Monitoring Report

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

Version 2.0
01 June 2010
Monitoring period: 01.08.2008 – 31.12.2009

Executed by CCGS LLC

CONTENTS

ANEXES

SECTION A. General Project activity information

A.1. Title of the project activity

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

A.2. Short description of the project activity

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.

The general design of the boiler house was carried out by Scientific Production Firm "ROSS MTK" Ltd.

Producer of boiler equipment - "Uniconfort" (Italy).

The supplier of boiler equipment - "TechStroiLider" Ltd.

Assembling of bearing and filler structures of the building of the boiler house and primary landing – "Green helmet" Ltd.

Assembling of boiler and auxiliary equipment, commissioning – "Eton Energetik" Ltd.

Assembling and commissioning of calculation point– OJSC "Engineering Center Skada".

A.3. Monitoring period

• Monitoring period starting date: 1.08.2008;
• Monitoring period closing date: 31.12.2009.

A.4. Methodology applied to the project activity (incl. version number)

A.4.1. Baseline methodology

The developer proposes his own approach [R1] to the baseline setting and GHG emission reductions calculation and does not agree it with any methodologies for the clean development mechanism (CDM), but he certainly makes his approach consistent with the requirements of *Decision 9/CMP.1, Appendix B* [R2].

A.4.2. Monitoring methodology

The monitoring plan was developed following our own approach [R1] in accordance with the project specifics and requirements of *Decision 9/CMP.1*, *Appendix B* [R2] without using any approved CDM methodologies.

A.5. Status of implementation including time table for major project parts

Activity	Dates
Construction and installation works starting date (start of project activity)	December, 2006
Putting into operation for carrying out of starting-up and adjustment works	July, 2008
Official putting into operation	February, 2009

A.6. Intended deviations or revisions to the registered PDD

There are no deviations or revisions to the registered PDD.

A.7. Intended deviations or revisions to the registered monitoring plan

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

A.8. Changes since last verification

There are no changes as this is the first monitoring verification.

A.9. Person(s) responsible for the preparation and submission of the monitoring report

The person (s) responsible for the preparation and submission of the monitoring report are:

OJSC «Mezhregionenergogaz» Branch in Severoonezhsk:
• Andrey Dyadura – Project Manager
• Michael Gudkov – The Director of "Severo-Zapadnoe" Local Division

CCGS LLC:
• Vladimir Dyachkov, Director of Project Implementation Department
• Evgeniy Zhuravskiy, Specialist of Project Implementation Department

SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period stated in A.3

B.1. Monitoring equipment types

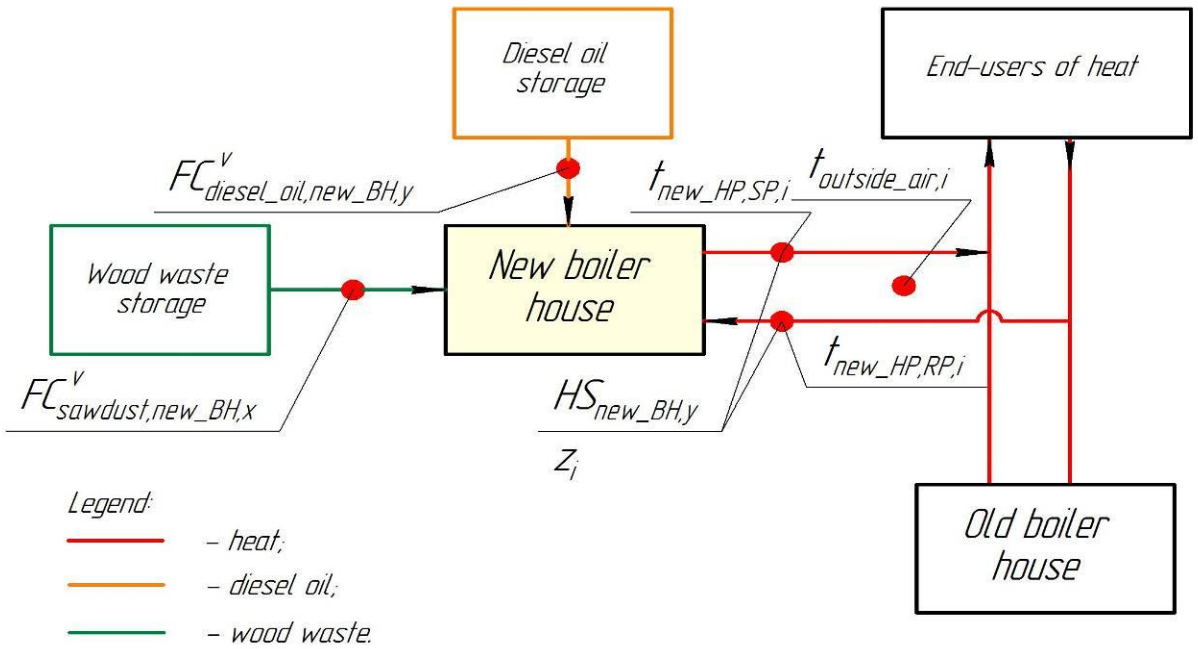
The measuring devices are provided in accordance with the official rules “Electricity Metering Rules”, “Heat Metering Rules” etc. The devices have to undergo regular inspection and supervision under the Federal Law “On Uniformity of Measurements”. Table B.1.1. shows metrological performance of the measuring devices used for monitoring.

