vl.net.ua

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Calculation of Project Activity Level

Project activity level, estimated by fuel and electricity consumption, will be reduced comparing to the baseline activity level due to fuel and electricity saving.

Project energy resources consumption is presented in the Table 8.

	Project Natural Gas consumption, ths m^3/yr	Project electricity consumption, MWh
ME "KhTM"	171.42	15.93
KhRME "Dyrektsiya RIT"	28306.26	6300.40
Izium HSNME	9567.31	1871.59
Krasnohrad HSNE	3747.36	411.65
Nova Vodolaha HSNE	1618.52	298.24
Pervomais'kyi ME "Teplomerezhi"	15562.81	0.00
MEBDC "BTM"	11333.70	1784.29
ME «Teplovi merezhi» of Lozova CC	17942.38	5286.21
"KLK" Ltd.	17017.16	3175.52
ME "Chuhuivteplo"	8936.93	2164.02
Kharkiv District HSNME	7197.74	931.98
Borova HSNME	1618.49	234.29
Total	**123020.08**	**22474.12**

Table 8. Project Energy resources consumption

Detailed information is presented in **Appendices 1 - 4.**

Estimation of Project Emissions

There are 2 kinds of emissions which are included in the project scenario:

1) GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region (E1r);
2) GHG emissions from the electricity production that is consumed by boiler houses and heat supply stations from the state grid (E2r).

Project Emissions after project implementation are shown in Table 9.

Project emissions		Project emissions, t CO_2e
GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region	E1r	235128
GHG emissions from the electricity production that is consumed by boiler houses and heat supply stations from the state grid	E2r	27576
Project Emissions	Er	**262704**

Table 9. Project Emissions after project implementation

See **Appendix 6**.

Project emissions after project implementation are ~ **262704** t CO_2e

In the PDD calculations, according to the conservative approach, only the minimal guaranteed effects from all energy saving measures were taken into account.

Project emissions from the beginning until the end of the crediting period for each year see in **section E.6** and **Appendix 6 (Baseline).**

E.2. Estimated leakage:

No leakage is expected in proposed project activity.

E.3. The sum of E.1. and E.2.:

Project Emissions + Leakages = 262704 + 0 = 262704 t CO_2e.

E.4. Estimated baseline emissions:

Estimation of Baseline Emissions

Baseline emissions consist of two types of GHG emissions:

1) GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region in the base year (E1b);
2) GHG emissions from the electricity production that is consumed by boiler houses and heat supply stations from the state grid in the base year (E2b).

Baseline emissions by the sources of GHG emission are presented in the Table 10.

Baseline emissions by the sources of GHG emission		Baseline emissions, t CO_2e
GHG emissions from boilers which are operated by the heat supply systems of Kharkiv region in the base year	E1b	334789
GHG emissions from the electricity production that is consumed by boiler houses and heat supply stations from the state grid in the base year	E2b	40776
Baseline emissions	Eb	**375565**

Table 10. Baseline Emissions

Baseline emissions are: ~ **375565** t CO_2e.

The following conservative assumption is used to calculate baseline and project GHG emissions:
Average inside temperature during the heating period above the normative level (18 ^{0}C) is treated as 18 ^{0}C (according to the conservative approach) and as meeting the normative.

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating period if DH systems of municipal enterprises that implement the project remains unchanged, see in **section B** and **Appendix 6 (Baseline).**

Baseline emissions for each year from the beginning until the end of the crediting period see in **section E.6** and **Appendix 6 (Baseline).**

E.5. Difference between E.4. and E.3. representing the emission reductions of the project:

Project Emission Reduction = Baseline emission - (Project emission +Estimated leakage) =

= 375565 – (262704 + 0) = 112861 t CO_2e / year.

In course of the project implementation, the different emission reductions will be achieved at the different stages of project implementation. The amounts of emission reductions are represented in the **Tables 3 – 6,** Paragraph **A.4.3.1.**

Project Emission Reductions by the types of project activity are presented in the Table 11.

Year	**GHG emission reduction, t CO2e**				
	Due to boiler-houses equipment rehabilitation / modernization	Due to network rehabilitation / modernization	Due to frequency controllers installation	Due to pumps replacement	**Total**
2007	25124	5134	0	360	**30618**
2008	31778	10288	0	1675	**43741**
2009	49539	11628	0	2160	**63327**
2010	51316	13596	0	2738	**67650**
2011	55865	22166	962	4557	**83550**
2012	70989	35402	1195	5275	**112861**
Total	**284611**	**98214**	**2157**	**16765**	**401747**

Table 11. Estimated Project Emission Reductions

See **Appendices 1 – 5**.

Project Emission Reductions after project complete implementation (starting from 2012) by the municipal enterprises that implement the project are presented in the Table 12.

	GHG emission reductions, t CO2e
ME “KhTM”	24
KhRME “Dyrektsiya RIT”	33853
Izium HSNME	6683
Krasnohrad HSNE	1501
Nova Vodolaha HSNE	977
Pervomais’kyi ME “Teplomerezhi”	7143
MEBDC “BTM”	15494
ME «Teplovi merezhi» of Lozova CC	20354
“KLK” Ltd.	10383
ME “Chuhuivteplo”	9619
Kharkiv District HSNME	4703
Borova HSNME	2127
Total	**112861**

Table 12. Estimated Emission Reductions for each municipal enterprises that implement the project

E.6. Table providing values obtained when applying formulae above:

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2007	333947	0	364565	30618
Subtotal 2007 (tonnes of CO_2 equivalent)	**333947**	**0**	**364565**	**30618**
2008	331558	0	375299	43741
2009	312571	0	375898	63327
2010	307849	0	375499	67650
2011	292015	0	375565	83550
2012	262704	0	375565	112861
Subtotal 2008 – 2012 (tonnes of CO_2 equivalent)	**1506697**	**0**	**1877826**	**371129**
2013	262704	0	375565	112861
2014	262704	0	375565	112861
2015	262704	0	375565	112861
2016	262704	0	375565	112861
2017	262704	0	375565	112861
2018	262704	0	375565	112861
2019	262704	0	375565	112861
2020	262704	0	375565	112861
2021	262704	0	375565	112861
2022	262704	0	375565	112861
2023	262704	0	375565	112861
2024	262704	0	375565	112861
2025	262704	0	375565	112861
2026	262704	0	375565	112861
2027	262704	0	375565	112861
2028	262704	0	375565	112861
2029	262704	0	375565	112861
2030	262704	0	375565	112861
2031	262704	0	375565	112861
2032	262704	0	375565	112861
Subtotal 2013 – 2032 (tonnes of CO_2 equivalent)	**5254080**	**0**	**7511300**	**2257220**
Total (2007 - 2032) (tonnes of CO_2 equivalent)	**7094724**	**0**	**9753691**	**2658967**

Table 13. Table providing values obtained when applying formulae above.

