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

"District Heating System Rehabilitation in Rivne Region"

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

"District Heating System Rehabilitation in Rivne Region"

PDD Version: 08, dated November 30, 2009

A.2. Description of the project:

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

Rivne region's district heating (DH) utility (system of heat supply enterprises) supplies and sells heat energy in forms of heat and hot water to local consumers, namely households, municipal consumers and state-owned organizations. It is a natural monopolist of heat production in the region. Heat supply market in the region is stable for years.

The project was initiated in 2002 to rehabilitate Rivne region's district heating system, including boiler and distribution network equipment replacement and rehabilitation, installation of cogeneration units and frequency controllers installation.

The project consists of two parts: rehabilitation of DH system of Rivne city and rehabilitation of DH system of Rivne region. 12 boiler-houses with 78 boilers and 110 km of heat distributing networks are involved in the rehabilitation of Rivne city and 7 boiler-houses with 19 boilers and 11 km of heat distributing networks are involved in the rehabilitation of Rivne region. The total number of boiler-houses which are involved in the project is 19 with 97 boilers and 121 km heat distribution networks. Beside this project provides installation of cogeneration units at boiler houses Knyazya Volodymyra, 71 (two steam-turbines 2,5 MW each). This is the large part of Rivne regional DH system.

The project employs the increase in fuel consumption efficiency to reduce greenhouse gas emissions relative to current practice. Reduction of fuel consumption is based on increase of the boiler efficiencies, reduction of heat losses in networks, CHP and frequency controllers installation. The following activities will ensure fuel saving:

- Replacement of old boilers by new highly efficient boilers;
- Upgrading of boilers' burners;
- Fuel switch from coal and fuel oil to natural gas;
- Improving of the network organization, application of the new insulation and the pre-insulated pipes;
- Installation of CHP;
- Installation of frequency controllers at smoke exhauster and hot water pumps engines.
- Installation of air heaters;
- Partial replacement of fossil fuel by the renewable sources of fuel such as wood and wood chips (expansion of this tendency).

Estimated project annual reductions of GHG emissions, in particular CO_2, are from 20,52 thousand tons to 29,5 thousand tons in 2004 – 2007, from 36,9 thousand tons to 38,1 thousand tons in 2008 – 2009, and over 47,3 thousand tons per year starting from 2010 comparing to business-as-usual or baseline scenario.

Implementation of the project will provide substantial economic, environmental, and social benefits to the Rivne region. Social impact of the project is positive since after project implementation heat supply service will be improved and tariffs for heat energy will not be raised to cover construction costs.

Environmental impact of the project is expected to be very positive as an emission of the greenhouse and toxic gases such as CO_2, NO_x, and CO will be reduced. Also due to a better after-implementation service, some part of population will cease to use electric heaters thus reducing electricity consumption, which is related to power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

District Heating enterprisers in Rivne region fulfils annual minimal repairing of the DH system to keep it working. Particularly it executes repairing of network's parts and boilers that might cause accidents. More economically feasible and realistic scenario without carbon credits sales is a baseline scenario with very slow reconstruction activities than to make a major overhaul of the heating system. Tariffs for heat do not include the resources for prospective reconstruction of the district heating system, only the resources for probable necessary repairing after possible accidents. Minimal annual repairing doesn't lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the same level. This scenario is less environmentally favorable for the near future (including first commitment period 2008-2012), since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is more attractive.

Estimated project risks are limited and minimized. Ukraine has claimed district heating and municipal energy sector as a priority for the national energy-saving development.

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)	"Rivneteploenergo", Ltd; Institute of Engineering Ecology, Ltd	No
Germany	Deutsche Bank AG	No

The project is initiated by three partners that distribute their functions in the project as follows:

- ***"Rivneteploenergo"**, Ltd**;:*** is a project implementation agency (**Supplier),** which represents heat supply enterprises of Rivne region. It operates equipment for heat production and distribution, and renders the heat supply services. As far as this organization purchases all the necessary inputs, including fuel, electricity, water, etc., it has the primary interest in the reduction of specific fuel consumption that can be achieved by the implementation of the project. It finances this project (partly on credit base) and receives profits.

Historical details:

The Department of regional boiler-houses of heat networks in Rivne city was founded by the Order № 14 of Rivne City Executive Committee from February 10, 1967 on the base of boiler-houses of housing-operational offices and house management of Rivne city.

At the moment of foundation on the basis of the enterprise there were 24 boiler-houses with total capacity 48.4 Gkal/h. The heating area was 260.0 ths. m^2 and the number of workers was 496 people.

The regional municipal district heating enterprise “Komunenergiya” was founded on May,8 1998. There were 43 boiler-houses, 86 central heating points and 250.19 km of heat networks in the Rivne city.

On January 2002 the Daughter enterprise “Teplotransservice” was organized on the base of municipal heat enterprise “Komunenergiya”.

During 2004-2009 Daughter enterprise “Teplotransservice” was reformed several times. Scheme of reformations is presented below:

Daughter enterprise “Teplotransservice” of municipal heat enterprise “Komunenergiya”

⇓

Order of Rivne regional council № 381 from 17.06.2004

⇓

Municipal enterprise “Teplotransservice”of Rivne regional council

⇓

Order of Rivne regional council № 23 from 16.06.2006
Order of Rivne city council № 159 from 01.08.2006
Order of Rivne regional council № 129 from 06.10.2006
Order of Rivne city council № 215 from 01.08.2006
Order of Rivne city council № 472 from 23.01.2007
Order of Rivne regional council № 84 from 11.08.2009

⇓

Municipal enterprise “Teplotransservice” of Rivne city council

The main types of activities of ME RCC “Teplotransservise” are:

- Steam and hot water supply;
- Distribution and supply of electric power;
- Electric power generation;
- Production of radiators and boilers of district heating;
- Renting of own real assets;
- Production of steam boilers.

The enterprise “Rivneteploenergo”, Ltd. was organized 07.08.2009.

According to the registration documents, the main types of activities of “Rivneteploenergo”, Ltd are:

- Steam and hot water supply;

- Engineering activity;
- Construction of local pipelines, communication and energy supply lines;
- Construction of buildings.

On the base of Contract "On leasing of buildings of boiler-houses and heating points" from 29.10.2009 between Department of Municipal Housing of Rivne city council and "Rivneteploenergo", Ltd., the buildings of boiler-houses and heating points listed in Appendices 1 and 2 to this contract are assigned for lease to "Rivneteploenergo", Ltd. The assets in question are at the balance of the municipal enterprise "Teplotransservice" of Rivne city council.

The municipal enterprise "Teplotransservice" of Rivne city council transfered the set of his rights to be Supplier and beneficiary for this JI Project to "Rivneteploenergo", Ltd. (Agreement #1193/TC from November 25, 2009 "On Authority Transfer").

- ***Deutsche Bank AG:*** is the purchaser of emission reduction units generated from this project. It is a corporation domiciled in Franfurt am Main, Germany, operating in the United Kingdom under branch registration number BR000005, acting through its London branch located at Winchester House, 1 Great Winchester Street, London EC2N 2DB, United Kingdom.

Founded in Berlin in 1870 to support the internationalization of business and to promote and facilitate trade relations between Germany, other European countries, and overseas markets, Deutsche Bank has developed into a leading global provider of financial services.

A leader in Germany and Europe, the bank is powerful and growing in North America, Asia and key emerging markets.

As of March 31, 2009, Deutsche Bank has over 80 thousand employees in 72 countries.

Deutsche Bank won a series of important awards, e.g. IFR "Bank of the Year" twice in three years.

Deutsche Bank's presence in the UK dates back to 1873, when it opened a branch in London. This became the Bank's most important foreign branch, until its closure at the outbreak of the First World War in 1914. Deutsche Bank returned to London in 1973 with a representative office, which was converted into a branch in 1976.

- *Institute of Engineering Ecology, Ltd:* is a research and engineering organization. It is responsible for development of project feasibility study, development of the Joint Implementation project, choice and development of appropriate technologies, and further selection of necessary equipment. It will also take part in project validation, monitoring and verification processes

  Historical details:

Institute of Engineering Ecology (IEE), Ltd., is the independent nongovernmental professional organization, created in February, 1992. It deals mainly with the engineering ecological problems in industrial sphere. Its activity is aimed at development, production and application of the new ecologically pure technologies and various equipment for fuel and energy saving and environmental protection, as well as at carrying out ecological and energy investigations and examinations.

Institute's activity is being executed by well-qualified and experienced specialists, including possessing DrSci and PhD degrees, in fields of heat power engineering, industrial and municipal heat supply, district heating, gas cleaning, toxic substances formation and decomposition in burning processes, waste utilization, etc.

IEE has accomplished a number of projects on development and application of the technologies for energy saving in the processes of heat generation and reduction of toxic and greenhouse gas emissions. Such projects are applied, in particular, in the municipal district heating systems of the cities of Kiev, Zhytomir, Vinnitsa, Sumy, Lugansk, Yalta, Khmelnitsky, Odessa, Sevastopol, Simferopol, etc., as well as at industrial enterprises in Kharkov, Lvov, Kiev, Donetsk and Khmelnitsky regions, and also in Moscow and Moscow region.

IEE deals with questions related to the global climate change, greenhouse gas mitigation and Kyoto protocol, since 1998.

IEE is the main scientific and engineering organization of the Ministry of Housing and Municipal Economy of Ukraine (under the management of which there are all district heating enterprises of the country, that consume over 30% of total fuel consumption by the country) in field of control and reduction of CO_2 emission, and by the task of this Ministry (previously the State Committee) has executed expert estimation of potential and possibilities of reduction of CO_2 emission into atmosphere from the municipal district heating utilities of Ukraine. To date, IEE has prepared the Project Idea Notes (PIN) for the JI projects on the rehabilitation of the district heating systems for several cities (Vinnitsa, Khmelnytsky, Luhansk, Chernihiv, Donetsk, Rivne, Kharkiv, etc) and regions (Chernihiv and Donetsk regions, Autonomous Republic of Crimea) of Ukraine, under preparation there are the Project Design Documents (PDDs) for some of these projects and PINs for cities Dnipropetrovsk, Zhytomyr, Odesa and several industrial enterprises. The complete PDDs developed for Chernihiv region (the first in Ukraine JI project), Donetsk region, AR Crimea and Kharkiv city, successfully passed the international determination process and received the Letters of Approval from Ukrainian government. Emission reductions achieved by these projects during period before 1 January 2008 and during 2008 are already successfully transferred to purchasers.

Questions of energy saving and reduction of greenhouse gas emission traditionally take the considerable part of reports at International conferences «Problems of ecology and exploitation of energy objects», annually held by IEE in Sevastopol (AR Crimea).

IEE was the co-organizer of the First (October 3-5, 2005, Kyiv, Ukraine) and the Second (October 23-25, 2006, Kyiv, Ukraine) International Conferences on JI Projects in Ukraine "Climate Change and Business".

A.4. Technical description of the project:

A.4.1. Location of the project:

The Project is located in Rivne Region of Ukraine, in the North-Western part of Ukraine (**Fig.1**).

Fig. 1. The map of Ukraine with dividing into regions and with neighboring countries

A.4.1.1. Host Party(ies):

Ukraine is an Eastern European country that ratified the Kyoto Protocol to UN FCCC on February 4, 2004, is listed in the Addition 1 to it and thus is eligible for the Joint Implementation projects.

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

The Project is situated in Rivne Region (Oblast). Rivne Region is located in the North-Western part of Ukraine. Its area is 20100 km^2 (3.3% of the total area of Ukraine). Rivne region has a mild-continental climate with mild winters and warm summer. The average temperatures: -5 ^{0}C in January, and +18 ^{0}C in July. Average annual precipitation is 560-620 mm.

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

Rivne city and towns of the Rivne region.

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

Rivne city accounts for 907 residential buildings, 39 boiler houses and 183.7 km of heat networks in 2-pipe calculation that belong to the communal property. The population of Rivne region is 1164.1 ths. people, the density of the population is 58 people/ km^2.

Rivne region borders in the North with Brest, in the South-East with Homel regions of Belorussia, in the East – with Zhytomir region, in the South-East-with Khmelnitskiy, in the South-with Ternopil, in the South-West-with Lviv, in the West-with Volyn regions of Ukraine.

In total Rivne region covers 16 districts, 4 towns of regional submission, 7 town of district submission, 16 urban villages and 1002 small villages.

The territory is divided into the following districts: Bereznivskiy, Volodymyretskiy, Hoshchanskiy, Demydivskiy, Dubenskiy, Dubrovytskiy, Zarichnenskiy, Zdolbunivskiy, Koretskiy, Kostopilskiy, Mlynivskiy, Ostrozkiy, Radyvilivskiy, Rivnenskiy, Rokytnivskiy, Sarnenskiy.

There are three towns of regional submission in Rivne region: Rivne, Dubno, Kuznetsovsk, Ostrih and 7 towns of district submission such as Berezne, Dubrovytsya, Zdolbuniv, Korets, Kostopil, Radyvyliv, Sarny.

It should be noted that the district heating systems from three territorial districts such as Dubrovitsa and Zdolbuniv of the Rivne Region are involved in the project (**Fig. 2**). Places involved in the project are marked with circles; Rivne city where the boiler-houses belong to "Rivneteploenergo", Ltd (Project Supplier) are marked with red circles, the other places where the Project Supplier is empowered to represent the owners of boiler-houses are marked with blue circles.

"Rivneteploenergo", Ltd on the basis of Agreement #1193/TC on Authority Transfer is empowered to represent the interests of other heat-supply enterprises of Rivne city and region. The objects of enterprises ME RCC "Teplotransservice", ME RCC "Komunenergiya", ME "ZdolbunivKomunenergiya"of Zdolbuniv City Council and ME "Teploservis" of Dubrovitsa Regional Council are included into the project as well. Short characterization of these enterprises is given in Table 1.

№	Enterprise	Number of boiler-houses included in project	Number of boilers included in project	Scheduled GHG emission reduction after complete implementation of the project, t CO_2
1	"Rivneteploenergo", Ltd., and ME RCC "Teplotransservice"	7	49	25132,0
2	ME RCC "Komunenergiya"	5	29	17720,8
4	ME "ZdolbunivKomunenergiya"of Zdolbuniv City Council	2	5	1490,4
3	ME "Teploservis" of Dubrovitsa Regional Council	5	14	2926,0
	Total	**19**	**97**	**47269,1**

Table 1.Heat-supply enterprises included in the project

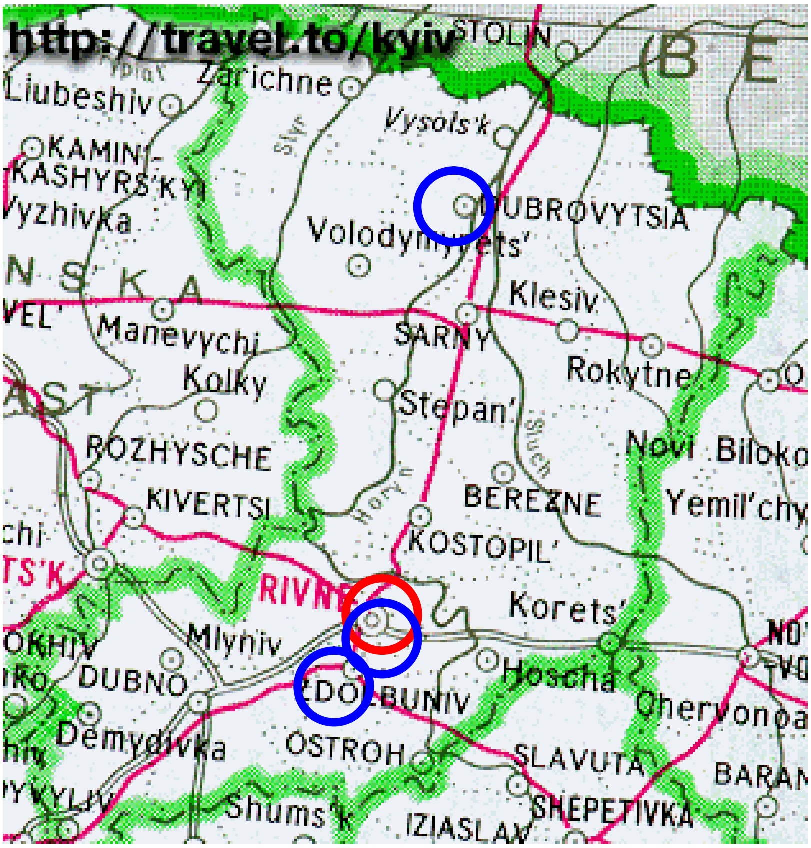


Fig. 2. Location of Rivne Region's major cities and towns where the project will be implemented.

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

Sectoral scope related to approved CDM methodologies and DOEs (version 18 Jan 08) are:

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

Measures that will be used to improve the efficiency of DH utility in Rivne region are the follows:

- Obsolete boilers will be replaced by new highly efficient ones that will result in efficiency increase from 70-73% up to 91-92%. Technical characteristic of new boilers scheduled to be installed are presented at the producer's websites that are listed in table below.