Table B.1.1. Data on metering devices for GHG emission reduction monitoring

Metered parameter	Mark and type of meter		Serial number	Measurement range	Unit	Error, accuracy class	Calibration interval (month)	Last calibration data	Organisation which performs calibration
Heat supply from the collectors of the new boiler house	Flowmeter (Supply pipeline)	CEPS-PB	300173	1600	m^3/h	1.0	48	06.08.09	FGU «Ulyanovskiy CSM»
	Flowmeter (Return pipeline)	CEPS-PB	300182	1600	m^3/h	1.0	48	06.08.09	FGU «Ulyanovskiy CSM»
	Flowmeter (Makeup pipeline)	Vzlet-ER	616764	764	m^3/h	2.0	48	20.07.07	CJSC «Vzlet»
	Pressure meter (Supply pipeline)	KRT9	842894	1.6	MPa	0.5	24	08.04.09	FGU «Ulyanovskiy CSM»
	Pressure meter (Return pipeline)	KRT9	843227	1.6	MPa	0.5	24	08.04.09	FGU «Ulyanovskiy CSM»
	Pressure meter (Makeup pipeline)	KRT9	811381	1.6	MPa	0.5	24	28.01.08	FGU «Ulyanovskiy CSM»
	Temperature meter (Supply pipeline)	KTPTR-05	5780A	200	°C	1.0	48	15.10.08	FGU «Mendeleevskiy CSM»
	Temperature meter (Return pipeline)	KTPTR-05	5780	200	°C	1.0	48	15.10.08	FGU «Mendeleevskiy CSM»
	Temperature meter (Makeup pipeline)	TPT-1	1541	300	°C	A	48	15.06.09	FGU «Mendeleevskiy CSM»
Average temperature of the outside air	Temperature meter	TPT-1	1343	300	°C	A	48	01.06.09	FGU «Mendeleevskiy CSM»
Length of operation of the heat network	Heat meter	SPT961.2	16737	9999999999	hours	0.01	48	10.07.09	FGU «Ulyanovskiy CSM»

B.2. Monitored data

The data were monitored in accordance with the scheme shown in Fig. B.2.1.



FigB.2.1. Location of the monitoring points

According to the emissions reduction monitoring plan, the following seven parameters have been controlled (see Table B.2.1). This table also contains parameter values for the year 2008 and 2009:

Table B.2.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Numerical value	
								2008	2009
1. $FC^{v}_{diesel\_oil,new\_BH,y}$	Volumetric diesel oil consumption in the new boiler house during the year *y*	The Department of Chief Power Engineer	l	m	Periodically	100 %	Electronic and paper	**3 901**	**77 460**
2. $HS_{new\_BH,y}$	Heat supply from the collectors of the new boiler house during the year *y*	The Department of Chief Power Engineer	GJ	m, c	Continuously	100 %	Electronic and paper	**56 577**	**158 501**
3. $t_{new\_HP,SP,i}$	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*	The Department of Chief Power Engineer	°C	m	Continuously	100 %	Electronic and paper	**See Annex 3**	**See Annex 3**
4. $t_{outside\_air,i}$	Average temperature of the outside air over the month *i*	The Department of Chief Power Engineer	°C	m	Four times per day	100 %	Electronic and paper	**See Annex 3**	**See Annex 3**
5. z_i	Length of operation of the heat network during the month *i*	The Department of Chief Power Engineer	h	m	Continuously	100 %	Electronic and paper	**3 088**	**6 160**

6. $t_{new\_HP,RP,i}$	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*	The Department of Chief Power Engineer	°C	m	Continuously	100 %	Electronic and paper	**See Annex 3**	**See Annex 3**
7. $FC^{v}_{sawdust,new\_BH,x}$	Volumetric sawdust consumption in the new boiler house during the year *y*	The Economics Department	bulk m^3	m	Continuously	100 %	Electronic and paper	**12 469**	**44 214**

B.3. The environmental service

The information on the environmental impact of the project are collected and archived in compliance with the Russian regulations.

B.4. Data processing and archiving (incl. software used)

Electronic databases and calculation spreadsheets are kept in the computer of Chief power engineer of the boiler house. To provide the protection of this data it is copied to a hard disk each week and besides it is sent by e-mail to the office of OJSC “Mezhregionenergogas” in Arkhangelsk and CCGS LLC in Arkhangelsk each month where this data is also kept in computer database.

All data will be stored in the Mill’s archive in electronic and paper form for at least 2 years after the end of the crediting period or the last issue of ERUs.

SECTION C. Quality assurance and quality control measures

C.1. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored

Table C.1.1. 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
Table B.2.1 ID 1	low	Consumption of diesel oil in the new boiler house is measured by level gauges in the diesel oil tanks.
Table B.2.1 ID 2	low	Flow meters and pressure meters are regularly calibrated. Measurement accuracy of flow meters: 1.0. Measurement accuracy of pressure meters: 0.5. Calibration frequency of flow meters: 48 months. Calibration frequency of pressure meters: 24 months.
Table B.2.1 ID 3, 4, 6	low	Temperature gauge is regularly calibrated. Measurement accuracy: 1.0. Calibration frequency 48 months.
Table B.2.1 ID 5	low	Heat meter is regularly calibrated. Measurement accuracy: 0.01. Calibration frequency 48 months.
Table B.2.1 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.

Internal check-out

Internal verification of Monitoring report was performed by Chief engineer of Separate subdivision “North-Western” of OJSC “Mezhregionenergogas” A. Shurygin (Positive opinion, reference number № 32/3 of 25.05.2010).

The powers of the Chief engineer Andrey Shurygin to check out GHG emission reduction calculation results are officially confirmed by the Order № 01/05 of 05.04.2010.

Cross-check

Check of the monitoring report is carried out by the Director of the Project Implementation Department of CCGS LLC, or, on his instructions, by other Specialist of the Project Implementation Department who was not directly involved in preparation of this project monitoring report.

