JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
FOR SMALL-SCALE PROJECTS
Version 01.1 - in effect as of: 27 October 2006

CONTENTS

Annexes

SECTION A. General description of the small-scale project

A.1. Title of the small-scale project:

Wood waste to energy in Severoonezhsk, the Arkhangelsk Region, the Russian Federation

Sectoral scopes[1]: 1. Energy industries (renewable/non-renewable sources) (1)
2. Waste handling and disposal (13)

Version number: 1.2

Date: 09 February 2010

A.2. Description of the small-scale project:

The project is aimed at wood waste utilization for heat supply of Severoonezhsk settlement, the Plesetsk District, the Arkhangelsk Region.

The project is structured around construction of a biofuel boiler house with the installed capacity of 20 Gcal/h (23.26 MW). The main fuel of the boiler house is wood waste (chips, sawdust and long sawmill residues). Wood waste is supplied from the local sawmills. The standby fuel of the boiler house is diesel oil. The heat supplied from the boiler house is delivered to end-users via the existing district heating network that is connected to the boiler house by a new section of heat pipeline, around 513 m long.

Prior to the project the settlement had been supplied with heat by a boiler house located in the territory of OJSC "Severoonezhsk Bauxite Mine" (OJSC "SBM") quite some distance away (around 6.8 km) from Severoonezhsk heat consumers. The main fuel of the boiler house was residual fuel oil. Wood waste from the local sawmills was stockpiled at the dumps because there were no utilisation capacities available.

In the absence of the project the usual practice of heat supply of the settlement would be continued and the local sawmills would go on with their practice of wood waste management.

As a result of the project:

- considerable quantity of wood waste from the local sawmills will be utilised;
- less wood waste will be disposed to the dumps;
- residual fuel oil consumption in the old boiler house owned by OJSC "SBM" will reduce;
- heat losses will be eliminated in the heat pipeline section from the old boiler house to the point where the new pipeline from the new boiler house connects with the district heating system;
- quality and reliability of heat supply of Severoonezhsk will improve;
- local employment rate will increase;
- negative environmental impact will be mitigated; and
- greenhouse gas (GHG) emissions will be cut down by an average of 26 thousand tonnes of CO_2e/year.

Construction and installation works under the project started in December 2006 (the actual starting date of the project) and were completed in January 2009. The required investments into the project amount to around EUR 12.8 million.

[1] In accordance with the list of sectors approved by the Joint Implementation Supervisory Committee http://ji.unfccc.int/Ref/Documents/List_Sectoral_Scopes.pdf.

It should be noted that the project has a marked environmental nature. The project is associated with a number of technological and operational barriers that have to be overcome. The economic parameters of the project without the joint implementation mechanism are unacceptably low. The decision to implement the project was taken by the company's management in view of the possibility to cover some of the costs and to offset project risks by selling GHG emission reductions in the international market. This issue was discussed with the Environmental Investment Center as early as 2006 and in 2009 – with CCGS LLC, the company that was chosen from among others as a partner for developing all necessary documentation and selling GHG emission reductions in the international market.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as a project participant (Yes/No)
Russian Federation (Host Party)	• Open Joint Stock Company "Mezhregionenergogas" • Closed Joint Stock Company "Teplo-Invest"	No
One of the Parties of Annex B to Kyoto Protocol	• To be determined upon approval of the project	No

Open Joint Stock Company "Mezhregionenergogas" (OJSC "Mezhregionenergogas") is a company whose business is related to improvement of gas utilization efficiency and to use of alternative fuels, it was incorporated on March 9, 2005.

Closed Joint Stock Company "Teplo-Invest" (CJSC "Teplo-Invest") is an investment company established on September 28, 2006.

A.4. Technical description of the small-scale project:

A.4.1. Location of the small-scale project:

The project activity is implemented in the settlement of Severoonezhsk, the Plesetsk District, the Arkhangelsk Region (See Fig. A.4-1, A.4-2).

Fig. A.4-1. Location of Severoonezhsk in the territory of the Russian Federation

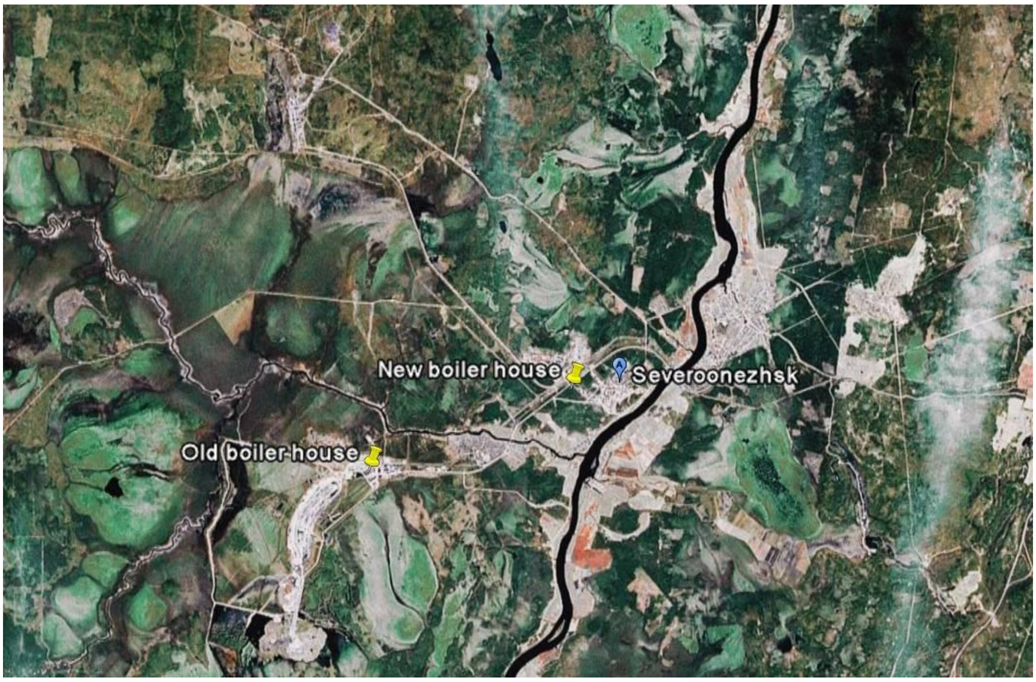

Fig. A.4-2. Google Earth map pinpointing the location of the project activity

A.4.1.1. Host Party(ies):

The Russian Federation

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

The Arkhangelsk Region, the Plesetsk District

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

The settlement of Severoonezhsk

A.4.1.4. Detail of physical location, including information allowing the unique identification of the small-scale project:

The settlement of Severoonezhsk lies on the left bank of the Onega River 30 km from the settlement of Plesetsk. There is Iksa railway station in Severoonezhsk, the main railway station of Zaonezhskaya Railway. The population of the settlement is around 5 300.

Geographical latitude: 62°35'22"N. Geographical longitude: 39°49'55"E. Time zone: GMT +3:00.

A.4.2. Small-scale project type(s) and category(ies):

The project activity can be referred to the following two types[2]:

1. Type I – Renewable energy projects. Category C – Thermal energy production with or without electricity;
2. Type III – Other project activities. Category E – Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment.

The project activity meets the small-scale activity criteria, because:

1. As of today the installed thermal capacity of the new biofuel boiler house is 23.26 MW. Shall the plans for installation of another hot water boiler be carried out, the installed thermal capacity of the boiler house will amount to 29.08 MW (See Section A.4.3), which will not exceed the limit of 45 MW set for small-scale projects;
2. GHG emission reductions generated by the project are estimated at an average of 26 thousand tonnes of CO_2e per year (See Section A.4.4.1), which is within the limit of 60 thousand tonnes of CO_2e per year set for small-scale projects.

A.4.3. Technology(ies) to be employed, or measures, operations or actions to be implemented by the small-scale project:

General characteristic of the production sites before the project implementation

Before the project implementation heat had been supplied to the settlement from the boiler house owned by OJSC "SBM" (Fig. A.4-3). The boiler house is situated in the territory of the mine quite far away (around 6.8 km) from Severoonezhsk heat consumers. The main fuel of the boiler house is residual fuel oil. The boiler house has two steam boilers of DKVR-10 type and two hot water boilers of PTVM-30M (KV-GM-30-150) type. The heat produced by these boilers is consumed for the mine's process needs and is used for heat supply of the settlement.

Wood waste from the local sawmills is stockpiled at the dumps because there are no capacities for their utilisation (Fig. A.4-4).

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[2] In accordance with the project types and categories adopted by the CDM Executive Board, http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

Fig. A.4-3. Residual fuel oil boiler house owned by OJSC "SBM"

Fig. A.4-4. Wood waste dump

The project activity characteristic

The project implementation started in December 2006. The project involves construction of a biofuel boiler house (Fig. A.4-5) with the installed capacity of 20 Gcal/h (23.26 MW). The boiler house is designed for district heating of housing and public utilities sector and industrial facilities of the settlement. On the 1st of August 2008 the boiler house was put into operation after completion of the major portion of construction and installation works.

The boiler house has four hot water boilers of Global/G/M-500 model (Fig. A.4-6) manufactured by an Italian company “Uniconfort” with the thermal capacity of 5 Gcal/h (5.8 MW) each. The boiler house also has spare area for installation of an additional boiler with the same capacity.

Global/G/M-500 boilers are fitted with a furnace with a reciprocating grate for wood waste firing. The outlet temperature of hot water is 115°C and the pressure is 0.78 MPa.

The main fuel of the boiler house is wood waste with moisture content between 30% and 50%, consisting of chips – 2.7%, bark – 5.5%, sawdust – 52% and long sawmill residues – 39.8%. Biofuel is delivered to the boiler house from the local sawmills by the fuel supplier’s motor transport. Long sawmill residues are chipped in situ before being fed for combustion. The standby fuel of the boiler house is diesel oil.

The heat supply system is open. The heat carrier is hot water. The heat from the boiler house collectors is supplied to end-users via the existing district heating network of the settlement that is connected to the boiler house by a new heat pipeline section, around 513 m long. The supply pipeline of the new heat network section is measuring 512 m, and the return pipe is measuring 514 m, the outside diameter of the heat network is 426 mm. The long section of the heat pipeline (6 650 m long) with an outside diameter of 630 mm running from the old residual fuel oil boiler house to the point where the new pipeline from the new boiler house connects with the existing district heating system is decommissioned (Fig. A.4-7).

Fig. A.4-5. New biofuel boiler house

Fig. A.4-6. General view of Global/G/M-500 hot water boiler

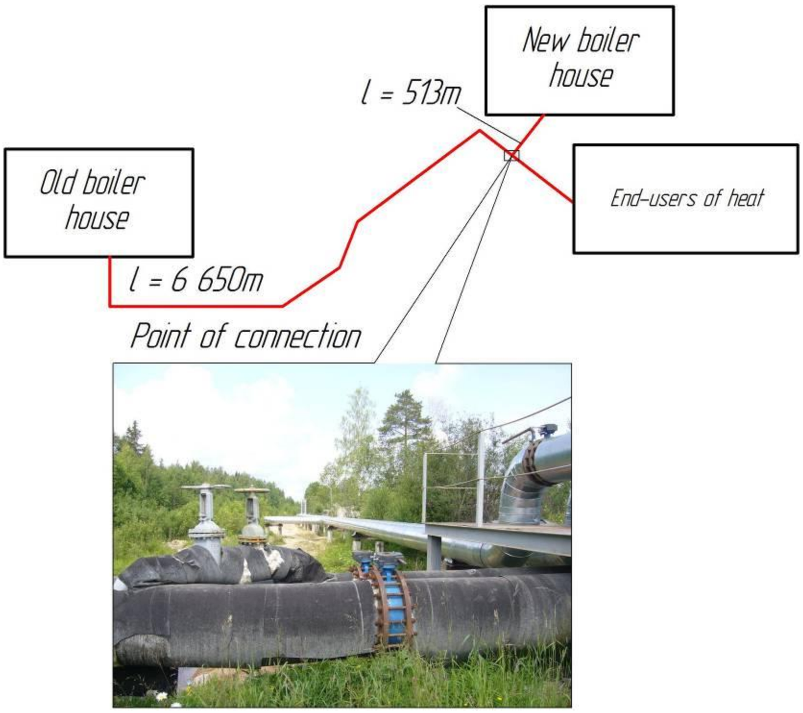

Fig. A.4-7. Basic diagram of heat supply of Severoonezhsk

A.4.4. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed small-scale project, including why the emission reductions would not occur in the absence of the proposed small-scale project, taking into account national and/or sectoral policies and circumstances:

The project implementation leads to reduction of GHG emissions from combustion of fossil fuel and anaerobic decomposition of wood waste at the dumps.

The principal GHG emitted from combustion of fossil fuel is CO_2. Emissions of CH_4 and N_2O from combustion of fossil fuel are negligibly small compared with emissions of CO_2 and were neglected when developing this Project [R11]. Emissions of CO_2 from combustion of wood waste are climatically neutral and are, therefore, assumed equal to zero. Anaerobic decomposition of wood waste at dumps is accompanied by release of CH_4.

The reduction of greenhouse gas emissions as a result of the project will be achieved due to:

- reduction of residual fuel oil consumption in the old boiler house owned by OJSC "SBM" as a result of construction of a new biofuel boiler house and reduction of heat losses in the heat pipeline; and
- reduction of wood waste disposal to the dumps.

It is unlikely that the project would be implemented in the absence of the joint implementation mechanism because:

- technical condition of the old boiler house allows to carry on its operation for a number of years yet[3];
- no major changes to the Russian environmental regulation are foreseen so far that would force OJSC "SBM" management to abandon the existing scheme of heat supply of Severoonezhsk, or to stop firing residual fuel oil in the existing boilers; and that would force the sawmills' management to stop disposing wood waste to the dumps;
- there are no limits on GHG emissions set for the Russian enterprises, and such are not expected at least until 2012[4]; and
- in the absence of the project it could have been possible to avoid additional and very risky investments of internal financial resources which may fail to pay back within reasonable time.

A.4.4.1. Estimated amount of emission reductions over the crediting period:

	Years
Length of the crediting period	
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	7 936
2009	27 964
2010	29 765
2011	31 485
2012	33 127
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	130 277
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	26 055

[3] After commissioning of the new boiler house the old boiler house was not shutdown and continues to produce heat (in the form of steam and hot water) to meet the process needs of OJSC "SBM".

[4] http://www.economy.gov.ru/minec/activity/sections/nature/kioto/doc1143621403750#

A.4.5. Confirmation that the proposed small-scale project is not a debundled component of a larger project:

In accordance with item 15 of the Provisions For Joint Implementation Small-Scale Projects [R15] a small-scale joint implementation (JI) project can be viewed as a debundled component of a larger project, if there already is a (small-scale) joint implementation project:

a) which has the same project participants;

b) which applies the same technology/measure and pertains to the same project category;

c) whose determination has been made publicly available in accordance with paragraph 34 of the JI guidelines within the previous 2 years; and

d) whose project boundary is within 1 km of the project boundary of the proposed JI SSC project at the closest point.

Since there are no registered projects that would answer the description this small-scale project is not a component of a larger project.

