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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

CMM Utilization at Severnaya Coal Mine of OJSC "Vorkutaugol", Russian Federation

Sectoral scopes[1]:

(8) Mining /mineral production

(10) Fugitive emissions from fuels (solid, oil and gas)

Version: 1.5

Date: 18 May 2011

A.2. Description of the project:

The aim of the project is utilization of coal mine methane (CMM) with power and heat generation at Severnaya Coal Mine of OJSC "Vorkutaugol".

Coal mining is one of the main sources of methane emissions to the atmosphere. Release of coal mine methane is inevitable in underground mining. Mine ventilation and gas drainage from mines are a compulsory requirement for any mining operations because this gas is highly explosive. Continuous degassing of a mine is ensured by vacuum pumping stations (VPSs). Methane is supplied to the surface as a component of methane-air mixture (MAM), methane concentration in which may vary between 20 and 70%.

Methane release at OJSC "Vorkutaugol" mines is significant – over 5 m^3 per tonne of extracted coal. Methane drainage at Severnaya Coal Mine prior to the project implementation was ensured by VPS-1 located on the main production site of the mine, and by VPS-2 located on the site of ventilation shaft No.1.

A lot of mines of Pechorsky coal basin already use CMM as fuel for production of heat for the mine's and neighbouring communities' needs. At Severnaya Coal Mine some CMM is used for heat production too – in gas air-heaters of the coal preparation plant (CPP) for coal drying and in autonomous gas air heaters (AGAH) for heating of air before feeding it to the mine. These consumers are located on the main production site and are supplied with gas coming from VPS-1. All undemanded methane is released into the atmosphere. While only part of methane is not utilized on the main production site, on the site of ventilation shaft No.1 all methane turns out to be unutilized as there are no heat consumers at all there.

The hot water demand for heating, ventilation and hot water supply of production facilities, offices and amenities buildings at Severnaya Coal Mine is satisfied by a reliable supplier – Vorkuta CHPP-2 which is located not far from the mine and is coal-fired. All electricity requirements are met by power supplies from the grid, OJSC "Vorkutaugol" does not have its own power generation facilities.

The baseline scenario envisages continuation of the current situation as described above.

The project scenario envisages utilization of undemanded methane in gas-piston heat and power co-generation plants (GPHPPs). However in order to ensure efficient and reliable operation of GPHPPs, it is necessary to ensure stable supply of MAM in required volumes and with a given methane concentration, and besides it is important to try to locate GPHPPs not only near VPSs but also close to

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

heat consumers. In this connection, before building GPHPPs it was necessary to invest into optimization of the mine's gas drainage system.

Thus the project is implemented in two consecutive stages:

Stage I: Construction of vacuum pumping station No.3 (VPS-3) on the site of ventilation shaft No.2 and decommissioning of VPS-2 for optimization of the mine's gas drainage system and for provision of stable drainage and preparation of methane for its combustion in GPHPPs. This stage also includes associated measures such as, for instance, optimization of the mine's underground network of gas drainage pipes, distribution of gas pumping volumes and attempting to achieve similar methane concentrations at VPS-1 and VPS-3.

VPS-3 is fitted with up-to-date equipment. Six dry rotary blowers manufactured by German company "Aerzener" are installed. VPS-3 is located in the vicinity of the existing heat network to which heat produced from methane can be fed.

The contract for VPS-3 construction was signed with LLC "Pechoruglerazvedka" on December 24, 2007 (this is considered to be the starting date of the project). VPS-3 was commissioned at the end of 2009.[2]

Stage II: Construction of two gas-piston heat and power plants with a capacity of 11.6 MW and 5.8 MW (GPHPP-1 and GPHPP-2 respectively), running on CMM and ensuring co-generation of heat and power for the needs of Severnaya Coal Mine.

GPHPP-1 will be located on the production site of ventilation shaft No.2 in the vicinity of VPS-3, and GPHPP-2 – on the main production site near VPS-1.

The power plants are fitted with gas-piston power generating units manufactured by German company "MWM" with a nominal capacity of 1932 kW. GPHPP-1 has six units, GPHPP-2 – three units.

The contractor for turnkey design and construction of the power plants is OJSC "Zvezda-Energetika". To date the development of design documentation has been completed and it is being reviewed by the state expert committee. Their commissioning is tentatively scheduled for October 01, 2011.

As a result of the project implementation at Severnaya Coal Mine there will be generated up to 110 million kWh of electricity and around 90 thousand Gcal of heat due to additional utilization of coal mine methane in the amount of up to 20 thousand tonnes per year.

The project serves to mitigate the environmental impact by reducing emissions of greenhouse gases (methane and carbon dioxide), sulphur oxides and nitrogen oxides and other pollutants.

GHG emissions will be cut down mainly due to reduction in methane emissions. Methane is a gas with global warming potential of 21. Besides, GHG emissions will be reduced also due to reduction in fossil fuel combustion by third-party heat and power suppliers. GHG emission reductions are expected to be at the level of 456 thousand tonnes of CO_2e per year.