Additional cross check is carried out by the director of the Project Development Department of CCGS LLC, or, on his instructions, by other specialist of the Project Development Department.

At CCGS LLC the procedure for verification of the monitoring reports are laid down in “Regulations on quality check and control of GHG emission reduction project design documents (PDD) and monitoring reports at CCGS LLC” (see Annex 2).

C.2. Operational and administrative structure

C.2.1. Monitoring procedures

Data Transfer

Original request for primary GHG emission reductions monitoring data is made by the Director of the Project Implementation Department of CCGS LLC to the office of OJSC «Mezhregionenergogaz» in Archangelsk to the Director of "Severo-Zapadnoe" Local Division, who in his turn gives instructions to the enterprise to collect the requested data. The responsibility of persons who responsible for collection, control and transfer of monitoring data is set forth in Order No.36-09-C of 21.08.2009.

The information collected at the enterprise is transferred to the Director of "Severo-Zapadnoe" Local Division, who in his turn transfers it to the Director of the Project Implementation Department of CCGS LLC. All information is transferred by e-mail.

On the basis of the received data the Department of Project Implementation of CCGS LLC prepares a GHG emission reduction monitoring report and submits it for additional cross-check to the Project Development Department of CCGS LLC. As soon as all comments made by the Project Development Department are incorporated or resolved the monitoring report is submitted for verification to the enterprise where the project is implemented. At CCGS LLC the procedure for verification of the monitoring reports are laid down in “Regulations on quality check and control of GHG emission reduction project design documents (PDD) and monitoring reports at CCGS LLC” (see Annex 2).

After the report is verified and amended as necessary, the Director of the Project Implementation Department of CCGS LLC informs the Director of "Severo-Zapadnoe" Local Division in Archangelsk about preliminary monitoring results and, if there are no comments on his part, the General Director of CCGS LLC takes the final decision to submit the monitoring report for verification to an independent expert organization.

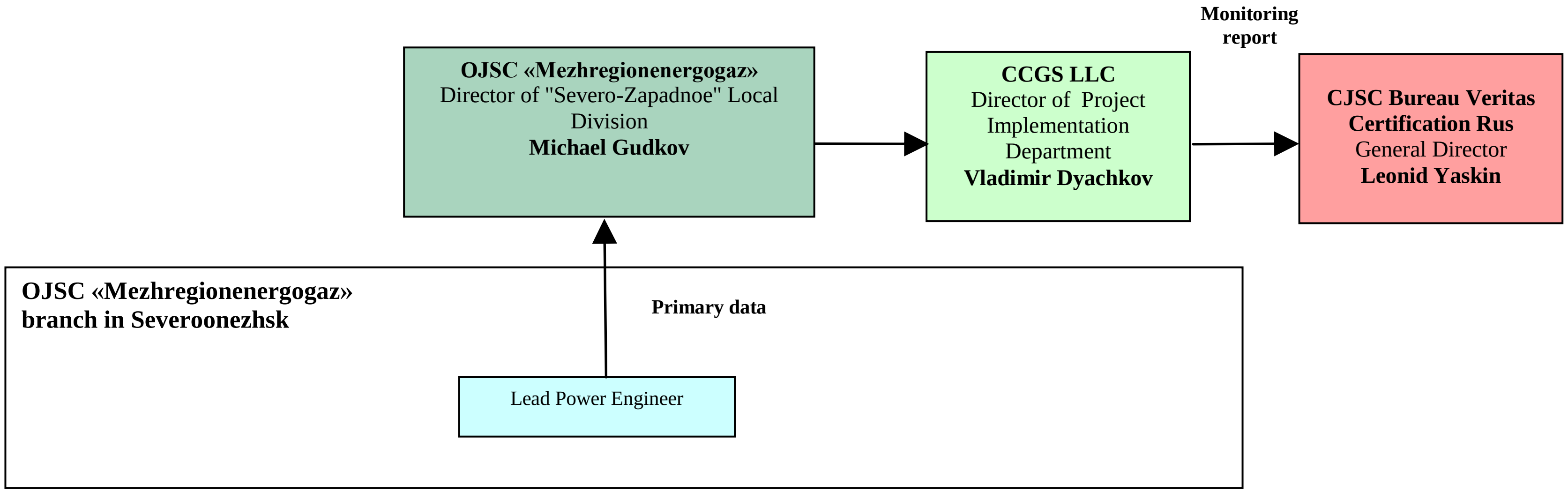


Fig. C.2.1. Data transfer scheme (from primary data to monitoring report).

The procedures for collection and record of primary data at the enterprise

Collection and record of data required for calculation of GHG emission reductions have been carried out in accordance with the metering points scheme shown in Fig B.2.1.

1. Volumetric diesel oil consumption in the new boiler house during the year *y* (ID 1) has been determined on the basis of the level gauges in the diesel oil tanks.
2. Heat supply from the collectors of the new boiler house during the year *y* (ID 2) has been determined based on the readings of heat meters. Data on heat supply has been regularly transferred to the Chief Power Engineer's computer and archived.
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 have been determined based on the heat meter readings. Temperature data has been 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) have been determined as average values at the end of the month *i*.
4. Outside air temperature has been 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) has been determined as average value at the end of the month *i*.
5. Length of operation of the heat network during the month *i* (ID 5) has been determined based on the heat meter readings. Data on the length of operation of the heat network has been regularly transferred to the Chief Power Engineer's computer and archived.
6. The quantity of sawdust combusted in the new boiler house has been 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) has been determined as a cumulative volume of sawdust fed for combustion during the year *x*.

Troubleshooting procedures

The measuring instruments have been calibrated during scheduled shutdowns of the equipment. If necessary, the removed measuring instrument is replaced with a gaged back-up instrument. Operation of the equipment without measuring instruments is not allowed.