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

According to the Ukrainian regulations, the design documentation for the new building, reconstruction and major technical re-equipment of industrial and civil objects must include the environmental impact assessment.

Environmental Impact Assessment (EIA) is directed on determination of scales and levels of the project activity impact on an environment, on development of measures for prevention or reduction of this impact, on estimation of acceptability of project decisions from the ecological point of view. The EIA is inalienable part of project documentation of any above economical activity, but does not influence on the process of economic decisions acceptance. The EIA is conducted under the strict requirements.

The legislative requirements to EIA materials content are enshrined in the Article 36 of the Law of Ukraine «On ecological expertise»[26]. Requirements to the structure, composition and content of the EIA sections are enshrined in the State Building Norms of Ukraine DBN A.2.2-1-2003 “Composition and content of the Environmental Impact Assessment (EIA) materials at designing and construction of enterprises, buildings and premises”[27].

Municipal enterprises that implement the project “Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region” make the necessary Environmental Impact Assessment for elements of this activity according to Ukrainian legislation.

For example, during implementation of the project activity the EIA for reconstruction of boiler-house Nekrasova str., 74 Izium town (#3.1 in the Project) has been fulfilled. In this EIA the following is established: emissions will not exceed the emission limit level, and the project activity in general is assessed as environmentally positive.

Overall, this JI project will have a positive effect on environment. Following points will give detailed information on environmental benefits.

1. Project implementation will allow saving about 50 million m^3 of natural gas and over 10 GWh of electricity per year after project complete implementation. Natural gas is the non-renewable resource and it saving is important.

2. Project implementation will reduce GHG emissions in Kharkiv region by 112 861 tons of CO_2e per year after project complete implementation due to increased efficiency of the DH systems. This will be achieved through installation of up-to-date boiler-houses equipment, particularly new boilers, burners, heat exchangers, pumps, and using of pre-insulated network pipes instead of existing regular network pipes, etc.

3. Due to fuel saving and new environmentally friendlier technologies for fuel combustion, project implementation will reduce also emissions of, NO_x and CO (co-products of natural gas combustion).

4. Due to electricity saving, project implementation will reduce also emissions of CO_2, SO_x, NO_x, CO and particulate matter by power plants.

5. Due to scheduled better heat supply service, population of Kharkiv region is expected to reduce electricity consumption by electric heaters thus also reducing emissions of CO_2, SO_x, NO_x, CO and particulate matter by power plants.

DBN A.2.2-1-2003 does not contain the requirement as to the obligatory analysis of the transboundary impact, and in accordance with this the EIAs usually do not contain such special analysis. However, for this project transboundary impact is not considered, taking into account the insignificant emissions and

[26] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=45%2F95-%E2%F0

[27] http://www.budinfo.com.ua/dbn/8.htm

that these emissions are localized not far away from the source sites.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Impact on the ambient air

The project implementation will have positive effect on ambient air:

1) Reduction of NO_x and CO due to application of cleaner combustion technologies at boiler houses;
2) Reduction of electricity consumption results in lower emissions of the NO_x, SO_x, CO and PM;
3) Heat impact on the atmosphere (due to lower temperatures of flue gases) will be decreased;
4) Lower emissions per unit of delivered heat at the same load on boiler house.

Impact on the water medium

Impact on water resources will be the same as in baseline scenario. The existing technology of heat energy production exploited at the objects of municipal enterprises that implement the project foresees discharging of waste water to the sewage network with obligatory chemical control in accordance to Water Code of Ukraine[28], SanPiN 4630-88 "Sanitary rules and norms of protection of surface waters from pollution"[29] on determining maximum concentration limits for internal water bodies. Discharge of waste water to the open water bodies will not take place.

Project implementation will have positive water environmental effect. It will allow to decrease the water consumption and as a result – to decrease the amount of waste water.

Impact on the land use

Impact on the land is not present.

Relevant regulation in the sphere of land use is presented by the Land Code of Ukraine[30].

Impact on the biodiversity

Impact on biodiversity is not present.

Waste generation, treatment and disposal

In the process of project implementation the generation of waste will occur after disassembling of physically and morally obsolete equipment, burners, pipes, etc. Also some construction waste will occur due to destruction of boiler settling, boiler house foundations, etc.

Possible recycling of the old equipment will by definition have a positive effect on the environment.

According to the "Law on waste products" (article 17) "Obligations of economical activity subjects in sphere of waste treatment":

- enterprises must apply statistic reports on waste creating, gathering, transporting, keeping, treating, utilizing, decontaminating and excreting.

- provide complete gathering, appropriate keeping and non-admission waste destruction and spoilage, for utilization of which there is an appropriate technology in Ukraine.

[28] *http://zakon.nau.ua/doc/?uid=1011.17.21&nobreak=1*

[29] *http://www.gosthelp.ru/text/SanPiN463088Sanitarnyepra.html*

[30] *http://zakon2.rada.gov.ua/laws/show/2768-14*

In view of the aforesaid, municipal enterprises that implement the project deliver old equipment to metal recycling.

Reporting on statistic supervision on environmental protection

The municipal enterprises that implement the project regularly fill all forms of statistic supervision reporting required for their activity according to the valid Ukrainian legislation, that are:

- Form #1–ecological expenses “Report about expenses for environmental protection and ecological payments”;
- Form #1–danger waste “Report about generation, handling and treatment of waste of the I-III classes of danger”;
- Form #2-tp(air) - report about amount of potential environmental polluting emissions to atmosphere.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

As project activity won't provide negative influence on environment and negative social effect, special public discussion was not hold. The local authorities (city councils that are the representatives of the population) of Kharkiv region have expressed the support for the project, in particular:

Balakliia district State administration of Kharkiv region (Letter #01-07/2256 dated 30.06.2011);

Nova Vodolaha district Council of Kharkiv region (Letter #401 dated 30.06.2011);

Executive Committee of Pervomais'kyi city Council of Kharkiv region (Letter #01-34/1723 dated 01.07.2011);

Krasnohrad district Council of Kharkiv region (Letter #06-05/410 dated 04.07.2011);

Borova district Council of Kharkiv region (Letter #249/1-03 dated 04.07.2011);

Kharkiv district State administration of Kharkiv region (Letter #4069/02-13 dated 05.07.2011);

Executive Committee of Lozova city Council of Kharkiv region (Letter #01-13/571 dated 05.07.2011);

Chief Department of housing and public utility authority and infrastructure development of Kharkiv Regional State Administration (Letter #07-01/3543 dated 13.10.2011);

Kharkiv region Council (Decision #273-VI dated 27.10.2011).