A.5. Project approval by the Parties involved:

The Letters of Approval will be received later.

SECTION B. Baseline

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

Indication and description of the approach chosen for baseline setting

The PDD developer has chosen JI specific approach for baseline setting in accordance with paragraph 9 (a) of the Guidance on criteria for baseline setting and monitoring [R3].

The baseline has been established in accordance with Appendix B of the JI guidelines[5]. Justification of the baseline has been provided in accordance with paragraph 23 through 29 of the Guidance on criteria for baseline setting and monitoring.

Firstly the most plausible baseline scenario has been identified based on the analysis of several alternatives which allow to ensure the required heat supply to end-users of the settlement, and alternative ways of handling wood waste that is fired under the project. The choice of baseline has been justified taking into account Annex 1 to the Guidance on criteria for baseline setting and monitoring.

After the baseline scenario has been selected, the project scenario is established on the basis of the data available and data projected for the period until 2012. And then building on the project scenario, everything related to the baseline scenario is justified. All key data, factors and assumptions that affect GHG emission reductions are considered in a transparent and conservative manner.

Identification of plausible future scenarios and selection of the baseline scenario

The following alternatives that can meet the heat demand of the settlement were identified:

Alternative HS1. Continuation of the current situation

Alternative HS2. Construction of a gas-fired boiler house

Alternative HS3. Construction of a coal-fired boiler house

Alternative HS4. The project activity without the joint implementation mechanism

The following alternatives to management of wood waste that is combusted under the project were identified:

Alternative WW1. Continuation of the current situation

Alternative WW2. Use of wood waste for fuel pellet production

Alternative WW3. The project activity without the joint implementation mechanism

Heat supply of the settlement

Alternative HS1. Continuation of the current situation

This alternative implies continuation of the situation that had taken place prior to the project implementation. The heat demand of the settlement would be met by firing residual fuel oil in the old boiler house owned by OJSC “SBM”.

The old boiler house had been supplying the settlement with heat for several decades. The heat supply process is well established, the operating and maintenance personnel of the boiler house have the required skills and qualification, and the fuel supplies are reliable.

Heat would be generated by firing residual fuel oil in the hot water boilers in the boiler house. Switching the boiler house to another type of fuel would be hardly possible, since it would involve significant

[5] The Annex to Decision 9/CMP.1 (referred to as JI guidelines) includes an Appendix B that lists criteria for baseline setting and monitoring.

modifications related to re-equipment of the existing boilers, installation of new boiler equipment, construction of fuel handling, storage and preparation facilities, all of which would require significant investments. Switching the boiler house to natural gas would in addition require construction of quite a long section of gas pipeline. It is unlikely that the management of OJSC "SBM" would be interested in such large-scale reconstruction, while heat supply of the settlement is not the core business of the company. The investments into modernization and expansion of the company's own production capacities, including introduction of state-of-the-art energy saving technologies, can yield much more profit for the company.

The advantage of Alternative HS1 is the absence of additional investments on the side of the municipal administration and on the side of OJSC "SBM".

Alternative HS1 is quite realistic and can be considered as the most likely baseline scenario.

Alternative HS2. Construction of a gas-fired boiler house

This alternative presupposes construction of a new gas-fired boiler house in the vicinity of the settlement. The heat supply of the settlement from the residual fuel oil fired boiler house owned by OJSC "SBM" would be discontinued. The heat demand of the settlement would be met by firing natural gas in a new boiler house.

The implementation of this alternative would require sizable investments into construction of the boiler house itself and into laying a fairly lengthy section of a gas pipeline. It is unlikely that the administration of the settlement would invest large sums of money into construction of heat generating capacities when there is a reliable heat supplier such as OJSC "SBM".

Moreover natural gas prices in Russia are likely to grow and in the short term are likely to come in line with the world's level. The profitability of projects that involve gas boiler houses construction will decrease gradually.

Alternative HS2 does not seem to be realistic and was excluded from consideration.

Alternative HS3. Construction of a coal-fired boiler house

This alternative presupposes construction of a new coal-fired boiler house in the vicinity of the settlement. The heat supply of the settlement from the residual fuel oil fired boiler house owned by OJSC "SBM" would be discontinued. The heat demand of the settlement would be met by firing coal in a new boiler house.

The implementation of this alternative, just as Alternative HS2, would require sizable investments into construction of a boiler house. It is unlikely that the administration of the settlement would invest large sums of money into construction of heat generating capacities when there is a reliable heat supplier such as OJSC "SBM".

Besides, the settlement is located very far from large coal fields. The construction of a coal-fired boiler house would require complicated fuel supply logistics. The operation of the boiler house would have an adverse impact upon the local environmental.

Alternative HS3 does not seem to be realistic and was excluded from consideration.

Alternative HS4. The project activity without the joint implementation mechanism

This alternative envisages construction of a new biofuel boiler house in the vicinity of the settlement. The heat supply of the settlement from the residual fuel oil fired boiler house owned by OJSC "SBM" would be discontinued. The heat demand of the settlement would be met by firing wood waste in a new boiler house.

The implementation of this alternative would require sizable investments. The Investment Analysis presented in Section B.2 has shown that the economic parameters of the project without JI mechanism would be unacceptably low. Besides the project without JI mechanism faces a number of serious barriers. See the Barrier Analysis also in Section B.2.

It is not likely that Alternative HS4 would be implemented as the baseline scenario.

Summarizing the above analysis Alternative HS1 that implies continuation of the current situation was chosen as the most likely baseline scenario for heat supply of the settlement.

Wood waste management

Alternative WW1. Continuation of the current situation

This alternative implies continuation of the situation that had taken place prior to the project implementation. Wood waste from the local sawmills would be disposed to the dumps (sites for organized stockpiling of wastes).

Wood waste disposal to the dumps (sites for organized stockpiling of wastes) does not conflict with the environmental legislation and is a common practice for Russian wood working companies. The disposal of wood waste to the dumps is not a problem for the local sawmills.

Of all wood waste stockpiled at the dumps, only sawdust would decompose under anaerobic conditions. Long sawmill residues, including slabwood, from which chips and bark are produced and then fired in the boiler house are very large in size. They decompose at the dumps under insufficiently anaerobic conditions with release of mainly CO_2 rather than CH_4.

The advantage of Alternative WW1 is the absence of additional investments into construction of wood waste utilization capacities.

Alternative WW1 is quite realistic and can be considered as the most likely baseline scenario.

Alternative WW2. Use of wood waste for fuel pellet production

This alternative presupposes utilization of wood waste as a raw stock for production of wood pellets.

Use of wood waste for pellet production is not common practice in Russia. There are no pelletizing plants in the Plesetsk District. Long distance transportation of wood waste for fuel pellet production at the existing plants is unpractical because of its high costs. Construction of a new pellet production plant near Plesetsk would require large investments and is associated with a number of serious barriers.

Alternative WW2 does not seem to be realistic and was excluded from consideration.

Alternative WW3. The project activity without the joint implementation mechanism

This alternative presupposes construction of a new biofuel boiler house and wood waste from the local sawmills would be fired in the boilers of the new boiler house.

The implementation of this alternative would require sizable investments. The Investment Analysis presented in Section B.2 has shown that the economic parameters of the project without JI mechanism would be unacceptably low. Besides the project without JI mechanism faces a number of serious barriers. See the Barrier Analysis also in Section B.2.

It is not likely that Alternative WW3 would be implemented as the baseline scenario.

Summarizing the above analysis Alternative WW1 that implies continuation of the current situation was chosen as the most likely baseline scenario for wood waste management.

Thus the baseline scenario envisages continuation of the existing practice of heat supply of the settlement from the old residual fuel oil boiler house owned by OJSC “SBM”. The unused wood waste generated at the local sawmills will be stockpiled at the dumps.

Detailed description of the project scenario

The key factors that characterize the project scenario are as follows:

- Heat generation;
- Heat supply;
- Wood waste combustion; and
- Electricity consumption from the external power grid.

Each factor is considered in detail further below.

Heat generation

The project scenario envisages production of heat (in the form of hot water) by the boilers of the new boiler house. The main fuel of the boilers will be wood waste, whereas diesel oil will be used as a standby fuel. Heat (in the form of hot water) ceased to be produced by hot water boilers of the old residual fuel oil boiler house for the purpose of heat supply of the settlement in mid-2008 after commissioning of the new boiler house. However the old residual fuel oil boiler house was not shut down and still continues to produce heat (in the form of steam and hot water) to meet the process needs of OJSC “SBM”.

In 2008 heat generation in the new boiler house amounted to 57 143 GJ. According to the design data [R1] 221 860 GJ/year will be produced in the new boiler house starting from 2009.

The heat generation in the new boiler house ($HG_{new\_BH,y}$) in 2008-2012 is given in Table B.1-1.

Table B.1-1. Heat generation in the new boiler house in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat generation in the new boiler house	GJ	57 143*	221 860	221 860	221 860	221 860	944 583

*actual value

Heat supply

Heat produced by the boilers of the new boiler house is consumed for auxiliary needs of the boiler house and is supplied to end-users via the new section of heat pipeline that connects the boiler house with the existing district heating network of the settlement.

The heat supply to end-users of the settlement under the project during the year *y* is determined as follows:

$$HS_{PJ,y} = HS_{new\_BH,y} - HL_{new\_HP,y} , \qquad \text{(B.1-1)}$$

where $HS_{PJ,y}$ is the heat supply to end-users of the settlement under the project during the year *y*, GJ;

$HS_{new\_BH,y}$ is the heat supply from the collectors of the new boiler house during the year *y*, GJ;

$HL_{new\_HP,y}$ is the heat losses in the heat pipeline section running from the new boiler house to the point of connection with the existing district heating network during the year *y*, GJ.

The heat supply from the collectors of the new boiler house during the year *y* is determined as follows:

$$HS_{new\_BH,y} = HG_{new\_BH,y} \times SHS_{new\_BH,y}\,,$$ (B.1-2)

where $HG_{new\_BH,y}$ is the heat generation in the new boiler house during the year *y*, GJ;

$SHS_{new\_BH,y}$ is the factor of heat supply from the new boiler house during the year *y*.

According to Table 3 of MDK 4-05.2004 [R7] proportion of heat used for auxiliary needs of a boiler house with fuel-bed firing can be assumed equal to 4%. Thus in the estimation the factor of heat supply from the new boiler house during the year *y* is assumed equal to 0.96.

Reported heat losses in the heat pipeline section running from the new boiler house to the point of connection with the existing district heating network in 2008 amounted to 756 GJ. Starting from 2009 heat losses in the heat pipeline section running from the new boiler house to the point of connection with the existing district heating network are assumed equal to 1 926 GJ per year[6].

The calculation of heat supply to end-users of the settlement under the project in 2008-2012 is given in Table B.1-2.

Table B.1-2. Calculation of heat supply to end-users of the settlement under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat supply from the collectors of the new boiler house	GJ	54 857*	212 986	212 986	212 986	212 986	906 800
Heat losses in the heat pipeline section running from the new boiler house to the point of connection with the existing district heating network	GJ	756*	1 926	1 926	1 926	1 926	8 460
Heat supply to end-users of the settlement	GJ	54 101*	211 060	211 060	211 060	211 060	898 340

*actual value

Wood waste combustion

The project scenario presupposes combustion of wood waste in the new boiler house. The standby fuel of the boiler house is diesel oil. In the estimation the consumption of standby fuel is assumed equal to zero.

The volumetric wood waste consumption in the new boiler house during the year *y* is determined as follows:

$$FC^{v}_{WW,new\_BH,y} = HG_{new\_BH,y} \times SFC^{v}_{WW,new\_BH,y}\,,$$ (B.1-3)

where $FC^{v}_{WW,new\_BH,y}$ is the volumetric wood waste consumption in the new boiler house during the year *y*, bulk m^3;

[6] According to the Annex to Contract No.15/2008 dated 07.07.2008 "The calculation of insulation losses in the supply and return heat pipelines from the point where the sensors of the heat metering unit are located and to the border dividing ownership and operational responsibilities".

$SFC^{v}_{WW,new\_BH,y}$ is the specific volumetric wood waste consumption for generation of 1 GJ of heat in the new boiler house during the year *y*, bulk m^3/GJ.

The specific volumetric wood waste consumption for generation of 1 GJ of heat in the new boiler house during the year *y* is assumed equal to 1.035 bulk m^3/GJ according to the design data [R1].

We shall separately determine the quantity of sawdust fired in the new boiler house[7].

The volumetric sawdust consumption in the new boiler house during the year *y* is determined as follows:

$$FC^{v}_{sawdust,new\_BH,y} = FC^{v}_{WW,new\_BH,y} \times w_{sawdust,new\_BH,y}, \qquad (B.1\text{-}4)$$

where $FC^{v}_{sawdust,new\_BH,y}$ is the volumetric sawdust consumption in the new boiler house during the year *y*, bulk m^3;

$w_{sawdust,new\_BH,y}$ is the proportion of sawdust in the total volume of wood waste fired in the new boiler house during the year *y*.

The proportion of sawdust in the total volume of wood waste fired in the new boiler house during the year *y* is assumed equal to 0.52 according to the design data [R1].

The volumetric wood waste consumption on the whole and of sawdust in particular in the new boiler house in 2008-2012 is given in Table B.1-3.

Table B.1-3. Volumetric wood waste consumption in the new boiler house in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Volumetric wood waste consumption in the new boiler house	bulk m^3	59 143	229 625	229 625	229 625	229 625	977 643
Volumetric sawdust consumption in the new boiler house	bulk m^3	30 754	119 405	119 405	119 405	119 405	508 375

<u>Electricity consumption from the external power grid</u>

The project scenario presupposes electricity consumption from the external power grid for auxiliary needs of the new boiler house.

The electricity consumption for auxiliary needs of the new boiler house during the year *y* is determined as follows:

$$EC_{new\_BH,y} = HS_{new\_BH,y} \times SEC_{HS,new\_BH,y}, \qquad (B.1\text{-}5)$$

where $EC_{new\_BH,y}$ is the electricity consumption for auxiliary needs of the new boiler house during the year *y*, MWh;

$SEC_{HS,new\_BH,y}$ is the specific electricity consumption for supply of 1 GJ of heat from the collectors of the new boiler house during the year *y*, MWh/GJ.

The specific electricity consumption for supply of 1 GJ of heat from the collectors of the new boiler house during the year *y* is assumed equal to 0.0205 MWh/GJ according to the design data [R1].

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[7] Herein under this parameter will be used for calculation of CH_4 emissions from decomposition of wood waste stockpiled at the dumps under the baseline scenario (see the description of the baseline scenario below).

The electricity consumption for auxiliary needs of the new boiler house in 2008-2012 is given in Table B.1-4.

Table B.1-4. Electricity consumption for auxiliary needs of the new boiler house in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Electricity consumption for auxiliary needs of the new boiler house	MWh	1 125	4 366	4 366	4 366	4 366	18 589

Detailed description of the baseline scenario

The baseline scenario envisages continuation of the existing practice of heat supply of the settlement from the old residual fuel oil boiler house owned by OJSC “SBM”. The unused wood waste generated at the local sawmills will be stockpiled at the dumps.