Shall any instrument fail, the respective parameters are to be monitored with a help of a duplicate instrument or, if such is not available, the failed instrument is to be replaced with a gaged back-up instrument. If the failed instrument cannot be replaced while the equipment is running, then the parameters are monitored for not more than 15 days in one year based on calculation of an average value of this instrument's readings taken over the three days prior to the failure. This monitoring procedure was developed based on paragraph 9.8 of "The Rules for Heat and Heat Carrier Metering" [R5].

If the equipment is operated without instrument-based monitoring of any parameter for more than 15 days, then the calculations are made using the most conservative (in terms of GHG emission reductions) value from the start of the project monitoring.

All incidents that take place at the enterprise are recorded by the department of the chief energy engineer in the prescribed order. Information on major incidents is recorded in the monitoring report.

C.2.2. Roles and responsibility

The management of OJSC “Mezhregionenergogaz” branch in Severoonezhsk is responsible for:

- normal operation of the equipment (the director of "Severo-Zapadnoe" local division);
- timely calibration and proper maintenance of instrumentation (the director of "Severo-Zapadnoe" local division);
- collection of all data required for calculation of GHG emission reductions under the project (the director of "Severo-Zapadnoe" local division);
- arranging and holding training sessions for the Mill’s personnel regarding collection of data required for the GHG emissions monitoring under the project (project manager).

The management of CCGS LLC is responsible for:

- arranging and holding training sessions for the Mill’s personnel regarding collection of data required for the GHG emissions monitoring under the project (director of project implementation department);
- drawing up of the monitoring report (director of project implementation department);
- check of correctness of the primary data and calculations GHG emissions reductions (director of project development department);
- interaction with the independent expert organization concerning verification of GHG emissions reductions (director of project implementation department).

C.2.3. Trainings

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 are 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 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.

At least once per year CCGS LLC together with the management of OJSC “Mezhregionenergogas” branch in Severoonezhsk arrange and hold training sessions for the boiler house personnel regarding collection of data required for the GHG emissions monitoring under the project.

Check-out of the equipment required for primary monitoring data collection and personnel training was carried out on 9.04.2009, 7.07.2009, 21.01.2010.

C.2.4. Involvement of Third Parties

FGU «Ulyanovskiy CSM», FGU «Mendeleevskiy CSM».

C.3. Influence estimation on environment

The following polluting substances are emitted into the atmospheric air during fuel (wood waste) consumption : nitric oxides, ash, carbonic oxide, benzpyrene and suspended matters. Combustion gases from each boiler unit are emitted into the atmosphere through a separate pipe. Pipe parameters are: hieght – 30 m., diameter – 1 m. The emitted gases are cleaned in built-in multicyclons, cleaning efficiency – 85 %.

Gross emissions of polluting substances are indicated in **Table C.3.1.**

Table C.3.1. Gross emissions of polluting substances [1]

№ of source	Name of gas cleaning units	Coefficient of providing gas cleaning, %	Medium exploitation cleaning level ----- maximum cleaning level, %	Polluting substance		Emissions of polluting substances			Gross emission from the source, t/year
				Code	Name	g/sec	mg/m3 at normal conditions	t/year	
Boiler №1				301	Nitrogen dioxide; (Nitric (IV) oxide)	0.8789907	90.1528923	18.7641164	18.7641164
				304	Nitric (II) oxide ; Nitric oxides	0.1428360	14.6498462	3.0491689	3.0491689
				703	Benzpyrene; 3,4-Benzpyrene	0.0000049	0.0005026	0.0001053	0.0001053
	Built-in ash-collector	100.0	85.00/85.00	2902	Suspended matters	0.1440000	14.7692308	3.0740175	3.0740175
		100.0	85.00/85.00	328	Carbon, Ash	0.6016157	61.7041744	12.8428965	12.8428965
				337	Carbonic oxide	12.8450557	1317.4416103	274.2078259	274.2078259
Boiler №2				301	Nitrogen dioxide; (Nitric (IV) oxide)	0.8447903	86.6451590	18.0339567	18.0339567
				304	Nitric (II) oxide ; Nitric oxides	0.1372784	14.0798359	2.9305180	2.9305180
				703	Benzpyrene; 3,4-Benzpyrene	0.0000047	0.0004821	0.0001011	0.0001011
	Built-in ash-collector	100.0	85.00/85.00	2902	Suspended matters	0.1395000	14.3076923	2.9779425	2.9779425
		100.0	85.00/85.00	328	Carbon, Ash	0.5828152	59.7759179	12.4415060	12.4415060
				337	Carbonic oxide	12.4436481	1276.2716000	265.6377651	265.6377651

[1] The source of data: Project of normative of maximum permitted emissions (MPE Project) developed by the organization "Branch of FSI "Center of laboratory analysis and technical measurements in the North-western federal area" – "Center of laboratory analysis and technical measurements in the Arkhangelsk region" (CLATM in the Arkhangelsk region)" for JSC "Arkhangeslkteplogas".