At the moment when the decision regarding the project implementation was made the required investments were estimated at RUR 652 million (USD 26.4 million). The actual cost of the first stage of the project amounted to RUR 183.4 million. According to the latest plans the cost of the second project stage is projected to amount to RUR 780 million, and the cost of the entire project – to RUR 963.4 million (USD 31.8 million).

[2] http://www.severstal.com/rus/media/news/document3022.phtml

It should be said that in 2005-2007 the company studied the possibility of implementing a big project titled “Optimization of Gas Drainage and Methane Utilization System in Vorkuta”. This project proposed optimization of the gas drainage system with a view to increasing methane drainage volumes; and installation of in-house generation facilities with a view to covering ~100% of the heat and power demand at all mines of OJSC “Vorkutaugol”. Severnaya Coal Mine was selected as a site for a pilot project. It was expected that construction of VPS-3 and energy generating facilities at this mine would be completed by the year 2008. Construction of similar facilities at other mines was supposed to be completed the by the end of 2010. Various options of project implementation together with foreign partners were considered. Due to multiple reasons the decision to implement the programme in full was not made. By the end of 2007 it was decided to implement only the pilot phase of the project – construction of VPS-3 and generation facilities at Severnaya Coal Mine.

The possibility to obtain carbon financing played the key role in making the decision to launch this project. All possible options of the project implementation as JI were considered and discussed with a number of specialized companies.

Thus, as early as 2005 Not-for-Profit Organization “Center of Coal and Methane Researches - “Uglemetan” (NPO “Uglemetan”) initiated and headed a consortium[3] for a major Joint Implementation Project under the Kyoto Protocol for CJSC “Severstal-Resource”. In 2006 the specialists of NPO “Uglemetan” developed a version of the project design documentation (PDD) covering measures of a comprehensive methane utilization programme at several mines of OJSC “Vorkutaugol”. Considering that the decision to implement the project in its entirety was never taken the project determination was postponed.

It should be also mentioned that in February 2007 CJSC “Severstal-Resource” and “STEAG Saar Energie AG” (Germany) signed a declaration of joint work on the project of optimization of coal mine methane[4] drainage and utilization at Vorkutaugol’s mines. To ensure financing of the project under the Kyoto Protocol, which was ratified by both Germany and Russia, the parties intended to use the Joint Implementation Mechanism.

Since the PDD, eventually, demanded a complete redesign, a tender was announced in April 2010 to determine a company-developer of a new PDD, the tender was awarded to CCGS LLC.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party A: Russia (Host Party)	Open Joint Stock Company “Vorkutaugol”	No
One of the parties of Annex B to the Kyoto Protocol	To be determined within 12 months after approval of the project by the Russian Government	No

[3] http://www.uglemetan.ru/carbon_documentation.htm

[4] http://www.ecoindustry.ru/news/company/view/13626.html#

OJSC "Vorkutaugol"

Vorkutaugol[5] is a part of feedstock division of OJSC "Severstal" and is the biggest enterprise in the city of Vorkuta. It is one of the biggest coal producers in Russia. The future of the multi-profile development of Pechorsky coal basin and adjacent territories of Polar and Northern Ural relies on Vorkutaugol. The company accounts for 6% of the total coal mined in the Russian Federation and for 22% of coking coals.

Pechorsky coal basin, where Vorkutaugol's mines are located, is a large base of raw material supplies for energy, metallurgical and coke-chemical industries. Vorkuta geological and industrial region has Europe's largest coal reserves (in the order of 4 billion tonnes) and high industrial potential.

The major consumer purchasing over half of coal produced by Vorkutaugol, is OJSC "Severstal" – one of the largest and most profitable iron and steel companies of the Russian Federation. Seven of the thirteen companies producing coke in Russia incorporate Vorkuta coals into their furnace charge. The current sale market for Vorkutaugol's produce is characterized by robust and stable relations not only with Cherepovetz (OJSC "Severstal") but also with Novolipetsk and Nizhnetagilsk integrated iron and steel works, with Moscow coke gasworks, Leningrad Industrial Hub, besides some coal is sold internationally. Moreover, high quality coals are also in demand with the Ural companies – Chelyabinsk and Magnitogorsk integrated iron and steel works.

OJSC "Vorkutaugol" consists of a main production line (five underground mines and one coal strip mine) and auxiliary production facilities (central coal preparation plant, mechanical plant and a transport company).

A.4. Technical description of the project:

A.4.1. Location of the project:

Location of the project: Russian Federation, Komi Republic, Vorkuta, Severny Settlement, Severnaya Mine (See Fig. A.4-1, A.4-2, A.4-3).