Type of boiler	Website of boiler producer
KBNG-2,5	www.tekom.com.ua/kotel/vk.html
Viessmann-9,3 МВт	http://www.viessmann.ua

Table 2.Boilers producer's web sites

- Obsolete coal-fired and fuel oil-fired boilers will be partially switched to or replaced by gas-fired ones.
- Upgrading of boilers' burners will increase the efficiency by 3-5% and reduce CO and NO_x emissions.
- Installation of cogeneration units will result in increasing the fuel consumption efficiency, decreasing of dependence on the power supply and improvement of operational stability and reliability, decreasing of power consumption from power stations, decreasing of power transfer losses, and decreasing of environmental pollution;

The project employs implementation of cogeneration units at Knyazya Volodymyra, 71 boiler-house. It is planning to install two steam-turbines P-2,5-15/3G with capacity 2500 kW each. For providing of nominal parameters for turbines operation it is necessary to realize implement reconstruction of two boilers B-25-15 GM.

Boilers B-25-15 GM before reconstruction prepare steam with following parameters:
- steam- production 25 t/h;
- temperature 350 °C;
- pressure 15 kg/sm^2.

Boilers B-28/24-380 G after reconstruction must prepare steam with following parameters:
- steam- production 28 t/h;
- temperature 380 °C;
- pressure 24 kg/sm^2.

Reconstruction of boiler-house Knyazya Volodymyra, 71 will allow to close low efficiency boiler-houses: Litivska, 49, Mitskevicha, 34, av. Miru, 4 and 24, Gagarina, 17, Naberezhna, 17 and switch several of them to standby emergency operational mode. It will result in decreasing the fuel consumption by enterprise.

It will be realized twenty-four-hour hot water supply service from the reconstructed boiler-house to population of residential areas "Pivnichniy", "Fabrichniy", area of streets: Gagarina- Ostafeva, that is 44,6% of all quantity of consumers, that connected to hot water supply service. For this purpose it is necessary to build main heat network with pre insulated pipes with diameters 377-325 mm, with total length 1415 m from CHP to area "Pivnichniy".

- The efficiency of distribution networks system will be considerably increased by:
  - Improvement of the heat networks system organization will be provided by liquidation of Heat Distribution Stations (HDS) - replacing 4-pipe lines by 2-pipe ones with simultaneous installation of heat exchangers directly at the consumers (Individual Heating Point – IHP). Technical characteristic of new heat exchangers are presented on the producer's website http://teploenergo.com.ua.
  - replacing of the main network pipes with diameter 57 mm and more by the pre-insulated ones and renovation pipe insulation with using of foamed polyurethane. These measures will substantially reduce heat losses from existing 20-29% and even more, down to 1-3 % per km. Enterprises use pipes previously heat and hydro insulated with foamed polyurethane produced by JSC "Transprogress" (http://www.transprogress.com.ua/products.htm).

- Installation of frequency controllers at smoke exhauster, hot water pumps engines and air heaters will result in energy saving. . Those regulators make it possible to change actual capacity of the motors depending on connected load, both as during a day when water consumption is changes, and during a year when in summer motors work only for hot water supply. Power consumption of boiler houses will be decreased at least by 10-20% from total annual boiler house power consumption.
  Technical characteristic of frequency controllers Altivar 38 are presented on the website of Schneider Electric (trademark Telemecanique):
  http://www.us.telemecanique.com/products/Motor_Control/Adjustable_Frequency_Drives/Panel_Drives/ATV31/index.html

The measures from this list will be implemented at boiler houses subject to rehabilitation.

The generalised schedule of their implementation will be the following:
- boiler houses rehabilitation - 2003 - 2009;
- network rehabilitation – 2003 - 2009;
- installation of CHP units – 2003 – 2009;
- installation of frequency controllers – 2008.

Achieved results of employing of these technologies and measures are listed in the **Appendixes 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 new technologies and equipment.

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 boilers, heat distribution networks, installation of combined heat and power coupling plants and use of renewable sources of fuel will increase energy efficiency of Rivne Region DH system, thus enabling it to produce the same amount of heat energy with less fuel consumed. Reduced fuel consumption will make lower CO_2 emissions.

In the absence of the proposed project, all equipment, including the old one, low efficient but still workable for a long life period, will operate in as-usual mode, and any emission reductions would 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 from 24.06.2004 № 1869-IV), The Law of Ukraine from 01.07. 1994 № 74/94-VR “On energy saving” and The Law of Ukraine from 22.12.2005 №3260- IV “On changes in The Law of Ukraine “On energy saving”. The law of Ukraine “On heat energy supply” (№ 2633-IV from 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 (by the years to the first commitment period of the Kyoto Protocol):

Length of the crediting period	**Years**
2004-2023	20
Year	**Estimate of annual emission reduction in tonnes CO_2 equivalent**
2004	20541,0
2005	22583,5
2006	27428,5
2007	29470,9
Subtotal 2004 - 2007	**100023,9**
2008	36869,6
2009	38058,2
2010	47269,1
2011	47269,1
2012	47269,1
Subtotal 2008 - 2012	**216735,3**
2013	47269,1
2014	47269,1
2015	47269,1
2016	47269,1
2017	47269,1
2018	47269,1
2019	47269,1
2020	47269,1
2021	47269,1
2022	47269,1
2023	47269,1
Subtotal 2013 - 2023	**519960,5**
Total estimated emission reduction over the crediting period (tones of CO_2 equivalent)	**836719,7**
Annual average of estimated emission reduction over the crediting period (tones CO_2 equivalent)	**43347,1**

Table 3.Estimated amount of CO_2e Emission Reductions

Thus the estimated amount of emission reductions over the commitment period (2008-2012) is **- 216735,3** tons of CO_2e, over the crediting period is **- 836719,7** tons of CO_2e. For more detailed information see **Appendixes 1 – 4**.

For more detailed information see **Appendixes 1 – 2**.

Average annual amount of ERUs will be the following:

During commitment period 2008-2012 years – **43347,1** t CO_2e;
After commitment period 2013-2023 years – **47269,1** t CO_2e.

Description of formulae used to estimate emission reductions is represented in paragraph D.1.4.

A.5. Project approval by the Parties involved:

The project is already approved by local authorities, namely Rivne Regional Council, and Ukrainian government representatives, namely Ministry for Environmental Protection of Ukraine (the Local focal point for Kyoto Protocol in Ukraine) Letter of Endorsement was issued in October 18, 2004. Therefore, organizational risk for this project is minimized.

The project was initiated in 2002.

January, 2003 - Institute of Engineering Ecology suggested ME “Komunenergiya” to develop the Joint Implementation Project on Green House Gas Emissions Reduction.

March, 2003 – Meeting of the Technical Council of ME “Komunenergiya” on question “ About realization of international agreements on Kyoto Protocol at Rivne region". Starting of Project planning.

July, 2004 – Agreement was signed (# 521 from 05.07.2004) between the MHSE “Komunenerhiya” and the Institute of Engineering Ecology on development of the PIN for Joint Implementation Project on Green House Gas Emissions Reduction through rehabilitation of the district heating system.

October, 2004 – This project was submitted to the tender ERUPT5, that was hold by agency SenterNovem on behalf of Netherlands Government (# ERU05/34, 7.10.2004).

October, 2004 - Ministry for Environmental Protection of Ukraine has issued the Letter of Endorsement for this JI project (# 10384/20/2-7 from 18.10.2004).

August, 2007 – Agreement was signed (# 593/254A/286A/TC from 27.08.2007) between the ME RCC “Teplotransservice” and the Institute of Engineering Ecology on development of the Joint Implementation Project on Green House Gas Emissions Reduction through rehabilitation of the district heating system in Rivne region.

November,2009 – Agreement on Authority Transfer was signed between the ME RCC “Teplotransservice”. and “Rivneteploenergo”, Ltd (#1193/TC from 25.11.2009). According to this Agreement the whole set of owner’s rights on this JI Project are transferred to “Rivneteploenergo”, Ltd.

SECTION B. Baseline

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

At the time when this Project was developed, no approved procedures existed. Our own-developed methodology is partly similar to later appeared “Baseline and monitoring methodology AM0044”. But the AM0044 was not used because the project “District Heating System Rehabilitation of Rivne Region” has some differences from applicability conditions of this methodology.

The main cause of impossibility of methodology AM0044 using for baseline calculation is no data for thermal energy output, because of thermal energy meters absence on the majority of boiler houses included in the project. That’s why “SVT e.V.” (Germany) and Institute of Engineering Ecology invented another methodology, that takes into account all measures involved in the project and it’s peculiarities. This methodology is presented in section D (monitoring plan). It was already approved by IAE for JI Project for Chernihiv Region and similar JI Projects for Donetsk region, Crimea and Kharkiv city..

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

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

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

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

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

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

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

Approved Consolidated Methodology ACM0009 “Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas” proposes the dependences for baseline and reporting year emissions quantity definition (see pages 4 and 5), that contain determination of Energy efficiency $\varepsilon_{project,i,y}$ and $\varepsilon_{baseline,i}$ for equipment. In the chapter “Baseline emissions” on the page 6 there is an explanation that: Efficiencies for the project activity ($\varepsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations. Efficiencies for the baseline scenario ($\varepsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations. These requirements are confirmed by tables for monitoring on the pages 13-15.

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

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

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

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

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

The baseline study will be fulfilled every year of the emission reduction purchasing, to correct adjustment factors which have an influence at the baseline. For more detailed information see **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 reconstruction works balanced by overall degradation of 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 represent the common practice in Ukraine.

The second version of Baseline scenario was to make reconstruction 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.

District Heating enterprisers of Rivne region fulfils annual minimal repairing of the DH system to keep it working. Particularly it executes repairing of network’s parts and boilers that might cause accidents. The most economically feasible and realistic scenario without carbon credits sales is a baseline scenario with very slow reconstruction activity, making a major overhaul of the heating system is not economically attractive and is not required according to valid regulations. Old boilers could remain in operation for the whole period when they pass the regular tests, with minimal repairing if necessary, without lifetime limitation; and at least during the crediting period. Switching of load from boiler-houses with obsolete equipment to modern equipped requires building of the new parts of network, that is the most expensive measure. Minimal annual repairing doesn’t lead to drooping of baseline emissions because of degradation of the whole system with efficiency droop at other objects, the overall actual emissions of Supplier would stay on the approximately same level. This scenario is less environmentally favorable for the near future (including first commitment period 2008-2012), since GHGs emissions of Supplier will continue to be kept at the same level or even higher, but economically such scenario is more attractive.

Status and adequacy of the current delivery system

Current supply of Rivne city and Rivne region DH systems is primarily based on Ukrainian, Russian made gas, fuel oil and coal fired boilers including B-28/24GM, PTVM-30, KVGM-30, TGV-8, TGV-8M, KBNG-2.5, DE- 2,5/14, NIISTU-5, Енергія-3, E 1/9, KVG-6,5, DKVR-4/13, DKVR-10/13, E - 2,5/4, DE-4, "Borzig", "Vizner", DKVR-6.5/13 and coal boilers NIISTU-5, Енергія-300, DKVR-10/13, KV-300. Detailed information is presented in **Appendixes 1 (Boilers)**. Current efficiencies of those boilers are in the range of 70-91 %.

Current distribution networks are characterized by heat losses from 8 % to 29 %. Detailed information is presented in **Appendix 2 (Networks)**.

Construction of the Baseline Scenario

Current operation of the Rivne region's district heating system 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 pretty much compensates deterioration, and makes annual total emissions level (the Baseline) about the same for years.

Project also provides electric power production on the new cogeneration units. This power will replace consumption from the national power system, that's why we take into account national standard of power system emissions for Baseline definition.

Calculation of Baseline Carbon Emission Factors

For all fuels we used CO_2 emission factors from the data table provided in Annex C of the Operational Guidelines for Project Design Documents of Joint Implementation Projects [Volume 1: General guidelines; Version 2.2].

Cef (natural gas) = 0.0561 $KtCO_2/TJ$;
Cef (coal) = 0.0946 $KtCO_2/TJ$; (taken as "Other bituminous coal").
Cef (mazut) = 0.0774 $KtCO_2/TJ$; (taken as "Residual fuel oil").
Cef (wood chips)= 0,112 $KtCO_2/TJ$

We assume that CO_2 emission factors for the fuels will be the same for period 2002-2012. For our calculations we assume that the Lower Heating Value of a fuel (LHV) doesn't change during that time, however in the Monitoring Plan the LHV factor will be taken into account for the baseline adjustment for any year until 2012. Lower Heating Values of the fuels, that are consumed by DH enterprisers, changes insignificantly from year to year. In Table 4 average lower heating value of fuels used by **Supplier** is represented:

Type of fuel	Average lower heating value of fuel	
	Kkal	MJ/m^3 (MJ/kg)
Natural gas	8067	33,8
Coal	4320	18,1
Fuel oil	9594	40,2
wood chips	2387	10,0

Table 4. Average lower heating value of fuels

Calculation of conversion factors of CO_2:

CF (Conversion Factor) = LHV (Lower Heating Value)* Cef (Carbon Emission Factor)

1000 m^3 of natural gas input = 33,8 [MJ/m^3]*0.0561 [KtCO_2/TJ] = 1.896 tCO_2

1t of coal input = 18.0 [MJ/kg]*0.0946 [KtCO_2/TJ] = 1.703 tCO_2

1t of fuel oil = 40.7 [MJ/kg]* 0.0774 [KtCO_2/TJ] = 3.15 tCO_2

1t of wood chips = 10 [MJ/kg]* 0.112 [KtCO_2/TJ] = 1.12 tCO_2

Calculation of Activity Level

Activity level is represented by annual fuel consumption. For calculation of Baseline emissions, the 2002 was taken as the Base year. This year is one of the typical years concerning the outside temperature in heating period, as well as concerning the conditions of production and consumption of the heat.

Name of enterprise	Baseline Natural Gas consumption, ths Nm3/yr	Baseline coal consumption, t/yr	Baseline fuel oil consumption, t/yr	Baseline wood chips consumption, t/yr
Objects that are operated by “Rivneteploenergo”, Ltd. and ME RCC „Teplotransservice”	49694,2	0		
Objects that are operated by ME RCC „Komunenergiya”	27101,4	0		
Rivne city Total	**76795,6**			
Objects that are operated by ME “ZdolbunivKomunenergiya”of Zdolbuniv City Council	4029,7	0		
Objects that are operated by ME “Teploservis” of Dubrovitsa Regional Council	0	638,0	2169,1	314,0
Total	**80825,3**	**6880,0**	**2169,1**	**314,0**

Table 5. Baseline fuel consumption

Detailed information is represented in **Annex 1 (Boilers).**

Calculation of Baseline Carbon Emissions

There are 3 types of GHG emissions involved in the baseline scenario: emissions due to fuel consumption, emissions due to power production, emissions due to power consumption.

1. Emissions due to fuel consumption.

Block of boiler-houses connected with boiler-house Knyazya Volodymyra,71:

1) CO_2 emissions due to historical fuel consumption in 2002 for providing of 132 Gkal of heat energy for heating and 37 Gkal for hot water supply service – 6 hours per day in heating period.
2) Additional CO_2 emissions at the conventional boiler-house for providing 37 Gkal for normative hot water supply service – (24 – 6 =19) hours per day during heating period and 24 hours per day during non heating period.

Other boiler-houses:

3) CO_2 emissions due to historical fuel consumption in 2002 for providing of heat energy for heating and hot water supply service.

2. Emissions due to power production.

Additional CO_2 emissions at the conventional power plant for production of 5MW*8400 hours of power, that will be replaced at the CHP units.

3. Emissions due to power consumption.

CO_2 emissions due to historical power consumption in 2002 at the boiler-houses where energy saving measures will be implemented.

CO_2 emissions from boilers operated by Rivne region DH systems are the Baseline Carbon Emissions. Baseline calculations were based on the assumption that baseline emissions during any report year (2008-2012) remain the same as in the basis year 2002.

Ukraine has united state power grid, therefore the averaged values for Carbon Emission factors (CEF) for electricity production should be used.

It is possible to use the new Carbon Emission factors (CEF) for 2006-2012, taken from 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”, verified by TUV SUD Industrie Service GmbH 17.08.2007 (Table 6).

Type of project	Parameter	EF (tCO2/MWh)
JI project producing electricity	EFgrid,produced,y	0.807
JI projects reducing electricity	EFgrid,reduced,y	0.896

Table 6. New Carbon Emission factors (CEF) for electricity generation and consumption in Ukraine

In course of development of the Monitoring reports for this project, the valid values for corresponding period will be used.

Calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if Rivne systems remains unchanged, see in **Appendix 4 (Baseline)**. They consist of an exact amount of total CO_2 emissions that took place during the base (2002) year, and additionally of emissions due to electricity production to the grid, that will be replaced after installation of CHP units.

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 will be reduced due to complex modernization of heat generating and distributing equipment with application of the technologies proposed in the project activities and described above, which include replacement of old obsolete boilers by new ones with higher efficiency, replacement of obsolete coal-fired boilers by the modern gas-fired ones, frequency controllers installation, reconstruction and liquidation of CHP (Central Heating Points), installation of cogeneration units, renovation of degraded heat distribution networks with using of the pre-insulated pipes.