№ of source	Name of gas cleaning units	Coefficient of providing gas cleaning, %	Medium exploitation cleaning level ----- maximum cleaning level, %	Polluting substance		Emissions of polluting substances			Gross emission from the source, t/year
				Code	Name	g/sec	mg/m3 at normal conditions	t/year	
Boiler №3				301	Nitrogen dioxide; (Nitric (IV) oxide)	0.8789907	90.1528923	18.7641164	18.7641164
				304	Nitric (II) oxide ; Nitric oxides	0.1428360	14.6498462	3.0491689	3.0491689
				703	Benzpyrene; 3,4-Benzpyrene	0.0000049	0.0005026	0.0001053	0.0001053
	Built-in ash-collector	100.0	85.00/85.00	2902	Suspended matters	0.1440000	14.7692308	3.0740175	3.0740175
		100.0	85.00/85.00	328	Carbon, Ash	0.6016157	61.7041744	12.8428965	12.8428965
				337	Carbonic oxide	12.8450557	1317.4416103	274.2078259	274.2078259
Boiler №4				301	Nitrogen dioxide; (Nitric (IV) oxide)	0.8618566	88.3955487	18.3973272	18.3973272
				304	Nitric (II) oxide ; Nitric oxides	0.1400517	14.3642769	2.9895657	2.9895657
				703	Benzpyrene; 3,4-Benzpyrene	0.0000049	0.0005026	0.0001047	0.0001047
	Built-in ash-collector	100.0	85.00/85.00	2902	Suspended matters	0.1417500	14.5384615	3.0258180	3.0258180
		100.0	85.00/85.00	328	Carbon, Ash	0.5922154	60.7400410	12.6415244	12.6415244
				337	Carbonic oxide	12.6443519	1296.8566051	269.9083448	269.9083448

Table C.3.2 shows calculation data on the variation of pollutant emissions as a result of the project implementation. The calculations were made in accordance with RD 34.02.305-98 “The Methodology for Calculation of Gross Pollutant Emissions from TPP Boilers” [R3], issued by VTI.

As a result of the project the residual fuel oil consumption at old boiler house in year 2008 reduces by an average of 2 265 tons. The emissions of sulfur dioxide reduce by 58.8 t/year, carbon oxide – by 29.0 t/year, nitrogen oxides (calculated as nitrogen dioxide) – by 2.3 t/year, and emissions of oil ash in vanadium equivalent – by 0.2 t/year. The overall reduction of gross pollutant emissions to the atmosphere amounts to 90.3 t/year.

As a result of the project the residual fuel oil consumption at old boiler house in year 2009 reduces by an average of 6 189 tons. The emissions of sulfur dioxide reduce by 160.7 t/year, carbon oxide – by 79.1 t/year, nitrogen oxides (calculated as nitrogen dioxide) – by 6.3 t/year, and emissions of oil ash in vanadium equivalent – by 0.6 t/year. The overall reduction of gross pollutant emissions to the atmosphere amounts to 246.7 t/year.

Table C.3.2. Variation of pollutant emissions at UI CHPP, t/year

Pollutant emissions	**Value**	
	2008	**2009**
Emissions of oil ash in vanadium equivalent, t	-0.2	-0.6
Sulfur dioxide (SO_2)	-58.8	-160.7
Nitrogen oxides calculated as nitrogen dioxide (NO_2)	-2.3	-6.3
Carbon oxide (CO)	-29.0	-79.1
Total emissions	**-90.3**	**-246.7**

SECTION D. Calculation of GHG emission reductions

D.1. Calculation of the project GHG emission reductions

The total project emissions of GHG during the year y, t CO_2e:

$$PE_y = PE_{diesel\_oil,y},$$

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;

$$PE_{diesel\_oil,y} = FC^v_{diesel\_oil,new\_BH,y} \times NCV_{diesel\_oil} \times EF_{CO2,diesel\_oil},$$

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, it was assumed NCV_{diesel_oil} =0.0371 GJ/l [R7, page 8, table 3];

$EF_{CO2,diesel\_oil}$ is the CO_2 emission factor for diesel oil combustion, t CO_2e/GJ. According to «2006 IPCC Guidelines for National Greenhouse Gas Inventories» [R6] it was assumed: $EF_{CO2,diesel\_oil}$ = 0.0741 t CO_2e/GJ.

D.2. Calculation of the baseline GHG emission reductions

The total baseline emissions of GHG during the year y, t CO_2e:

$$BE_y = BE_{RFO,y} + BE_{WW,dump,y},$$

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;

$$BE_{RFO,y} = FC^{settlement}_{RFO,old\_BH,BL,y} \times EF_{CO2,RFO},$$

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;

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

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;

q_{old_BH} is the proportion of heat used for auxiliary needs of the old boiler house, it was assumed q_{old_BH} =0.0351 [R10, table.3];

η_{HWB,old_BH} is the efficiency factor of the hot water boilers of the old boiler house, it was assumed η_{HWB,old_BH} =0.87 [R9, page 267];

$$HS^{settlement}_{old\_BH,BL,y} = HS_{BL,y} + HL_{old\_HP,BL,y},$$

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

$$HS_{BL,y} = HS_{PJ,y},$$

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

$$HS_{PJ,y} = HS_{new\_BH,y} - HL_{new\_HP,y},$$

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;

$$HL_{new\_HP,y} = HL^{standard}_{new\_HP,SP,y} + HL^{standard}_{new\_HP,RP,y},$$

where $HL^{standard}_{new\_HP,SP,y}$ 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;

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

where β_{new_HP} is the factor of local heat losses for the new heat pipeline, it was assumed β_{new_HP}=1.15 [R8, section 11.3.3];

$L_{new\_HP,SP}$ 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 it was assumed $L_{new\_HP,SP}$=512m (the length of the heat network was determined on the basis of the design documents);

$q^{standard}_{new\_HP,SP}$ 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), it was assumed $q^{standard}_{new\_HP,SP}$=194.6 kJ/(m*h) [R8, annex 4, table 4.1];

$t_{new\_HP,SP,i}$ 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, it was assumed $t_{new\_HP,SP,i}$ =54.8°C (see Annex 4);

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;

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

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, it was assumed $L_{new\_HP,RP}$ =514m (the length of the heat network was determined on the basis of the design documents);

$q^{standard}_{new\_HP,RP}$ 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), it was assumed $q^{standard}_{new\_HP,RP}$ =169.5 kJ/(m*h) [R8, annex 4, table 4.1];

$t_{new\_HP,RP,i}$ 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, it was assumed $t_{new\_HP,RP}$ =44.9°C (see Annex 4).