The baseline scenario is “business as usual” within the existing regulatory framework that does not prohibit OJSC “SBM” from supplying heat to the settlement, firing residual fuel oil in the existing boilers nor imposes any constraints on stockpiling of wood waste at the dumps by the local sawmills. The baseline scenario is reasonably conservative and much less expensive compared with the project activity. It should be also noted that there are no caps on emissions of greenhouse gases for individual companies in Russia and such are not projected to be set until 2012.

Let us identify the key factors that determine greenhouse gas emissions under the baseline scenario. These factors are:

- Heat supply;
- Fossil fuel combustion;
- Electricity consumption from the external power grid; and
- Disposal of wood waste to the dumps.

Each factor is considered in detail further below.

Heat supply

The baseline scenario implies that heat (in the form of hot water) is supplied to end-users of the settlement from the old boiler house operated by OJSC “SBM”. The main fuel of this boiler house will be residual fuel oil. The boiler house will also supply heat (in the form of steam and hot water) in the same quantity as under the project to meet the process needs of OJSC “SBM” itself.

The heat supply to end-users of the settlement under the baseline scenario during the year *y* is numerically equal to this value under the project:

$$HS_{BL,y} = HS_{PJ,y}, \quad \text{(B.1-6)}$$

where $HS_{BL,y}$ is the heat supply to end-users of the settlement under the baseline scenario during the year *y*, GJ.

The required quantity of heat will be supplied to the settlement via the existing district heating network. In that process a considerable amount of heat will be lost in the heat pipeline section from the old boiler house to the connection point of the pipeline from the new project boiler house.

The heat supply from the collectors of the old boiler house to meet the heat demand of the settlement under the baseline scenario during the year *y* is determined as follows:

$$HS_{old\_BH,BL,y}^{settlement} = HS_{BL,y} + HL_{old\_HP,BL,y},\tag{B.1-7}$$

where $HS_{old\_BH,BL,y}^{settlement}$ is the heat supply from the collectors of the old boiler house to meet the heat demand of the settlement under the baseline scenario during the year *y*, GJ;

$HL_{old\_HP,BL,y}$ is the heat losses in the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ.

The heat losses will be calculated separately for the supply and return pipelines of the heat network based on the standard values of heat losses.

The heat losses in the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y* are determined as follows:

$$HL_{old\_HP,BL,y} = HL_{old\_HP,SP,BL,y}^{standard} + HL_{old\_HP,RP,BL,y}^{standard},\tag{B.1-8}$$

where $HL_{old\_HP,SP,BL,y}^{standard}$ is the standard heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ;

$HL_{old\_HP,RP,BL,y}^{standard}$ is the standard heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ.

The standard heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y* are determined as follows:

$$HL_{old\_HP,SP,BL,y}^{standard} = \beta_{old\_HP} \times L_{old\_HP} \times \frac{q_{old\_HP,SP}^{standard}}{10^6} \times \sum_i \left(\frac{\left(t_{old\_HP,SP,i} - t_{outside\_air,i}\right)}{t_{old\_HP,SP} - 5} \times z_i \right),\tag{B.1-9}$$

where β_{old_HP} is the factor of local heat losses for the old heat pipeline;

L_{old_HP} is the length of the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, m;

$q_{old\_HP,SP}^{standard}$ is the standard specific heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, kJ/(m*h);

$t_{old\_HP,SP,i}$ is the average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the month *i*, °C;

$t_{outside\_air,i}$ is the average temperature of the outside air over the month *i*, °C;

$t_{old\_HP,SP}$ is the average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year, °C;

5 is the average annual rated temperature of the outside air, °C;

z_i is the length of operation of the heat network during the month *i*, h.

The standard heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y* are determined as follows:

$$HL^{standard}_{old\_HP,RP,BL,y} = \beta_{old\_HP} \times L_{old\_HP} \times \frac{q^{standard}_{old\_HP,RP}}{10^6} \times \sum_i \left(\frac{\left(t_{old\_HP,RP,i} - t_{outside\_air,i}\right)}{t_{old\_HP,RP} - 5} \times z_i \right), \quad \text{(B.1-10)}$$

where $q^{standard}_{old\_HP,RP}$ is the standard specific heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, kJ/(m*h);

$t_{old\_HP,RP,i}$ is the average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the month *i*, °C;

$t_{old\_HP,RP}$ is the average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year, °C.

The temperature chart for heat load control is assumed to be identical for the project and for the baseline scenarios.

The temperatures in the supply and return pipelines from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network and from the new boiler house to the point where they connect with the existing district heating network are assumed to be identical, i.e.:

$$t_{old\_HP,SP,i} = t_{new\_HP,SP,i}, \quad \text{(B.1-11)}$$

where $t_{new\_HP,SP,i}$ is the average temperature in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*, °C.

$$t_{old\_HP,RP,i} = t_{new\_HP,RP,i}, \quad \text{(B.1-12)}$$

where $t_{new\_HP,RP,i}$ is the average temperature in the return pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*, °C.

<u>Fossil fuel combustion</u>

The baseline scenario implies combustion of residual fuel oil in the old boiler house owned by OJSC “SBM” for generation of heat supplied to end-users of the settlement.

The quantity of residual fuel oil fired in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y* is determined as follows:

$$FC^{settlement}_{RFO,old\_BH,BL,y} = \frac{HS^{settlement}_{old\_BH,BL,y}}{\eta_{HWB,old\_BH} \times \left(1 - q_{old\_BH}\right)}, \qquad \text{(B.1-13)}$$

where $FC^{settlement}_{RFO,old\_BH,BL,y}$ is the quantity of residual fuel oil fired in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y*, GJ;

η_{HWB,old_BH} is the efficiency factor of the hot water boilers of the old boiler house;

q_{old_BH} is the proportion of heat used for auxiliary needs of the old boiler house.

Electricity consumption from the external power grid

The baseline scenario presupposes consumption of electricity from the external power grid by the old boiler house for generation of heat supplied to end-users of the settlement.

The electricity consumption in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y* is determined as follows:

$$EC^{settlement}_{old\_BH,BL,y} = \frac{HS^{settlement}_{old\_BH,BL,y}}{\left(1 - q_{old\_BH}\right)} \times SEC_{HG,old\_BH}, \qquad \text{(B.1-14)}$$

where $EC^{settlement}_{old\_BH,BL,y}$ is the electricity consumption in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y*, MWh;

SEC_{HG,old_BH} is the specific electricity consumption for generation of 1 GJ of heat in the old boiler house, MWh/GJ.

Disposal of wood waste to the dumps

The project scenario implies combustion of wood waste in the new boiler house which will allow reducing their disposal to the dumps and thereby cutting methane emissions due to waste decay. We cannot assert that all wood waste that is fired under the project would, under the baseline scenario, decompose at the dumps under anaerobic conditions. Of all wood waste stockpiled at the dumps, only sawdust would decompose under anaerobic conditions. Long sawmill residues, including slabwood, from which chips and bark are produced and then fired in the boiler house are very large in size. They decompose at the dumps under insufficiently anaerobic conditions with release of mainly CO_2 rather than CH_4.

Hereinafter it shall be assumed that the quantity of wood waste disposed to the dumps under the baseline scenario will be equal to the quantity of sawdust fired under the project, whereas the remaining portion of wood waste is conservatively excluded from consideration.

The numerical estimations of avoided methane emissions from anaerobic decomposition of wood waste are made using the model “Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles” developed by “BTG biomass technology group B.V.” for the World Bank [R12]. The model is built on the First Order Decay method with experimental specification of a number of parameters for waste wood dumps (See Section E.4).

The wood waste disposal to the dumps under the baseline scenario during the year *y* is determined as follows:

$$WW^{dry}_{dump,BL,y} = FC^{v}_{sawdust,new\_BH,y} \times k_{sawdust}, \quad \text{(B.1-15)}$$

where $WW^{dry}_{dump,BL,y}$ is the wood waste disposal to the dumps under the baseline scenario during the year *y*, t d.m.[8];

$k_{sawdust}$ is the factor for conversion of bulk cubic meters of sawdust to tonnes of dry matter, t d.m./bulk m^3.

The factor for conversion of bulk cubic meters of sawdust to tonnes of dry matter is determined as follows:

$$k_{sawdust} = k'_{sawdust} \times \rho_{sawdust,PJ,y} \times \frac{(100 - W_{sawdust,PJ,y})}{100} \times 10^{-3}, \quad \text{(B.1-16)}$$

where $k'_{sawdust}$ is the factor for conversion of bulk cubic meters of sawdust to dense cubic meters, dense m^3/bulk m^3;

$\rho_{sawdust,PJ,y}$ is the average density of sawdust under the project during the year *y*, kg/dense m^3;

$W_{sawdust,PJ,y}$ is the average moisture content of sawdust under the project during the year *y*, %.

The average density of sawdust under the project during the year *y* according to [R9] is determined as follows:

$$\rho_{sawdust,PJ,y} = 0.823 \times \frac{100}{(100 - W_{sawdust,PJ,y})} \times \rho_{12,sawdust}, \quad \text{(B.1-17)}$$

where $\rho_{12,sawdust}$ is the average density of sawdust at standard moisture content of 12%, kg/dense m^3.

By inserting the formula (B.1-17) into the formula (B.1-16), we get the following:

$$k_{sawdust} = 0.823 \times k'_{sawdust} \times \rho_{12,sawdust} \times 10^{-3}. \quad \text{(B.1-18)}$$

Application of the chosen approach for the baseline scenario

All necessary parameters of the baseline scenario were calculated following the above mentioned methodology and taking into account actual project data. The calculation results for the period 2008-2012 are given in Annex 2-1.

In our estimation the monthly average temperatures in the supply ($t_{new\_HP,SP,i}$) and return ($t_{new\_HP,RP,i}$) pipelines running from the new boiler house to the point of connection with the existing district heating network, and also the length of operation of the heat network were assumed as per the temperature chart for heat load control[9]. Monthly average temperatures of the outside air ($t_{outside\_air,i}$) were assumed as per SNiP (Construction Standards and Rules) "Construction Climatology" [R5]. Accurate values will be established in the course of monitoring.

[8] d.m.– dry matter

[9] Annex to Contract No.15/2008 dated 07.07.2008 for heat supply.

Those key parameters that were assumed as constants under the baseline scenario are described in the table below.

Data / Parameter:	β_{old_HP}
Data unit:	-
Description:	Factor of local heat losses for the old heat pipeline
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, paragraph 11.3.3. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	1.15
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default for pipelines measuring in diameter 150 mm and higher
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	L_{old_HP}
Data unit:	m
Description:	Length of the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The owner of the heat network
Value of data applied:	6 650
Justification of the choice of data or description of measurement methods and procedures applied:	The length of the heat pipeline was determined based on the scheme of the district heating network of the settlement
QA/QC procedures (to be) applied	Determined on the basis of the heat network scheme
Any comment:	-

Data / Parameter:	$q^{standard}_{old\_HP,SP}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, Annex 1, Table 1.2. Approved by the order of the Ministry of Energy of the Russia Federation dated December

	30, 2008 No.325.
Value of data applied:	477.9
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the supply pipeline is 600 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the supply pipeline is 54.8 °C). Value of data was determined using the following equation of linear regression: $q_{old\_HP,SP}^{standard} = 4.187 \times (1.14 \times (t_{old\_HP,SP} - t_{outside\_air}) + 52.7)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 104 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 70 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 133 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 160 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 120 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 190 kcal/(m*h).
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter:	$t_{old\_HP,SP}$
Data unit:	°C
Description:	Average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	54.8
Justification of the choice of data or description of measurement methods and procedures applied:	Average annual value is determined as per the temperature chart for heat load control
QA/QC procedures (to be) applied	Determined on the basis of the heat supply contract
Any comment:	-

Data / Parameter:	$q_{old\_HP,RP}^{standard}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network

Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, Annex 1, Table 1.2. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	430.7
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the return pipeline is 600 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the return pipeline is 44.9 °C). Value of data was determined using the following equation of linear regression: $q_{old\_HP,RP}^{standard} = 4.187 \times (1.14 \times (t_{old\_HP,RP} - t_{outside\_air}) + 52.7)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 104 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 70 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 133 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 160 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 120 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 190 kcal/(m*h).
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter:	$t_{old\_HP,RP}$
Data unit:	°C
Description:	Average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	44.9
Justification of the choice of data or description of measurement methods and procedures applied:	Average annual value is determined as per the temperature chart for heat load control
QA/QC procedures (to be) applied	Determined on the basis of the heat supply contract
Any comment:	-

Data / Parameter:	η_{HWB,old_BH}

Data unit:	-
Description:	Efficiency factor of the hot water boilers of the old boiler house
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Reference Book on Small Boiler Units/Edited by K.F.Roddatis. M.: Energoatomizdat, 1989
Value of data applied:	0.87
Justification of the choice of data or description of measurement methods and procedures applied:	The rated value for the hot water boilers installed in the old boiler house
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	q_{old_BH}
Data unit:	-
Description:	Proportion of heat used for auxiliary needs of the old boiler house
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The methodology for determination of fuel, electricity and water demand for production and delivery of heat and heat carriers in the public heating systems. MDK 4-05.2004. Moscow, 2004
Value of data applied:	0.0351
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value for boiler houses running on liquid fuel
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	SEC_{HG,old_BH}
Data unit:	MWh/GJ
Description:	Specific electricity consumption for generation of 1 GJ of heat in the old boiler house
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	E.F.Buznikov, Industrial and Heat Supply Boiler Houses. – M.: Energoatomizdat, 1984
Value of data applied:	0.00597
Justification of the choice of data or description of measurement methods and procedures applied:	Conservative value for heating industrial boiler houses running on residual fuel oil with open heat supply system
QA/QC procedures (to	Determined on the basis of reference data

be) applied	
Any comment:	-

Data / Parameter:	$k_{sawdust}$
Data unit:	t d.m./bulk m^3
Description:	Factor for conversion of bulk cubic meters of sawdust to tonnes of dry matter
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Calculation based on physical properties of sawdust
Value of data applied:	0.0879
Justification of the choice of data or description of measurement methods and procedures applied:	The factor was determined using the methodology [R9].
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	$k'_{sawdust}$
Data unit:	dense m^3/bulk m^3
Description:	Factor for conversion of bulk cubic meters of sawdust to dense cubic meters
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	S.I.Golovkov. Wood Waste-To-Energy. – M.: Forest Industry, 1987
Value of data applied:	0.24
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value for large-size loose sawdust
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	$\rho_{12,sawdust}$
Data unit:	kg/dense m^3
Description:	Average density of sawdust at standard moisture content of 12%
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Reference Book on Wood Drying/Edited by E.S.Bogdanov. – 4th Edition, revised and supplemented. – M.: Forest Industry, 1990
Value of data applied:	445
Justification of the choice of data or description of measurement methods and procedures applied:	Softwood (pine and spruce) sawdust is fired in the new boiler house. Average density is assumed equal to the average density of sawdust produced from spruce, because it has the lowest value.
QA/QC procedures (to	Determined on the basis of reference data

be) applied	
Any comment:	-

Data / Parameter:	$EF_{CO2,RFO}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor for residual fuel oil combustion
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, Table 2.2.
Value of data applied:	0.0774
Justification of the choice of data or description of measurement methods and procedures applied:	Default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	$w_{lignin,WW}$
Data unit:	-
Description:	Lignin fraction of C for the wood waste
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.25
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	k_{WW}
Data unit:	year^{-1}
Description:	Decomposition rate constant for the wood waste
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.046
Justification of the choice of data or description of measurement methods and procedures	Formula evaluation: $k_{WW} = \ln(1/2)/15$

applied:	
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	15 is the recommended default value for half-life of wood, year

Data / Parameter:	C_{WW}^{db}
Data unit:	%
Description:	Organic carbon content in the wood waste on dry basis
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	50
Justification of the choice of data or description of measurement methods and procedures applied:	The default value proposed for wood waste is 53.6%. We adopted a more conservative value: 50%.
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	a
Data unit:	m^3/kg carbon
Description:	Conversion factor from kg carbon to landfill gas quantity
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	1.87
Justification of the choice of data or description of measurement methods and procedures applied:	Formula evaluation: $a = 22.4/12$
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	22.4 is molar volume of gas at normal conditions, l/mol; 12 is molar mass of C, g/mol.