Fig. A.4-1. The Komi Republic on the map of the Russian Federation

[5] http://www.vorkutaugol.ru

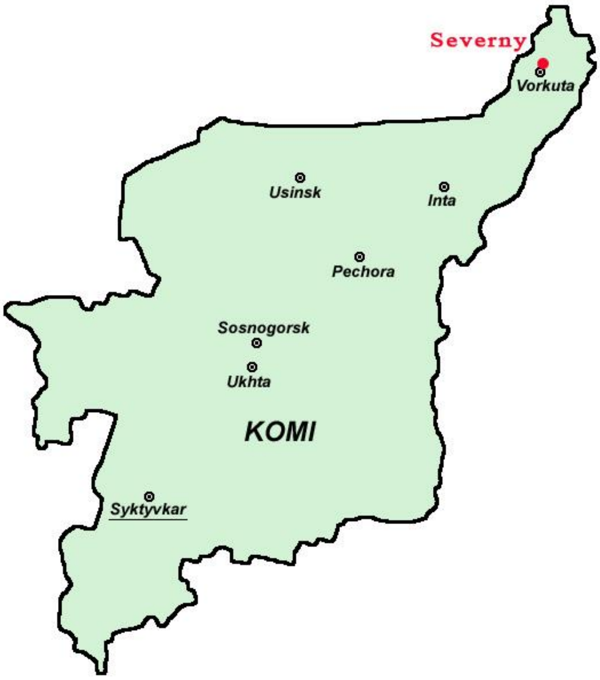

Fig. A.4-2. City of Vorkuta and Severny settlement on the map of the Komi Republic

A.4.1.1. Host Party(ies):

Russian Federation

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

The Komi Republic

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

City of Vorkuta, Severny urban-type settlement

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

Severnaya Coal Mine is located 12 km from the city of Vorkuta near Severny urban-type settlement which forms a part of "Vorkuta" urban district.

Vorkuta is a city in the north of the Komi Republic on the Vorkuta River, 904 km from the capital of the Republic – Syktyvkar. The population is 71.4 thousand (2009). The Komi Republic lies in the eastern part of the North-Western Federal District of the Russian Federation. Time zone GMT: +3:00

Location of the plants (determined by GPS navigator during the initial site visit):

GPHPP-1: geographical latitude: 67°34'. Geographic longitude: 64°00'.

GPHPP-2: geographical latitude: 67°35'. Geographic longitude: 64°04'.