$HL_{old\_HP,BL,y}$ 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;

$$HL_{old\_HP,BL,y} = HL^{standard}_{old\_HP,SP,BL,y} + HL^{standard}_{old\_HP,RP,BL,y},$$

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;

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

where β_{old_HP} is the factor of local heat losses for the old heat pipeline, it was assumed β_{old_HP} =1,15 [R8, section 11.3.3];

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, it was assumed L_{old_HP} =6 650m (the length of the heat pipeline was determined based on the scheme of the district heating network of the settlement);

$q^{standard}_{old\_HP,SP}$ 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), it was assumed $q^{standard}_{old\_HP,SP}$ =477.9 kJ/(m*h) [R8, annex 1, table 1.2];

$t_{old\_HP,SP,i}$ 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;

$t_{old\_HP,SP,i} = t_{new\_HP,SP,i}$.

$t_{old\_HP,SP}$ 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, it was assumed $t_{old\_HP,SP}$ =54.8°C (see Annex 4).

$HL^{standard}_{old\_HP,RP,BL,y}$ 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;

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

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), it was assumed $q^{standard}_{old\_HP,RP}$ =430.7 kJ/(m*h) [R8, annex 1, table 1.2];

$t_{old\_HP,RP,i}$ 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;

$t_{old\_HP,RP,i} = t_{new\_HP,RP,i}$.

$t_{old\_HP,RP}$ 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, it was assumed $t_{old\_HP,RP}$ =44.9°C (see Annex 4).

η_{HWB,old_BH} is the efficiency factor of the hot water boilers of the old boiler house, it was assumed η_{HWB,old_BH} =0.87 [R9, page 267];

q_{old_BH} is the proportion of heat used for auxiliary needs of the old boiler house, it was assumed q_{old_BH} =0.0351 [R10,table 3].

$EF_{CO2,RFO}$ is the CO_2 emission factor for residual fuel oil combustion, t CO_2e/GJ. According to «2006 IPCC Guidelines for National Greenhouse Gas Inventories» [R6] it was assumed: $EF_{CO2,RFO}$ = 0.0774 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 [R4] (See Annex 1).

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

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.;

$$WW_{dump,BL,x}^{dry} = FC_{sawdust,new\_BH,x}^{v} \times k_{sawdust},$$

where $FC_{sawdust,new\_BH,x}^{v}$ 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, it was assumed $k_{sawdust}$ =0.0879 [R1, Section B1];

$w_{lignin,WW}$ is the lignin fraction of C for the wood waste, it was assumed $w_{lignin,WW}$ =0.25 [R4, page43];

k_{WW} is the decomposition rate constant for the wood waste, year^{-1}, it was assumed k_{WW} = ln(1/2)/15 = 0.046 year^{-1} [R4, page 42];

C_{WW}^{db} is the organic carbon content in the wood waste on dry basis, %, it was assumed C_{WW}^{db} =50% [R4, page 45];

a is the conversion factor from kg carbon to landfill gas quantity, m^3/kg carbon, it was assumed a =1.87 m^3/kg carbon [R4 page 24];

ζ is the generation factor, it was assumed ζ =0.77 [R4, page 41];

φ is the percentage of the stockpile under aerobic conditions, %, it was assumed φ =10% [R4, page 80];

ζ_{OX} is the methane oxidation factor, it was assumed ζ_{OX} =0.10 [R4, page 43];

V_m is the methane concentration biogas, %, it was assumed V_m =60% [R4, page 41];

ρ_{CH4} is the density of methane, kg/m^3, it was assumed ρ_{CH4} =0.714 кг/м^3 [R1, Section E4];

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

GWP_{CH4} =21 t CO_2e/t CH_4 [R4, page 12];

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.3. Calculation of the project GHG emission reductions

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

$$ER_y = BE_y - PE_y$$

The calculation method of GHG emission reductions was implemented in the computational model in the form of excel-file (Annex 5).

The calculation results are presented in the Table D.3.1.

Table D.3.1. Calculation of reduction of emissions GHG for 2008 and 2009

Parameter	Symbol	Unit	Value	
			2008	2009
Project emissions				
Project emissions of CO_2	$PE_{NG,y}$	t CO_2e	11	213
Baseline emissions				
Baseline emissions of CO_2	$BE_{NG,y}$	t CO_2e	7 221	20 083
GHG emission reductions				
GHG emission reductions	ER_y	t CO_2e	**7 210**	**19 870**

In accordance with the PDD, the projected GHG emission reductions amount to **7 936** t CO_2e for 2008.
In accordance with the PDD, the projected GHG emission reductions amount to **27 964** t CO_2e for 2009.

The factors that have led to GHG emission reductions level being lower than the level projected in the PDD are as follows:

1. Decrease in heat supply from the old boiler house under the baseline scenario by 4 585 GJ in 2008 and by 69 420 GJ in 2009 (Table D.3.2). This has reduced GHG emission reductions level down to 7513 and 21 563 tonnes CO_2 in 2008 and 2009 respectively. In terms of percentage, the contribution of this factor in the total decrease in ERUs amount against the PDD level is estimated at 58.3 % for 2008 and 79.1 % for 2009.