Data / Parameter:	ζ
Data unit:	-
Description:	Generation factor
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.77
Justification of the choice of data or	Recommended default value

description of measurement methods and procedures applied:	
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	φ
Data unit:	%
Description:	Percentage of the stockpile under aerobic conditions
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	10
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	ζ_{OX}
Data unit:	-
Description:	Methane oxidation factor
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.10
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	V_m
Data unit:	%
Description:	Methane concentration biogas
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	60

Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

Data / Parameter:	ρ_{CH4}
Data unit:	kg/m^3
Description:	Density of methane
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.714
Justification of the choice of data or description of measurement methods and procedures applied:	Formula evaluation: $\rho_{CH4} = 16/22.4$
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	16 is molar mass of CH_4, g/mol; 22.4 is molar volume of gas at normal conditions, l/mol.

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of methane
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	21
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	Determined on the basis of reference data
Any comment:	-

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 small-scale project:

The approach defined in the paragraph 2 (a) of the Annex I to the Guidance on criteria for baseline setting and monitoring [R3] has been chosen to demonstrate that the SSC project provides reductions in emissions by sources that are additional to any that would otherwise occur.

Within the bounds of the approach chosen the additionality has been demonstrated using the Analysis of the Project Alternatives, the Investment and the Barrier Analyses, and the Common Practice Analysis.

The Analysis of the Project Alternatives

The alternatives were identified separately for the following two components of the project activity:

- Heat supply of the settlement;
- Use of wood waste.

The following alternatives that can meet the heat demand of the settlement were identified:

Alternative HS1. Continuation of the current situation

Alternative HS2. Construction of a gas-fired boiler house

Alternative HS3. Construction of a coal-fired boiler house

Alternative HS4. The project activity without the joint implementation mechanism

The following alternatives to management of wood waste that is combusted under the project were identified:

Alternative WW1. Continuation of the current situation

Alternative WW2. Use of wood waste for fuel pellet production

Alternative WW3. The project activity without the joint implementation mechanism

Detailed analysis of the project alternatives is given in Section B.1. In summary Alternative HS1 that implies continuation of the current situation was chosen as the most likely baseline scenario for heat supply of the settlement, Alternative WW1 that implies continuation of the current situation was chosen as the most likely baseline scenario for wood waste management.

Thus the baseline scenario envisages continuation of the existing practice of heat supply of the settlement from the old residual fuel oil boiler house owned by OJSC “SBM”. The unused wood waste generated at the local sawmills will be stockpiled at the dumps.

The Investment Analysis

The main economic parameters of the project were compared for the two implementation options:

(a) without selling emission reduction units (ERUs);

(b) with selling emission reduction units.

The values of IRR and NPV were estimated for each option. NPV was chosen as the main benchmark parameter.

The volume of capital investments into the project amounted to around EUR 10 million [R2]. The specified amount was required for implementation of the project in 2007. The project was financed from the internal resources of CJSC “Teplo-Invest”.

The average EUR/RUR exchange rate in 2007 was 35.03 RUR/EUR[10].

The selling price of ERU (2008-2012) was assumed at 15 EUR/t CO_2e.

The time horizon of the analysis is limited to the year 2023 (15 years is the operating life of the main equipment).

The cost of raw stock and resources and the estimated project effects that affect the cash flow were assumed as per the Feasibility Study [R2].

The discount rate was assumed at 11%[11].

Detailed information on the investment analysis of the project is given in Annex 2-3.

Table B.2-1 shows the main economic parameters of the project for the two implementation options.

Table B.2-1. Investments, NPV and IRR

Parameter	Unit	Without selling GHG emission reduction units	With selling GHG emission reduction units
Investments	thousand EUR	9 991	9 991
NPV	thousand EUR	-446	1 820
IRR	%	10.26	14.20

The economic parameters of the project without JI mechanism are unacceptably low (NPV<0). The revenues from selling ERUs amount to around 32% of the total required investments. With these revenues the project becomes more commercially attractive and NPV rises above zero. Moreover, the project becomes less sensitive to risks (see the results of the sensitivity analysis in Table B.2-2).

Table B.2-2. The sensitivity analysis of the main economic parameters of the project

Parameter	Unit	Without selling GHG emission reduction units	With selling GHG emission reduction units
1) Increase of investment costs by 10%			
NPV	thousand EUR	-1 398	868
IRR	%	8.85	12.41
2) Reduction of heat generation by 10%			
NPV	thousand EUR	-1 353	720
IRR	%	8.71	12.29
3) Increase of operating costs by 10%			
NPV	thousand EUR	-1 571	695
IRR	%	8.34	12.26
4) Reduction of the ERU price by 10%			
NPV	thousand EUR	-446	1 593
IRR	%	10.26	13.78

It is important to note that the project is aimed at mitigation of anthropogenic impact upon the environment. The project cannot be implemented within the framework of common commercial practice without selling ERUs.

[10] http://www.cbr.ru/currency_base/dynamics.aspx

[11] The refinance rate of the Central Bank of the Russian Federation as of the beginning of the project implementation http://www.cbr.ru/print.asp?file=/statistics/credit_statistics/refinancing_rates.htm.

The Barrier Analysis

The project faced serious barriers, particularly technological and operational ones.

The technological barriers

Wood waste is a difficult-to-combust fuel because of its high moisture content and non-uniform fractional composition. More complicated and expensive technologies are required for combustion of wood waste compared with natural gas and liquid fuel.

High moisture content of wood waste accounts for its lower calorific value, adiabatic temperature of combustion and stability of burning process and, finally, for the lower overall performance of the boilers. For comparison: the efficiency of hot water boilers running on residual fuel oil and natural gas is 87÷91%, and the efficiency of wood waste fired boilers is 70÷85%.

The fractional composition of wood waste has to be optimum for a given furnace arrangement. Any deviation of the particle size towards the higher or the lower end of the range reduces efficiency of the boiler operation. Very small particles can fall through the fire grate or be carried from the furnace with flue gases even before starting to burn. Large particles, on the other hand, can damage the fuel feed system and impair normal burning conditions in the furnace.

To ensure wood waste feeding to the boilers it is necessary to build a special fuel storage facility with a "travelling" floor.

Because of a high content of mineral admixtures combustion of wood waste produces fly ash and furnace bottom ash, which need to be removed regularly from the furnace and ash collection units and to be disposed to the ash disposal site.

Russian industry does not manufacture boiler units which can ensure efficient combustion of wood waste.[12] In Russian boiler units biomass, as a general rule, is fired using fossil fuel for flame stabilization and the combustion efficiency is low, especially when high-moisture biomass is fired. In foreign boilers (manufactured in Europe and USA) flame stabilization is not used at all even if the moisture content of biomass is high and the efficiency is up to 90%. Also reliability of domestic biomass boilers often is much lower than foreign ones.

The technologies that enable efficient heat production from wood waste are available in the USA and Europe. These are fairly complicated technologies that require installation of state-of-the-art automation and process control systems to ensure stable operation of the boilers. Otherwise there is a risk of boiler breakdown.

CJSC "Teplo-Invest" had never invested in any projects related to construction of wood waste fired boiler houses. OJSC "Mezhregionenergogas" had never built or operated such installations. From the technological point of view the project implementation was a real challenge for the companies.

The operational barriers

OJSC "Mezhregionenergogas" had to overcome certain difficulties not only at the stage of construction, but also at the stage of the boiler house operation. It was necessary to set up and adjust the wood waste supply system, to take on staff, train them and get them obtain certificates for the boiler house operation, which took time and involved certain expenses.

During the first year of operation a number of problems with the fuel feed system were detected. These problems made it necessary to totally replace the system with a new one with a different configuration.

[12] See for example the article "Technological aspects of biofuel combustion" http://www.rosteplo.ru/Tech_stat/stat_shablon.php?id=418.

The project owner does not have its own sources of wood waste. This makes the operation of the new boiler house almost totally dependent on the wood waste supplies from the outside. Any delays or troubles with wood waste supplies from the outside may result in lower quality and reliability of heat supply of the settlement.

The use of energy equipment and technology of such level requires high motivation, moral, skills and knowledge from all technical staff: workers, engineers and managers alike. It should be also noted that a high moisture content and low calorific value of wood waste constitute a problem that calls to constant attention of the maintenance personnel.

The Common Practice Analysis

The common practice of heat supply of small towns and settlements in Russia includes:

1. District heating of consumers from combined heat and power plants (CHPPs).
2. District heating of consumers from district boiler houses.
3. Heat supply from small boiler houses located near the heated buildings and from the boiler rooms located inside the heated buildings.

Heat is produced in boiler houses and CHPPs from fossil fuels (natural gas, coal and residual fuel oil). Wood waste in the district heating systems is used very rarely. One of the reasons for that are the difficulties associated with their combustion (in comparison with fossil fuels) because of very high moisture content and low calorific value of wood waste.

Combustion of wood waste for heat production is common practice for Russian pulp and paper mills and large sawmills that are located close to large cities. Sawmills located in rural areas, as a rule, do not have their own wood waste utilization capacities. Wood waste generated at such sawmills is disposed to the dumps. Disposal of wood waste to the dumps is allowed by the environmental regulations of the Russian Federation.

The common practice of heat supply in small towns and settlements of the Arkhangelsk Region is district heating from boiler houses running chiefly on residual fuel oil and coal.

As of the starting date of the project not a single project that involved switching of settlements' heat supply systems to local biofuel had been implemented in the Arkhangelsk Region.

Only two biofuel boiler house construction projects were implemented in the towns of the Arkhangelsk Region: one at Saw Mill 25 in Arkhangelsk and one in the town of Onega.

Therefore this project is not common practice.

Based on the above, GHG emission reductions generated by this project are additional to those that might have otherwise occurred.

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

Fig. B.3-1 shows the principal components and boundaries of the project, as well as the fuel, heat and electricity flows.

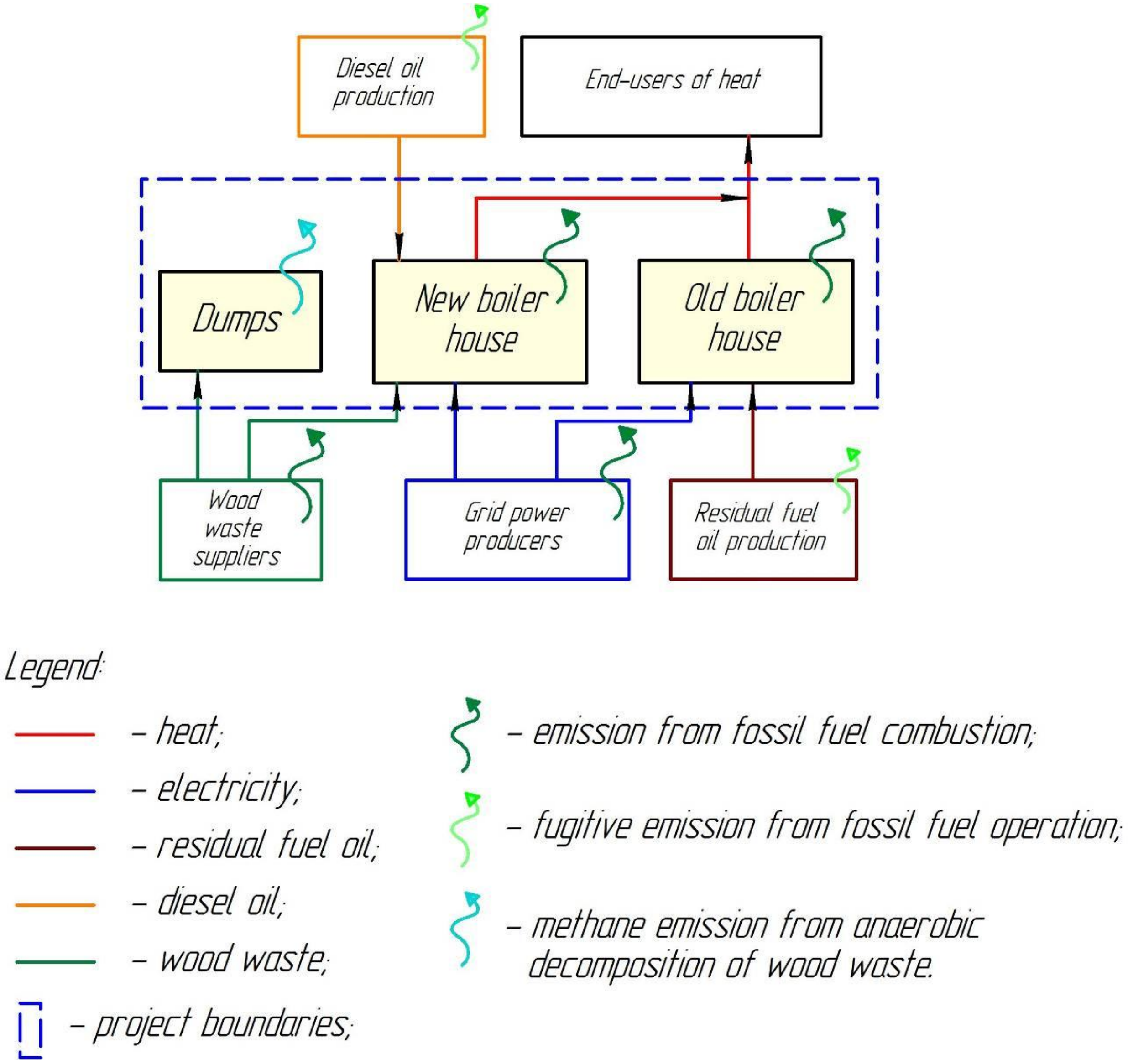

Fig. B.3-1. Main project components and boundaries

Table B.3-1 indicates the sources of emissions included in and excluded from the boundaries of the project and baseline scenarios.