This project was presented at the XVI, XVII, XX and XXI International Conferences "Problems of Ecology and Exploitation of Energy Objects" (Yalta, 2006, 2007, 2010 and 2011), where it was comprehensively discussed with representatives of governmental and district heating organizations.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Municipal Enterprise "Kharkivski teplovi merezhi"
Street/P.O.Box:	Dobrohotova str.
Building:	11
City:	Kharkiv
State/Region:	Kharkiv
Postal code:	61037
Country:	Ukraine
Phone:	+38 057 738 70 00
Fax:	+38 057 737 94 00
E-mail:	ji.project@hte.vl.net.ua
URL:	www.hts.kharkov.ua
Represented by:	
Title:	General director
Salutation:	Mr.
Last name:	Andreev
Middle name:	Yuriyovych
First name:	Sergiy
Department:	
Phone (direct):	+38 057 738 70 00
Fax (direct):	+38 057 737 94 00
Mobile:	
Personal e-mail:	

Organisation:	E-Energy B.V.
Street/P.O.Box:	Strawinskylaan
Building:	1143 C-11
City:	Amsterdam
State/Region:	
Postal code:	1077XX
Country:	The Netherlands
Phone:	+370 5 268 59 89
Fax:	+370 5 268 59 88
E-mail:	a.strolia@e-energija.lt
URL:	www.e-energy.eu
Represented by:	
Title:	Head of Climate Change department
Salutation:	Mr.
Last name:	Strolia
Middle name:	
First name:	Arturas
Department:	Climate Change department
Phone (direct):	+370 5 268 59 89
Fax (direct):	+370 5 268 59 88
Mobile:	
Personal e-mail:	

Annex 2

BASELINE INFORMATION

The key elements of the baseline (including variables, parameters and data sources) are presented in table below.

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	**B_b**	Fuel (natural gas) consumption by a boiler-house	ths.m^3	m
2	**P_b**	Electricity consumption	MWh	m
3	**NCV_b**	Averaged calorific value of fuel (natural gas)	MJ/m^3	m, c
4		Carbon emission factors for:		Normative documents:
4.1	**Cef** (natural gas)	Natural gas	t CO_2/GJ	The national inventory report of Ukraine for 1990 - 2009, Annex 2, section P2.5.1, Table P2.6, p.376
4.2	**CEF_c**	Electricity consumption	t CO_2e/ MWh	Table B2 "Baseline carbon emission factors for JI projects reducing electricity consumption" of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004; Table 8 "Emission Factors for the Ukrainian grid 2006-2012" of Annex 2 "Standardized Emission Factors for the Ukrainian Electricity Grid" to "Ukraine - Assessment of new calculation of CEF", confirmed by TUV SUD Industrie Service GmbH 17.08.2007; Orders of the National Environmental Investment Agency of Ukraine: # 62 dated 15.04.2011; # 63 dated 15.04.2011; # 43 dated 28.03.2011; # 75 dated 12.05.2011

Table An2-1. The key elements of the baseline

Annex 3

MONITORING PLAN

This monitoring plan describes the project specific approach that will be used to calculate the ongoing amount of greenhouse gas emission reductions resulting from implementation of the JI project in Kharkiv Region. Modernization and technical re-equipment of the district heating systems are expected to result in improved systems performance. Each component of the JI project is expected to result in a reduction of greenhouse gas emissions. The reductions of GHG emissions will be quantified using the project specific approach presented in section D and this Annex 3 "Monitoring Plan".

Relevant monitoring approach:

In course of development of the monitoring plan for the JI project **"Greenhouse gas emission reduction due to modernization and technical re-equipment of municipal enterprises of Kharkiv region"**, the project specific approach for "District Heating system rehabilitation" projects in Ukrainian conditions was used (see section B.1).

This Monitoring project specific approach is presented in details in section D.1.1. of this PDD (Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario).

Formulae for monitoring

Formulae used for calculation of the project emissions, baseline emissions and the total emission reductions are presented in the tables below.

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)	
	$ERUs = \sum[E_{(i)}^{b} - E_{(i)}^{r}]$
	$E_{(i)}^{b}$ – baseline emissions for an (i) boiler-house in the reported year, t CO_2e; $E_{(i)}^{r}$ – project emissions for an (i) boiler-house 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 – Project emissions in the reported year (E^r)	
	$E^r = E_1^r + E_{cons}^r$
	E_1^r – emissions due to fuel consumption for heating and hot water supply service by a boiler-house in the reported year, t CO_2e; E_{cons}^r – emissions due to electricity consumption by a boiler-house and heat supply stations related to it in the reported year, t CO_2e.

Formula 3 – Emissions due to fuel consumption for heating and hot water supply service by a boiler-house in the reported year (E_1^r)	
	$E_1^r = B^r * NCV^r * Cef$
	B^r – fuel (natural gas) consumption by a boiler-house in the reported year, ths m^3; NCV^r – averaged calorific value of a fuel (natural gas) in the reported year, GJ/ ths m^3; Cef – carbon emission factor for a fuel (natural gas), tCO_2/GJ.

Formula 4 – Emissions due to electricity consumption by a boiler-house and heat supply stations related to it in the reported year (E_{cons}^r)	
	$E_{cons}^r = P^r * CEF_c$
	P^r – electricity consumption by a boiler-house and heat supply stations related to it in the reported year, MWh; CEF_c – carbon emission factor for electricity consumption in Ukraine, tCO_2e/MWh.

Baseline emissions

Formula 5 – Baseline emissions in the reported year (E_b)	
	$E^b = E_1^b + E_{cons}^b$
	E_1^b – emissions due to fuel consumption for heating and hot water supply service by a boiler-house that would be in the base year in terms of the reported year, t CO_2e; E_{cons}^b –emissions due to electricity consumption by a boiler-house and heat supply stations related to it that would be in the base year in terms of the reported year, t CO_2e.