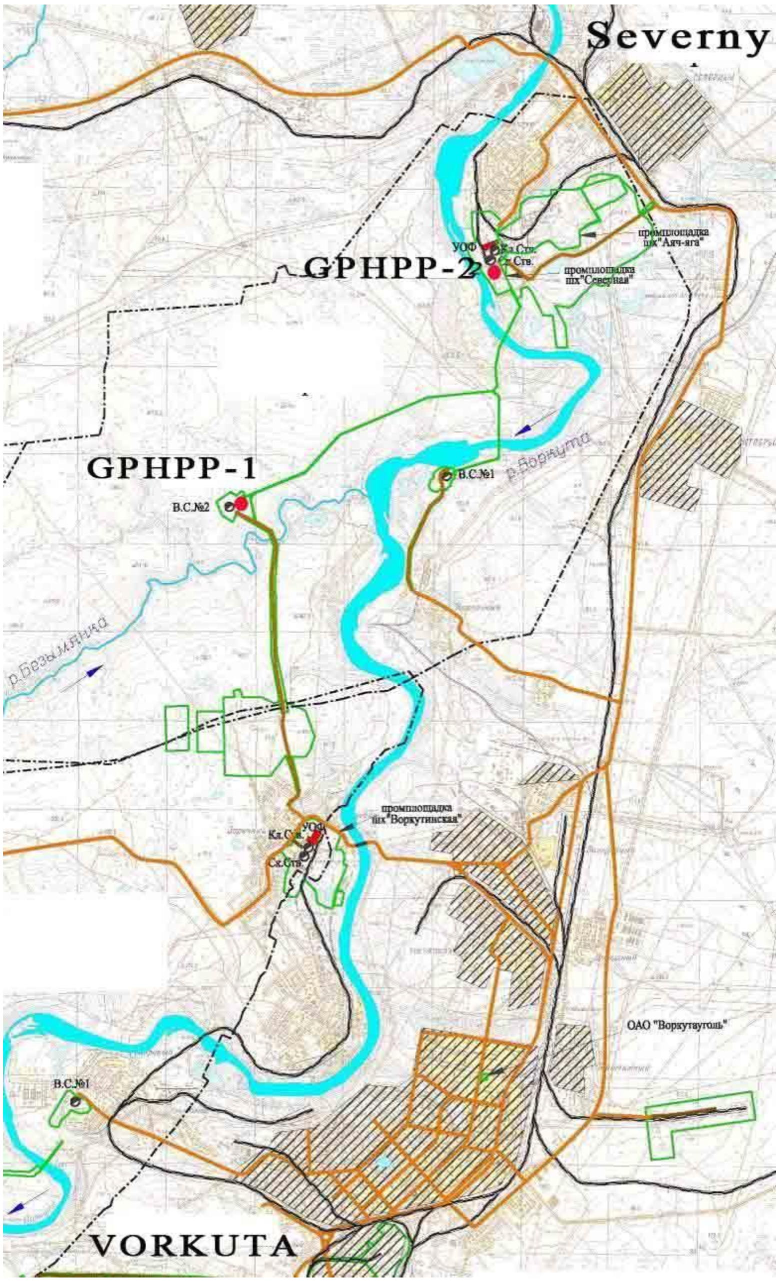

Fig. A.4-3. Location of GPHPP-1 and GPHPP-2

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

Severnaya Coal Mine

Severnaya Coal Mine where the project is implemented was put into operation in 1969. On site of the mine there is a coal preparation plant operational from March, 1971. Today the design capacity of the mine is 2.91 million tonnes of mined rock per year and 2.21 million tonnes of commercial coal per year.

The produced coal falls under the category of mid-ash, low-sulfur and low-phosphorous coals. The ash content in clean coal varies from seam to seam between 12% and 15%, sulfur content is 0.5-0.7%. Volatile-matter content varies between 30% and 32.5%, thickness of plastic layer – from 17 to 20 mm, vitrinite reflectance – from 0.97 to 1.09. Judging by these parameters in accordance with GOST 25543-88 this coal falls under ZH grade, being a valuable raw material for coking.

Fig. A.4-4. Severnaya Coal Mine of OJSC “Vorkutaugol”

<u>Overview of the existing technological processes affected by the project</u>

Description of the existing gas drainage system (prior to the project)

Currently the mine has accumulated a lot of experience in mine degassing. These operations are necessitated by the following:

- impossibility to achieve high working face output without gas drainage and, as a consequence, reduction in efficiency of high-performance equipment and reduction in the mine’s operation efficiency on the whole;

- requirement to reduce methane release into the mine tunnels in order to reduce the load on ventilation network and main ventilation fans, to ensure more suitable, safer and more comfortable working conditions in the mine;

- possibility to utilize methane for air heating, coal drying and in local energy generating units.

The main degassing method is methane capture from underworked (overworked) seams (adjacent seams) in the zone of their underworking (overworking) through underground boreholes.

The holes are bored from mine tunnels and are located along the outline of the worked-out area of extraction pillars. Boring is made from mine tunnels adjacent to the working face, and in paired development – from parallel headings supported after longwall face and also from flank headings.

Parameters, number of boreholes and distance between bunches at each section are determined by the longwall face design which takes into account geological and mining conditions of a given mine section.

Prior to the project implementation mine gas drainage and methane capture were ensured by two vacuum pumping stations: VPS-1 located on the main production site of the mine and VPS-2 located on the production site of ventilation shaft No.1.

The flow of methane/air mixture to VPSs is made up by MAM volume in the operating sections, air inleakage to the gas pipeline and MAM volume drained from the old gas drainage fields. Methane concentration in MAM may vary between 25% and 70%.

MAM is transported from the sources to the vacuum pumping stations via a network of underground degassing pipelines.

Vacuum pumping station No.1 (VPS-1)

Vacuum pumping station No.1 is designed for MAM suction during gas drainage at Severnaya Coal Mine and for supply of the gaseous fuel to the drying shop of the coal preparation plant (CPP) and to autonomous gas air heater (AGAH) of Severnaya Coal Mine for heating of air that is supplied to the mine through a shaft with cage winding. The plant operates in a continuous mode.

VPS-1 has 11 water-ring vacuum pumps of HB-50 type, of which six are constantly in operation.

Vacuum pumping station No. 1 has the following facilities:

1. Machine hall No.1 housing five water-circuit vacuum pumps with instrumentation and control equipment, suction and discharge gas ducts, intermediate tanks, circulating water supply pipeline and emergency ventilation fan No.1.

2. Machine hall No.2 housing six water-circuit vacuum pumps with instrumentation and control equipment, suction and discharge gas ducts, circulating water supply pipeline, emergency ventilation fans, gas control unit for gas supply at AGAH.

3. Switch bay with complete transformer substation 2KTP-1000 with two transformers TSZ-1000/6/0.4 and 380 V switchgear. Electric equipment, industrial version.

4. Operator's room with control board and control and signalization relay cabinets. Electric equipment, industrial version.

5. 2nd floor room where head tank of the station's hydraulic system and gas control device of gas supply to the CPP drying shop are located, emergency ventilation fan No. 4.

6. Control and instrumentation room with AG0012 automatic gas analyzers, emergency ventilation fan.

Vacuum pumping station No.2 (VPS-2)

Vacuum pumping station No.2 is intended to pump out MAM at ventilation shaft No.1. VPS-2 has 12 vacuum pumps, of which 2 are in operation.

Methane utilization at ventilation shaft No.1 is not possible because there are no heat consumers in the area where VPS-2 is located, therefore prior to the project implementation significant volumes of methane were vented into the atmosphere.

The analysis of the existing gas drainage network of the mine indicates its main drawbacks: no utilization of captured methane at ventilation shaft No.1 (VPS-2) and limited throughput capacity of the gas drainage pipeline from the mine to the surface (along the skip shaft and boreholes) at VPS-1.