Table B.3-1. The sources of emissions included in and excluded from consideration

	Source	Gas	Incl./Excl.	Justification / explanation
Baseline	Old boiler house, combustion of residual fuel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small. This is conservative
		N_2O	Excl.	Considered negligibly small. This is conservative
	Grid power producers, combustion of fossil fuel	CO_2	Excl.	Considered negligibly small*
		CH_4	Excl.	Considered negligibly small. This is conservative
		N_2O	Excl.	Considered negligibly small. This is conservative
	Wood waste dumps, anaerobic decomposition of wood waste	CO_2	Excl.	Considered equal to zero
		CH_4	**Incl.**	**Main emission source**
		N_2O	Excl.	Considered negligibly small. This is conservative
Project activity	New boiler house, combustion of wood waste	CO_2	Excl.	CO_2 emissions from combustion of biomass are considered to be climatically neutral
		CH_4	Excl.	Considered negligibly small and is completely offset by reduction of fugitive methane emissions related to use of residual fuel oil in the old boiler house*
		N_2O	Excl.	Considered negligibly small and is completely offset by reduction of fugitive methane emissions related to use of residual fuel oil in the old boiler house*
	New boiler house, combustion of diesel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small
	Grid power producers, combustion of fossil fuel	CO_2	Excl.	Considered negligibly small and is completely offset by reduction of fugitive methane emissions related to use of residual fuel oil in the old boiler house*
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small
Leakages	Reduction in production, processing, storage, transportation and distribution of fossil fuel	CO_2	Excl.	Considered negligibly small. This is conservative
		CH_4	Excl.	Neglected because the owner cannot monitor this parameter. This is conservative*
		N_2O	Excl.	Considered negligibly small. This is conservative
	Wood waste supplies from the outside	CO_2	Excl.	Considered negligibly small and is completely offset by reduction of fugitive methane emissions related to use of residual fuel oil in the old boiler house*
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small

* The significance of the excluded sources is estimated in terms of numbers below

Reduction in production, processing, storage, transportation and distribution of oil and oil products

The consumption of residual fuel oil in the old boiler house will reduce by 330 570 GJ/year as a result of the project.

Table B.3-2 shows the factors for fugitive CH_4 upstream emissions related to use of oil and oil products specified for developing countries and countries with economies in transition according to 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R11], Volume 2, Chapter 4, Table 4.2.5.

The factor of fugitive CH_4 upstream emissions related to use of residual fuel oil is assumed equal to 0.0300 t CH_4/m^3.

For the estimation purposes the density of residual fuel oil according to Table 2.8 of Reference Book on Small Boiler Units [R6] is assumed at 1.015 t/m^3, and the net calorific value of residual fuel oil according to 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R11], Volume 2, Chapter 1, Table 1.2 – at 40.4 GJ/t. The reduction of fugitive methane emissions related to use of residual fuel oil in the old boiler house would amount to $330\,570/40.4\times0.03/1.015\times21 = 5\,079$ t CO_2e/year.

Table B.3-2. Factors for fugitive CH_4 upstream emissions related to use of oil and oil products

Category	Subcategory	CH_4			Unit
		Minimum value	Maximum value	Average value	
Oil production	Fugitives	0.0022	0.037	0.0196	t CH_4/m^3
	Venting	0.0087	0.012	0.01035	t CH_4/m^3
	Flaring	0.000021	0.000029	0.000025	t CH_4/m^3
Oil transportation	All	0.000025	0.000025	0.000025	t CH_4/m^3
Oil processing	All	N/A*	N/A	N/A	t CH_4/m^3
Storage of oil and oil products	All	N/A	N/A	N/A	t CH_4/m^3
Total	-	**0.0109**	**0.0491**	**0.0300**	t CH_4/m^3

*data not available

The reductions of methane emissions related to production, transportation, processing and storage of oil and oil products amount to around 15% of the annual reduction of GHG emissions. However from conservative point of view and due to impossibility of their monitoring, these leakages are neglected both at the projection stage and at the stage of monitoring.

Increase of electricity consumption from the external power grid

Electricity consumption from the external power grid will increase by 2 649 MWh/year[13] as a result of the project.

According to Operational Guidelines for Project Design Documents of Joint Implementation Projects [R13], Table B2, the CO_2 emission factors for electricity consumed from the grid in Russia depending on the year under consideration are assumed equal to: 2008 – 0.565 t CO_2e/MWh, 2009 – 0.557 t CO_2e/MWh, 2010 – 0.550 t CO_2e/MWh, 2011 – 0.542 t CO_2e/MWh, 2012 – 0.534 t CO_2e/MWh.

It should be noted that according to the 2008 annual report[14] of JSC "Territorial generating company #2", p.7, "Arkhangelsk power grid has a surplus of existing generating capacities. The existing net

[13] This value was determined by subtraction of the electricity consumption in the old boiler house for generation of heat supplied to end-users of the settlement (Annex 2-1) from the electricity consumption for auxiliary needs of the new boiler house (Table B.1-4).

power flow from Vologda power grid is due to economic factors – the high generating cost because power generation relies on heavy fuel oil".

Thus any increment of electricity consumption in Arkhangelsk region will be covered rather with supply from Central European part of Russia where electricity generation is based on natural gas. Under the circumstances the electricity grid emission factor of 0.557 tCO_2e/MWh or so can be used for estimation.

The increase of greenhouse gas emissions form combustion of fossil fuels at grid power plants will amount to around 2 649×0.557 = 1 476 t CO_2e/year.

The increase of greenhouse gas emissions form additional generation of grid electricity is marginal and is fully offset by reduction of fugitive methane emissions related to consumption of residual fuel oil in the old boiler house.

Increase of wood waste supplies

It is expected that wood waste supplies to the new boiler house will amount to around 230 thousand bulk m^3 per year. Wood waste will be delivered by motor transport from less than 100 km away. Therefore one trip is a 200 km haul. It is assumed that the most typical Russian truck-tractor MAZ with a semitrailer will transport 30 bulk m^3, using around 40 liters of diesel oil per 100 km. Thus, the total consumption of diesel oil in one year will amount to 230 000/30×200/100×40 = 613 333 l/year.

According to Table 3 of WRI 2008 [R14] the net calorific value and the emission factor for diesel oil can be assumed at 0.0371 GJ/l and 74.01 kg CO_2e/GJ, respectively. The annual increase of GHG emissions will amount to 613.333×0.0371×74.01 = 1 684 t CO_2e/year.

The growth of GHG emissions due to increase of wood waste supplies is marginal and is fully offset by reduction of methane emissions related to use of residual fuel oil.

Increase of wood waste combustion

It is expected that wood waste combustion in the new boiler house will amount to around 230 thousand bulk m^3 per year (418 600 GJ)[15].

According to 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R11], Volume 2, Chapter 2, Table 2.2 the CH_4 emission factor for wood waste combustion is equal to 0.030 kg CH_4/GJ, the N_2O emission factor – 0.004 kg N_2O/GJ. CO_2 emissions from combustion of biomass are considered to be climatically neutral. The annual increase of GHG emissions will amount to 418 600×(0.030×21+0.004×310)×0.001 = 783 t CO_2e/year.

The growth of GHG emissions due to increase of wood waste combustion is marginal and is fully offset by reduction of methane emissions related to use of residual fuel oil.

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

The date of baseline setting: 10/07/2009

Baseline was developed by CCGS LLC (CCGS LLC is not the project participant listed in Annex 1 of the PDD).

Contact person: Ilya Goryashin

E-mail: i.goryashin@ccgs.ru

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[14] http://www.tgc-2.ru/invest/documents/areport-2008.pdf

[15] According to the design data [R1] the net calorific value of wood waste is 1.82 GJ/bulk m^3.

SECTION C. Duration of the small-scale project / crediting period

C.1. Starting date of the small-scale project:

December 13, 2006 (the date of the investment contract for the boiler house construction)

C.2. Expected operational lifetime of the small-scale project:

15 years/180 months (the service life of the main equipment)

C.3. Length of the crediting period:

Length of the crediting period is 4.42 years/53 months (from the 1st of August 2008 till the 31st of December 2012)

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The PDD developer has chosen JI specific approach for monitoring in accordance with paragraph 9 (a) of the Guidance on criteria for baseline setting and monitoring [R3].

All data (to be recorded in any case) required for estimation of GHG emission reduction are collected in compliance with the highest sectoral standards and best practice of fuel and energy monitoring and environmental impact assessment.

The information on the environmental impact of the project will be collected and archived in compliance with the Russian regulations. The enterprise has reporting obligations as per the statistic form 2-tp (air) Data on Atmospheric Air containing information on the quantities of trapped and destroyed air pollutants, detailed emissions of specific pollutants, number of emission sources, emission reduction actions and emissions from separate groups of pollutant sources.

The GHG emission reductions during the year *y*, t CO_2e:

$$ER_y = BE_y - PE_y \quad \text{(D.1-1)}$$

where PE_y is the total project emissions of GHG during the year *y*, t CO_2e;

$$PE_y = PE_{diesel\_oil,y}, \quad \text{(D.1-2)}$$

where $PE_{diesel\_oil,y}$ is the project emissions of CO_2 from combustion of diesel oil in the new boiler house during the year *y*, t CO_2e;

$$PE_{diesel\_oil,y} = FC^{v}_{diesel\_oil,new\_BH,y} \times NCV_{diesel\_oil} \times EF_{CO2,diesel\_oil}, \quad \text{(D.1-3)}$$

where $FC^{v}_{diesel\_oil,new\_BH,y}$ is the volumetric diesel oil consumption in the new boiler house during the year *y*, l;

NCV_{diesel_oil} is the net calorific value of diesel oil, GJ/l;

$EF_{CO2,diesel\_oil}$ is the CO_2 emission factor for diesel oil combustion, t CO_2e/GJ.

BE_y is the total baseline emissions of GHG during the year *y*, t CO_2e;

$$BE_y = BE_{RFO,y} + BE_{WW,dump,y}, \quad \text{(D.1-4)}$$

where $BE_{RFO,y}$ is the baseline emissions of CO_2 from combustion of residual fuel oil in the old boiler house for generation of heat supplied to end-users of the settlement during the year *y*, t CO_2e;

$$BE_{RFO,y} = FC^{settlement}_{RFO,old\_BH,BL,y} \times EF_{CO2,RFO}, \quad \text{(D.1-5)}$$

where $FC^{settlement}_{RFO,old\_BH,BL,y}$ is the quantity of residual fuel oil fired in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y*, GJ;

$$FC^{settlement}_{RFO,old\_BH,BL,y} = \frac{HS^{settlement}_{old\_BH,BL,y}}{\eta_{HWB,old\_BH} \times \left(1 - q_{old\_BH}\right)}, \quad \text{(D.1-6)}$$

where $HS^{settlement}_{old\_BH,BL,y}$ is the heat supply from the collectors of the old boiler house to meet the heat demand of the settlement under the baseline scenario during the year *y*, GJ;

$$HS^{settlement}_{old\_BH,BL,y} = HS_{BL,y} + HL_{old\_HP,BL,y}, \quad \text{(D.1-7)}$$

where $HS_{BL,y}$ is the heat supplied to end-users of the settlement under the baseline scenario during the year *y*, GJ;

$$HS_{BL,y} = HS_{PJ,y}, \quad \text{(D.1-8)}$$

where $HS_{PJ,y}$ is the heat supply to end-users of the settlement under the project during the year *y*, GJ;

$$HS_{PJ,y} = HS_{new\_BH,y} - HL_{new\_HP,y}, \quad \text{(D.1-9)}$$

where $HS_{new\_BH,y}$ is the heat supply from the collectors of the new boiler house during the year *y*, GJ;

$HL_{new\_HP,y}$ is the heat losses in the heat pipeline section running from the new boiler house to the point of connection with the existing district heating network during the year *y*, GJ;

$$HL_{new\_HP,y} = HL_{new\_HP,SP,y}^{standard} + HL_{new\_HP,RP,y}^{standard}, \quad (D.1-10)$$

where $HL_{new\_HP,SP,y}^{standard}$ is the standard heat losses in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network during the year *y*, GJ;

$$HL_{new\_HP,SP,y}^{standard} = \beta_{new\_HP} \times L_{new\_HP,SP} \times \frac{q_{new\_HP,SP}^{standard}}{10^6} \times \sum_i \left(\frac{\left(t_{new\_HP,SP,i} - t_{outside\_air,i}\right)}{t_{new\_HP,SP} - 5} \times z_i \right), \quad (D.1-11)$$

where β_{new_HP} is the factor of local heat losses for the new heat pipeline;

$L_{new\_HP,SP}$ is the length of the supply pipeline section running from the new boiler house to the point of connection with the existing district heating network, m;

$q_{new\_HP,SP}^{standard}$ is the standard specific heat losses in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network, kJ/(m*h);

$t_{new\_HP,SP,i}$ is the average temperature in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*, °C;

$t_{outside\_air,i}$ is the average temperature of the outside air over the month *i*, °C;

$t_{new\_HP,SP}$ is the average temperature in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network over the year, °C;

5 is the average annual rated temperature of the outside air, °C;

z_i is the length of operation of the heat network during the month *i*, h.

$HL^{standard}_{new\_HP,RP,y}$ is the standard heat losses in the return pipeline running from the new boiler house to the point of connection with the existing district heating network during the year *y*, GJ;

$$HL^{standard}_{new\_HP,RP,y} = \beta_{new\_HP} \times L_{new\_HP,RP} \times \frac{q^{standard}_{new\_HP,RP}}{10^6} \times \sum_i \left(\frac{\left(t_{new\_HP,RP,i} - t_{outside\_air,i}\right)}{t_{new\_HP,RP} - 5} \times z_i \right), \quad \text{(D.1-12)}$$

where $L_{new\_HP,RP}$ is the length of the return pipeline section running from the new boiler house to the point of connection with the existing district heating network, m;

$q^{standard}_{new\_HP,RP}$ is the standard specific heat losses in the return pipeline running from the new boiler house to the point of connection with the existing district heating network, kJ/(m*h);

$t_{new\_HP,RP,i}$ is the average temperature in the return pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*, °C;

$t_{new\_HP,RP}$ is the average temperature in the return pipeline running from the new boiler house to the point of connection with the existing district heating network over the year, °C.

$HL_{old\_HP,BL,y}$ is the heat losses in the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ;

$$HL_{old\_HP,BL,y} = HL^{standard}_{old\_HP,SP,BL,y} + HL^{standard}_{old\_HP,RP,BL,y}, \quad \text{(D.1-13)}$$

where $HL^{standard}_{old\_HP,SP,BL,y}$ is the standard heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ;

$$HL^{standard}_{old\_HP,SP,BL,y} = \beta_{old\_HP} \times L_{old\_HP} \times \frac{q^{standard}_{old\_HP,SP}}{10^6} \times \sum_i \left(\frac{\left(t_{old\_HP,SP,i} - t_{outside\_air,i}\right)}{t_{old\_HP,SP} - 5} \times z_i \right), \quad \text{(D.1-14)}$$

where β_{old_HP} is the factor of local heat losses for the old heat pipeline;

L_{old_HP} is the length of the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, m;

$q^{standard}_{old\_HP,SP}$ is the standard specific heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, kJ/(m*h);

$t_{old\_HP,SP,i}$ is the average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the month *i*, °C;

$$t_{old\_HP,SP,i} = t_{new\_HP,SP,i} . \quad \text{(D.1-15)}$$

$t_{old\_HP,SP}$ is the average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year, °C.