Formula 6 – Emissions due to fuel consumption for heating and hot water supply service by a boiler-house that would be in the base year in terms of the reported year (E_1^b)	
	For the case when in the base year the hot water supply service was provided ($(1-a^b) \neq 0$): $E_1^b = NCV^b * Cef * [B^b * a^b * K_1 * K_h + B^b * (1-a^b) * K_1 * K_w]$, 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): $E_1^b = NCV^b * Cef * [B^b * a^b * K_1 * K_h + B^r * (1-a^r) * K_1 * 1]$.
	B^b – fuel (natural gas) consumption by a boiler-house in the base year, ths m^3; B^r – fuel (natural gas) consumption by a boiler-house in the reported year, ths m^3; NCV^b – averaged calorific value of a fuel (natural gas) in the base year, GJ/ ths m^3; Cef – carbon emission factor for a fuel, tCO_2/GJ; 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 service in the base year; a^r – portion of fuel (heat), consumed for heating purposes in the reported year; $(1-a^r)$ – portion of fuel (heat), consumed for hot water supply service purposes in the reported year.

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

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

Formula 9 – Recalculation factor for average heat load during heating period ($g^{b,\ r}$)	
	$g^{b,\ r} = (T_{in}^{b,\ r} - T_{out}^{b,\ r}) / (T_{in}^{b,\ r} - T_{out\ min}^{b,\ r})$
	$T_{in}^{b,r}$ – average inside temperature during the heating period, ^{0}C ; $T_{out}^{b,r}$ – average outside temperature during the heating period, ^{0}C; $T_{out\ min}^{b,r}$ – minimal outside temperature during the heating period, ^{0}C.

Formula 10 – Calorific value of a fuel change factor (K_1)	
	$K_1 = NCV^b / NCV^r$
	NCV^b – averaged calorific value of a fuel (natural gas) in the base year, GJ/ ths m^3; NCV^r – averaged calorific value of a fuel (natural gas) in the reported year, GJ/ ths m^3.

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 during the heating period in the reported year, ^{0}C; T_{in}^b – average inside temperature during the heating period in the base year, ^{0}C; T_{out}^r – average outside temperature during the heating period in the reported year, ^{0}C; T_{out}^b – average outside temperature during the heating period in the base year, ^{0}C.

Formula 12 – Heated area and building heat 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^r – heated area in the reported year, m^2; F_h^b – heated area in the base year, m^2; $F_{h\,n}^r$ – heated area of newly connected buildings (assumed with the new (improved) heat insulation) in the reported year, m^2; $F_{h\,t}^r$ – heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation in the reported year, m^2; k_h^b – averaged heat transfer factor of heated buildings in the base year, $kW/(m^2*K)$; $k_{h\,n}$ – heat transfer factor of buildings with new heat insulation, $kW/(m^2*K)$.

Formula 13 – Heating period duration change factor (K_4)	
	$K_4=N_h^r/N_h^b$
	N_h^r – heating period duration in the reported year, hours; N_h^b – heating period duration in the base year, hours.

Formula 14 – Number of consumers of hot water supply service change factor (K_5)	
	$K_5 =n_w^r / n_w^b$
	n_w^r – number of consumers of hot water supply service in the reported year; n_w^b – number of consumers of hot water supply service in the base 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 – Duration of period of hot water supply service change factor (K_7)	
	$K_7 = N_w^r / N_w^b$
	N_w^r – duration of period of hot water supply service in the reported year, hours; N_w^b – duration of period of hot water supply service in the base year, hours.

Formula 17 –Emissions due to electricity consumption by a boiler-house and heat supply stations related to it that would be in the base year in terms of the reported year (E_{cons}^{b})	
	$E_{cons}^{b} = [P^{b}*a^{b}*K_{h} + P^{b}*(1-a^{b})*K_{w}] * CEF_{c}$
	P^{b} – electricity consumption by a boiler-house and heat supply stations related to it in the base year, MWh; K_{h}, K_{w} – 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 service in the base year; CEF_{c} – carbon emission factor for electricity consumption, tCO_2e/MWh.

Parameters to be monitored

Monitoring project specific approach identifies and takes into account the parameters that are need to be measured or monitored at regular intervals. These parameters will then be input into a project Tracking Database, which will be an Excel based spreadsheets that will track GHG emission reductions yearly.

Parameters to be monitored are presented in the tables below.

Parameter number and name	**1.** Fuel (natural gas) consumption by a boiler house
Description	Natural gas consumption by boiler houses. 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.
Monitoring method	Gas flow meters
Recording frequency	Registered every day and calculated once per year
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	According to the conservative approach, the volume of consumed natural gas will be corrected by measurement error. Amount of natural gas consumed in the reported year that will be used for Project emissions calculations will be increased by the portion proportional to the level of accuracy of gas flow meter installed at a boiler-house.

Parameter number and name	**2.** Electricity consumption
Description	Electricity consumption by boiler-houses and heat supply stations related to them
Monitoring method	Electricity meter
Recording frequency	Measured continuously and calculated once per year
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	According to the conservative approach, the volume of consumed electricity will be corrected by measurement error. Amount of electricity consumed in the reported year that will be used for Project emissions calculations will be increased by the portion proportional to the level of accuracy of electricity meter installed at boiler-houses.

Parameter number and name	**3.** Averaged calorific value of a fuel (natural gas)
Description	Averaged calorific value of natural gas calculated by net calorific value for every town
Monitoring method	Accepted in accordance with reference or telephone message from natural gas supplier or independent chemical lab analysis report. Independent chemical lab analysis is used in questionable cases. It is used rarely

Recording frequency	Data is provided by natural gas suppliers usually 3 times per month. Registered every month and calculated once per year.
Background data	Registered in the paper journal
Calculation method	Weighted average value

Parameter number and name	**4.** Carbon emission factor
Description	Carbon emission factor for natural gas and for electricity consumption
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	For natural gas the carbon emission factor is used from the data of table P2.6 provided in The national inventory report of Ukraine for 1990-2009. The values of the carbon emission factors for JI projects on reducing electricity consumption in Ukraine were taken for relevant years according to: - Table B2 “Baseline carbon emission factors for JI projects reducing electricity consumption” of Operational Guidelines for PDD's of JI projects. Volume 1: General guidelines Version 2.3. Ministry of Economic Affairs of the Netherlands, 2004; - Table 8 “Emission Factors for the Ukrainian grid 2006-2012” of Annex 2 “Standardized Emission Factors for the Ukrainian Electricity Grid” to “Ukraine - Assessment of new calculation of CEF”, confirmed by TUV SUD Industrie Service GmbH 17.08.2007; - Orders of the National Environmental Investment Agency of Ukraine # 62 dated 15.04.2011; # 63 dated 15.04.2011; # 43 dated 28.03.2011; # 75 dated 12.05.2011. In course of development of the Monitoring reports for this project, the valid at that time Carbon emission factor’s values for corresponding period will be used.
Calculation method	n.a.