The optimum development option for the mine gas drainage scheme is construction and commissioning of a new vacuum pumping station VPS-3 at ventilation shaft No.2. Methane drained at ventilation shaft No.2 can be utilized to generate heat and power. At that, this will not cause any problems with consumption of energy generated at this section.

At present, as a result of the project VPS-2 is out of operation and is laid up.

The existing scheme of drained methane utilization

At the present time methane is utilized at Severnaya Coal Mine only in the drying unit of CPP and in AGAH.

These installations are located on the main production site of the mine and the methane/air mixture is supplied to them from VPS-1. There are constantly gas surpluses which are released into atmosphere through gas vent stacks at VPS-1, CPP and AGAH respectively.

Description of the project measures

Stage I: Construction of vacuum pumping station No.3 (VPS-3)

Vacuum pumping station No.3 is designed for MAM suction during gas drainage at Severnaya Coal Mine with further utilization of MAM in gas-piston engines. VPS-3 is installed on the production site of ventilation shaft No.2, whereas VPS-2 at ventilation shaft No.1 is decommissioned. The pumping rate of VPS-3 is 450 m^3 of MAM per minute.

Vacuum pumping station No.3 has the following rooms:

1. Machine hall housing six dry rotary Aerzener GM 240 S blowers with control and monitor equipment (there shall be three air blowers in operation at a time), suction and discharge gas pipelines with shut-off and regulating valves, 4 emergency ventilation fans, and a centrifugal vertical separator of SCV 5G-1220/0.5-450 type.
2. Operator's room where control cubicles for six blowers and shut-off and regulating valves are installed.
3. Control room, where "Mikon 1R" gas protection equipment and "Krug" equipment are installed.

Stage I has been completed by now. The contract for VPS-3 construction was signed with LLC "Pechoruglerazvedka" on December 24, 2007. Construction and installation works were carried out from November 2008 to November 2009. The facility was accepted for operation on November 16, 2009 which is confirmed by the act of the working committee.

Construction of VPS-3 helped to optimize the mine's degassing system which was a necessary step in ensuring methane utilization for heat and power generation.

Fig. A.4-5. VPS-3 is the first completed facility within the framework of the methane utilization project at Severnaya Coal Mine of OJSC "Vorkutaugol"

Stage II: Construction of GPHPP-1 and GPHPP-2

The project involves construction of two gas-piston heat and power plants running on drained methane.

11.6 MW GPHPP-1 will be located on the production site of ventilation shaft No.2, and 5.8 MW GPHPP-2 – on the main production site of Severnaya Coal Mine. Gas will be supplied to GPHPP-1 from VPS-3 and to GPHPP-2 – from VPS-1.

GPHPP-1's site has the following facilities:

- 6 gas-piston power generator modules;
- Module of 6.3 kV indoor switch-gear (ISG);
- Module of 0.4 kV main switchboard (MSB);
- Heat substation module;
- Gas preparation block with metering unit;
- Reservoirs for cooling fluid and lubricant drain;
- Floodlight towers with lightning rods;
- Flue stacks;
- Engineering and cable networks;
- Fencing and access way.

GPHPP-2's site has the following facilities:

- 3 gas-piston power generator modules;
- Module of 6.3 kV indoor switch-gear (ISG);
- Module of 0.4 kV main switchboard (MSB);
- Heat substation module;
- Gas preparation block with metering unit;
- Reservoirs for cooling fluid and lubricant drain;
- Floodlight towers with lightning rods;
- Flue stacks;
- Engineering and cable networks;
- Fencing and access way.

Besides VPS-1 and central heating substation are subjected to partial reconstruction.

Fig. A.4-6 shows the concept scheme of the project.

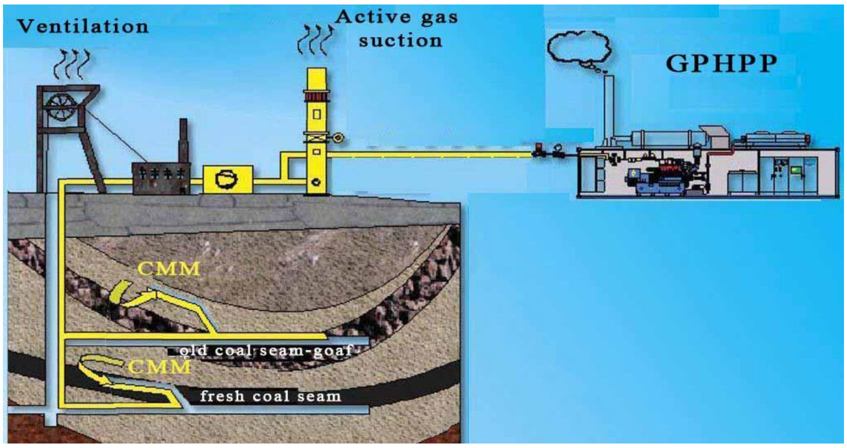

Fig. A.4-6. The concept scheme of the project

Gas-piston power generator and main characteristics of GPHPPs

The power plants are built on the basis of generating sets with the generator being driven by a gas-piston engine with a waste heat recovery system. The manufacturer of these generating sets is "MWM" (Germany), the engine type is TCG2020V20 (See Fig. A.4-7). The unit capacity of the generating set when running on coal mine gas with 35-45% methane concentration is 1932 kW.