$HL^{standard}_{old\_HP,RP,BL,y}$ is the standard heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network under the baseline scenario during the year *y*, GJ;

$$HL^{standard}_{old\_HP,RP,BL,y} = \beta_{old\_HP} \times L_{old\_HP} \times \frac{q^{standard}_{old\_HP,RP}}{10^6} \times \sum_i \left(\frac{\left(t_{old\_HP,RP,i} - t_{outside\_air,i}\right)}{t_{old\_HP,RP} - 5} \times z_i \right), \quad \text{(D.1-16)}$$

where $q_{old\_HP,RP}^{standard}$ is the standard specific heat losses in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network, kJ/(m*h);

$t_{old\_HP,RP,i}$ is the average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the month i, °C;

$$t_{old\_HP,RP,i} = t_{new\_HP,RP,i} . \quad \text{(D.1-17)}$$

$t_{old\_HP,RP}$ is the average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year, °C.

η_{HWB,old_BH} is the efficiency factor of the hot water boilers of the old boiler house;

q_{old_BH} is the proportion of heat used for auxiliary needs of the old boiler house.

$EF_{CO2,RFO}$ is the CO_2 emission factor for residual fuel oil combustion, t CO_2e/GJ.

$BE_{WW,dump,y}$ is the baseline emissions of CH_4 from decomposition of wood waste at the dumps during the year y, t CO_2e;

The numerical value of $BE_{WW,dump,y}$ is determined using the model *"Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles"* developed by *"BTG biomass technology group B.V."* based on [R12] (See Section E.4 and Annex 2-2).

$$BE_{WW,dump,y} = \left(1 - w_{lignin,WW}\right) \times k_{WW} \times \frac{C_{WW}^{db}}{100} \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \rho_{CH4} \times GWP_{CH4} \times \sum_{x=2008}^{x=y} \left(WW_{dump,BL,x}^{dry} \times e^{-k_{WW}(y-x)}\right), \quad \text{(D.1-18)}$$

where $WW_{dump,BL,x}^{dry}$ is the wood waste disposal to the dumps under the baseline scenario during the year x, t d.m.;

$$WW_{dump,BL,x}^{dry} = FC_{sawdust,new\_BH,x}^{v} \times k_{sawdust} , \quad \text{(D.1-19)}$$

where $FC^{v}_{sawdust,new\_BH,x}$ is the volumetric sawdust consumption in the new boiler house during the year x, bulk m^3;

$k_{sawdust}$ is the factor for conversion of bulk cubic meters of sawdust to tonnes of dry matter, t d.m./ bulk m^3.

$w_{lignin,WW}$ is the lignin fraction of C for the wood waste;

k_{WW} is the decomposition rate constant for the wood waste, $year^{-1}$;

C^{db}_{WW} is the organic carbon content in the wood waste on dry basis, %;

a is the conversion factor from kg carbon to landfill gas quantity, m^3/kg carbon;

ζ is the generation factor;

φ is the percentage of the stockpile under aerobic conditions, %;

ζ_{OX} is the methane oxidation factor;

V_m is the methane concentration biogas, %;

ρ_{CH4} is the density of methane, kg/m^3;

GWP_{CH4} is the global warming potential of methane, t CO_2e/t CH_4;

y is the year for which to calculate the CO_2-equivalent reduction, year;

x is the year in which fresh biomass is utilized instead of stockpiled, year.

The calculation of methane emissions for each year *y* uses data on sawdust disposal to the dumps starting from 2008.

D.2. Data to be monitored:

Data and parameter subject to monitoring during the crediting period:

Data / Parameter 1:	$FC^{v}_{diesel\_oil,new\_BH,y}$
Data unit:	l
Description:	Volumetric diesel oil consumption in the new boiler house during the year *y*
Time of determination:	Continuously
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the flow meters installed at the supply and return lines feeding diesel fuel to the boilers
QA/QC procedures (to be) applied	Flow meters for diesel oil are regularly calibrated. Readings of the flow meters are cross-checked with readings of the level gauges in the diesel oil tanks.
Any comment:	-

Data / Parameter 2:	$HS_{new\_BH,y}$
Data unit:	GJ
Description:	Heat supply from the collectors of the new boiler house during the year *y*
Time of determination:	Continuously
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the heat meters
QA/QC procedures (to be) applied	Heat meters are regularly calibrated; readings are cross-checked with the balance data
Any comment:	-

Data / Parameter 3:	$t_{new\_HP,SP,i}$
Data unit:	°C
Description:	Average temperature in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*
Time of determination:	Continuously
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the heat meter
QA/QC procedures (to be) applied	Temperature gauge is regularly calibrated

Any comment:	Average value is determined at the end of the month *i*

Data / Parameter 4:	$t_{outside\_air,i}$
Data unit:	°C
Description:	Average temperature of the outside air over the month *i*
Time of determination:	Four times per day
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the temperature gauge installed at the external wall of the boiler house
QA/QC procedures (to be) applied	Temperature gauge is regularly calibrated
Any comment:	Average value is determined at the end of the month *i*

Data / Parameter 5:	z_i
Data unit:	h
Description:	Length of operation of the heat network during the month *i*
Time of determination:	Continuously
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the heat meter
QA/QC procedures (to be) applied	Heat meter is regularly calibrated
Any comment:	-

Data / Parameter 6:	$t_{new\_HP,RP,i}$
Data unit:	°C
Description:	Average temperature in the return pipeline running from the new boiler house to the point of connection with the existing district heating network over the month *i*
Time of determination:	Continuously
Source of data used:	The Department of Chief Power Engineer
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of readings of the heat meter
QA/QC procedures (to be) applied	Temperature gauge is regularly calibrated
Any comment:	Average value is determined at the end of the month *i*

Data / Parameter 7:	$FC^{v}_{sawdust,new\_BH,x}$
Data unit:	bulk m^3
Description:	Volumetric sawdust consumption in the new boiler house during the year *x*
Time of determination:	Continuously
Source of data used:	The Economics Department
Justification of the choice of data or description of measurement methods and procedures applied:	Determined on the basis of the number of loader scoops
QA/QC procedures (to be) applied	Sawdust consumption in the new boiler house is measured by the number of scoops of the wood waste loader and is cross-checked with the data of the facility for wood waste delivery from the outside.
Any comment:	-

Data and parameters assumed as constants for the crediting period:

Data / Parameter 8:	NCV_{diesel_oil}
Data unit:	GJ/l
Description:	Net calorific value of diesel oil
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	WRI 2008 [R14], Table 3
Value of data applied:	0.0371
Justification of the choice of data or description of measurement methods and procedures applied:	Default value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 9:	$EF_{CO2,diesel\_oil}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor for diesel oil combustion
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, Table 2.2.
Value of data applied:	0.0741
Justification of the choice of data or description of measurement methods and procedures applied:	Default value
QA/QC procedures (to	-

be) applied	
Any comment:	-

Data / Parameter 10:	β_{new_HP}
Data unit:	-
Description:	Factor of local heat losses for the new heat pipeline
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, paragraph 11.3.3. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	1.15
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default for pipelines measuring in diameter 150 mm and higher
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 11:	$L_{new\_HP,SP}$
Data unit:	m
Description:	Length of the supply pipeline section running from the new boiler house to the point of connection with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The owner of the heat network
Value of data applied:	512
Justification of the choice of data or description of measurement methods and procedures applied:	The length of the heat network was determined on the basis of the design documents
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 12:	$q_{new\_HP,SP}^{standard}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, Annex 4, Table 4.1. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	194.6

Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the supply pipeline is 400 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the supply pipeline is 54.8 °C). Value of data was determined using the following equation of linear regression: $q_{new\_HP,SP}^{standard} = 4.187 \times (0.6051 \times (t_{new\_HP,SP} - t_{outside\_air}) + 13.867)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 15 °C; standard specific heat losses is 22 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses is 42 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses is 72 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 145 °C; standard specific heat losses is 101 kcal/(m*h).
QA/QC procedures (to be) applied	-
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter 13:	$t_{new\_HP,SP}$
Data unit:	°C
Description:	Average temperature in the supply pipeline running from the new boiler house to the point of connection with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	54.8
Justification of the choice of data or description of measurement methods and procedures applied:	Average annual value is determined as per the temperature chart for heat load control
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 14:	$L_{new\_HP,RP}$
Data unit:	m
Description:	Length of the return pipeline section running from the new boiler house to the point of connection with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The owner of the heat network
Value of data applied:	514
Justification of the choice of data or description of measurement methods	The length of the heat network was determined on the basis of the design documents

and procedures applied:	
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 15:	$q_{new\_HP,RP}^{standard}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the return pipeline running from the new boiler house to the point of connection with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, Annex 4, Table 4.1. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	169.5
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the return pipeline is 400 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the return pipeline is 44.9 °C). Value of data was determined using the following equation of linear regression: $q_{new\_HP,RP}^{standard} = 4.187 \times (0.6051 \times (t_{new\_HP,RP} - t_{outside\_air}) + 13.867)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 15 °C; standard specific heat losses is 22 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses is 42 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses is 72 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 145 °C; standard specific heat losses is 101 kcal/(m*h).
QA/QC procedures (to be) applied	-
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter 16:	$t_{new\_HP,RP}$
Data unit:	°C
Description:	Average temperature in the return pipeline running from the new boiler house to the point of connection with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	44.9
Justification of the choice of data or description of measurement methods and procedures	Average annual value is determined as per the temperature chart for heat load control

applied:	
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 17:	β_{old_HP}
Data unit:	-
Description:	Factor of local heat losses for the old heat pipeline
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, paragraph 11.3.3. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	1.15
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default for pipelines measuring in diameter 150 mm and higher
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 18:	L_{old_HP}
Data unit:	m
Description:	Length of the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The owner of the heat network
Value of data applied:	6 650
Justification of the choice of data or description of measurement methods and procedures applied:	The length of the heat pipeline was determined based on the scheme of the district heating network of the settlement
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 19:	$q_{old\_HP,SP}^{standard}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat

	delivery in the Russian Ministry of Energy, Annex 1, Table 1.2. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	477.9
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the supply pipeline is 600 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the supply pipeline is 54.8 °C). Value of data was determined using the following equation of linear regression: $q_{old\_HP,SP}^{standard} = 4.187 \times (1.14 \times (t_{old\_HP,SP} - t_{outside\_air}) + 52.7)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 104 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 70 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 133 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 160 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 120 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 190 kcal/(m*h).
QA/QC procedures (to be) applied	-
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter 20:	$t_{old\_HP,SP}$
Data unit:	°C
Description:	Average temperature in the supply pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	54.8
Justification of the choice of data or description of measurement methods and procedures applied:	Average annual value is determined as per the temperature chart for heat load control
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 21:	$q_{old\_HP,RP}^{standard}$
Data unit:	kJ/(m*h)
Description:	Standard specific heat losses in the return pipeline running from the old boiler

	house to the point where the heat pipeline from the new boiler house connects with the existing district heating network
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Guidelines for calculation and justification of standard process losses for heat delivery in the Russian Ministry of Energy, Annex 1, Table 1.2. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325.
Value of data applied:	430.7
Justification of the choice of data or description of measurement methods and procedures applied:	Assumed on default based on the heat pipeline diameter (passage diameter of the return pipeline is 600 mm), climatological data for the area where the heat pipeline is laid (average annual temperature of the outside air is 0.9 °C) and also based on the temperature chart for heat load control (average annual temperature in the return pipeline is 44.9 °C). Value of data was determined using the following equation of linear regression: $q_{old\_HP,RP}^{standard} = 4.187 \times (1.14 \times (t_{old\_HP,RP} - t_{outside\_air}) + 52.7)$. This formula was determined base on the following reference points: 1. Temperature difference between heat-transfer agent and the outside air is 45 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 104 kcal/(m*h). 2. Temperature difference between heat-transfer agent and the outside air is 70 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 133 kcal/(m*h). 3. Temperature difference between heat-transfer agent and the outside air is 95 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 160 kcal/(m*h). 4. Temperature difference between heat-transfer agent and the outside air is 120 °C; standard specific heat losses for designed temperature of the outside air (5 °C) is 190 kcal/(m*h).
QA/QC procedures (to be) applied	-
Any comment:	4.187 is the factor for conversion of kcal to kJ, kJ/kcal

Data / Parameter 22:	$t_{old\_HP,RP}$
Data unit:	°C
Description:	Average temperature in the return pipeline running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network over the year
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Annex to Contract No.15/2008 dated 07.07.2008 for heat supply
Value of data applied:	44.9
Justification of the choice of data or description of measurement methods and procedures applied:	Average annual value is determined as per the temperature chart for heat load control
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 23:	η_{HWB,old_BH}
Data unit:	-
Description:	Efficiency factor of the hot water boilers of the old boiler house
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Reference Book on Small Boiler Units/Edited by K.F.Roddatis. M.: Energoatomizdat, 1989
Value of data applied:	0.87
Justification of the choice of data or description of measurement methods and procedures applied:	The rated value for the hot water boilers installed in the old boiler house
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 24:	q_{old_BH}
Data unit:	-
Description:	Proportion of heat used for auxiliary needs of the old boiler house
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	The methodology for determination of fuel, electricity and water demand for production and delivery of heat and heat carriers in the public heating systems. MDK 4-05.2004. Moscow, 2004
Value of data applied:	0.0351
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value for boiler houses running on liquid fuel
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 25:	$EF_{CO2,RFO}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor for residual fuel oil combustion
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, Table 2.2.
Value of data applied:	0.0774
Justification of the choice of data or description of measurement methods and procedures applied:	Default value

QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 26:	$k_{sawdust}$
Data unit:	t d.m./bulk m^3
Description:	Factor for conversion of bulk cubic meters of sawdust to tonnes of dry matter
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Calculation based on physical properties of sawdust
Value of data applied:	0.0879
Justification of the choice of data or description of measurement methods and procedures applied:	The factor was determined using the methodology [R9].
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 27:	$w_{lignin,WW}$
Data unit:	-
Description:	Lignin fraction of C for the wood waste
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.25
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 28:	k_{WW}
Data unit:	$year^{-1}$
Description:	Decomposition rate constant for the wood waste
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.046
Justification of the choice of data or description of measurement methods and procedures	Formula evaluation: $k_{WW} = \ln(1/2)/15$

applied:	
QA/QC procedures (to be) applied	-
Any comment:	15 is the recommended default value for half-life of wood, year

Data / Parameter 29:	C_{WW}^{db}
Data unit:	%
Description:	Organic carbon content in the wood waste on dry basis
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	50
Justification of the choice of data or description of measurement methods and procedures applied:	Conservative value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 30:	a
Data unit:	m^3/kg carbon
Description:	Conversion factor from kg carbon to landfill gas quantity
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	1.87
Justification of the choice of data or description of measurement methods and procedures applied:	Formula evaluation: $a = 22.4/12$
QA/QC procedures (to be) applied	-
Any comment:	22.4 is molar volume of gas at normal conditions, l/mol; 12 is molar mass of C, g/mol.