Parameter number and name	**5.** Average outside temperature during the heating period
Description	Average outside temperature during the heating period
Monitoring method	Average outside temperature during the heating period is calculated by municipal enterprises that implement the project from the values of daily outside temperature taken by dispatchers of enterprises from local Meteorological Centre at 10 to 11 a.m. every day of heating period.
Recording frequency	Average outside temperature is calculated once per year. Daily outside temperature is recorded every 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	**6.** Average inside temperature during the heating period
Description	Average inside temperature during the heating period is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied).
Monitoring method	Sum of returned payments
Recording frequency	Once per heating period
Background data	Accounting documents
Calculation method	According to item 24 of “Rules of rendering of heat and hot water supply service to population” № 1497 from 30.12.1997[31], 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): $\mathbf{T_{in\,b}}$ = 18 ^{o}C. If $0.05 < R \le 0.3$: $\mathbf{T_{in\,b}} = 18 – (R/0.05)$ [^{o}C] If 0.3 < R < 1: $\mathbf{T_{in\,b}} = 12 – [(R – 0.3)/0.1]$ [^{o}C] where: R - portion of returned payment of NP – amount of normative payment. According to item 5 of the “Order for recalculation of payment for rendering the centralized heating, cold and hot water supply services in cases of their non- rendering or non-full rendering, quality decrease” confirmed by the Order of Cabinet of Ministries of Ukraine No. 151 dated 17.02.2010[32], valid since 17.02.2010, enterprise makes the return payment of: – 5% from payment for every degree from 18 to 12 ^{o}C; – when inside temperature is lower than 12 ^{o}C, the payment is to be returned completely. Therefore the inside temperature since 17.02.2010 is calculated by formulae: If R = 0 (according to conservative approach, R < 0.05 is assumed for the baseline): $\mathbf{T_{in\,b}}$ = 18 ^{o}C. If $0.05 < R \le 0.3$: $\mathbf{T_{in\,b}} = 18 – (R/0.05)$ [^{o}C]; If 0.3 < R < 1: $\mathbf{T_{in\,b}}$ = 12 ^{o}C is accepted. Thus if the inside temperature will be 18 ^{o}C or higher, it will be accepted as 18 ^{o}C according to conservative approach, and if it will be lower than 18 ^{o}C it will be calculated from return payments by the algorithm presented above.

[31] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=1497-97-%EF

[32] http://zakon2.rada.gov.ua/laws/show/151-2010-%D0%BF

Parameter number and name	**7.** Number of consumers of hot water supply service
Description	Number of consumers of hot water supply service for every boiler house
Monitoring method	Statistics of district heating enterprises
Recording frequency	Contracts with population, organizations and legal entities are concludes directly with district heating enterprise. 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	The data is taken for January, 01 of the next to the reported year

Parameter number and name	**8.** Heated area (total)
Description	Heated area for every boiler house
Monitoring method	Statistics of district heating enterprises
Recording frequency	The revise is made in case of new contracts with consumers or in case of contracts break
Background data	The information is collected at the sale departments of District heating enterprises by the certificates of owners in accordance with technical 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 of the next to the reported year

Parameter number and name	**9.** Averaged heat transfer factor of heated buildings in the base year
Description	Averaged heat transfer factor of buildings existed in the base year
Monitoring method	Normative documents
Recording frequency	Once after the end of the base year
Background data	SNiP 2-3-79 (1998)[33], table 1a
Calculation method	n.a.

Parameter number and name	**10.** Heated area of buildings (previously existed in the base year) with the renewed (improved) heat insulation in the reported year
Description	Heated area of reconstructed buildings with application of new heat insulation
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Documents of district heating enterprises
Calculation method	The data is taken for January, 01 of the next to the reported year

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

Parameter number and name	**11.** Heated area of newly connected buildings (assumed with the new (improved) heat insulation) in the reported year
Description	Heated area of newly connected buildings with application of the new heat insulation
Monitoring method	Statistics of district heating enterprises
Recording frequency	Once per year
Background data	Documents of district heating enterprises
Calculation method	The data is taken for January, 01 of the next to the reported year

Parameter number and name)	**12.** Heat transfer factor of buildings with new heat insulation
Description	Heat transfer factor of buildings with new heat insulation
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	State Buildings Norms B.2.6-31:2006[34], Table 1
Calculation method	n.a.

Parameter number and name	**13.** Heating period duration
Description	Heating period duration for every boiler house
Monitoring method	Statistics of the district heating enterprises
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"[35]. 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. Actual duration of the heating period is to be taken for a boiler house
Calculation method	Sum of durations from the beginning of the calendar year till data of ending of the heating season, and from date of beginning of the new heating season till ending of this calendar year

Parameter number and name	**14.** Duration of period of hot water supply service
Description	Duration of the period of hot water supply service for every boiler house.
Monitoring method	Statistics of the district heating enterprises
Recording frequency	Once per year
Background data	Hot water supply service is realized by hot water delivery schedule for every boiler-house.
Calculation method	Total duration of the hot water supply time per the calendar year

[34] *http://dbn.at.ua/load/1-1-0-13*

[35] *http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?page=6&nreg=z0197-07*

Parameter number and name	**15.** Maximum connected load to a boiler-house that is required for heating
Description	Maximum connected load to a boiler-house, that is required for heating
Monitoring method	Calculated by district heating enterprises
Recording frequency	Once per year
Background data	Maximum connected load to a boiler-house, that is required for heating, is calculated by District heating enterprises for every heating period. It is calculated according to heat demand at nominal minimal outside temperatures [KTM 204 Ukraine 244-94, Annex 1][36]
Calculation method	n.a.

Parameter number and name	**16.** Connected load to a boiler-house that is required for hot water supply service
Description	Connected load to a boiler-house required for providing the hot water supply service
Monitoring method	Calculated by district heating enterprises
Recording frequency	Once per year
Background data	Connected load to a boiler-house, that is required for hot water supply service, is calculated by District heating enterprises every year according to contracts with consumers.
Calculation method	n.a.