For 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, we have built a dynamic baseline, which is the function of the stage of project implementation (see Fig. 3).

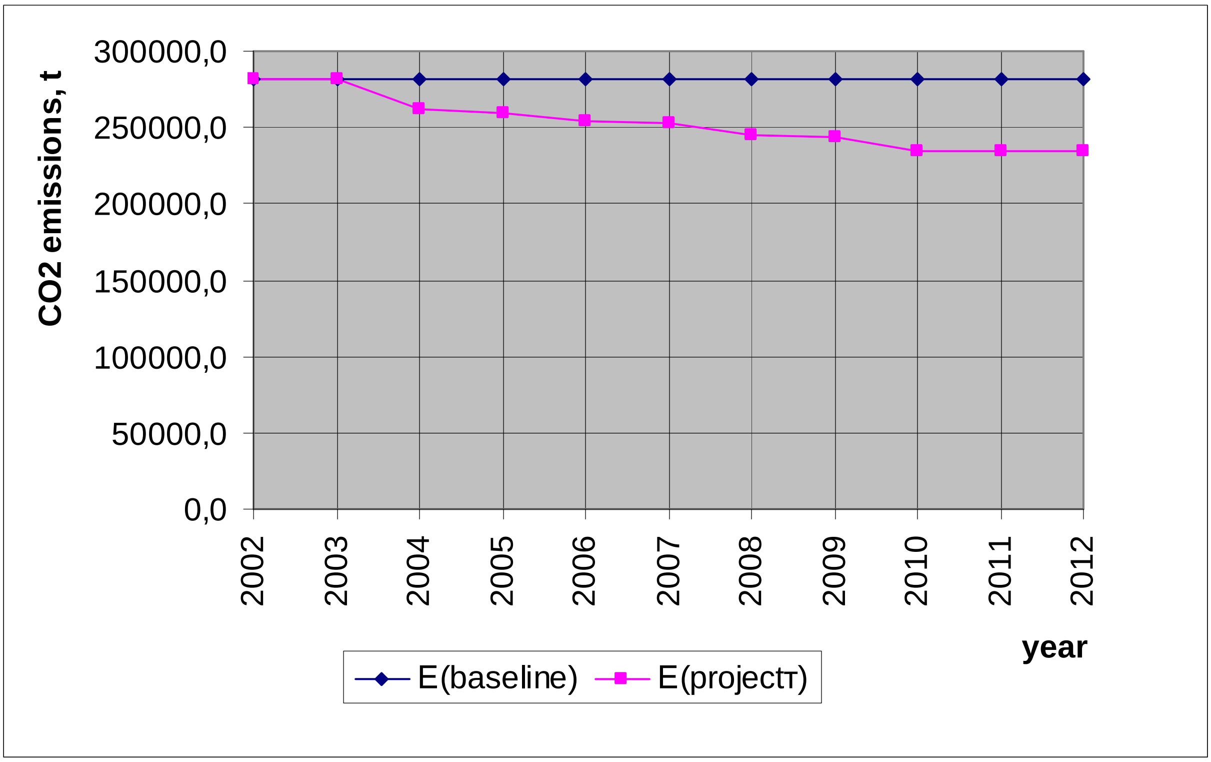
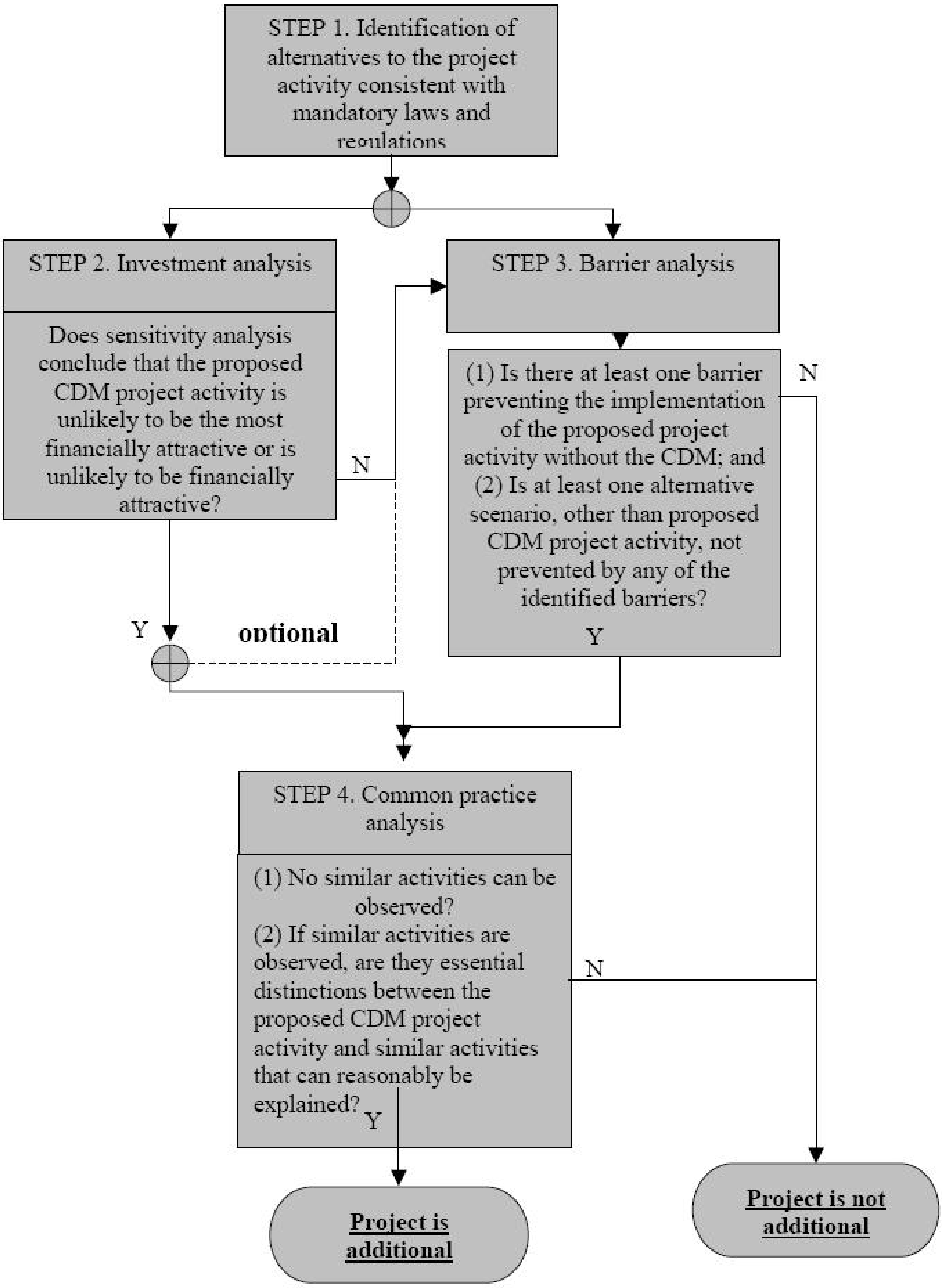


Fig. 3. Dynamic baseline and project emissions of GHG

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 5.2) (see **Fig. 4**). This tool was originally developed for CDM projects but may be applied to JI projects as well. This tool is used for the project in accordance with the guidance on its use provided in the partly similar “Baseline and monitoring methodology AM0044”.



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.
1. The first alternative is business-as-usual scenario with minimum reconstruction works, approximately balanced by overall degradation of the DH system.
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 to exploit boilers which was installed in 70 th. and even 50-60 th. and earlier in Ukraine, if they pass the technical examination pass by the authorized body ("Derzhnagliadohoronpratsi").

2. The second alternative is to make reconstruction works 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.

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, from June 01, 2000) and "On heat energy supply" (№ 2633-IV from 02.06.2005); Ukrainian Government Regulation "On introduction of changes to the Government Regulations №1698 from 14.11.2000 and №756 from 04.07.2001" №549 from 19.04.2006 and "On approval of the list of licensing bodies" №1698 from 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.

"Rivneteploenergo", Ltd and other regional enterprises included in the project have such licenses.

The JI Project "District Heating System Rehabilitation of Rivne Region" is in line with The Law of Ukraine from 01.07. 1994 №74/94-VR "On energy saving" and The Law of Ukraine from 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 reconstruction 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 5.2), for further additionality analysis it is possible to follow the Step 2 or Step 3 (or both).

We shall follow the Step 3.

Also the alternatives, which are: to continue business-as-usual scenario, to make reconstruction works without JI mechanism and to 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.

Step 3: Barrier analysis

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

Investment barriers

All project activities require substantial investment – about 14.4 million EUR (The prices for the new equipment, that is planned to be installed in the project, are represented on the sheets "Parameters" in the **Appendixes 1 - 2** in Excel format, based on the averaged prices of the manufacturers. These prices are used for calculations of investment costs, and should be corrected in future according to actual manufacturer's prices (changed due to inflation, etc.). The final table with necessary investments for each year is available in the **Appendix 5**. Operational and maintenance costs are not included in the project because it is assumed that they will remain at the previous level or even decreased due to less such costs for the new equipment).

The financial indicators Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated for two cases of project implementation – with and without the JI mechanism (see **Appendix 5**). Calculations were made with the help of Microsoft office Excel financial functions.

The simple pay back period without JI mechanism will be 14.5 years, with JI mechanism – 13.4 years.

In both cases the project is not attractive for investment, since the IRR values (8.5 % and 9.8 % respectively) are lower than typical values of deposit interest rate in Ukrainian banks (from 9 % to 12 % in Euro/USD and up to 18 % in Ukrainian hryvnas, see for example information of KreditPromBank [www.kreditprombank.com], UkrGasBank [www.ukrgasbank.com] and deposit market review [http://news.finance.ua/ru/orgtrg/~/3/1/114/130266], etc.). Using of JI mechanism enables to slightly improve project attractiveness.

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.

"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. http://www.energyagency.at/(publ)/themen/elektrizitaet_index.htm].

"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 modernisation. … 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. http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1819].

"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. www.case-ukraine.com.ua].

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. www.case-ukraine.com.ua].

As to loans, the Ukrainian DH heat supply companies practically couldn't get loans from Ukrainian banks, where the annual interest rates due to high risks, etc. are usually up to 20 % and even more [http://news.finance.ua/ru/~/3/20/all/2008/07/14/131967]. Moreover, no bank gives credits without the proper guarantees. ME "Kharkivski teplovi merezhi" is a communal ownership enterprise, and all its main funds belong to territorial population. For this reason the property of enterprise 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].

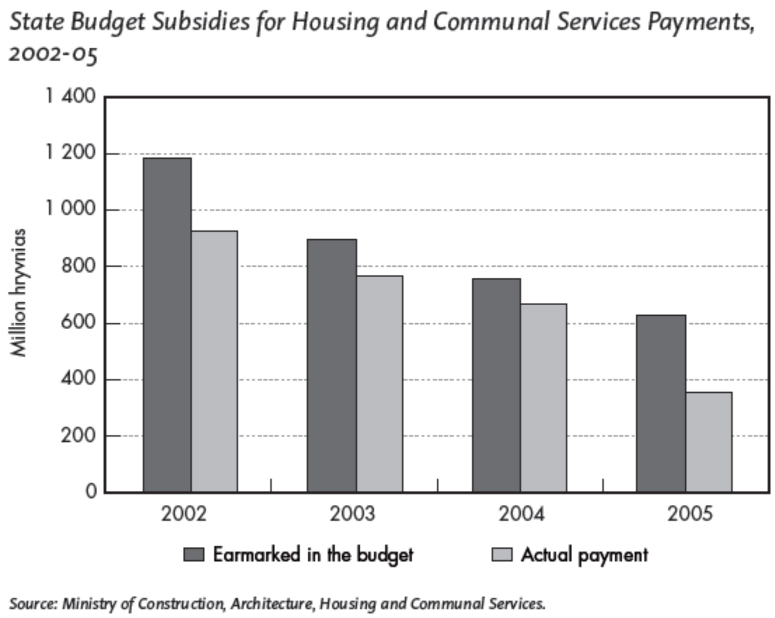


Fig.5. Diagram of the real State budget subsidies for Housing and communal services payments

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 the fact of signing of the external economic contract between Supplier and Purchaser itself is a very positive factor that even can enable to shift the priorities of budget financing in favor of the project, 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 project Supplier and the purchaser of the Emissions reduction units provides the priority for distribution of funds from the state and local budgets to the rehabilitation of the city district heating system, thus to provide fulfillment of international liabilities on the joint implementation project. This is evidenced by the real situation with budget financing for ME RCC „Teplotransservice": after the decision on development of the Joint Implementation Project on Green House Gas Emissions Reduction (2003) the abrupt increasing of financing from the city budget took place.

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 proper activity implementation in time.

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. Last years Ukraine faced with incomplete delivery of natural gas from Russian Federation. Ukrainian Government realized attempts to decrease dependence from Russian natural gas delivery. Unfortunately it could lead to impossibility of boiler houses fuel switch from coal to natural gas.

Organizational barriers

The management experience in implementation of JI projects is absent, including international collaboration, determination, 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 reconstruction works without JI mechanism and to 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 (except the proposed project activity)

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 Rivne Region district heating system, there is no impediment for ME RCC "Teplotransservise" to maintain the district heating system 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.

It should be noted that the district heating systems from 3 territorial districts (Rivne city, Dubrovitsa and Zdolbuniv) of the Rivne Region are involved in the project. The enterprises “Rivneteploenergo”, Ltd, ME RCC „Teplotransservice” and ME RCC ‘Komunenergiya” are the main heat-supply enterprises in Rivne city. ME “Teploservis” of Dubrovitsa Regional Council and ME “ZdolbunivKomunenergiya”of Zdolbuniv City Council are the main heat-supply enterprises in their towns. “Rivneteploenergo”, Ltd is empowered to represent the interests of other heat-supply enterprises of Rivne region. But there are no similar intensive rehabilitation activity observed in the Rivne region.

At present there are at least 4 District Heating Rehabilitation Projects with JI mechanism in Ukraine at advansed stages beside this project: for DH systems in Chernihiv region, Donetsk region, AR Crimea and Kharkiv city. But other CDM (JI) project activities are not to be included in Common practice analysis. The common practice for district heating enterprises in Ukraine without JI is only a necessary repairment of the old equipment, mainly in emergensy cases, and not the renewal. With the JI component it is possible to obtain the additional funds for real rehabilitation of the district heating system.

Outcome of Step 4a: Since the similar projects are not observed in the region, there is no basis for analysis of similar activities.

Conclusion:

The results of the above discussed analysis 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:

Greenhouse Gas Sources and Project Boundaries:

Project boundaries for Baseline scenario are represented by dotted line on the graphical picture on the **Fig. 6.**

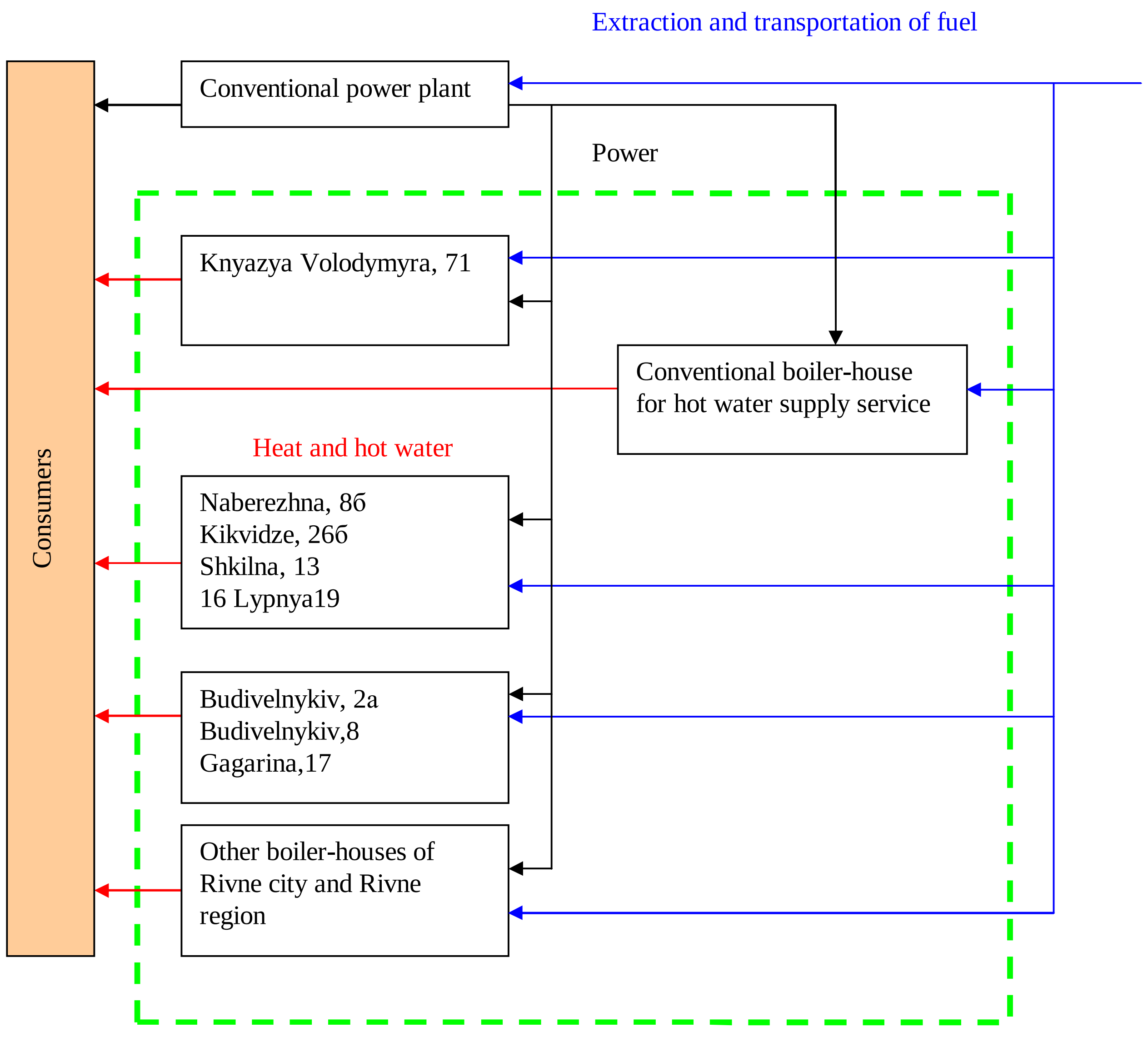


Fig.6. Flowchart of Project boundaries for Baseline scenario

Project boundaries for **Baseline scenario** are shown at the **Fig 6** with green dotted line.
As we can see from the picture, under the current heating system consumers receive heat and hot water from the boiler houses of Rivne city and Rivne region. Boiler-houses are provided by power from united State grid (Conventional Power Plant)
Beside this Baseline scenario included Conventional boiler-house for hot water supply service 24 hours during the year. In 2002 Base year consumers received hot water not more than 6 hours per day only in heating season.