Fig. A.4-7. General view of the generating set manufactured by "MWM" (Germany), TCG2020V20 type

At methane concentration ranging between 28% and 35% and between 45% and 60% the engines are operational but have lower output. The range of rated power output at 35-45% methane concentration was chosen because of the requirement that the engines could be moved from one site to another without replacing the fuel equipment. Methane concentration at VPS-1 (main production site) according to the log data in the period from 6.01.2010 to 12.01.2010 was 60-71% (machine hall No.1), and 46-55% (machine hall No.2). Methane concentration at VPS-3 (ventilation shaft No.2) according to the log data in the period from 29.12.2009 to 12.01.10 was 25-34%.

Methane concentration at VPS-3 can be increased by switching it to the gas drainage system of the gassy sections of the mine. Methane concentration at VPS-1 can be reduced by switching additional vacuum pumps in operation, or alternatively, by switching it to less gassy sections. Thus methane concentrations at both sites can be levelled at 35-45% by some arrangements.

Generating sets of each GPHPP are united (electrically) in 6.3kV indoor switchgear (ISG-6.3kV). Power from ISG-6.3kV is transmitted via two outgoing lines to the substations of Severnaya Coal Mine. The GPHPP's consumers of auxiliary needs are supplied with power from the main 0.4 kV switchboard of auxiliary needs (MSB AN-0.4 kV).

The heat and power plant is connected to the gas pipeline, process pipelines of the heat supply system, connecting cable lines and other systems which ensure technological connection of the plant with the external systems of Severnaya Coal Mine.

Main performance characteristics of both GPHPPs are given in Table A.4-1.

Table A.4-1. Main performance characteristics of GPHPPs

No.	Characteristic	Unit	Value	
			GPHPP No.1	GPHPP No.2
1.	Engine type	-	TCG2020V20	

2.	Installed electric capacity at methane number MI 40	kW	6x1932=11592	3x1932=5796
3.	Installed thermal capacity at 100% load of GPHPP	kW	6x1990=11940	3x1990=5970
4.	Electric efficiency	%	42	
5.	Thermal efficiency	%	43	
6.	NOx emission	mg/m^3	500	

Waste heat recovery system

The project envisages recovery of heat from exhaust gases and engine's inner high-temperature cooling circuits using gas-water heat recovery boilers and heat exchangers. Heat (hot water) recovered from secondary circuits of heat exchangers is used for heat supply of the consumers. All heat from the GPHPPs' recovery systems is supplied to the heat supply networks of the main production site and of ventilation shaft No.2 via existing heat substations which are to be partially reconstructed.

Due to the heat recovery up to 11.9 MW (10.3 Gcal/hour) of heat are supplied from GPHPP-1, and up to 6 MW (5.1 Gcal/hour) are supplied from GPHPP-2 at 100% load and 115/70 °C temperatures. The quantity of recovered heat is directly proportional to generated power. If the level of heat loads is insufficient:

- gas-piston engine's own circuits are cooled by means of emergency cooling air fans;
- heat from the heat recovery boiler is fed to the air cooler. In the time between the heating seasons the combustion products are directed around the heat recovery boiler. Heat carrier is supplied to the heat recovery systems and to the separating network heat exchangers (intermediate loop) by circulating pumps installed in the heat substation of GPHPPs. The circulating pumps installed in the heat substation of GPHPPs also supply delivery water to the network dividing heat exchangers.

Gas conditioning system

The efficiency and lifetime of the gas-piston engines depends on the performance and reliability of the gas conditioning system.

Gas conditioning is governed by the type of the gas drainage equipment.

VPS-1 pumps out gas with a 100% moisture content and contaminated with coal dust and all non-organic elements that are present in the make-up circuit – carbonates, iron, and colonies of sulfate-reducing bacteria. VPS-3 pumps out gas with a moisture content of up to 90%, contaminated with coal dust, but in a much lesser degree. This is due to preliminary treatment of gas in separators/cyclones at the suction side of rotary vacuum pumps.

The measures envisaged at VPS-1 include boosting the methane/air mixture (MAM) pressure to 0.8 bar, using a filtration (including by gravity) system, 2-stage separation and heating by means of flow-through electric heaters (and as a result – reduction in relative moisture content down to ≤80%). All gas conditioning equipment will be well packed and located in isolated cabinets close to the containers with gas-piston generating sets.