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

[36] http://www.twirpx.com/file/153194/

Scheme of monitoring system

The control and monitoring system comes to fuel and electricity consumption measurement. Other parameters are defined by calculations or taken from statistic data. Fuel consumption measurements are realized at the Gas distributing units of the boiler-houses. Gas registration is carried out in volume units reduced to standard conditions by means of automatic correction for temperature and pressure. The scheme of typical Gas distribution unit is shown at the Fig. An3-1.

The typical Gas distributing system usually consists of the following equipment:

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

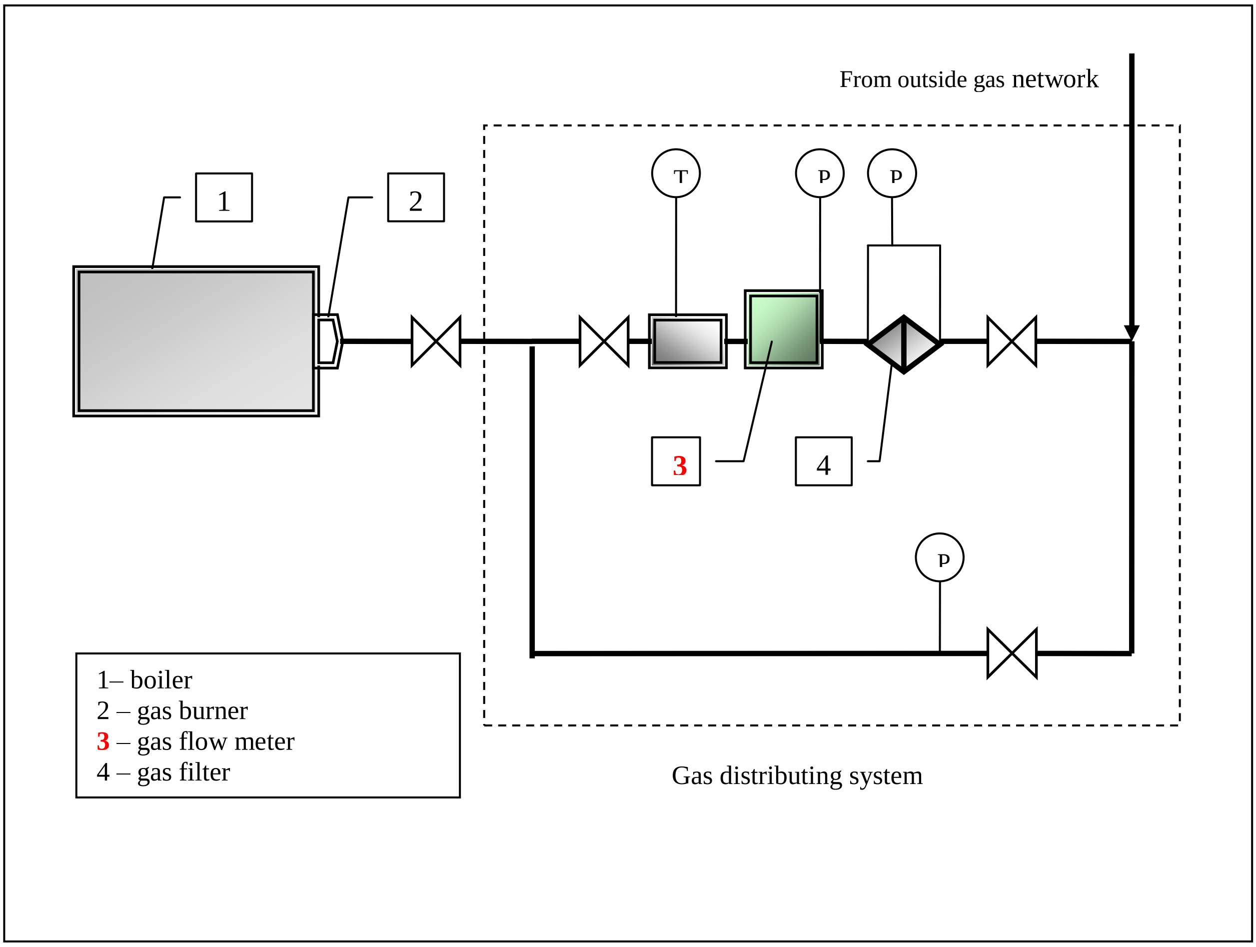


Fig. An3-1. Scheme of the Gas distribution system

Monitoring equipment

The equipment to be used by the project executors for monitoring of the relevant parameters are summarized in Tables An3-1 – An3-3. The tables also provide information on equipment accuracy, main types, calibration and procedures to follow in case of equipment failure.

ID number and data variable	Equipment	Accuracy	Calibration authority	Calibration interval	Procedure in case of failure
1. Fuel (natural gas) consumption by a boiler house	Gas flow meters	+/- (0.5…2.0) % Usually 1%	SE “Kharkiv-standart-metrologiya”	According to technical specifications of the meters	Failure should be immediately reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events are to be recorded in the site events log book
2. Electricity consumption	Electricity meters	+/- (0.2…1) % Usually 0.2%	SE “Kharkiv-standart-metrologiya”	According to technical specifications of the meters	Failure should be immediately reported to the Project manager or Chief Engineer. If failure is not removed within 48 hrs, the equipment supplier should be ordered for repair. If repair is not possible, equipment should be replaced by equivalent item. Failure events are to be recorded in the site events log book.