Data / Parameter 31:	ζ
Data unit:	-
Description:	Generation factor
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.77
Justification of the choice of data or	Recommended default value

description of measurement methods and procedures applied:	
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 32:	φ
Data unit:	%
Description:	Percentage of the stockpile under aerobic conditions
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	10
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 33:	ζ_{OX}
Data unit:	-
Description:	Methane oxidation factor
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.10
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 34:	V_m
Data unit:	%
Description:	Methane concentration biogas
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	60

Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	-
Any comment:	-

Data / Parameter 35:	ρ_{CH4}
Data unit:	kg/m^3
Description:	Density of methane
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	0.714
Justification of the choice of data or description of measurement methods and procedures applied:	Formula evaluation: $\rho_{CH4} = 16/22.4$
QA/QC procedures (to be) applied	-
Any comment:	16 is molar mass of CH_4, g/mol; 22.4 is molar volume of gas at normal conditions, l/mol.

Data / Parameter 36:	GWP_{CH4}
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of methane
Time of determination:	Determined once at the stage of the PDD preparation
Source of data used:	Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.
Value of data applied:	21
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended default value
QA/QC procedures (to be) applied	-
Any comment:	-

D.3. 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.
Section D.2 ID 1	low	Flow meters for diesel oil are regularly calibrated. Readings of the flow meters are cross-checked with readings of the level gauges in the diesel oil tanks.
Section D.2 ID 2	low	Heat meters are regularly calibrated; readings are cross-checked with the balance data.
Section D.2 ID 3, 4, 6	low	Temperature gauges are regularly calibrated.
Section D.2 ID 5	low	Heat meter is regularly calibrated.
Section D.2 ID 7	low	Sawdust consumption in the new boiler house is measured by the number of scoops of the wood waste loader and is cross-checked with the data of the facility for wood waste delivery from the outside.

D.4. Brief description of the operational and management structure that will be applied in implementing the monitoring plan:

The following operational and management structure shall be applied:

1. Data and sources

1.1. Volumetric diesel oil consumption in the new boiler house during the year *y* (ID 1) will be determined on the basis of flow meters readings installed on the supply and return lines feeding diesel oil to the boilers. Readings of the flow meters shall be cross-checked with readings of the level gauges in the diesel oil tanks.

1.2. Heat supply from the collectors of the new boiler house during the year *y* (ID 2) shall be determined based on the readings of heat meters. Data on heat supply shall be regularly transferred to the Chief Power Engineer's computer and archived.

1.3. Temperatures in the supply and return pipelines running from the new boiler house to the point of connection with the existing district heating network shall be determined based on the heat meter readings. Temperature data shall be regularly transferred to the Chief Power Engineer's computer and archived. Average temperatures in the supply and return pipelines running from the new boiler house to the point of connection with the existing district heating network over the month *i* (ID 3, 6) shall be determined as average values at the end of the month *i*.

1.4. Outside air temperature shall be determined based on the reading of the temperature gauge mounted on the outer wall of the boiler house. Average temperature of the outside air over the month *i* (ID 4) shall be determined as average value at the end of the month *i*.

1.5. Length of operation of the heat network during the month *i* (ID 5) shall be determined based on the heat meter readings. Data on the length of operation of the heat network shall be regularly transferred to the Chief Power Engineer's computer and archived.

1.6. The quantity of sawdust combusted in the new boiler house will be determined by the number of loader scoops of sawdust fed for combustion. Volumetric sawdust consumption in the new boiler house during the year *x* (ID 7) shall be determined as a cumulative volume of sawdust fed for combustion during the year *x*.

The sources of data for calculation of GHG emission reduction in the course of monitoring during the year *y* shall be the internal reports of the boiler house.

The location of the monitoring points is shown in Fig. D.4-1.

All calculations are made using the formulae given in Section D.1.

2. Monitoring management

2.1. The monitoring team

The personnel of the boiler house underwent necessary training in certified educational institutions. All maintenance personnel have the required qualification and valid permits to operate the main equipment of the boiler house. New employees and personnel who need to confirm their admission group are required to undergo respective training, pass a test and obtain a permission certificate in accordance with the Federal law "On industrial safety of hazardous facilities". The person responsible for the personnel training is the Director of the boiler house. His responsibilities shall include:

a) Collection of training applications.

b) Drawing up training schedules.

c) Concluding contracts for training and submission to the accounting department for payment.

d) Control over training documents.

The maintenance personnel of the boiler house are responsible for daily control over the monitoring plan implementation.

The Director of the boiler house is responsible for timely calibration of all instrumentation in accordance with the manufacturer's requirements.

The management of OJSC "Mezhregionenergogas" is responsible for normal operation of the boiler house equipment, pollutant emissions estimation and for collection of all data required for calculation of GHG emission reductions.

The management of CJSC "Teplo-Invest" is fully responsible for the project implementation and overall control.

The GHG emission reductions shall be calculated every year by specialists of LLC "CCGS" on the basis of data received from OJSC "Mezhregionenergogas". In case of any doubts as to the accuracy of the input data, the specialists of OJSC "Mezhregionenergogas" shall check and correct the data. The preliminary version of the monitoring report shall be submitted to the specialists of OJSC "Mezhregionenergogas" for review. In case any mistakes are found in the calculations of GHG emission reductions, the specialists of LLC "CCGS" shall correct these calculations accordingly.

Regularly, at least once a year, specialists of LLC "CCGS" shall carry out "test verification" with a view to checking out the observance of the monitoring plan at OJSC "Mezhregionenergogas".

2.2. Instrumentation calibration

The instrumentation calibration and check-out shall be carried out by contracted specialized organizations licensed for this type of activity in accordance with the Federal law "On uniformity of measurements".

2.3. Data storage

The maintenance personnel of the boiler house are responsible for daily data collection and archiving according to the internal rules and regulations.

Every day the Chief Power Engineer receives from the heat meters data on daily heat supply, average daily temperatures in the supply and return pipelined running from the new boiler house to the point of connection with the existing district heating and length of operation of the heat network. The received data are entered into special logs. Reports are drawn up on a monthly basis. These logs and reports are submitted to the Economist.

The operator of the loader is responsible for daily control of the volume of sawdust fed for combustion. The received data are entered into special logs. These logs are submitted to the Economist.

The chemical water treatment specialist is responsible for daily control of the outside air temperature. The received data are entered into special logs. These logs are submitted to the Chief Power Engineer and to the Economist.

The Director of the boiler house is responsible for control over consumption of standby diesel oil in the boiler house. The received data are entered into special logs. These logs are submitted to the Economist.

The economist shall summarize the provided data and draw up reports. The reports shall be submitted to the Director of the boiler house.

The data to be monitored and required for determination according to parag.37 of Decision 9/CMP.1 shall be stored for at least 2 years after the last ERU transfer under the project. The data shall be archived in paper and electronic form. The person responsible for data collection and storage is the Economist.

3. Emergency situations

If any instrument that is used in the monitoring process fails, the Instrumentation and Automation Service shall remedy the situation as soon as possible and if necessary shall replace the instrument.

In case of breakdown of any of the boilers, heat generation will go down, and heat supply to end-users shall reduce. In case of any delays and problems with wood waste supplies the boilers shall run on the standby diesel oil. Any variation of fuel consumption or reduction of heat supply as a result of emergency situations will be automatically reordered by the meters.

All accidents that take place in the boiler house shall be recorded by labour safety specialists. Information on major accidents shall be included in the monitoring report.

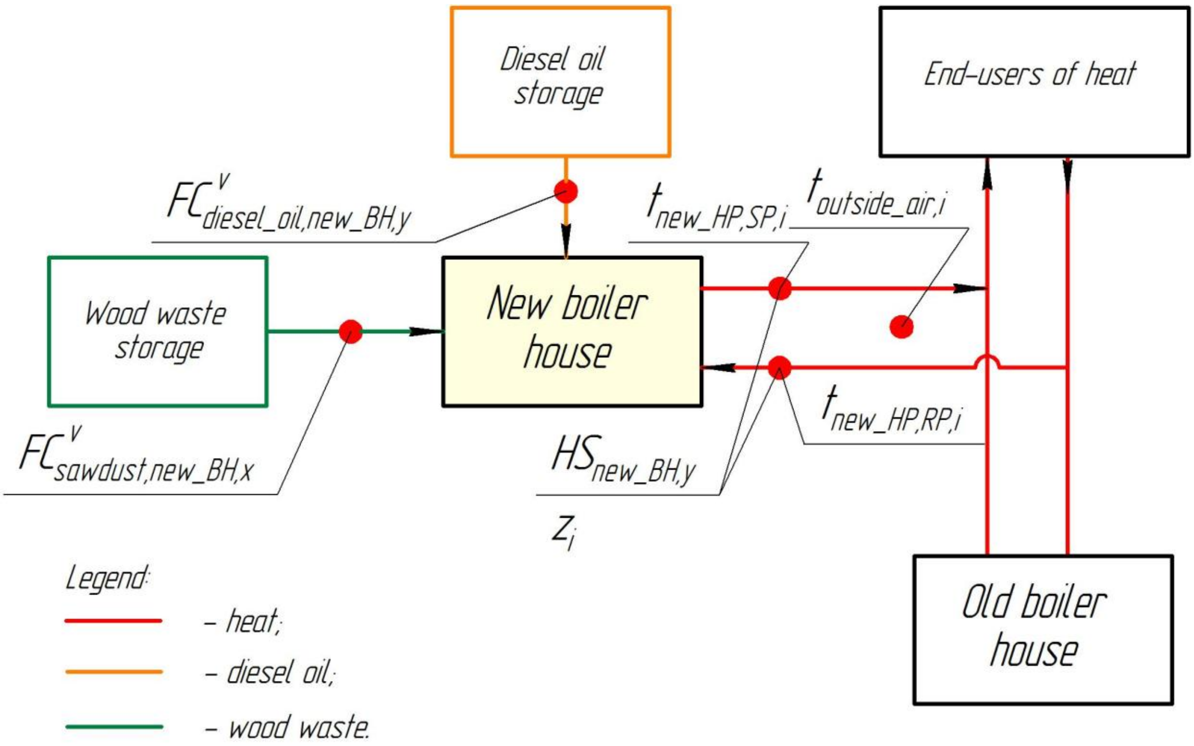

Fig. D.4-1. Location of monitoring points

D.5. Name of person(s)/entity(ies) establishing the monitoring plan:

The monitoring plan was developed by CCGS LLC

Contact person: Ilya Goryashin

E-mail: i.goryashin@ccgs.ru

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions and formulae used in the estimation:

CO_2 emissions from combustion of biomass are considered to be climatically neutral. The emissions of GHG under the project are equal to zero.

E.2. Estimated leakage and formulae used in the estimation, if applicable:

As shown in Section B.3, leakages can be neglected, therefore they are assumed equal to zero.

E.3. Sum of E.1. and E.2.:

Since leakages can be neglected: E.1+E.2=E.1.

E.4. Estimated baseline emissions and formulae used in the estimation:

The total baseline emissions of GHG during the year *y* are determined as follows:

$$BE_y = BE_{RFO,y} + BE_{WW,dump,y}, \qquad \text{(E.4-1)}$$

where BE_y is the total baseline emissions of GHG during the year *y*, t CO_2e;

$BE_{RFO,y}$ is the baseline emissions of CO_2 from combustion of residual fuel oil in the old boiler house for generation of heat supplied to end-users of the settlement during the year *y*, t CO_2e;

$BE_{WW,dump,y}$ is the baseline emissions of CH_4 from decomposition of wood waste at the dumps during the year *y*, t CO_2e.

Emissions of CH_4 and N_2O from combustion of fossil fuel are considered to be negligibly small.

The baseline emissions of CO_2 from combustion of residual fuel oil in the old boiler house for generation of heat supplied to end-users of the settlement during the year *y* are determined as follows:

$$BE_{RFO,y} = FC^{settlement}_{RFO,old\_BH,BL,y} \times EF_{CO2,RFO}, \qquad \text{(E.4-2)}$$

where $FC^{settlement}_{RFO,old\_BH,BL,y}$ is the quantity of residual fuel oil fired in the old boiler house for generation of heat supplied to end-users of the settlement under the baseline scenario during the year *y*, GJ (See Annex 2-1);

$EF_{CO2,RFO}$ is the CO_2 emission factor for residual fuel oil combustion, t CO_2e/GJ.

The CO_2 emission factor is assumed on the basis of 2006 IPCC Guideline for National Greenhouse Gas Inventories [R11], Volume 2, Chapter 2, Table 2.2. For the entire project period it is assumed: $EF_{CO2,RFO}$ = 0.0774 t CO_2e/GJ.

The numerical estimations of avoided methane emissions from anaerobic decomposition of wood waste are made using the model "*Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles*" developed by "*BTG biomass technology group B.V.*" for the World Bank [R12]. The model is built on the *First Order Decay method* with experimental specification of a number of parameters for waste wood dumps.

The baseline emissions of CH_4 from decomposition of wood waste at the dumps during the year *y* are determined as follows:

$$BE_{WW,dump,y} = \left(1 - w_{lignin,WW}\right) \times k_{WW} \times \frac{C_{WW}^{db}}{100} \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \times \rho_{CH4} \times GWP_{CH4} \times \sum_{x=2008}^{x=y} \left(WW_{dump,BL,x}^{dry} \times e^{-k_{WW}(y-x)}\right), \quad \text{(E.4-3)}$$

where $WW_{dump,BL,x}^{dry}$ is the wood waste disposal to the dumps under the baseline scenario (quantity of fresh biomass utilized) during the year *x*, t d.m.[16];

$w_{lignin,WW}$ is the lignin fraction of C for the wood waste;

k_{WW} is the decomposition rate constant for the wood waste, year^{-1};

C_{WW}^{db} is the organic carbon content in the wood waste on dry basis, %;

a is the conversion factor from kg carbon to landfill gas quantity, m^3/kg carbon;

ζ is the generation factor;

φ is the percentage of the stockpile under aerobic conditions, %;

ζ_{OX} is the methane oxidation factor;

V_m is the methane concentration biogas, %;

ρ_{CH4} is the density of methane, kg/m^3;

GWP_{CH4} is the global warming potential of methane, t CO_2e/t CH_4;

y is the year for which to calculate the CO_2-equivalent reduction, year;

x is the year in which fresh biomass is utilized instead of stockpiled, year.

The following input values for estimation of methane emission reductions are allowed to be changed (or accepted on default) in this model [R12]:

1. *Amount of fresh biomass utilized.* Annual data on wood waste ($WW_{dump,BL,x}^{dry}$) disposed at the dumps under the baseline scenario for the period till 2012 were put into the model (See Annex 2-1).
2. *Lignin fraction of C.* The adopted recommended default value for the wood waste: $w_{lignin,WW}$ = 0.25.
3. *Decomposition rate constant*. The adopted recommended default value for the wood waste: k_{WW} = ln(1/2)/15 = 0.046 year^{-1}, where 15 is the recommended default value for half-life of wood, years.
4. *Organic carbon content on dry basis.* The default value proposed for wood waste is 53.6%; we adopted a more conservative value: C_{WW}^{db} = 50%.