VPS-3 shall have a filtration (including by gravity) system, separation. Gas moisture content is decreased by means of consecutive cooling of MAM mixture in the air cooling installation and then heating it up in the gas/gas heat exchanger using the heat of the outlet MAM flow at the pump discharge side. The gas treatment equipment is located in a block container on site of GPHPP No.1.

VPS-1 and VPS-3 are fitted with gas metering within the boundaries of the MAM conditioning systems.

Planned timeframe of the second stage of the project

The general contractor contract for power plant design and turnkey construction was signed with OJSC "Zvezda-Energetika" on May 18, 2010. Table A.2-1 shows the planned timeframe of main contract works.

Table A.2-1. Key milestones and dates of the second stage of the project

Milestone	Implementation period
Development of design documentation	01.07.2010 – 15.12.2010
Expert review of design documentation	01.02.2010 – 01.08.2011
Development of working documentation	01.12.2010 – 01.08.2011
Equipment supply	20.09.2010 – 01.07.2011
Equipment mounting	15.06.2011 – 18.08.2011
Set up and adjustment	01.09.2011 – 25.09.2011
Commissioning	Tentatively October 1, 2011

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

GHG emission reductions are mainly due to reduction in coal mine methane emissions achieved by the project. Methane, a gas with high Global Warming Potential (GWP= 21), will be fired in gas-piston power plants and become CO_2 (GWP=1) and water vapor.

Moreover the project will cause reduction in GHG emissions from fossil fuel combustion. Power generation will allow to substitute some grid power, and heat production will allow to decrease heat consumption from the external source – Vorkuta CHPP-2 of OJSC "TGK-9". The grid power plants will reduce their fossil fuel consumption and Vorkuta CHPP-2, specifically, will cut down on coal combustion.

It is unlikely that the project which results in GHG emission reductions would have been implemented without the joint implementation mechanism. There are the following reasons for that:

- It is not expected that there will be any significant changes in the Russian environmental legislation, which might force the company to discontinue its CMM handling practice;
- There are no caps on GHG emissions for companies in Russia;
- External suppliers can still ensure reliable power and heat supplies which can fully cover the mine's demand;
- Unlike many other mines in the Russian Federation, Severnaya Coal Mine already utilizes a significant proportion of CMM for heat production;
- The project's rate of return without additional revenues from sale of emission reductions is not sufficiently high;

- Without the project the company could have avoided significant and fairly risky financial investments into operation of new and unknown equipment. OJSC "Vorkutaugol" has no previous experience with power generating equipment. Unstable methane concentration in MAM and potential changes in MAM flow may make GPHPPs operation very challenging and reduce its performance efficiency.

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

	Years
Length of the crediting period	1.25
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2011	114 035
2012	456 141
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**570 176**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	456 141

A.5. Project approval by the Parties involved:

The Letters of Approval will be obtained later.

SECTION B. Baseline

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

Selection of the approach to baseline setting

In setting the baseline the PDD developer used JI specific approach based on paragraph 9 (a) of the "Guidance on criteria for baseline setting and monitoring" [R9].

The baseline was set in accordance with Appendix B of Annex to *Decision 9/CMP.1* [R1]. The justification of the baseline was elaborated in accordance with paragraphs 23-29 of the "Guidance on criteria for baseline setting and monitoring".

The most likely baseline scenario was selected based on the analysis of several project alternatives. The selection of the baseline was justified using Annex 1 of the "Guidance on criteria for baseline setting and monitoring".

Then main factors affecting emission reductions were identified and analyzed. The projections were made on the basis of the design GPHPP performance data with allowance for the available methane drainage data and for the mine's power consumption data. All key data, factors and assumptions affecting GHG emission reductions are considered on a transparent and conservative basis.

Identification of the plausible future scenarios and selection of the baseline scenario

Step 1: Identification of plausible future scenarios

Step 1a: Identification of the type of removed methane

a) ventilation methane;

b) drained methane;

c) possible combinations of *a* and *b*.

At Severnaya coal mine methane is removed by means of ventilation and gas drainage because of a high release level. Gas is removed continuously – before, during and after coal mining operations. Since methane concentration in gas removed during ventilation of the mine is small (0.1-1%) its utilization is technically challenging and is not economically attractive. Thus the project covers only handling of **drained methane** which is pumped out of the mine continuously with the help of vacuum pumping stations. The drained methane concentration in the pumped MAM is significant (20-70%).

Step 1b: Identification of drained methane handling methods

Further below are technically feasible methods of handling drained methane which was supplied to the surface:[6]

I. *Venting*. The fundamental requirement of the Russian legislation related to coal mine methane is ensuring safety during mining operations. To this end according to the "Recommended practice of gas drainage from coal mines" [R7] gas should be removed and at least released into the atmosphere. The Russian legislation does not prescribe to fire/destroy or in any way utilize coal mine methane. Venting of methane is widely practiced at Russian coal mines, because this method is quite simple and does not require any additional financial investments. Other ways of drained coal mine methane handling as shown below turn out to be unfeasible. **The methane venting**

[6] Meaning the quantity of methane which will be used within the framework of the project activity, that is in GPHPP-1 and GPHPP-2.

alternative is the most likely method of drained coal mine methane handling for the baseline scenario.