Project boundaries also include CO_2 emissions due to electricity consumption from the grid that boiler houses consume for heat and hot water supply service providing. Emissions due to production and transportation of fuel are not included in project boundaries.

Project boundaries for **Project scenario** are shown at the **Fig 7**. with green dotted line.
Boiler-houses Naberezhna, 8б, Kikvidze, 26б, Shkilna, 13, 16 Lypnya19 – will be cloused and their heat caparcity will be switched to boiler-house Knyazya Volodymyra, 71, where CHP units will be installed. Boiler-house Naberezhna, 8б will be switched in the emergency mode. Boiler-houses Budivelnykiv, 2a, Budivelnykiv,8 and Gagarina,17 will receive hot water from boiler-house Knyazya Volodymyra, 71.

Project boundaries also include CO_2 emissions due to electricity consumption from the grid that boiler houses consume for heat and hot water supply service providing. Emissions due to production and transportation of fuel are not included in project boundaries.

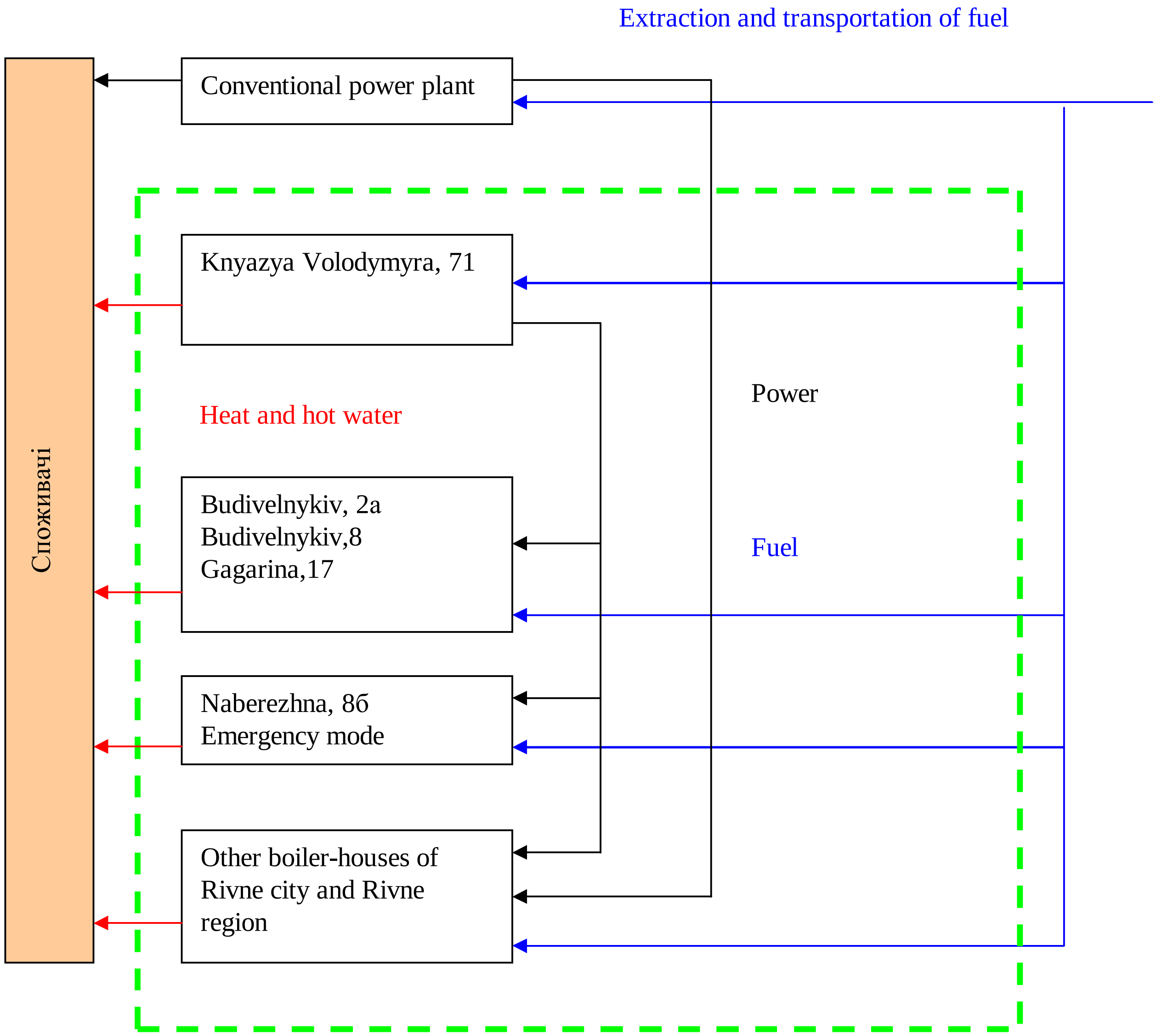


Fig.5. Flowchart of the Project boundaries for Project scenario

Direct and Indirect Emissions

Direct on-site emissions: CO_2 from natural gas combustion in boilers (in some cases coal and fuel oil are used as a fuel), NO_x and CO emission from combustion in the existing boilers/ burners, CO_2 emissions from fuel combustion in gas engines on the new CHP units, additional CO_2 emissions from fuel combustion in boilers on the boiler houses due to the too large heat losses in the distribution networks.

Direct off-site emissions: CO_2 emissions from power plant(s) due to electricity consumption from the grid, which will be replaced after installation of CHP units, CO_2 emissions from power plant(s) due to ineffective electricity consumption from the grid, which will be saved after installation of frequency controllers, CO_2 emissions from power plant(s) due to power consumption used for heating by Rivne region customers. 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.
CO_2 emissions from power station(s) due to heat networks power consumption. It is not efficient due to water leakages, and extended networks' distance.

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	Include or exclude
CO_2 emissions from fuel combustion in boilers	Reduced CO_2 emissions from fuel combustion in boilers due to increased efficiency and fuel saving. Additional CO_2 emissions on the boiler houses where the new CHP units will be installed due to additional fuel consumption for CHP	Direct	Include
NO_x and CO emission from combustion in existing boilers/ burners	Reduced NO_x and CO emissions from fuel combustion after boiler / burners' replacement	Direct	Exclude. NO_x and CO are not GHGs.
CO_2 emissions from fuel combustion in boilers on 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, reconstruction of Central Heating Points and reduction of networks' length	Direct	Include

Off-site emissions			
Current situation	Project	Direct or indirect	Include or exclude
CO_2 emissions from power plant(s) due to electricity consumption (for own needs, etc.) from the grid, which will be replaced after installation of CHP units	Reduced CO_2 emissions from power plant(s)	Direct	Include
CO_2 emissions from power plant(s) due to ineffective electricity consumption from the grid, which will be saved after energy saving measures implementation	Reduced CO_2 emissions from power plant(s)	Direct	Include
CO_2 emissions from power plant(s) due to power consumption used for heating by Rivne region customers. 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 power consumption for heating by Rivne region customers. This will take place after project implementation when heat supply service will become more efficient. Exploitation of power heaters will decrease substantially.	Direct	Exclude, not under control of project developer
CO_2 emissions from fuel extraction and transportation.	Reduced CO_2 emissions from fuel extraction and transportation.	Indirect	Exclude, not under control of project developer

Table 7. Project boundaries

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: 20/09/2004.

The baseline was determined by the Institute of Engineering Ecology (IEE), project developer and project partner, and ME RCC "Teplotransservise", previous project supplier.

IEE:
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SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

The starting date of the project is: 15/03/2003

C.2. Expected operational lifetime of the project:

Minimum 20 years (the nominal lifetime of the new boiler and network equipment). The real average lifetime of the new boiler and network equipment is estimated to be up to 30 – 40 years. Thus the expected operational lifetime of the project may be about 30 years. According to conservatism principle, for further calculations we assume lifetime and corresponding crediting period for the project equal to 20 years (2004 – 2023).

C.3. Length of the crediting period:

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

The starting date of the crediting period is set to the date where the first emission reduction units are expected to be generated from the project that is January 1, 2004. The end of the crediting period is the end of the lifetime of the main equipment that is minimal December 31, 2023. Thus the length of the crediting period is 20 years (240 months).

If the post-first commitment period under the Kyoto Protocol will be applicable, the commitment period may be expanded up to the end of the expected operational lifetime of the project (20 years, 2004 – 2023).

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 – is *fuel saving*. It can be identified as a difference between baseline fuel consumption and fuel consumption after project implementation If boilers consume fuel at the projected level, than all other relevant indicators such as efficiencies of new boilers and burners, specific gas consumption of CHP units, as well as heat losses in pre-insulated pipes are adequate.

Verification of project performance indicators

Project Supplier and oter DH enterprises involven in the project collect data on fuel bought for heating in form of fuel bills. Information on saved fuel will be attached to verification reports on a yearly basis (before April 1st for all years of project implementation) with all relevant documentation and historical information on fuel purchasing transactions made by Supplier.

Verification of Emission Reduction Units and Baseline Scenario

The monitoring methodology developed for “District Heating” projects in Ukrainian conditions consists in the following:

For any project year, the baseline scenario may be different due to the influence of external factors such as weather conditions, possible changes of the lower heating value of fuel(s), number of customers, heating area, etc. The Baseline and the amount of ERUs for each project year should be corrected with taking into account these and some other factors.

The following methodology is proposed to be used.

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

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

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

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

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

For each i boiler-house:

$E_1^b = LHV_b*Cef_b*B_b$

$E_1^r = LHV_r* Cef_r*B_r$

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

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

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

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

where:

LHV – lower heating value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, kt CO_2/TJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tons;
W_b – scheduled electric power production by the new CHP units at a boiler-house, MWh;
W_r – electric power production by the installed new CHP units, MWh;

CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;
P_b – electric power consumption by a boiler-house where energy saving measures are scheduled to be implemented, MWh;
P_r – electric power consumption by a boiler-house with energy saving measures implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Q_b – scheduled heat energy production by the new CHP units at a boiler-house, MWh;
Q_r – heat energy production by the installed new CHP units at a boiler-house in reported year, MWh;
f_b – specific natural gas consumption by a boiler-house, where CHP units are scheduled to be installed, m^3/MW;
B_g – amount of fuel (gas) consumed by the installed CHP units for heat and power generation, ths m^3;
[$_b$] index – related to the base year;
[$_r$] index – related to the reported year.

If any boiler-house consumes more than one type of fuel, the calculations of E are to be made for each type of fuel separately, and results are to be summed.

According to the Dynamic Baseline assumption, the efficient value of E_1^b may be defined as follows:
$E_{1i}^b = E_{hi}^b, + E_{wi}^b$;
where the first term describes emissions from fuel consumption for heating, and the second one – from fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$,
where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$

$E_1^r = LHV_r* Cef_r*B_r$

where:
LHV – lower heating value, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, kt CO_2/TJ;
B – amount of fuel consumed by a boiler-house, ths m^3 or tons per year;

K_1, K_h, K_w, K_{w0} – adjustment factors;
a – portion of fuel (heat), consumed for heating purposes;
(1-a) – portion of fuel (heat), consumed for hot water supply services;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

$a_b = L_h^b * g * N_h^b / (L_h^b * g * N_h^b + L_w^b * N_w^b)$;
$a_r = L_h^r * g * N_h^r / (L_h^r * g * N_h^r + L_w^r * N_w^r)$,

where:
L_h, L_w – maximum connected load to the boiler-house, that is required for heating and for hot water supply service, MW;
g – recalculating factor for average load during heating period (is determined for each boiler-house on historical base, usually is in the range 0,4 – 0,8);
N_h, N_w – duration of heating period and period of hot water supply service per year, hours.

Adjustment factors:

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

$K_1 = LHV_b / LHV_r$

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

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

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

where η is overall heating system efficiency.

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

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

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

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

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

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

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

Then:
$K_h = (F_{h\,r} * k_{h\,r}) * (T_{in\,r} - T_{out\,r}) * N_{h\,r} / F_{h\,b} * k_{h\,b} * (T_{in\,b} - T_{out\,b}) * N_{h\,b}$
2.1. K_2 (temperature change factor):

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

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

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

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

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

2.4. K_4 (heating period duration change factor):

$K_4 = N_{h\,r} / N_{h\,b}$

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

Thus,

$K_h = K_2 * K_3 * K_4$

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

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

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

where η is overall hot water supply system efficiency.

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

$Q_{w\,br} = Q_{w\,b} * K_w = Q_{w\,r}$

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

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

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

$Q_w = n_w * v_w * N_w$,

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

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

3.1. K_5 (number of customers change factor):

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

3.2. K_6 (standard specific discharge of hot water per personal account change factor):
$K_6 = v_{w\,r} / v_{w\,b}$

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

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

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

where:
$N_{w\,b}$ – duration of the hot water supply period in the base year, hours;
$N_{w\,r}$ – duration of the hot water supply period in the reported year, hours.

Thus,

$K_w = K_5 * K_6 * K_7$.

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

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

$K_5 = K_6 = K_7 = 1$.

Thus

$K_{w0} = 1$.

The table of parameters included in the process of monitoring and verification for ERUs calculation, is represented in the Section **D.1.1.1** 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 ERUs will be calculated**.**

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 consumption at boiler houses: (**B_r**)	Every Boiler house		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
1.1	Natural Gas		m^3					
1.2	Coal		ton					
1.3	Fuel oil		ton					
1.4	Wood chips		ton					
2	Average annual Heating Value of a fuel calculated by Lower Heating Value (**LHV_r**)	Fuel Supplier's Report or Chem. Lab Analysis Report		m, c	Once per month	100%	Registered in the journal (paper and/or electronic)	
2.1	Natural Gas		MJ/m^3					
2.2	Coal		MJ/kg					
2.3	Fuel oil		MJ/kg					

2.4	Wood chips		MJ/kg					
3	Power consumption (**P_r**)	Boiler houses where power saving measures will take place	MWh	m	Every month	100%	Registered in the journal (paper and/or electronic)	
4	Power production (**W_{gr}**)	New CHP units	MWh	m	Every day	100%	Registered in the journal (paper and/or electronic)	
5	Fuel consumption at the CHP units: (**B_g**)	Every CHP units	1000 m^3	m	Every day	100%	Registered in the journal (paper and/or electronic)	

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

For example, the gas flow meters of the SG type should meet the requirements of the standard TU 4213-001-07513518-02, in particular the measurement error should be not more than ± 2% in the flow range from Qmin to 0,2Qmax; ± 1% - in the range from 0,2Qmax to Qmax.

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.

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

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

where:
E_{1i}^r – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, t CO_2e;
$E_{gen\ i}^r$ – CO_2 emissions due to electric power generated by included into the project objects in the reported year, t CO_2e;
$E_{cons\ i}^r$ – CO_2 emissions due to electric power consumption from grid by the i boiler-house in the reported year, t CO_2e.