Table An3-1. Monitoring equipment

The main types of gas flow meters, used for gas consumption measurement, are the following:

Manufacturer	Type of gas flow meter
SE "Arsenal", Kyiv	GMS G 10 … 250
OJSC "Pomprilad", Ivano-Frankivsk	LG-K-80 … 200-Ex
	RGK G 40 … 400-Ex
PKF "KURS" Ltd., Dnipropetrovsk	Kurs-01
"Itron" (before "Actaris"), France	DELTA G 16 … 650
	TZ/FLUXI G 400 … 650

Table An3-2. Gas flow meters

The main types of electricity meters, used for electricity consumption measurement, are the following:

Manufacturer	Type of electricity meter
SE "Kharkivskyi Zavod Elektroaparatury", subdivision of SSPE Community "Komunar", Kharkiv	SA4U - 195
	SA4U - 196
	SA4U - 198
Plant "Komunarschetmash", subdivision of SSPE Community "Komunar", Kharkiv	ST-EA01
	ST-EA 05
	ST-EA 08
	SO-EA05
	SO-EA 02
	SO-EA 09
"Nik-elektronika" Ltd., Kyiv	NIK 2102-02
CJSC "MITEL", Dnipropetrovsk	Delta 8010-02
OJSC "LEMZ", Russia	SA4U - I672M
	SR4U - I673M
	SA4 – I678
	SA3U - I670M
"Firma Incotex" Ltd., Russia	Mercuriy 230 AM
	Mercuriy 232 AM
OJSC "Kontsern Energomira", Russia	CE6801M
	CE-6803B
	CE-6811
	SE 302 S33
CJSC "ELGAMA elektronika", Lithuania	EMS-135.10.1
Landis&Gyr, Switzerland	ZMG 410 CR 4.440b.43

Table An3-3. Electricity meters

Level of uncertainty and errors

Possible uncertainty and errors for such type project may arise from two main reasons: measurement and stipulation. Measurement error is due to metering equipment inaccuracies. Stipulation occurs when some values are required to complete calculations, but these values cannot be measured directly. In these cases estimates are used in place of actual measurements, and therefore an error may be introduced. The stipulation error itself may be estimated based on the expected accuracy of the stipulated values.

The project error can be calculated from the two error components described above. The total project error (Standard Error, SE) can be calculated by taking the square root of the sum of the squares of the individual error components, as below:
$SE = \sqrt{[(\text{measurement error})^2 + (\text{stipulation error})^2]}$

The monitoring plan developed for this project does not rely on any estimates and is therefore free of any stipulation errors.

Thus, $SE = \sqrt{[(\text{measurement error})^2 + (0)^2]} = (\text{measurement error})$

Although the project has 17 monitoring parameters, only 2 of these (natural gas consumption, electricity consumption) are measured directly. The remaining monitoring parameters used in calculation of the baseline and project emissions are taken as statistic data. Furthermore, they are used for adjustment factors calculation. Calculations of adjustment factors are based on reported and base year parameters ratio. For example, temperature change factor is calculated as ratio of inside and outside temperature differences in reported and base years: $K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$. Therefore any error in statistic data will be cancelled.

The measurement errors (maximal) for the two parameters, that impact on the Standard Error, and their level of accuracy are presented in Table An3-4.

ID number and data variable	Measurement error	Comment
1. Fuel (natural gas) consumption by a boiler house	± (0.5…2.0) %	Accuracy of data is high due to necessity of information for commercial account purposes
2. Electricity consumption	± (0.2…1.0) %	Accuracy of data is high due to necessity of information for commercial account purposes

Table An3-4. Measurement errors

Monitoring of environmental impacts

As the project involves rehabilitation of existing district heating system leading to improvement of its energy efficiency and therefore to the better environmental performance of the system, and is not a new building project, no negative environmental impacts are expected.
Municipal enterprises that implement the project make the Environmental Impact Assessments in cases when it is required according to Ukrainian regulations.

There is therefore no need to monitor special environmental impact indicators during implementation and operation of the project activities.

Project management planning

The overall responsibility for the project management and implementation is carried out by the General Director of ME "Kharkivski teplovi merezhi", Mr. Sergiy Andreev. He has appointed responsible persons leaded by Mr. Andriy Repin, Chief of PTS of ME "KhTM". The stuff of PTSs of municipal enterprises that implement the project are also responsible for project activity.

Possible bottlenecks and mistakes in project implementation should be identified and solved by responsible stuff of PTSs.

Responsibilities for data collection

The General Director of ME "Kharkivski teplovi merezhi", Mr. Sergiy Andreev, appointed the responsible person, Mr. Andriy Repin, for the implementation and management of the monitoring process at the ME "Kharkivski teplovi merezhi". Mr. Andriy Repin is responsible for supervising of data collection, measurements, calibration, data recording and storage also at all municipal enterprises that implement the project.

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

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

Data collection for fuel consumption is provided in the following way:

1. Natural gas consumption is measured by gas flow meter, installed at a boiler-house. All boiler-houses are equipped with gas flow meters.

2. The majority of boiler-houses are equipped with automatic correctors for gas temperature and pressure. Gas consumption is registered automatically. Every day operator of a boiler house makes registration of daily gas consumption in the special paper journal "Journal of registration of boiler-house's operation parameters".

3. At the boiler-houses that are not equipped with gas volume correctors, operator of a boiler house every 2 hours registers parameters of natural gas (temperature and pressure) in the paper journal "Journal of registration of boiler-house's operation parameters". These parameters are used to bring gas consumption to standard conditions.

4. Every day operators report values of gas consumption by phone to Production-Technical Service (PTS) of district heating enterprises, where they are storing and used for payments to gas suppliers.

5. Every month the account centers transfer data to gas suppliers.

Data monitored and required for emission reductions calculation and verification, according to paragraph 37 of the JI guidelines, are to be kept for two years after the last transfer of ERs for the project.

Scheme of data collection for a Monitoring Report is shown at Fig. An3-2.