2. Reduction of avoided dumping of BWW against the PDD projections by 1 607 tonnes in 2008 and 6 610 tonnes in 2009. This has reduced GHG emission reductions level down to 7 221 and 20 083 tonnes CO_2 in 2008 and 2009 respectively. In terms of percentage, the contribution of this factor in the total decrease in ERUs amount against the PDD level is estimated at 40.2 % for 2008 and 18.3 % for 2009.

3. Use of backup diesel oil in the amount of 3 901 l in 2008 and 77 460 l in 2009. This has reduced GHG emission reductions level down to 7 210 and 19 870 t CO_2 in 2008 and 2009 respectively. In terms of percentage, the contribution of this factor in the total decrease in ERUs amount against the PDD level is estimated at 1.5 % for 2008 and 2.6 % for 2009.

Table D.3.2. Factors causing decrease in GHG emission reductions against the PDD projections

Factor	2008		2009	
	PDD	Monitoring Report	PDD	Monitoring Report
Heat supply from the old boiler house under the baseline scenario, GJ	80 737	76 152	277 502	208 082
Avoided disposal of BWW to dumps, t	2 703	1 096	10 496	3 886
Use of backup diesel oil, l	0	3 901	0	77 460

CCGS LLC
01.06.2010

V. Dyachkov - Director of Project Implementation Department

Evgeniy Zhuravskiy, Specialist of Project Implementation Department

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[R10] 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.

[R11] S.I.Golovkov. Wood Waste-To-Energy. – M.: Forest Industry, 1987.

[R12] Annex to Contract No.15/2008 dated 07.07.2008 for heat supply.

Annex 1

Calculation of methane emissions from anaerobic decomposition of BWW at the dump

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

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%	

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 (ton$_w$)	Age of biomass (years)	Fresh (ton$_w$)	2008	2009
				ton CO2-eq	
2008			1 096	199	190
2009			3 886		707
2010					
2011					
2012					
2013					
2014					
2015					
2016					
2017					
2018					
2019					
2020					
2021					
2022					
2023					
Total	0		4 982		
	Total emission prevention			199	897
	Cumulative total emission prevention			199	1 096

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

Regulations on quality check and control of GHG emission reduction project design documents (PDD) and monitoring reports at CCGS LLC

CCGS

Approved by
Director General
M.Yulkin
December 8, 2009

"СиСиДжиЭс"

REGULATIONS

on quality check and control of GHG emission reduction project design documents (PDD) and monitoring reports at CCGS LLC

1. GENERAL PROVISIONS

1.1. These regulations specify the quality control procedure for development of project design documents (PDDs) and monitoring reports for the projects aimed at GHG emission reduction from sources and/or increase of removal by sinks (hereinafter the "Projects").

1.2. The quality control of PDDs and monitoring reports is carried out in conjunction with the structural subdivisions (departments) of CCGS LLC (hereinafter the "Company") and the Project Owners (hereinafter the "Client").

1.3. The quality control of PDDs and monitoring reports precedes their submission to an independent auditor for review.

2. QUALITY CONTROL OF PROJECT DESIGN DOCUMENTS

2.1. The PDD developed by a specialist of the Project Development Department shall undergo the following quality control procedure:

2.1.1. The PDD shall be checked up by the Director of the Project Development Department or, on his instructions, by other specialist of the Project Development Department who was not directly involved in development of this PDD;

2.1.2. Corrective actions shall be taken by the PDD developer and all corrections and amendments shall be agreed with the Director of the Project Development Department;

2.1.3. The PDD shall be checked up by the Director of the Project Implementation Department or, on his instructions, by other specialist of the Project Implementation Department;

2.1.4. Corrective actions shall be taken by the PDD developer and all corrections and amendments shall be agreed with the Director of the Project Implementation Department;

2.1.5. Final check-up and correction of the PDD shall be made by the Director of the Project Development Department;

2.1.6. The PDD shall be submitted to the Client for review;

2.1.7. Corrective actions shall be taken by the PDD developer and all corrections and amendments shall be agreed with the Client and the Director of the Project Development Department and if necessary with the Director of the Project Implementation Department;

2.1.8. The PDD shall be furnished to the Director General and the Client.

2.2. Upon completion of the above-described procedure and if there are no comments from the Director General and/or from the Client the PDD shall be deemed ready for determination by an independent auditor. Otherwise the procedure shall be repeated.

2.3. The Director of the Project Development Department shall check all sections of the PDD.

2.4. The Director of the Project Implementation Department shall check those sections of the PDD which describe the project monitoring plan and procedure. Other sections shall be checked by the Director of the Project Implementation Department if necessary or at his discretion.

2.5. The Director General shall take the final decision regarding submission of the PDD for determination to an independent auditor.

3. QUALITY CONTROL OF PROJECT MONITORING REPORTS

3.1. The project monitoring report prepared by a specialist of the Project Implementation Department shall undergo the following quality control procedure:

3.1.1. The project monitoring report shall be checked up by the Director of the Project Implementation Department or, on his instructions, by other specialist of the Project Implementation Department who was not directly involved in preparation of this project monitoring report;

3.1.2. Corrective actions shall be taken by the monitoring report developer and all corrections and amendments shall be agreed with the Director of the Project Implementation Department;

3.1.3. The project monitoring report shall be checked up by the Director of the Project Development Department or, on his instructions, by other specialist of the Project Development Department;

3.1.4. Corrective actions shall be taken by the monitoring report developer and all corrections and amendments shall be agreed with the Director of the Project Development Department;

3.1.5. Final check-up and correction of the monitoring report shall be made by the Director of the Project Implementation Department;

3.1.6. The monitoring report shall be submitted to the Client for review;

3.1.7. Corrective actions shall be taken by the monitoring report developer and all corrections and amendments shall be agreed with the Client and the Director of the Project Implementation Department and, if necessary, with the Director of the Project Development Department;

3.1.8. The monitoring report shall be submitted to the Director General and the Client.

3.2. Upon completion of the above-described procedure and if there are no comments from the Director General and/or from the Client the monitoring report shall be deemed ready for verification by an independent auditor. Otherwise the procedure shall be repeated.