$E_{1i}^r = LHV_r * Cef_r * B_{ri}$,

where:
LHV_{ri} – Average annual lower heating value, MJ/m^3 (MJ/kg)
Average annual Heating Value is calculated for every town;
Cef – carbon emission factor, $ktCO_2/TJ$;
B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons;

$E_{gen}^r = (W_b - W_r) * CEF_g + B_g * LHV_r * Cef$

where:
W_b – scheduled electric power production by the all new CHP units, MWh;
W_r – electric power production by the installed new CHP units in reported year, MWh;
CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;
B_g – amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;

Q_b – scheduled heat energy production by the all new CHP units and Q_r – heat energy production by the installed new CHP units are not measured for this project, because in calculations total heat energy that produced by the boiler-house with cogeneration units takes into account.

$E_{cons\ i}{}^{r} = P_r * CEF_c$;

where:
P_r – electric power consumption by the boiler-houses with energy saving measures implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;
[$_r$] index – related to the reporting year

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 consumption at boiler houses (**B_b**)	Every Boiler-house		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 base year
1.1	Natural Gas		m^3					
1.2	Coal		ton					
1.3	Fuel oil		ton					
1.4	Wood chips		ton					

2	Average annual Heating Value of a fuel calculated by Lower Heating Value (**LHV_b**)	Fuel Supplier's Report or Chem. Lab Analysis Report		m, c	Once per month	100%	Registered in the journal (paper and/or electronic)	Data which allows to calculate GHG emissions in the base year
2.1	Natural Gas		MJ/m3					
2.2	Coal		MJ/kg					
2.3	Fuel oil		MJ/kg					
2.4	Wood chips		MJ/kg					
3	Average outside temperature during the heating season (**$T_{out\ b}$** and **$T_{out\ r}$**)	"Rivneteploenergo", Ltd , Meteorological Service	^{0}C (K)	m, c	Once per heating season. Daily temperature is registered every day	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline
4	Average inside temperature during the heating season (**$T_{in\ b}$** and **$T_{in\ r}$**)	"Rivneteploenergo", Ltd The average inside temperature will be calculated from the sum of returned payments caused by insufficient heating (in case of normative level is not satisfied)	^{0}C (K)	m, c	Once per heating season	100%	Registered in the journal (paper and/or electronic)	Auxiliary data which allows correcting of the dynamic baseline

5	Number of Customers ($\mathbf{n_{wb}}$ and $\mathbf{n_{wr}}$)	"Rivneteploenergo", Ltd		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
6	Heating area (total) ($\mathbf{F_{h\,b}}$ and $\mathbf{F_{h\,r}}$)	"Rivneteploenergo", Ltd	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
7	Average heat transfer factor of heated buildings in the base year ($\mathbf{k_{hb}}$)	"Rivneteploenergo", Ltd	W/m^2*K	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
8	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year ($\mathbf{F_{h\,t\,r}}$)	"Rivneteploenergo", Ltd	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

9	Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year ($\mathbf{F_{h\,n\,r}}$)	"Rivneteploenergo", Ltd	m^2	Statistics	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
10	Heat transfer factor of buildings with new thermal insulation ($\mathbf{k_{h\,n}}$)	"Rivneteploenergo", Ltd, State Buildings Norms (B.2.6-31:2006)	W/m^2*K	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
11	Heating period duration ($\mathbf{N_{h\,b}}$ and $\mathbf{N_{h\,r}}$)	"Rivneteploenergo", Ltd	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
12	Duration of period of hot water supply service ($\mathbf{N_{w\,b}}$ and $\mathbf{N_{w\,r}}$)	"Rivneteploenergo", Ltd	Hours	m	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline

13	Maximum connected load to the boiler-house, that is required for heating (**L_h^b** and **L_h^r**)	"Rivneteploenergo", Ltd	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
14	Connected load to the boiler-house, that is required for hot water supply service (**L_w^b** and **L_w^r**)	"Rivneteploenergo", Ltd	MW	c	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
15	Standard specific discharge of hot water per personal account (**$v_{w\,r}$** and **$v_{w\,b}$**)	"Rivneteploenergo", Ltd	kWh/h	Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
16	Carbon emission factor (**Cef_b** and **Cef_r**)	IPCC		Normative documents	Once per year	100%	Special Reports (paper and/or electronic)	Auxiliary data which allows correcting the dynamic baseline
16.1	Natural Gas		kt CO_2/TJ					
16.2	Coal		kt CO_2/TJ					
16.3	Fuel oil		kt CO_2/TJ					
16.4	Wood chips		kt CO_2/TJ					

17	Recalculating factor for average load during heating period (**g**)	"Rivneteploenergo", Ltd		Statistics	Once per year	100%	Special Reports (paper and/or electronic)	
18	Scheduled electric power production (**W_{gb}**)	"Rivneteploenergo", Ltd	MWh	c	Once	100%	Special Reports (paper and/or electronic)	Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario
19	Power consumption (**P_b**)	Boiler houses where power saving measures will take place	MWh	m	Every month	100%	Data journal, (paper and electronic file)	Data which allows to calculate GHG emissions due to power consumption from the grid in the baseline scenario

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

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

where:
E_i^b – baseline emissions, t CO_2
E_{1i}^b – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the base year, t CO_2e;
$E_{gen\ i}^b$ – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year, t CO_2e;
$E_{cons\ i}^b$ – CO_2 emissions due to electric power consumption for an i boiler-house in the base year, t CO_2e.

For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$,
where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply.

For the case when in the base year the hot water supply service was absent at all ($(1-a_b) = 0$), and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is:
$E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.

where:
LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg);
Cef – carbon emission factor, $KtCO_2$/TJ;
B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tons;
K_1, $K_h = K_2*K_3*K_4$; $K_w = K_5*K_6*K_7$ – adjustment factors;
a_b – portion of fuel (heat), consumed for heating purposes in the base year;
$(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year;
a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

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

where:

L_h^b– maximum connected load required for heating in the base year, MW;
L_w^b– connected load required for hot water supply service in the base year, MW;
g – recalculating factor for average load during heating period (usually 0,5-0,8);
N_h^b– duration of heating period in the base year , hours
N_w^b – duration of hot water supply service in the base year, hours

$$a_r= L_h^r*q*N_h^r/ (L_h^r*g*N_h^r+L_w^r*N_w^r)$$

where:
L_h^r– maximum connected load required for heating in the reported year, MW;
L_w^r– connected load required for hot water supply service in the reported year, MW;
g – recalculating factor for average load during heating period (usually 0,5-0,8);
N_h^r– duration of heating period in the reported year, hours,
N_w^r– duration of hot water supply service in the reported year, hours.

$$K_1=LHV_b/LHV_r;$$

where:
LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg);
LHV_r – Average annual lower heating value in the reported year, MJ/m^3 (MJ/kg)

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

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

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

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

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

where:
N_{hb},– duration of heating period in the base year, hours
N_{hr}– duration of heating period in the reported year, hours

$K_5 = n_{wr} / n_{wb;}$
where:
N_{wb},– number of customers in the base year;
N_{wr}– number of customers in the reported year

$K_6 = v_{w\,r} / v_{w\,b}$;

where:
$v_{w\,r}$ – 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).

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

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

$E_{gen}^{b} = W_b*CEF_g$;

where:
W_b – scheduled electric power production by the all new CHP units, MWh;
CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh;

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

where:
P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;
[$_b$] index – related to the base year;
[$_r$] index – related to the reporting year.

The Methodology for "District Heating" 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 ^{0}C), and hot water supply is insufficient or absent. Therefore this Methodology allows to take into account improving of the heat supply quality for the consumers and excludes deliberate reduction of heat delivery, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project activity.

Delivery of the less than necessary amount of heat and hot water really took place previously in cities and regions of 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" № 1497 from 30.12.1997, 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 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 season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied).

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

The average inside temperature is calculated by formulae:

If R = 0 (according to conservatism principle for the baseline assume R < 0.05):
$\mathbf{T_{in\ b}}$ = 18 ^{o}C.

If 0.05 < R ≤ 0.3 NP:
$\mathbf{T_{in\ b}}$ = 18 – (R/5) [^{o}C]

If 0.3 NP < R < NP:
$\mathbf{T_{in\ b}}$ = 12 – [(R – 0.3 NP)/10] [^{o}C]

where:
R - % of return payment from NP;
NP – amount of normative payment.

Thus if the inside temperature will be 18 ^{o}C or higher we will accept it as 18 ^{o}C according to conservatism principle, if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented before.

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

There are no data to be collected in order to monitor emission reductions from the project, because emission reductions will be calculate by means of formulae presented in paragraph **D.1.2.2.**

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):

Amount of the Emission Reduction Units (ERUs), t CO_2e:
ERUs = $\sum[E_i^b - E_i^r]$;

The sum is taken over all boiler-houses which are included into the project.
$E_i^b = E_{1i}^b + E_{gen\ i}^b + E_{cons\ i}^b$,
$E_i^r = E_{1i}^r + E_{gen\ i}^r + E_{cons\ i}^r$,

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

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 D.1.1. - D.1.3. will be used for monitoring of the emissions in the project scenario and the baseline scenario. They will be used in Monitoring report. The baseline is dynamic and depends on conditions of every reporting year. Therefore we can't use these formulae in PDD to estimate emission reductions because we have no data (whether conditions, low heating value of fuels, etc.) for any reporting year yet.

Formulae presented in 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 equipment efficiency increasing.

Appendix 1 - replacement of boilers.
Replacement of old operating boilers with low efficiency by the new highly efficient ones, replacement of obsolete coal-fired and oil-fired boilers by the new gas-fired boilers, switching load from the boiler houses with obsolete equipment to the boiler houses with highly effective equipment and CHP plants.
Appendix 2 - replacement of network pipes.
Replacement of the main and distribution networks pipes with diameter 57 mm - 460 mm by the pre-insulated ones. Replacement of heat exchangers and reconstruction of Central Heating Points.
Appendix 3 - Contains total sums of emission reductions for every year for each technology;
Appendix 4 - Contains calculations of baseline emissions and project emissions as well as GHG emissions reduction for every project year, based on formulae presented in D.1.4.

Appendix 3 and **Appendix 4** contain links with all **Appendices 1 - 2**.

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

ERUs = $E_b - E_r$.

where:
ERUs – emission reduction units, t CO_2e;
E_r – project emissions, t CO_2e
E_b – baseline emissions, t CO_2e

Baseline emissions

The main cause of impossibility of methodology AM0044 using for baseline calculation is no data for thermal energy output, because of thermal energy meters absence on the majority of boiler houses included in the project.
According to AM0044 methodology the following steps shall be used to estimate the baseline emissions:
Step 1 – Determine the thermal efficiency of each baseline boiler
The baseline thermal efficiency for each boiler included in the project boundary shall be determined using the following formula:

$$\eta_{BL,m,i} = EG_{BL,his,i} / FC_{BL,his,i} \qquad (1)$$

Where:
$\eta_{BL,m,I}$ - Average baseline thermal efficiency of boiler 'i'
$EG_{BL,his,I}$ - Average historic thermal energy output from the baseline boiler 'i' (MJ/yr).
$FC_{BL,his,i}$ - Average historic fossil fuel consumption from the baseline boiler 'i' (MJ/yr).

Where possible, the above calculation shall be based on historical data for the project activity site for the most recent 3 years before the implementation of the project activity. The average thermal output and fuel consumption value for the 3 years will be used in the equation. This data shall be reported in the CDM PDD.

Total thermal output for each baseline boiler will be determined from **actual measured baseline data for steam flow**, pressure and temperature, using acceptable standard methods as outlined in ASME PTC 4- 19987 or BS8458 or other recognized national or international standard.

Thus, without heat meters at each boiler (as in case of this project) it is impossible to use the AM0044 methodology.

Baseline emissions consist of 3 types of GHG emissions:
1) CO_2e emissions from boilers operated by the Supplier.
2) CO_2e emissions due to electricity production to the grid, that will be replaced after CHP units installation.

3) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses, where energy saving measures will be implemented.

$E_b = E1_b + E2_b + E3_b$

Where:
$E1_b$ – emissions from boilers operated by the Supplier, t CO_2e;
$E2_b$ –emissions due to electricity production to the grid, that will be replaced after CHP units installation, t CO_2e;
$E3_b$ – emissions due to electricity production to the grid, that consumed by boiler houses where energy saving measures will be implemented, t CO_2e;

1) Emissions from heat generating sources operated by the Supplier:

$E1_b = \sum (B_{b(i)} * LHV_{b(i)} * Cef_i)$,
where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), 1000 m^3 (t);
$LHV_{b(i)}$ – Lower Heating Value for each fuel, MJ/m^3 (MJ/kg);
Cef_{i-} – Carbon Emission Factors for each fuel, Kt CO_2/TJ.
For more detailed information see **Appendix 1.**

2) Baseline CO_2e emissions due to electricity production to the grid, that will be replaced after CHP units installation.

$E3_b = W_b * CEF_g$,
where:
W_b - annual power production of new CHP units, which will be installed by Supplier, MWh;
CEF_g - Carbon Emission factors for electricity production, tCO_2e/MWh, see **Table 6**.

3) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses, where energy saving measures will be implemented.

$E2_b = P_2 * CEF_c$,

where:

P_2 – annual power consumption of boiler houses in the area of which reconstruction and liquidation of CHP will take place, where frequency controllers will be installed, and also other energy saving measures will be implemented, MWh;

CEF_c – Carbon Emission factor for reducing electricity consumption, tCO_2e/MWh., see **Table 6**.

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

Heat, that will be produced from this CHP units, will be used for the hot water supply service. For more detailed information see **Appendix 6.**

Project emissions

Project emissions consist of 3 types of GHG emissions:

$E_r = E1_r + E2_r + E3_r$

Where:
$E1_r$ – emissions from boilers operated by the Supplier, t CO_2e;
$E2_r$ – emissions from new CHP units, t CO_2e.
$E3_r$ – emissions due to electricity production to the grid, that consumed by boiler houses where energy saving measures will be implemented, t CO_2e;

Project scenario emissions from boiler-houses are a sum of actual fuel amounts to be used in any report year (starting from 2008) multiplied by corresponding conversion factors. Actual – means with subtracted fuel saving due to improving of the network efficiency, HDS liquidation and reconstruction:

$E1_r = \sum ([B_{r(i)} – V_{(i)}] *LHV_{(i)} *Cef_i)$;

where:
$E1_r$ – project emissions from boiler-houses in any reported year, t CO_2e
$B_{r(i)}$ – fuel consumption by boiler-houses in the project scenario (for each fuel), 1000 m^3 (t);
$V_{(i)}$ –fuel saving due to network rehabilitation for each fuel, 1000 m^3 (t);

$LHV_{(i)}$ – Lower Heating Value for each fuel, MJ/m^3 (MJ/kg);
Cef_{i} – Carbon Emission Factors for each fuel, kt CO_2/TJ.

$$B_{r(i)} = [B_{b(i)} * LHV_{b(i)} * BBE_i] / [LHV_{r(i)} * PBE_i],$$

where:
BBE_i - Baseline Boilers Efficiency, %;
PBE_i - Project Boilers Efficiency, %.

Parameter **BBEi** - Baseline Boilers Efficiency was taken from operation sheets of each boiler.

Operation sheets established experimentally during the adjustment works are kept at the front of boilers at every boiler-house.

$$V_{(i)} = B_{b(i)} - B_{b(i)} * (100-L_b)/(100-L_r),$$

where:
$B_{b(i)}$ – fuel consumption in the baseline scenario (for each fuel), 1000 m^3 (t);
L_b – heat losses in the network in the baseline scenario, %;
L_r – heat losses in the network in the project scenario, %.

$E2_r = (W_b - W_r)*CEF_g + B_g * LHV_r * Cef$;

where:
Cef_{i-} – Carbon Emission Factors for each fuel, kt CO_2/TJ.
W_b – scheduled electric power production by the all new CHP units, MWh;
W_r – electric power production by the installed new CHP units, MWh;
CEF_g - Carbon Emission factors for electricity production, tCO_2e/MWh, see **Table 6**.
B_g – calculated amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;

$E3_r = (P_2 – P1_r)* CEF_{c,}$

where:
P_2 – annual power consumption of boiler houses where energy saving measures will be implemented, MWh;
CEF_c – Carbon Emission factors for reducing electricity consumption, tCO_2e/MWh;
$P1_r$ – calculated power saving due to reconstruction, MWh;

For more detailed information see **Appendices 1 –2 and 3.**

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:

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.
Quantity of natural gas consumed by boiler houses. Amount of fuel oil consumed by boiler houses. Amount of coal consumed by boiler houses. Amount of wood chips consumed by boiler houses.	Low for gas. Medium for fuel oil Medium for coal Medium for coal	Measuring instruments must be calibrated according to national regulations
Outside temperature.	Low	Measuring instruments must be calibrated according to national regulations
Fuel quality (Lower Heating Values).	Low	Measuring instruments must be calibrated according to national regulations
Number of customers (heating area).	Low	Statistic data. No quality assurance is needed.