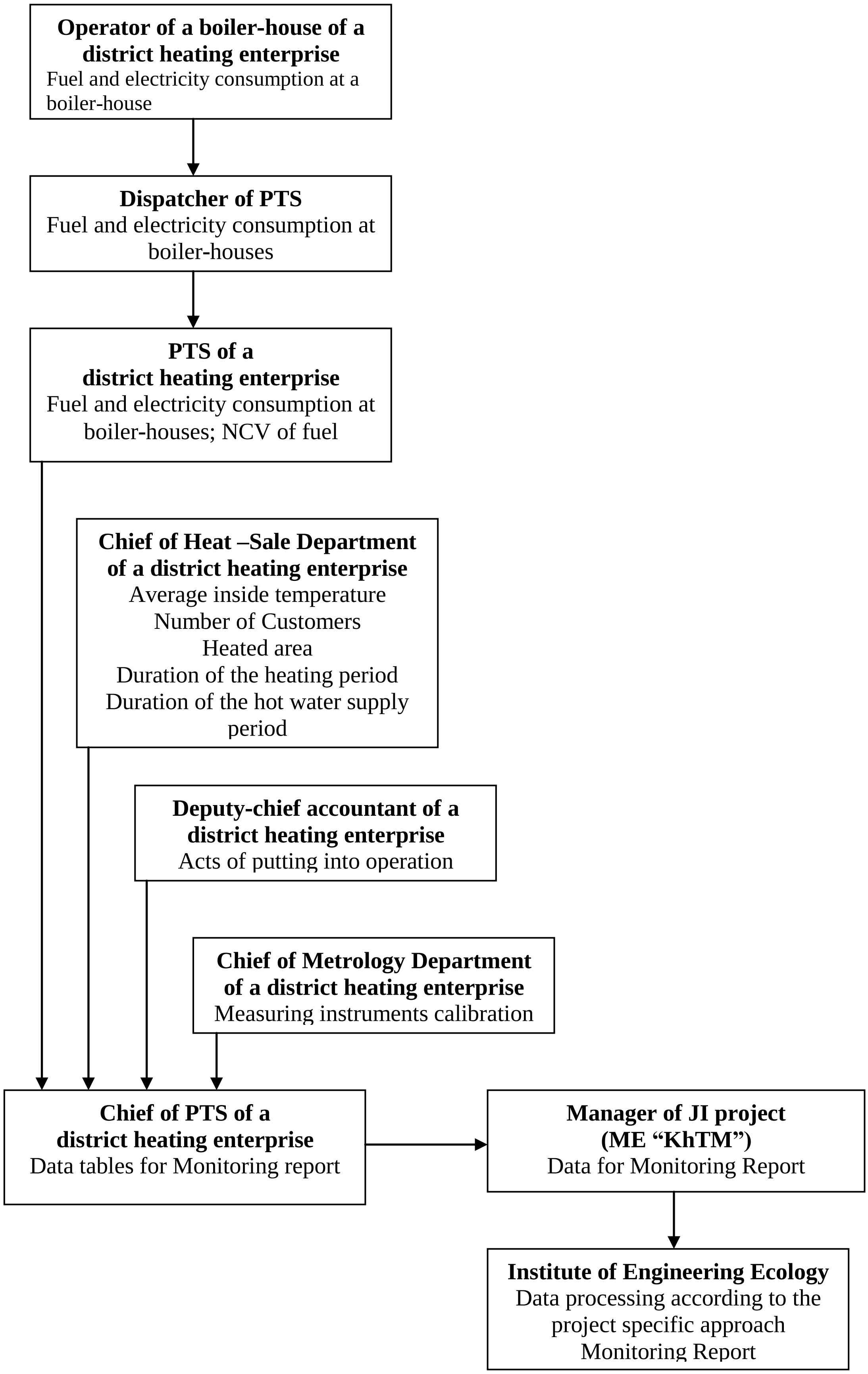


Fig.An3-2. Scheme of data collection for Monitoring Report

Trainings

As far as the main activity of municipal enterprises that implement the project will not change in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprise 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 foreign produced boilers, etc.) equipment installation, the company - producer of this equipment should provide trainings for personnel.

Municipal enterprises that implement the project provide 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, specialists of Institute of Engineering Ecology carried out a comprehensive consultations and trainings for representatives of involved district heating enterprises on the necessary data collection according to Monitoring plan for the project.

The special training was held in May, 2011.
The special group was organized consisted of representatives of municipal enterprises that implement the project and Institute of Engineering Ecology, in particular:
Zoya Sudakevich - ME "KhTM", chief of JI project supporting group;
Olga Gubina - KhRME "Dyrektsiya RIT", senior engineer;
Igor Teslenko– Izium HSNME, chief of Production-Technical Service;
Maryna Krymova - Krasnohrad HSNE, engineer;
Eduard Pikalov - Nova Vodolaha HSNE, engineer;
Iryna Maltseva - Pervomais'kyi ME "Teplomerezhi", engineer;
Vyacheslav Solodov - MEBDC "BTM", chief of Production-Technical Service;
Iryna Ploschadyna - ME «Teplovi merezhi» of Lozova CC, engineer;
Vasyl Dyadkov - "KLK" Ltd., Deputy director;
Ludmyla Yanto - ME "Chuhuivteplo", senior engineer;
Ruslan Makarenko - Kharkiv District HSNME, chief of Production-Technical Service;
Andriy Omelchenko - Borova HSNME, Director;
Dmytro Paderno - Institute of Engineering Ecology, Deputy director;
Kateryna Korinchuk - Institute of Engineering Ecology, engineer.

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

Responsibilities for data management

All collected data will be transferred to Zoya Sudakevich, who will be responsible for data storage and archiving, entry of the data into the monitoring spreadsheets. Kateryna Korinchuk will be responsible for the data processing according to the JI project specific approach and for development of Monitoring Reports. Support and coordination of monitoring and verification processes will be undertaken by Dmytro Paderno. Responsibilities for data management are presented in Table An3-5.

Activity	Responsible person	
	Name	Position and department
Data storage and archiving	Olga Gubina	Senior engineer of KhRME “Dyrektsiya RIT”
Data storage and archiving	Igor Teslenko	Chief of Production-Technical Service of Izium HSNME
Data storage and archiving	Maryna Krymova	Engineer of Krasnohrad HSNE
Data storage and archiving	Eduard Pikalov	Engineer of Nova Vodolaha HSNE
Data storage and archiving	Iryna Maltseva	Engineer of Pervomais’kyi ME “Teplomerezhi“
Data storage and archiving	Vyacheslav Solodov	Chief of Production-Technical Service of MEBDC “BTM”
Data storage and archiving	Iryna Ploschadyna	Engineer of ME «Teplovi merezhi» of Lozova CC
Data storage and archiving	Vasyl Dyadkov	Deputy director of “KLK” Ltd.
Data storage and archiving	Ludmyla Yanto	Senior engineer of ME “Chuhuivteplo”
Data storage and archiving	Ruslan Makarenko	Chief of Production-Technical Service of Kharkiv District HSNME
Data storage and archiving	Andriy Omelchenko	Director of Borova HSNME
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Zoya Sudakevich	Chief of JI project supporting group of ME “KhTM”
Management of the JI project	Andriy Repin	Chief of Production-Technical Service of ME “KhTM”
Coordination of monitoring and verification processes	Sergiy Andreev	General Director of ME “KhTM”
Support and coordination of monitoring and verification processes	Dmytro Paderno	Deputy Director of Institute of Engineering Ecology, Ltd
Data processing according to the JI project specific approach, development of Monitoring Reports	Kateryna Korinchuk	Scientific researcher of Institute of Engineering Ecology, Ltd

Table An3-5. Responsibilities for data management