[16] The formula (B.1-15) is used for recalculation of sawdust consumption in the new boiler house ($FC_{sawdust,new\_BH,y}^{v}$) to the dry matter of wood waste disposal to the dumps ($WW_{dump,BL,x}^{dry}$).

5. *Conversion factor from kg carbon to landfill gas quantity*. The adopted recommended default value: a = 22.4/12 = 1.87 m^3/kg carbon, where 22.4 is molar volume of gas at normal conditions, l/mol; 12 is molar mass of C, g/mol.
6. *Generation factor*. The adopted recommended default value: ζ = 0.77.
7. *Percentage of the stockpile under aerobic conditions.* The adopted recommended default value: φ = 10%.
8. *Methane oxidation factor.* The adopted recommended default value: ζ_{OX} = 0.10.
9. *Methane concentration biogas*. The adopted recommended default value: V_m = 60%.
10. *Density of methane.* The adopted value: ρ_{CH4} = 16/22.4 = 0.714 kg/m^3, where 16 is molar mass of CH_4, g/mol.
11. *Global warning potential of methane.* The adopted recommended default value: GWP_{CH4} = 21 t CO_2e/t CH_4.
12. *Year for which to calculate the CO_2-equivalent reduction.* It is assumed: *y* = 2008-2012.
13. *Year in which fresh biomass is utilized instead of stockpiled.* It is assumed: *x* = 2008-2012.

The results of calculation of the baseline GHG emissions are given in Table E.4-1 and in Annex 2-2.

Table E.4-1. The baseline GHG emissions, t CO_2e

Name	Reporting years					2008-2012
	2008	2009	2010	2011	2012	
CO_2 from combustion of residual fuel oil	7 444	25 586	25 586	25 586	25 586	109 789
CH_4 from wood waste decomposition at the dumps	492	2 378	4 179	5 898	7 540	20 487
Total baseline GHG emissions	**7 936**	**27 964**	**29 765**	**31 485**	**33 127**	**130 277**

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

The results of calculation of the GHG emission reductions are given in Table E.5-1.

Table E.5-1. The GHG emission reductions, t CO_2e

Name	Reporting years					2008-2012
	2008	2009	2010	2011	2012	
CO_2 from combustion of residual fuel oil	7 444	25 586	25 586	25 586	25 586	109 789
CH_4 from wood waste decomposition at the dumps	492	2 378	4 179	5 898	7 540	20 487
Total reduction of GHG emissions	**7 936**	**27 964**	**29 765**	**31 485**	**33 127**	**130 277**

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2008	0	0	7 936	7 936
2009	0	0	27 964	27 964
2010	0	0	29 765	29 765
2011	0	0	31 485	31 485
2012	0	0	33 127	33 127
Total (tonnes of CO_2 equivalent)	0	0	130 277	130 277

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:

The environmental impact assessment of the project was carried out in accordance with the Russian legislation within the framework of the design documentation development [R1]. In the course of analysis the following conclusions were made:

- the impact of the project activity upon the environment is acceptable;
- the additional impact upon the atmospheric air in terms of pollutant emissions is marginal;
- the project activity excludes the danger of pollution of surface and underground waters and the boiler house territory;
- the impact upon soil during operation of the boiler house is minimized.

The project envisages switching the heat supply system of the settlement to a more ecofriendly fuel. The project implementation leads to reduction of residual fuel oil combustion in the boiler house owned by OJSC “SBM”.

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

The project does not have any significant environmental impact.

The project has the following permits and positive expert opinions:

- Positive opinion of the state expertise No.29-1-4-0356-07 issued on 4.04.2008;
- Permit issued by Rostekhnadzor for operation of the energy generating unit No.01-07-T/024 dated 09.02.2009.

SECTION G. Stakeholders' comments

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

Comments on behalf of local and federal authorities were received in the form of positive opinions regarding the project activity from the state expert examinations and permits for the project implementation.

The project has the following permits and positive expert opinions:

- Positive opinion of the state expertise No.29-1-4-0356-07 issued on 4.04.2008;
- Permit issued by Rostekhnadzor for operation of the energy generating unit No.01-07-T/024 dated 09.02.2009.

State expert examinations confirmed that the design documentation complies with the industrial safety requirements, including environmental, health and safety requirements, fire safety requirements and agrees with the results of engineering surveys. The results of engineering surveys comply with the requirements of technical regulations.

REFERENCES

[R1] Detailed Design "Biofuel Hot Water Boiler House with the Thermal Capacity of 18 MW", Severodvinsk, 2007.

[R2] Feasibility Study for Efficiency of Heat Production by BMK running on Biofuel in Severoonezhsk, the Arkhangelsk region. OJSC "Mezhregionenergogas".

[R3] Guidance on criteria for baseline setting and monitoring, Version 02, JISC (http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf)

[R4] Guidelines for calculation and justification of standards of process losses for heat delivery in the Russian Ministry of Energy. Approved by the order of the Ministry of Energy of the Russia Federation dated December 30, 2008 No.325 (http://www.spbustavsud.ru/printdoc?tid=&nd=902148459&nh=0&ssect=0).

[R5] Construction Standards and Rules of the Russian Federation SNiP 23-01-99 (2003) "Construction Climatology".

[R6] Reference Book on Small Boiler Units/Edited by K.F.Roddatis. M.: Energoatomizdat, 1989.

[R7] Methodology for determination of fuel, electricity and water demand for production and delivery of heat and heat carriers in the public heating systems. MDK 4-05.2004. Moscow, 2004.

[R8] E.F.Buznikov, Industrial and Heat Supply Boiler Houses. – M.: Energoatomizdat, 1984.

[R9] S.I.Golovkov. Wood Waste-To-Energy. – M.: Forest Industry, 1987.

[R10] Reference Book on Wood Drying/Edited by E.S.Bogdanov. – 4th Edition, revised and supplemented. – M.: Forest Industry, 1990.

[R11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2, Energy (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.htm).

[R12] Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.

[R13] Operational Guidelines for Project Design Documents of Joint Implementation Projects. Vol.1. General Guidelines./ Version 2.3. Ministry of Economic Affair of the Netherlands. May 2004 (http://ji.unfccc.int/CritBasMon/CallForInputs/BaselineSettingMonitoring/ERUPT/index.html).

[R14] The World Resources Institute (WRI) and World Business Council for Sustainable Development. 2008. Calculating CO_2 emissions from mobile sources - Guide to calculation worksheets. Washington, DC: World Resources Institute.

[R15] Provisions For Joint Implementation Small-Scale Projects, Version 03, JISC (http://ji.unfccc.int/Ref/Documents/Provisions_for_JI_SSC_projects.pdf).

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Represented by:	
Title:	Director General
Salutation:	Mr.
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Organisation:	Closed Joint Stock Company “Teplo-Invest”
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Represented by:	
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Mobile:	
Personal e-mail:	

Annex 2

BASELINE INFORMATION

Annex 2-1. The results of calculation of the main baseline parameters[17]

Heat losses in the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network

Parameter	Unit	Months												Year
		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	
Length of operation of the heat network*	h	744	678	744	720	744	720	744	744	720	744	720	744	8766
Average temperature of the outside air*	°C	-14.1	-12.8	-7.3	-0.1	6.6	13.4	16.1	13.9	8.0	1.2	-4.5	-10.2	0.9
Average temperature in the supply pipeline*	°C	68.0	67.0	57.6	50.0	50.0	50.0	50.0	50.0	50.0	50.0	53.0	62.0	54.8
Average temperature in the return pipeline*	°C	53.0	52.0	46.3	42.0	42.0	42.0	42.0	42.0	42.0	42.0	44.5	49.0	44.9
Standard heat losses in the supply pipeline	GJ	4 483	3 971	3 544	2 647	2 370	1 934	1 851	1 971	2 219	2 665	3 038	3 942	34 634
Standard heat losses in the return pipeline	GJ	4 121	3 627	3 292	2 502	2 174	1 700	1 591	1 726	2 021	2 506	2 912	3 636	31 808
Total heat losses	GJ	8 604	7 597	6 836	5 150	4 544	3 634	3 442	3 697	4 240	5 170	5 951	7 578	66 442

* According to the Annex to Contract No.15/2008 dated 07.07.2008 “The calculation of insulation losses in the supply and return heat pipelines from the point where the sensors of the heat metering unit are located and to the border dividing ownership and operational responsibilities”.

[17] Calculating algorithm see in Section B.1.

Annex 2-1. The results of calculation of the main baseline parameters (continuation)

Heat supply

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat supply to end-users of the settlement	GJ	54 101*	211 060	211 060	211 060	211 060	898 340
Heat losses in the heat pipeline section running from the old boiler house to the point where the heat pipeline from the new boiler house connects with the existing district heating network	GJ	26 636 **	66 442	66 442	66 442	66 442	292 404
Heat supply from the collectors of the old boiler house to meet the heat demand of the settlement	GJ	80 737	277 502	277 502	277 502	277 502	1 190 744

* Actual data

** The sum of heat losses over the last five months is given as per calculation given in the Table above, more accurate value will be determined in the course of monitoring

Fossil fuel combustion

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Quantity of residual fuel oil fired in the old boiler house for generation of heat supplied to end-users of the settlement	GJ	96 177	330 570	330 570	330 570	330 570	1 418 459

Electricity consumption from the external power grid

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Electricity consumption in the old boiler house for generation of heat supplied to end-users of the settlement	MWh	500	1 717	1 717	1 717	1 717	7 367

Disposal of wood waste to the dumps

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Disposal of wood waste to the dumps	t d.m.	2 703	10 496	10 496	10 496	10 496	44 686

Annex 2-2. Calculation of methane emissions from anaerobic decomposition of wood waste at the dumps under the baseline scenario

Calculation of CO_2-equivalent emission reduction from BWW prevented from stockpiling or taken from stockpiles

BWW - bark wood waste

General input data		
Conversion factor organic carbon to biogas (a)	1,87	m^3 biogas/kg carbon
GWP CH_4	21	
Density methane	0,714	kg/m^3
Methane concentration biogas	60%	
Half-life biomass (tau)	15	year
Decomposition constant (k)	0,046	$year^{-1}$
Generation factor (zeta)	0,77	
Methane oxidation factor	0,10	
Percentage of the stockpile under aerobic conditions	10%	

LEGEND

db = dry basis
wb = wet basis
yellow cells = unprotected cells
red marks = comment field included

Biomass specific input data	Biomass from stockpile	Fresh	
Organic carbon content (db)		50,0%	db
Moisture content		0%	wb
Organic carbon content (wb)	0,0%	50,0%	wb
Lignin fraction of C		0,25	

Year	Fresh biomass prevented from stockpiling or taken from stockpile			Year				
	Biomass from stockpile	Age of biomass	Fresh	2008	2009	2010	2011	2012
	(ton$_w$)	(years)	(ton$_w$)	ton CO2-eq				
2008			2 703	492	469	448	428	409
2009			10 496		1 908	1 822	1 740	1 661
2010			10 496			1 908	1 822	1 740
2011			10 496				1 908	1 822
2012			10 496					1 908
2013								
2014								
2015								
2016								
2017								
2018								
2019								
2020								
2021								
2022								
2023								
Total	**0**		**44 686**					
	Total emission prevention			**492**	**2 378**	**4 179**	**5 898**	**7 540**
	Cumulative total emission prevention			**492**	**2 869**	**7 048**	**12 946**	**20 487**

Spreadsheet model developed by:

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This spreadsheet model is based on the report: "Methane and Nitrous Oxide Emissions from Biomass Waste Stockpiles", Worldbank PCF*plus* research, August 2002

Annex 2-3. Calculation of main economic parameters of the project for the two implementation options

Input data

Parameter	Unit	Value
EUR exchange rate	RUR/EUR	35,03
Heat tariff	RUR/Gcal	1 626,56
	EUR/GJ	11,09
Discount rate	%	11
ERU price	€/tCO2e	15

Annual heat supply to end-users

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Heat supply to end-users	Gcal		54 749	54 749	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982	87 982
	GJ		229 234	229 234	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381	368 381

Annual income

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Income from heat sale	thous.EUR		2 542,18	2 542,18	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30
Total income	thous.EUR		2 542,18	2 542,18	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30	4 085,30

Annual expenses

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cost of heat supply	RUR/Gcal		1 010,19	1 010,19	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00	879,00
	EUR/GJ		6,89	6,89	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99
Costs of boiler house operation	thous.EUR		-1 578,84	-1 578,84	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71
Total expenses	thous.EUR		-1 578,84	-1 578,84	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71	-2 207,71

Total income from the project implementation

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total income	thous.EUR		963,34	963,34	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59	1 877,59

Annex 2-3. Calculation of main economic parameters of the project for the two implementation options (ending)

Capital expenditure

Parameter	Unit	2007
Capital expenditure	thous.EUR	-9 991,44

Depreciation

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Depreciation charges	thous.EUR		-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10	-666,10
Value of fixed assets	thous.EUR		9 325,34	8 659,24	7 993,15	7 327,05	6 660,96	5 994,86	5 328,77	4 662,67	3 996,57	3 330,48	2 664,38	1 998,29	1 332,19	666,10	0,00

Taxes

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Property tax	thous.EUR		-102,58	-197,83	-183,18	-168,52	-153,87	-139,21	-124,56	-109,91	-95,25	-80,60	-65,94	-51,29	-36,64	-21,98	-7,33
Profit tax	thous.EUR		-46,72	-23,86	-246,80	-250,31	-253,83	-257,35	-260,86	-264,38	-267,90	-271,41	-274,93	-278,45	-281,97	-285,48	-289,00

Economic parameters without selling ERUs

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Net cash flow	thous.EUR	-9 991,44	814,04	741,65	1 447,61	1 458,75	1 469,89	1 481,03	1 492,16	1 503,30	1 514,44	1 525,57	1 536,71	1 547,85	1 558,99	1 570,12	1 581,26
Accumulated net cash flow	thous.EUR	-9 991,44	-9 177,40	-8 435,75	-6 988,14	-5 529,39	-4 059,50	-2 578,47	-1 086,31	416,99	1 931,43	3 457,00	4 993,71	6 541,56	8 100,54	9 670,67	11 251,93

NPV	**thous.EUR**	**-446**
IRR	**%**	**10,26%**

Economic parameters with ERUs sale

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Amount of ERUs	tCO2e	0	29 333	31 311	47 275	50 269	53 127										
Net cash flow	thous.EUR	-9 991,44	1 254,03	1 211,31	2 156,74	2 212,79	2 266,79	1 481,03	1 492,16	1 503,30	1 514,44	1 525,57	1 536,71	1 547,85	1 558,99	1 570,12	1 581,26
Accumulated net cash flow	thous.EUR	-9 991,44	-8 737,40	-7 526,09	-5 369,35	-3 156,57	-889,77	591,25	2 083,42	3 586,71	5 101,15	6 626,73	8 163,44	9 711,28	11 270,27	12 840,39	14 421,65

NPV	**thous.EUR**	**1 820**
IRR	**%**	**14,20%**