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

The operational structure will include operation departments (repairment and adjustment, etc.) of Supplier ("Rivneteploenergo", Ltd) and boiler house operation personnel.
The management structure will include management departments of Supplier and specialists of the project developer (Institute of Engineering Ecology).

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

The monitoring plan is determined by the Institute of Engineering Ecology (IEE), project developer and project partner, and "Rivneteploenergo", Ltd, project supplier.

IEE:
Institute of Engineering Ecology
Kiev, Ukraine.
Dmitri Paderno,
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"Rivneteploenergo", Ltd
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Stepan Koropetskiy
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SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Project Carbon Emission Factors are assumed equal to the Baseline Carbon Emission Factors.

Calculation of Project Activity Level

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

	Project Natural Gas Consumption, ths Nm^3/yr
"Rivneteploenergo", Ltd and ME RCC "Teplotransservise"	93197,0
ME RCC "Komunenergiya"	17081,8
Rivne city Subtotal	**110278,8**
ME "ZdolbunivKomunenergiya"of Zdolbuniv City Council	3243,7
ME "Teploservis" of Dubrovitsa Regional Council	2650,3
Total	**116172,8**

Table 8. Project fuel consumption

Detailed information is presented in **Appendix 1 - 2.**

Estimation of Direct Project Emissions

Project emissions consist of four types of GHG emissions:

$E1_r$ – emissions from boilers operated by the Supplier, t CO_2e;
$E2_r$ – emissions from new CHP units, t CO_2e.
$E3_r$ – emissions due to electricity production to the grid, that consumed by boiler houses where energy saving measures will be implemented, t CO_2e;
Project emissions by the types of project activity are presented in **Appendix 4**

Total Project emissions are ~ **234952,8** t CO_2

E.2. Estimated leakage:

We assume that possible leakage is negligible that is less than 1% of the total direct emissions. These indirect emissions are not under control of project developer so we do not include them in calculations**.**

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

Project Emissions + Leakages = ~ **234952,8** + 0 = ~ **234952,8** t CO_2

E.4. Estimated baseline emissions:

Baseline emissions estimation

Baseline emissions consist of 3 types of GHG emissions:

1) CO_2e emissions from boilers operated by the Supplier.
2) CO_2e emissions due to electricity production to the grid, that will be replaced after CHP units installation.
3) CO_2e emissions due to electricity production to the grid, that consumed by boiler houses where energy saving measures will be implemented.

	Baseline emissions, t CO_2
"Rivneteploenergo", Ltd and ME RCC "Teplotransservise"	103480,7
ME RCC "Komunenergiya"	55887,9
Conventional power plant	33894,0
Conventional boiler-house for hot water supply servise	73366,9
Rivne city Subtotal	**266629,4**
ME "ZdolbunivKomunenergiya"of Zdolbuniv City Council	7641,1
ME "Teploservice" of Dubrovitsa Regional Council	7951,4
Subtotal	**282222,0**
Total	**103480,7**

Table 9. Baseline Emissions of CO_2

Baseline emissions ~ **282222,0** t CO_2.

More detailed calculation of resulting annual Baseline Carbon Emissions, that would take place during typical heating season if Rivne region DH system, remains unchanged, see in **section B** and **Appendixes 4 (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) =

282222,0 - 234952,9 = 47269,1 t CO_2 / yr.

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

Year	GHG emissions reduction due to boiler-houses rehabilitation, t CO_2	GHG emissions reduction due to network rehabilitation, t CO_2	Total GHG emissions reduction, t CO_2
2004	18498,6	2042,4	20541,0
2005	18498,6	4084,9	22583,5
2006	21301,2	6127,3	27428,5
2007	21301,2	8169,7	29470,9
Subtotal	**79599,5**	**20424,4**	**100023,9**
2008	24437,1	12432,5	36869,6
2009	25625,7	12432,5	38058,2
2010	34836,6	12432,5	47269,1
2011	34836,6	12432,5	47269,1
2012	34836,6	12432,5	47269,1
Subtotal	**154572,7**	**62162,6**	**216735,3**
Total	**234172,2**	**82587,0**	**316759,2**

Table 10.Estimated amount of CO_2e Emission Reductions

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

Year	Estimated project emissions (tones of CO_2 equivalent)	Estimated leakage (tones of CO_2 equivalent)	Estimated baseline emissions (tones of CO_2 equivalent)	Estimated emission reduction (tones of CO_2 equivalent)
2004	261681	0	282222	20541
2005	259639	0	282222	22584
2006	254794	0	282222	27429
2007	252751	0	282222	29471
Subtotal	**1028864**	**0**	**1128888**	**100024**
2008	245352	0	282222	36870
2009	244164	0	282222	38058
2010	234953	0	282222	47269
2011	234953	0	282222	47269
2012	234953	0	282222	47269
Subtotal	**1194375**	**0**	**1411110**	**216735**
2013	234953	0	282222	47269
2014	234953	0	282222	47269
2015	234953	0	282222	47269
2016	234953	0	282222	47269
2017	234953	0	282222	47269
2018	234953	0	282222	47269
2019	234953	0	282222	47269
2020	234953	0	282222	47269
2021	234953	0	282222	47269
2022	234953	0	282222	47269
2023	234953	0	282222	47269
Subtotal	**2584481**	**0**	**3104442**	**519961**
Total (tones of CO_2 equivalent)	**4807720**	**0**	**5644440**	**836720**

Table 11. 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 rules, the design documentation for the new building, reconstruction and technical re-equipment of industrial and civil objects must include the environmental impact assessment, the main requirements for which are listed in the State Building Norms of Ukraine A.2.2-1-2003.

Supplier has all the necessary Environmental Impact Assessments for its activity on heating system rehabilitation according to Ukrainian legislation.

Overall, the project "District Heating System Rehabilitation in Rivne Region" will have a positive effect on environment. Following points will give detailed information on environmental benefits.

1. Project implementation will allow to save more than 2557 thousand tons of natural gas per year, 2169 ton of fuel oil and 638 ton of coal. Natural gas, fuel oil and coal are a non-renewable resources and its economy is important.

2. Project implementation will reduce CO_2 emissions in Rivne region by over 47 thousand tons per year starting from 2010 due to increased boilers efficiencies, achieved through installation of up-to-date boiler equipment, particularly new boilers, CHP units, heat exchangers, reconstruction and liquidation of Central Heating Points, and installation of pre-insulated networks pipes instead of existing regular networks pipes.

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

4. It is expected that due to a better DH service Rivne region population will reduce electricity consumption from electric heaters thus reducing power plants emissions of CO_2, SO_x, NO_x, CO and particulate matter.

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 water medium

Impact on the water medium is present. Impact on water resources is will be the same as in baseline scenario. The existing technology of heat energy production exploited at the objects of DH enterprises foresees discharging of waste water to the sewage network with obligatory chemical control in accordance to Water Code of Ukraine, GOST 28.74-82 "Hygienic regulations and quality control", SNiP 4630-92 on determining maximum concentration limits for internal water bodies. Discharge of wastewater to the open water bodies will not take place.

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

Effects on the medium air

The project implementation will have positive effect on air medium:

- Reduction of NO_x, SO_x, CO and PM due to application of cleaner technologies at boiler houses;
- Reduction of electricity consumption results in lower emissions of the same air pollutants;
- Heat stress on the atmosphere (due to lower temperatures of flue gases);
- Lower emissions per unit of fuel at the same load on boiler house.

Effects on land use

Impact on the land medium is not present.

Relevant regulation is the sphere of land use is presented by the Land Code of Ukraine. National technological practice/standard: GOST 17.4.1.02.-83 “Protection of Nature, Soils. Classification of chemical substances for pollution control”.

Effects on biodiversity

Impact on biodiversity is not present.

Waste generation, treatment and disposal

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

Positive effect on the environment is recycling of old equipment is a positive effect by the definition.

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 authorities of Rivne city have expressed the support for the project.

Project "Rehabilitation of the District Heating System in Rivne region" was presented at the XVII (Yalta, June 5-9, 2007) and XVIII (Yalta, June 10-14, 2008) International Conferences "Problems of Ecology and Exploitation of Energy Objects", where it was comprehensively discussed with representatives of governmental and district heating organizations.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

See Section B for the Baseline information.

Annex 3

MONITORING PLAN

1. REHABILITATION OF THE DISTRICT HEATING SYSTEM IN KHARKIV CITY

This monitoring plan describes the methodology that will be used to calculate the ongoing amount of greenhouse gas emission reduction units (ERUs) resulting from installation and commissioning of the JI project in Rivne Region. Upgrades to the district heating system are expected to result in improved system performance. Each component of the JI project is expected to result in a reduction in greenhouse gas emissions. The reduction in greenhouse gas emissions will be quantified using the methodology presented in this Monitoring Plan.

2. PROJECT DESCRIPTION

The project consists of two parts: rehabilitation of DH system of Rivne city and rehabilitation of DH system of Rivne region. 12 boiler-houses with 78 boilers and 110 km of heat distributing networks are involved in the rehabilitation of Rivne city and 7 boiler-houses with 19 boilers and 11 km of heat distributing networks are involved in the rehabilitation of Rivne region. The total number of boiler-houses which are involved in the project is 19 with 97 boilers and 121 km heat distribution networks. Beside this project provides installation of cogeneration units at boiler houses Knyazya Volodymyra, 71 (two steam-turbines 2,5 MW each). This is the large part of Rivne regional DH system.

Measures that will be used to improve the efficiency of DH utility in Rivne region are the follows:

- Obsolete boilers will be replaced by new highly efficient ones that will result in efficiency increase from 70-73% up to 91-92%. Technical characteristic of new boilers scheduled to be installed are presented at the producer's websites that are listed in table below.
- Obsolete coal-fired and fuel oil-fired boilers will be partially switched to or replaced by gas-fired ones. Upgrading of boilers' burners will increase the efficiency by 3-5% and reduce CO and NO_x emissions.
- Installation of cogeneration units will result in increasing the fuel consumption efficiency, decreasing of dependence on the power supply and improvement of operational stability and reliability, decreasing of power consumption from power stations, decreasing of power transfer losses, and decreasing of environmental pollution. The project employs implementation of cogeneration units at Knyazya Volodymyra, 71 boiler-house. It is planning to install two steam-turbines P-2,5-15/3G with capacity 2500 kW each. For providing of nominal parameters for turbines operation it is necessary to realize implement reconstruction of two boilers B-25-15 GM.

Boilers B-25-15 GM before reconstruction prepare steam with following parameters:
- steam- production 25 t/h;
- temperature 350 °C;
- pressure 15 kg/sm^2.

Boilers B-28/24-380 G after reconstruction must prepare steam with following parameters:
- steam- production 28 t/h;
- temperature 380 °C;
- pressure 24 kg/sm^2.

Reconstruction of boiler-house Knyazya Volodymyra, 71 will allow to close low efficiency boiler-houses: Litivska, 49, Mitskevicha, 34, av. Miru, 4 and 24, Gagarina, 17, Naberezhna, 17 and switch several of them to standby emergency operational mode. It will result in decreasing the fuel consumption by enterprise.

It will be realized twenty-four-hour hot water supply service from the reconstructed boiler-house to population of residential areas "Pivnichniy", "Fabrichniy", area of streets: Gagarina- Ostafeva, that is 44,6% of all quantity of consumers, that connected to hot water supply service. For this purpose it is necessary to build main heat network with pre insulated pipes with diameters 377-325 mm, with total length 1415 m from CHP to area "Pivnichniy".

- The efficiency of distribution networks system will be considerably increased by:
  - Improvement of the heat networks system organization will be provided by liquidation of Heat Distribution Stations (HDS) - replacing 4-pipe lines by 2-pipe ones with simultaneous installation of heat exchangers directly at the consumers (Individual Heating Point – IHP).
  - replacing of the main network pipes with diameter 57 mm and more by the pre-insulated ones and renovation pipe insulation with using of foamed polyurethane. These measures will substantially reduce heat losses from existing 20-29% and even more, down to 1-3 % per km.

- Installation of frequency controllers at smoke exhauster, hot water pumps engines and air heaters will result in energy saving. . Those regulators make it possible to change actual capacity of the motors depending on connected load, both as during a day when water consumption is changes, and during a year when in summer motors work only for hot water supply. Power consumption of boiler houses will be decreased at least by 10-20% from total annual boiler house power consumption.

3. MONITORING METHODOLOGY

Relevant monitoring methodologies

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

The main cause of impossibility of using the methodology AM0044 for baseline calculation is absence of data for heat energy output, because of heat energy meters absence at the majority of boiler houses included in the project. That's why "SVT e.V." (Germany) and Institute of Engineering Ecology (Ukraine) have developed the project specific methodology, which takes into account all activity involved in the project and its peculiarities.This methodology is presented in section D (monitoring plan). It was already approved by IAE for JI Project for Chernihiv Region and similar JI Projects for Donetsk region, Crimea and Kharkiv city.

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

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

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

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

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

- It takes into account the quality of heat supply (heating and hot water supply). Almost annually for the various reasons (receiving of less amount and high price of the fuel, in particular natural gas which is nearly 95 % of fuel type used in Ukraine for the needs of the municipal heat supply), the consumers receive less than necessary amount of heat, in the result of which the temperature inside the buildings is much lower than normative one, and hot water supply is insufficient or absent. As the purpose of JI projects, including the current project, is the GHG (CO_2) emission reduction under the conditions of not worsening in any circumstances of the social conditions of population, the issue of approaching of the heat supply quality to the normative one is extremely important. Therefore, the amount of the fuel consumption for the after project implementation period is calculated for the conditions of providing the normative parameters of heat supply and at least partially of hot water supply, and in accordance with the monitoring plan, the implementation of continuous control (monitoring) of its quality (measurement of internal temperature in the specific buildings as well as registration of residents' complaints for the poor-quality heat supply) is foreseen. This increases the control for the qualitative heat supply for the consumers and excludes deliberate reduction of heat consumption, and, in such a way, of fuel consumption with the purpose of increasing of generation of GHG emissions reduction units (ERUs) at the project verification.
- Definition of the fuel consumption in base year (baseline) in view of the fact that in Ukraine at the majority of the municipal heat supply enterprises the natural gas is used as a fuel, which consumption is measured constantly by the counters with the high measurement accuracy, seems to be more exact, than definition of the fuel consumption with use of heat power, boiler efficiency and heat value of the fuel. This especially concerns the efficiency, which changes greatly depending on load of boilers, which also changes essentially, and often not automatically but manually, in the heat supply systems within a day and within a year. Averaging of such values without having of the heat account system is fraught with serious discrepancies. Definition of the fuel consumption in the presence of counters requires only data collection and implementation of arithmetic actions.

Approved Consolidated Methodology ACM0009 "Consolidated baseline methodology for fuel switching from coal or petroleum fuel to natural gas" proposes the dependences for baseline and reporting year emissions quantity definition (see pages 4 and 5), that contain determination of Energy efficiency $\varepsilon_{project,i,y}$ and $\varepsilon_{baseline,i}$ for equipment. In the chapter "Baseline emissions" on the page 6 there is an explanation that: Efficiencies for the project activity ($\varepsilon_{project,i,y}$) should be measured monthly throughout the crediting period, and annual averages should be used for emission calculations. Efficiencies for the baseline scenario ($\varepsilon_{baseline,i}$) should be measured monthly during 6 months before project implementation, and the 6 months average should be used for emission calculations. These requirements are confirmed by tables for monitoring on the pages 13-15.

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

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

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

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

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

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

Monitoring methodology developed for "District Heating" projects in Ukrainian conditions

Monitoring methodology developed for "District Heating" projects in Ukrainian conditions is presented 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 computing project emissions, baseline emissions and the total emission reduction 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)	
	$ERUs = \sum[E_i^b - E_i^r]$; [t CO_2e]
	ERUs - Total annual emission reduction [t CO_2e] E^b_i - Baseline CO_2 emissions [t CO_2e] E^r_i - CO_2 emissions in the reported year [t CO_2e]
	The sum is taken over all boiler-houses (i) which are included into the project

Project emissions

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

Formula 3 – CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house in the reported year, (E_{1i}^r)	
	$E_{1i}^r = LHV_r * Cef_r * B_{ri}$, [tCO2-eq.]

	LHV_{ri} – Average annual lower heating value, MJ/m^3 (MJ/kg) Average annual Heating Value is calculated for every town; Cef – carbon emission factor, $ktCO_2/TJ$; B_{ri} – amount of fuel consumed by a boiler-house in the reported year, ths m^3 or tons;

Formula 4 – CO_2 emissions due to electric power generated by included into the project objects in the reported year ($E_{gen\ i}{}^r$)	
	$E_{gen}{}^r = (W_b - W_r)*CEF_g + B_g* LHV_r* Cef$
	W_b – scheduled electric power production by the all new CHP units, MWh; W_r – electric power production by the installed new CHP units in reported year, MWh; CEF_g – Carbon Emission factor for electricity generation in Ukraine, t CO_2e/MWh; B_g – amount of fuel (gas) consumed by the installed CHP units for generation, ths m^3;
	Q_b – scheduled heat energy production by the all new CHP units and Q_r – heat energy production by the installed new CHP units are not measured for this project, because in calculations the total heat energy that produced by the boiler-house with cogeneration units takes into account.