3.3. The Director of the Project Implementation Department shall check all sections of the monitoring report.

3.4. The Director of the Project Development Department shall check those sections of the monitoring report which contain results of calculations of GHG emission reductions from sources and/or increase of GHG removals by sinks. Other sections shall be checked up by the Director of the Project Development Department if necessary or at his discretion.

3.5. The Director General shall take the final decision regarding submission of the monitoring report for verification to an independent auditor.

Annex 3

Input data for 2008 and 2009

Data for monitoring of greenhouse gas emission reductions in 2008 for the project "Wood Waste to Energy in Severoonezhsk, the Arkhangelsk Region, the Russian Federation"

No.	Parameter	Unit	August	September	October	November	December	2008
1	Heat supply from of the header of the new boiler house	Gcal	509	1 891	3 269	3 750	4 094	13 513
2	Average temperature in the supply pipeline in the section running from the new boiler house to the connection point with the existing district heating network	^{0}C	48,23	48,3	50,03	50,44	53,21	-
3	Average temperature in the return pipeline in the section running from the new boiler house to the connection point with the existing district heating network	^{0}C	43,99	39,77	40,14	41,0	43,3	-
4	Average outside air temperature	^{0}C	13,05	8,37	5,47	1,38	-3,51	-
5	Running hours of the heat pipeline	h	304	586	721	757	720	3 088
6	Volumetric consumption of diesel fuel in the new boiler house	l	0	0	3 098	209	594	3 901
7	Volumetric consumption of sawdust in the new boiler house	bulk m^3	1 520	1 610	2 489	3 175	3 675	12 469

Data for monitoring of greenhouse gas emission reductions in 2009
for the project "Wood Waste to Energy in Severoonezhsk, the Arkhangelsk Region, the Russian Federation"

No.	Parameter	Unit	January	February	March	April	May	June	July	August	September	October	November	December	2009
1	Heat supply from of the header of the new boiler house	Gcal	4 900	5 140	4 056	4 182	2 618	0	0	0	2 069	4 303	4 526	6 062	37 855
2	Average temperature in the supply pipeline in the section running from the new boiler house to the connection point with the existing district heating network	^{0}C	56,95	59,52	56,03	53,44	49,35	0	0	0	54,70	55,10	58,00	67,10	-
3	Average temperature in the return pipeline in the section running from the new boiler house to the connection point with the existing district heating network	^{0}C	45,29	47,229	45,29	43,64	40,99	0	0	0	41,80	43,50	46,60	51,80	-
4	Average outside air temperature	^{0}C	-10,23	-9,51	-4,05	-1,01	8,83	0	0	0	10,40	1,50	-0,40	-11,20	--
5	Running hours of the heat pipeline	h	744	744	672	744	537	0	0	0	535	744	720	720	6 160
6	Volumetric consumption of diesel fuel in the new boiler house	l	77 460	0	0	0	0	0	0	0	0	0	0	0	77 460
7	Volumetric consumption of sawdust in the new boiler house	bulk m^3	3 807	3 489	3 537	3 432	1 954	0	0	0	4 914	9 319	9 385	4 377	44 214

Annex 4

Heat losses through insulated surface of supply and return pipelines from the point where the measuring device of the heat metering unit is installed to the border line of ownership and operational responsibility (Annex to Contract No.15/2008 dated 07.07.2008 for heat supply)

50^0C	100^0C
44.600	75.120

No.	Operation periods	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1	Number of hours in the period, hours,T	744	678	744	720	744	720	744	744	720	744	720	744	8 766
2	Average monthly and annual temperatures of outside air t_{oa}	-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
3	Temperatures in the supply pipeline according to the heating chart t_s	68	67	57,6	50	50	50	50	50	50	50	53	62	54,8
4	Temperatures in the return pipeline according to the heating chart t_r	53	52	46,3	42	42	42	42	42	42	42	44,5	49	44,9
5	Deviations of temperature in the supply pipeline from the table data Δt_s	18,0	17,0	7,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	12,0	4,8
6	Deviations of temperature in the return pipeline from the table data Δt_r	3	2	-3,7	-8	-8	-8	-8	-8	-8	-8	-5,5	-1	-5,1
7	Specific losses in the supply pipeline per 1 running m normalized to the chart temperature, (kcal/(m*h) $q_{in.s}$	55,587	54,977	49,239	44,600	44,600	44,600	44,600	44,600	44,600	44,600	46,431	51,925	47,501
8	Specific losses in the return pipeline per 1 running m normalized to the chart temperature, (kcal/(m*h) $q_{in.r}$	46,431	45,821	42,342	39,717	39,717	39,717	39,717	39,717	39,717	39,717	41,243	43,990	41,470
9	Total losses in the supply pipeline for the period normalized to the temperature chart, (Gcal) $Q_{in.s}$	24,351	21,947	21,570	18,908	19,538	18,908	19,538	19,538	18,908	19,538	19,684	22,747	245,172
10	Total losses in the return pipeline for the period normalized to the temperature chart, (Gcal) $Q_{in.r}$	20,419	18,363	18,621	16,903	17,467	16,903	17,467	17,467	16,903	17,467	17,553	19,346	214,878
11	Sum of losses in both pipelines (Gcal) $\sum Q$	44,770	40,310	40,191	35,811	37,004	35,811	37,004	37,004	35,811	37,004	37,236	42,092	460,050