Formula 5 – CO_2 emissions due to electric power consumption from greed by the i boiler-house in the reported year ($E_{cons\ i}{}^r$)	
	$E_{cons\ i}{}^r = P_r*CEF_c$
	P_r – electric power consumption by the boiler-houses with energy saving measures implemented, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh;

Baseline emissions

Formula 6 – Annual baseline emissions **(**E_b)	
	$E_i{}^b = E_{1i}{}^b + E_{gen\ i}{}^b + E_{cons\ i}{}^b$; [t CO_2e]
	$E_{1i}{}^b$ – baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house , t CO_2e; $E_{gen\ i}{}^b$– CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year (consumed from grid, amount to be substituted in the reported year), t CO_2e; $E_{cons\ i}{}^b$ – CO_2 emissions due to electric power consumption from grid by the i boiler-house in the base year, t CO_2e.

Formula 7 – Baseline CO_2 emissions due to fuel consumption for heating and hot water supply service for an i boiler-house, (E_{1i}^{b})	
	For the case when in the base year the hot water supply service was provided (independent of this service duration, $(1-a_b) \neq 0$), the formulae for E_1^b is: $E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_b*(1-a_b)*K_1*K_w]$, where the first term in brackets describes fuel consumption for heating, and the second one – fuel consumption for hot water supply. For the case when in the base year the hot water supply service was absent at all $((1-a_b) = 0)$, and in the reported year this service was provided (due to improvement of heat supply service quality for population), the formulae for E_1^b is: $E_1^b = LHV_b*Cef_b*[B_b*a_b*K_1*K_h + B_r*(1-a_r)*K_1*K_{w0}]$.
	LHV_b – Average annual lower heating value in the base year, MJ/m^3 (MJ/kg); Cef – carbon emission factor, $KtCO_2/TJ$; B_b – amount of fuel consumed by a boiler-house in the base year, ths m^3 or tons; K_1, $K_h = K_2*K_3*K_4$; $K_w = K_5*K_6*K_7$ – adjustment factors; a_b – portion of fuel (heat), consumed for heating purposes in the base year; $(1-a_b)$ – portion of fuel (heat), consumed for hot water supply services in the base year; a_r – portion of fuel (heat), consumed for heating purposes in the reported year.

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

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

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

Formula 11 – Temperature change factor (K_2)	
	$K_2 = (T_{in\ r} - T_{out\ r}) / (T_{in\ b} - T_{out\ b})$
	$T_{in\ r}$ – average inside temperature for the heating period in the reported year, K (or ^0C); $T_{in\ b}$ – average inside temperature for the heating period in the base year, K (or ^0C); $T_{out\ r}$– average outside temperature for the heating period in the reported year , K (or ^0C); $T_{out\ b}$– average outside temperature for the heating period in the reported year , K (or ^0C)

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

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

Formula 14 – Number of customers change factor (K_5)	
	$K_5 = n_{wr} / n_{wb}$
	N_{wb},– number of customers in base year; N_{wr} – number of customers in the reported year

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

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

Formula 17 – CO_2 emissions due to electric power generation associated to the project for an i boiler-house in the base year ($E_{gen\,i}{}^{b}$)	
	$E_{gen}{}^{b} = W_b{*}CEF_g$
	W_b – scheduled electric power production by the all new CHP units, MWh; CEF_g – Carbon Emission factor for electricity generation in Ukraine, tCO_2e/MWh
	Q_b – scheduled heat energy production by the all new CHP units is not measured for this project, because in calculations the total heat energy that produced by the boiler-house with cogeneration units takes into account.

Formula 18 – CO_2 emissions due to electric power consumption for an i boiler-house in the base year ($E_{cons\,i}{}^{b}$)	
	$E_{cons}{}^{b} = P_b{*}CEF_c$

	P_b – electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented in the base year, MWh; CEF_c – Carbon Emission factors for reducing electricity consumption in Ukraine, tCO_2e/MWh

4. MONITORING OF BASELINE AND PROJECT EMISSIONS

Parameters to be monitored

Monitoring methodology 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 spreadsheet that will track GHG emission reductions annually.
List of parameters to be monitored are in the table below.

	Symbol	Data variable	Data unit	Measured (m), calculated (c), estimated (e)
1	**(B_b)** and **(B_r)**	Fuel consumption at boiler houses		m
1.1		Natural Gas	m^3	
1.2		Coal	ton	
1.3		Fuel oil	ton	
1.4		Wood chips	ton	
2	**(LHV_b)** and **(LHV_r)**	Average annual Heating Value of a fuel calculated by Lower Heating Value		m, c
2.1		Natural Gas	MJ/m^3	
2.2		Coal	MJ/kg	
2.3		Fuel oil	MJ/kg	
2.4		Wood chips	MJ/kg	
3	**($T_{out\ b}$)** and **($T_{out\ r}$)**	Average outside temperature during the heating season	^0C (K)	m, c
4	**($T_{in\ b}$)** and **($T_{in\ r}$)**	Average inside temperature during the heating season	^0C (K)	m, c
5	**(n_{wb}** and **(n_{wr})**	Number of Customers		Statistics
6	**($F_{h\ b}$** and **($F_{h\ r}$)**	Heating area (total)	m^2	Statistics
7	**(k_{hb})**	Average heat transfer factor of heated buildings in the base year	$W/m^2{*}K$	c
8	**($F_{h\ t\ r}$)**	Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year	m^2	Statistics
9	**($F_{h\ n\ r}$)**	Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year	m^2	Statistics
10	**($k_{h\ n}$)**	Heat transfer factor of buildings with the new thermal insulation	$W/m^2{*}K$	Normative documents
11	**($N_{h\ b}$)** and **($N_{h\ r}$)**	Duration of the heating period	Hours	m

12	($N_{w\,b}$) and ($N_{w\,r}$)	Duration of the hot water supply period	Hours	m
13	(L_h^b) and (L_h^r)	Maximum connected load to the boiler-house, that is required for heating	MW	c
14	(L_w^b) and (L_w^r)	Connected load to the boiler-house, that is required for hot water supply service	MW	c
15	($v_{w\,r}$) and ($v_{w\,b}$)	Standard specific discharge of hot water per personal account	kWh/h	Normative documents
16	(Cef_r) and (Cef_b)	Carbon emission factor		Normative documents
16.1		Natural Gas	kt CO_2/TJ	
16.2		Coal	kt CO_2/TJ	
16.3		Fuel oil	kt CO_2/TJ	
16.4		Wood chips	kt CO_2/TJ	
17	**g**	Recalculating factor for average load during heating period		Statistics
18	(W_b) and (W_r)	Scheduled electric power production by the all new CHP units and electric power generation by the installed new CHP units in reported year, MWh	MWh	c/m
19	(P_b) and (P_r)	Electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented	MWh	m

Data to be monitored

Parameter number and name	**1.1** Natural gas consumption at boiler houses
Description	Natural gas consumption at 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	Every day
Background data	Instrument readings are registered in the paper journals at every boiler-house.
Calculation method	n.a.

Parameter number and name	**1.2** Coal consumption at boiler houses
Description	Coal consumption at boiler houses
Monitoring method	Purchasing of coal is realized in accordance with invoices. Consumption of coal is measured by wheelbarrows and pails then recalculated to weight
Recording frequency	Every day
Background data	Coal consumption is registered in the paper journals at every boiler-house. Invoices are filed in special journals.
Calculation method	n.a.

Parameter number and name	**1.3** Fuel oil consumption at boiler houses
Description	Fuel oil consumption at boiler houses
Monitoring method	Purchasing of Heavy oil is realized in accordance with invoices. Consumption of Heavy oil is measured by measured tare – torque tanks with rod
Recording frequency	Every day
Background data	Heavy oil consumption is registered in the paper journal Invoices are filed in special journals.
Calculation method	n.a.

Parameter number and name	**1.4** Wood chips consumption at boiler houses
Description	Wood chips consumption at boiler houses
Monitoring method	Purchasing of wood chips is realized in accordance with invoices or railway consignment notes. Consumption of Wood chips is measured by wheelbarrows then recalculated to weight
Recording frequency	Every day
Background data	Wood chips consumption is registered in the paper journals at every boiler-house. Avery month special commission completes the act of fuel writing-off. Invoices or railway consignment notes are filed in special journals.
Calculation method	n.a.

Parameter number and name	**2.1** Average annual Heating Value of Natural Gas
Description	Average annual Heating Value of Natural Gas calculated by Lower Heating 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
Background data	Registered in the paper journal
Calculation method	Weighted average value

Parameter number and name	**2.2** Average annual Heating Value of Coal
Description	Average annual Heating Value of Coal calculated by Lower Heating Value
Monitoring method	Accepted in accordance with quality certificate from coal supplier's or independent chemical lab analysis report. Independent chemical lab analysis is used in contentious cases. It is used rarely.
Recording frequency	Quality certificate is given by coal supplier's for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value

Parameter number and name	**2.3** Average annual Heating Value of Fuel oil
Description	Average annual Heating Value of Fuel oil calculated by Lower Heating Value
Monitoring method	Accepted in accordance with quality certificate from Fuel oil supplier's or independent chemical lab analysis report. Independent chemical lab analysis is used in contentious cases. It is used rarely.
Recording frequency	Quality certificate is given by Fuel oil supplier's for every consignment
Background data	Certificates are filed in special journals
Calculation method	Weighted average value

Parameter number and name	**2.4** Average annual Heating Value of Wood chips
Description	Average annual Heating Value of Wood chips calculated by Lower Heating Value
Monitoring method	Lower Heating Value of the wood chips accepted -10 MJ/Nm3 - as a wood chips from timber cutting from the table of wood chips characteristics from the site http://www.energosys.info/biotoplivo/.
Recording frequency	
Background data	
Calculation method	

Parameter number and name	**3.** Average outside temperature during the heating season
Description	Average outside temperature during the heating season
Monitoring method	Average outside temperature during the heating season is calculated by “Rivneteploenergo”, Ltd from the daily outside temperature values taken by dispatcher of “Rivneteploenergo”, Ltd from Rivne Meteorological Centre from 10 to 11 a.m. every day of heating season.
Recording frequency	Once per heating season. Daily temperature is registered every day of heating season
Background data	Meteorological Centre sends the Report every decade or month for every day of heating season. Reports are filed in special journals
Calculation method	Average value

Parameter number and name	**4.** Average inside temperature during the heating season
Description	Average inside temperature during the heating season is calculated from the sum of returned payments caused by insufficient heating (in case of normative level (18 ^{0}C) is not satisfied) Above 18 ^{0}C – is treated as 18 ^{0}C (according to the conservatism principle) and as meeting the normative. Below 18 ^{0}C – is treated as not meeting the normative, and is calculated as below.
Monitoring method	Sum of returned payments
Recording frequency	Once per heating season
Background data	Sums of return payment
Calculation method	According to “Rules of rendering of heat and hot water supply service to population” № 1497 from 30.12.1997, the enterprises must make the return payments to population for delivery less than necessary amount of heat. The normative inside temperature should be not lower than 18 ^{o}C. Amount of the return payment is: – 5% from normative payment for every degree from 18 to 12 ^{o}C; – 10% from normative payment for every degree from 12 to 5 ^{o}C; – when inside temperature is lower than 5 ^{o}C the payment is to be returned completely. Therefore the inside temperature will be calculated by formulae: If R = 0 (according to conservatism principle for the baseline assume R < 0.05): $\mathbf{T_{in\ b}}$ = 18 ^{o}C. If $0.05 < R \leq 0.3$ NP: $\mathbf{T_{in\ b}} = 18 – (R/5)$ [^{o}C] If 0.3 NP < R < NP: $\mathbf{T_{in\ b}} = 12 – [(R – 0.3\ NP)/10]$ [^{o}C] where: R - % of return payment from NP; NP – amount of normative payment. Thus if the inside temperature will be 18 ^{o}C or higher we will accept it as 18 ^{o}C according to conservatism principle, if it will be lower than 18 ^{o}C it will be calculated from return payments by the methodology presented before.

Parameter number and name	**5.** Number of Customers for hot water supply service
Description	Number of Customers for hot water supply service for every boiler houses
Monitoring method	Statistics of “Rivneteploenergo”, Ltd., ME RCC „Teplotransservise” and other enterprises.
Recording frequency	Customers update the contracts for hot water supply service with balance-owners (ZhEK) once per year. ZhEK give to “Rivneteploenergo”, Ltd., ME RCC „Teplotransservise” and other enterprises personal accounts of customers once per month. Contracts with organizations and legal entities are concludes directly with “Rivneteploenergo”, Ltd., ME RCC „Teplotransservise” and other enterprises. They are updated once per year.
Background data	The information is collected in special electronic journals “Registration of income from population” (for inhabitants). For organizations and legal entities such information is taken from contracts concluded with them
Calculation method	

Parameter number and name	**6.** Heating area (Total)
Description	Heating area for every boiler houses
Monitoring method	Statistics of “Rivneteploenergo”, Ltd., ME RCC „Teplotransservise” and other enterprises.
Recording frequency	The revise is made in case of new contracts with Customers or in case of contracts break.
Background data	The information is collected at the sale departments of “Rivneteploenergo”, Ltd., ME RCC „Teplotransservise” and other enterprises by the certificates of owners in accordance with technical passport of building. Total area with balconies and stairs and Heating area are displayed in the special journal
Calculation method	The data is taken for January, 01 for every year

Parameter number and name	**7.** Heat transfer factor of buildings
Description	Heat transfer factor of buildings for every boiler-house
Monitoring method	Statistics “Rivneteploenergo”, Ltd, ME RCC „Teplotransservise” and other enterprises .
Recording frequency	Heat transfer factor is recorded ones per year at recording of connection or disconnection of any heating area to boiler-houses included in project.
Background data	
Calculation method	For calculation of Heat transfer factor of buildings for every boiler-house, the method of Weighted average value was used,

	that depends on heating area of existing buildings and heating area of the new buildings. Values of the heat transfer factor for existing buildings were taken from SNiP 2-3-79 (1998) - not higher than 0.63. Values of the heat transfer factor of new buildings were taken according to State Buildings Norms (B.2.6-31:2006) - not higher than 0.36.

Parameter number and name	**8.** Heating area of buildings (previously existed in the base year) with the renewed (improved) thermal insulation in the reported year
Description	Heating area of reconstructed buildings with application of new insulations for walls
Monitoring method	Statistics of "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name	**9.** Heating area of newly connected buildings (assumed with the new (improved) thermal insulation) in the reported year
Description	Heating area of newly connected buildings with application of the new insulation for walls
Monitoring method	Statistics of "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per year
Background data	
Calculation method	

Parameter number and name)	**10.** Heat transfer factor of new buildings and buildings with new thermal insulation
Description	Heat transfer factor of buildings with new thermal insulation
Monitoring method	According to State Buildings Norms (B.2.6-31:2006)
Recording frequency	
Background data	
Calculation method	

Parameter number and name	**11.** Heating period duration
Description	Heating period duration in every town
Monitoring method	Measured by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per year
Background data	The duration of the Heating period is accepted in accordance with

	item 7.9.4 of "Rules of technical exploitation of heating equipment and networks. 2007". Beginning and ending of the heating period are determined in every town separately. The heating period begins if the average daily outside temperature is 8 °C or lower during 3 days, and finishes if average daily outside temperature is 8 °C or higher during 3 days. According to SNiP 2.01.01-84 (Climatology in heating engineering) the duration of heating period for project development is to be taken as 183 days, and usually it is from October,15, till April 15.
Calculation method	

Parameter number and name	**12.** Duration of the hot water supply period
Description	Duration of the period of hot water supply service for every boiler house.
Monitoring method	Measured by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per day
Background data	Hot water supply service is realized by hot water delivery schedule for every town. In Rivne city Hot water supply service used to be 6 hours per day only in heating season before the project implementation. There is a plan of disconnection of load for Hot water supply service for maintenance and preventive measures for every boiler-house.
Calculation method	

Parameter number and name	**13.** Maximum connected load to the boiler-house, that is required for heating
Description	Maximum connected load to the boiler-house, that is required for heating.
Monitoring method	Calculated by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per year
Background data	Maximum connected load to the boiler-house, that is required for heating, is calculated by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises for every heating season. It is calculated according to heat demand at outside temperature -23 °C.
Calculation method	

Parameter number and name	**14.** Connected load to the boiler-house, that is required for hot water supply service
Description	Connected load to the boiler-house, that is required for providing the hot water supply service
Monitoring method	Calculated by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.

Recording frequency	Once per year
Background data	Connected load to the boiler-house, that is required for hot water supply service, is calculated by "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises every year according to contracts with consumers.
Calculation method	

Parameter number and name	**15.** Standard specific discharge of hot water per personal account
Description	Standard specific discharge of hot water per personal account
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" in 1993, and no information is available on any propositions to change it.
Calculation method	

Parameter number and name	**16.** Carbon emission factor
Description	Carbon emission factor for different fuels
Monitoring method	Normative documents
Recording frequency	Once per year
Background data	For all fuels we used CO_2 emission factors from the data table provided in Annex C of the Operational Guidelines for Project Design Documents of Joint Implementation Projects [Volume 1: General guidelines; Version 2.2]. Cef (natural gas) = 0.0561 $ktCO_2/TJ$; Cef (coal) = 0.0946 $ktCO_2/TJ$; (taken as "Other bituminous coal"). Cef: (fuel oil)=0,0774 $ktCO_2/TJ$; Cef: (wood chips)=0,112 $ktCO_2/TJ$.
Calculation method	

Parameter number and name	**17.** Recalculating factor for average load during heating period
Description	Recalculating factor for determination of the average load during heating period
Monitoring method	Statistics of "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises.
Recording frequency	Once per year
Background data	Recalculating factor for average load during heating period is determined for each boiler-house on historical base, usually it is in the range (0,4 – 0,8)

Calculation method	$g = Q_{av}/Q_{max} = F_h*k_h*(T_{in} - T_{out\ av})/F_h*k_h*(T_{in} - T_{out\ min})$ where: g – recalculating factor for average load during heating period; F_h – heating area of buildings, m^2; k_h – average heat transfer factor of heated buildings,(W/m^2*K); T_{in} – average inside temperature for the heating period, K ; $T_{out\ av}$ – average outside temperature for the heating period, K (or ^0C); $T_{out\ min}$ – minimal outside temperature for the heating period, K (or ^0C).

Parameter number and name	**18.** Electric power generation
Description	Electric power generation by the installed new CHP units
Monitoring method	Measurement of generated electricity by power meter
Recording frequency	Every day
Background data	
Calculation method	

Parameter number and name	**19.** Electric power consumption
Description	Electric power consumption by the boiler-houses where energy saving measures are scheduled to be implemented
Monitoring method	Measurement by Electricity supply meters
Recording frequency	Every day
Background data	Electric power consumption is registered in the paper journals at every boiler-house and storage in electronic files.
Calculation method	

Scheme of monitoring system

The control and monitoring system comes to fuel consumption measurement. Other parameters are defined by calculations or taken from statistic data. Fuel consumption measurement is realized at the Gas distributing units of the boiler-houses. Gas registration is 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. 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.

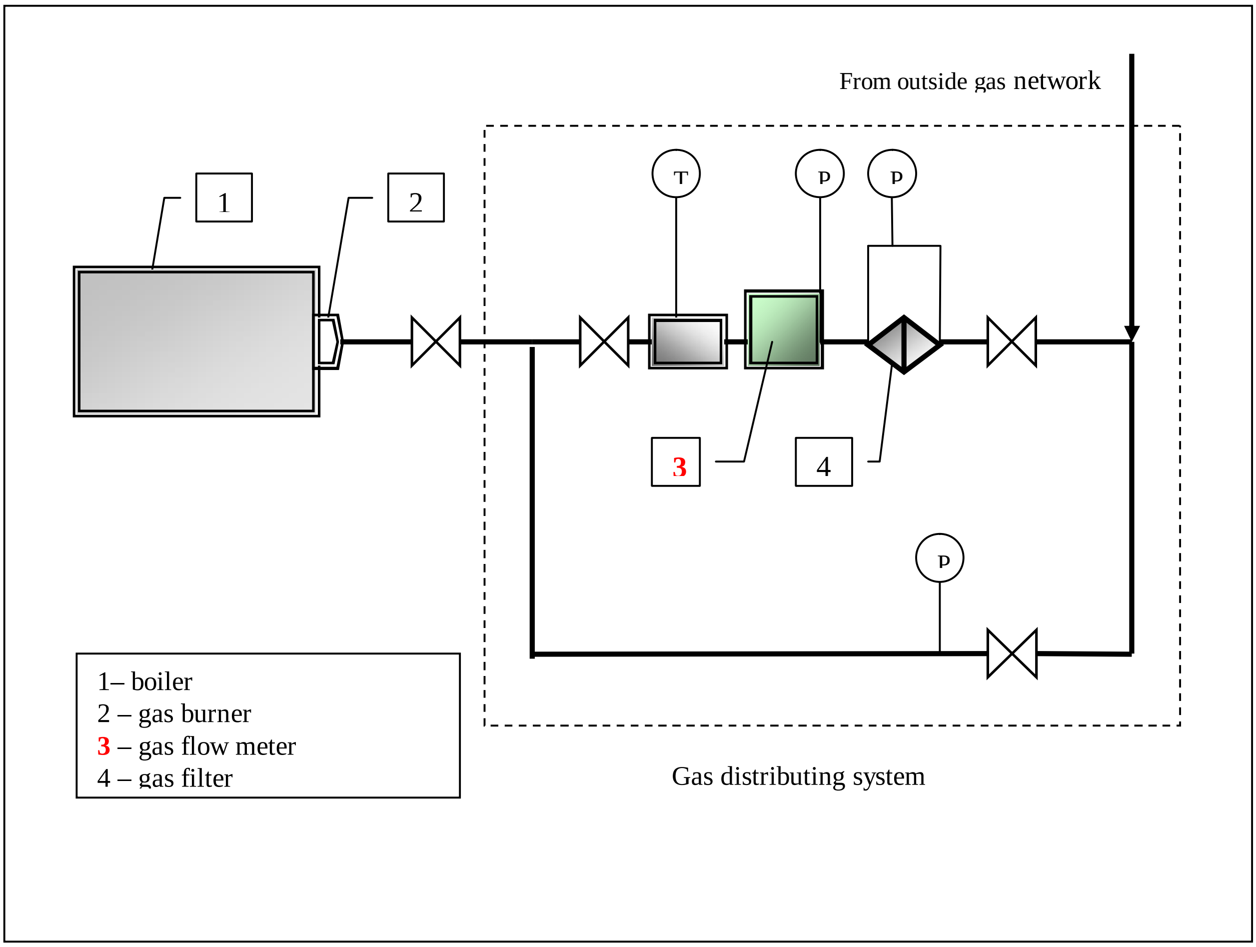

Fig. 1. Scheme of the Gas distribution system

Monitoring equipment

The equipment to be used by the project executor for monitoring of the relevant parameters are summarized in Table 1. The table also provides information on equipment type, calibration and procedures to follow in case of equipment failure.

ID number and data variable	Equipment	Accuracy	Calibration	Frequency	Procedure in case of failure
1.1 Natural Gas consumption	Gas flow meters	+/- (0.5…2)% Usually 1%	JSC “Rivne State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly 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 will be recorded in the site events log book.
17. Power consumption	Electricity supply meters	+/- (0.2…0.5) % Usually 0.2%	JSC “Rivne State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly 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 will be recorded in the site events log book.
18. Power production by the new CHP unit	Generated electricity meter	+/- (0.2…0.5) % Usually 0.2%	JSC “Rivne State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly 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 will be recorded in the site events log book.
19. Heat production by the new CHP unit	Heat flow meter	+/-2.0%	JSC “Rivne State center of standardization, metrology and certification”	Once per from 1 to 5 years, usually two years	Failure should be firstly 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 will be recorded in the site events log book.

Table 1. Monitoring equipment

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 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 20 monitoring points, only four of these (quantity of natural gas consumption, power consumption, power production on the new CHP and heat production on the new CHP unit) are measured directly. The remaining monitoring points used in calculation of the baseline and project line 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 four measurement errors (maximal values) which impact on the Standard Error and their level of accuracy are presented in Table 2.

ID number and data variable	Measurement error (maximal)	Comment
1.1 Natural Gas consumption	± 1.0%	Accuracy of data is high due to necessity of information for commercial account purposes.
18. Power production by the new CHP unit	±0.5%	Accuracy of data is high due to necessity of information for account purposes.
19. Heat production by the new CHP unit	±1.0%	Accuracy of data is high due to necessity of information for account purposes.
20. Power consumption	± 0.5%	Accuracy of data is high due to necessity of information for commercial account purposes.

Table 2: Measurement errors (accuracy) for standard error

5. MONITORING OF ENVIRONMENTAL IMPACTS

As the project involves rehabilitation of an existing district heating network leading to an improvement of energy efficiency and therefore better environmental performance of the system, and is not a new build project, no negative environmental impacts are expected, and therefore no formal environmental impact assessment is required by the relevant Ukrainian authorities.
There is therefore no need to monitor specified environmental impact indicators during implementation and operation of the project activities.

6. PROJECT MANAGEMENT PLANNING

The overall responsibility for the project management and implementation is carried out by the director of "Rivneteploenergo", Ltd. Mr. Stepan Koropetskiy, and by responsible persons appointed by director leaded by Mrs. Tetiana Kazachek, chief financial officer. The stuff of the Production-Technical Department (PTD) is responsible for project activity.

Compliance of the project activity with the operational requirements is constantly controlled by responsible stuff of a boiler-house, and according to their reports – by PTD.
Possible bottlenecks and mistakes in project implementation should be identified and solved by responsible stuff of PTD.

Responsibilities for data collection

The director of "Rivneteploenergo", Ltd., Mr. Stepan Koropetskiy appointed the responsible person, Mrs. Tetiana Kazachek, for the implementation and management of the monitoring process at the "Rivneteploenergo", Ltd.. Mrs. Tetiana Kazachek is responsible for supervising of data collection, measurements, calibration, data recording and storage. The director of ME RCC „Teplotransservise", Mr. Petro Sergiychuk, appointed the responsible person, Mrs. Oksana Trush, for the implementation and management of the monitoring process at the ME RCC „Teplotransservise".
Dr. Dmitri Paderno, vice director of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development.
Ms. Tetiana Grechko, senior engineer of Institute of Engineering Ecology, is responsible for baseline and monitoring methodology development and data processing.

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

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

2. Operators of all boiler-houses register the instrument readings in the paper journals "Journal of registration of boiler-house's operation parameters" every day.

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

4. Every day operators transfer values of gas consumption to dispatchers of the corresponding enterprises: "Rivneteploenergo", Ltd, ME RCC „Teplotransservise", ME RCC "Komunenergiya", ME "ZdolbunivKomunenergiya"of Zdolbuniv City Council and ME "Teploservis" of Dubrovitsa Regional

Council by phone. Monthly they transfer the paper report. Data are storing in the Production-Technical departments (PTD) and used for payments with gas suppliers.

Scheme of data collection for Monitoring Report is shown at the Fig. 2.

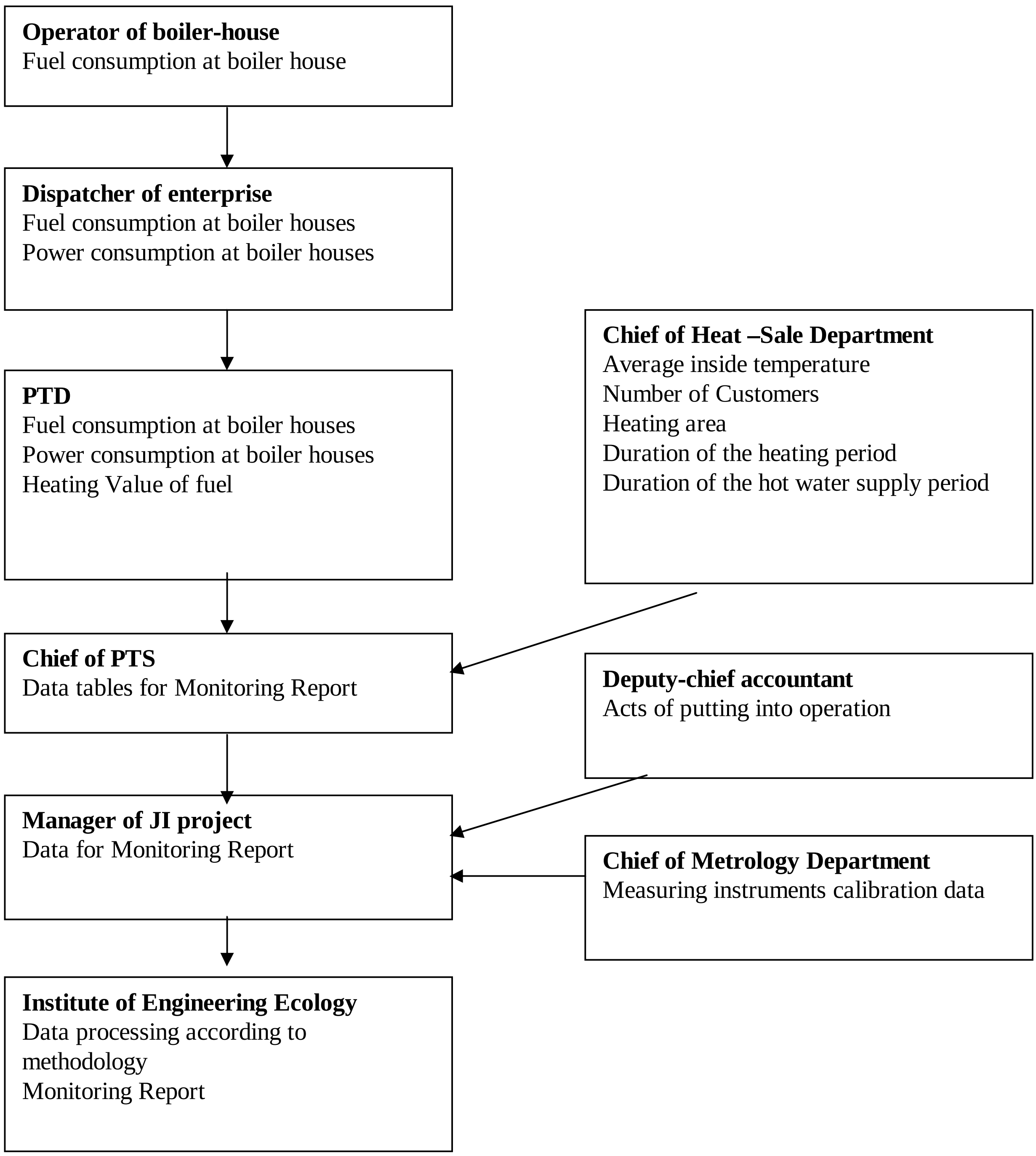

Fig.2. Scheme of data collection for Monitoring Report

Trainings

As far as the main activity of "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises will not change in course of the JI project implementation, the special technical trainings for personnel are not necessary. The technical personnel of the enterprise has sufficient knowledge and experience for implmentation of the project activity and maintenance of the usual equipment.
In cases of the new (never used at this enterprise before at the enterprise), equipment installation, the company - producer of this equipment should provide trainings for personnel.

"Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises provides personnel retraining according to protection of labour norms. The enterprise has the Labour protection department, which is responsible for raising the level of personnel skills and trainings.

In course of the JI project development (starting from 2004), specialists of Institute of Engineering Ecology and then also of the European Institute for safety, security, insurance and environmental technics carried out a comprehensive consultations and trainings for involved representatives of ME RCC „Teplotransservise" on the necessary data collection according to Monitoring plan for the project.

The special training was hold in January 2009.
The special group was organized consisted of representatives of ME RCC „Teplotransservise", ME RCC "Komunenergiya" and Institute of Engineering Ecology, in particular:

Petro Sergiychuk - ME RCC „Teplotransservise", Director;
Oksana Trush - ME RCC „Teplotransservise", Coordinator of projects with foreign investments;
Volodymyr Novozhilov - ME RCC "Komunenergiya", Acting Director;
Ludmyla Danyluk - ME RCC "Komunenergiya", Chief of PTD;
Natalya Rachinska - ME RCC „Teplotransservise", Chief of PTD;
Tetiana Grechko - Institute of Engineering Ecology, senior engineer;
Dmitri Paderno - Institute of Engineering Ecology, vice director.

The responsible stuff of the Production-Technical Service of "Rivneteploenergo", Ltd., ME RCC „Teplotransservise" and other enterprises is involved in this process.

Responsibilities for data management

All collected data will be transferred to Tetiana Kazachek , who will be responsible for data storage and archiving, entry of the data into the monitoring spreadsheets. Tetiana Grechko will be responsible for the data processing according to methodology and for development of Monitoring Report. Support in co-ordination of verification process will be undertaken by Dmitry Paderno. Responsibilities for data management are presented in Table 3.

Activity	Responsible person	
	Name	Position and department
Data storage and archiving	Natalya Rachinska	Chief of PTD, ME RCC „Teplotransservise”
Data storage and archiving	Ludmyla Danyluk	Chief of PTD, “Rivneteploenergo”, Ltd
Data storage and archiving, filling up the spreadsheets for Monitoring Report	Oksana Trush	Coordinator of projects with foreign investments, ME RCC „Teplotransservise”
Data storage and archiving, filling up the spreadsheets for Monitoring Report, coordination of verification process	Tetiana Kazachek	Chief financial officer, “Rivneteploenergo”, Ltd
Data processing according to methodology, development of Monitoring Report	Tetiana Grechko	Senior engineer of Institute of Engineering Ecology, Ltd
Support in coordination of verification process	Dmitri Paderno	Vice Director of Institute of Engineering Ecology, Ltd

Table 3: Responsibilities for data management