II. *Flaring of drained methane.* This alternative presupposes combustion of methane in a special gas utilization installation without energy generation. As it was mentioned above, Russian legislation does not prescribe to utilize coal mine methane by means of its combustion. However, simple combustion of drained methane in a flare unit without its preliminary preparation is not allowed. According to the "Recommended practice of gas drainage from coal mines" [R7], stable and safe combustion of methane requires that methane concentration in MAM should not be less than 25%. It is necessary to approve a separate design for gas combustion installations and to ensure combustion control. All these measures require additional financial investments, which however are economically meaningless for an enterprise unless they are implemented within the framework of joint implementation mechanism. Therefore this alternative is unlikely.

III. *Use for power generation.* This scenario envisages construction of power plants running on drained CMM, and so it is related to the project scenario. Maintenance and operation of generating units is a new and non-core line of activity for OJSC "Vorkutaugol". Moreover, Russia hardly knows any previous examples of similar projects implementation. Of all possible types of energy generating installations gas-piston power plants are the most reliable and ensure the most sustainable operation when running on methane air mixture. This also allows heat production. Implementation of this alternative requires significant capital expenditure. The investment analysis (See Section B.2) shows that **economic parameters of the project without the joint implementation mechanism are unacceptably low.** Thus, this alternative is unlikely to be implemented as the baseline scenario.

IV. *Use for heat production.* At a lot of mines of Pechorsky coal basin coal mine methane is used as fuel for boiler houses to meet the mine's heat demand. At Severnaya Coal Mine some drained CMM is already used for heat production too – in gas air heaters of CPP for coal drying and in AGAH for air heating before feeding it to the mine. The hot water demand for heating, ventilation and hot water supply of the production facilities, offices and amenities buildings is met by a reliable third-party supplier – Vorkuta CHPP-2 located near Severnaya Coal Mine. The company is not interested in construction of a boiler house only. On one hand, this option would fully cover its heat demand; on the other hand, electricity would have to be purchased from the outside suppliers. This does not comply with the company's goals, as the company is striving to cover both heat and electricity demand by its own generation. The project envisages construction of GPHPPs with co-generation of heat and power. Thus this methane handling scenario is possible only within the framework of the project activity which in its turn is unlikely without using joint implementation mechanism.

V. *Supply to the gas pipeline* (to be used as fuel for transport vehicles or for production of heat/power). This alternative is not considered due to the lack of potential purchasers/consumers of this gas/air mixture with such inconstant composition. This alternative is not applicable.

Step 1c: Identification of heat and power generation options

Below we consider technically viable options of heat and power generation for the needs of Severnaya Coal Mine:[7]

1. *Power generation by combustion of coal mine methane.* As shown under item *III* above, **this scenario is a part of the project scenario.** It is unlikely that this alternative will be implemented as the baseline scenario.

[7] Meaning that quantity of heat and power which will be supplied from GPHPP-1 and GPHPP-2

2. *Heat production by combustion of coal mine methane.* As shown under item *IV* above, **this scenario is a part of the project scenario.** It is unlikely that this alternative will be implemented as the baseline scenario.
3. *Construction of a CHPP/boiler house running on a traditional fossil fuel* (natural gas, heavy fuel oil, coal). OJSC "Vorkutaugol" is not interested in construction of its own energy source for Severnaya Coal Mine which would run on a traditional fossil fuel, which in actual fact can be only coal. Coal-fired boiler houses and, even more so, coal-fired power plants require higher investments than gas-fired energy sources, if for no other reason than because they need to have a fuel supply and an ash handling systems. The nearby Vorkuta CHPP-2 meets the heat demand. The power demand is completely covered from the grid, there are no problems with power supplies. Energy generation is not the core business for OJSC "Vorkutaugol", the investments are primarily spent on maintenance and development of the mine's fixed assets to ensure stable and safe coal mining. Besides, coal combustion would have increased the environmental impact and environmental payments. In this connection, construction of the mine's own energy sources on a traditional fossil fuel is unlikely.
4. *Power supply from the grid and heat supply from the third party suppliers.* Severnaya Coal Mine receives all necessary power from the external power grid. Heat is supplied from Vorkuta CHPP-2 in the required quantity. Energy supply of the mine is reliable and does not cause any concern. **This alternative represents the most likely scenario regarding heat and power generation.**

Step 2: Ruling out scenarios which do not comply with legal and standard requirements

None of the specified drained CMM handling options and heat and power generation options contradicts the current legislation of the Russian Federation.

Step 3: Selection of the baseline scenario

Summarizing the above analysis of future scenarios with allowance for the investment analysis given in Section B.2, it was decided that the most likely scenario is **continuation of the current situation which suggests venting of drained methane (I) and provision of heat and power by third party suppliers (4).**

<u>Main factors that determine GHG emission reductions</u>

The main factors that determine GHG emission reductions as a result of the project:

- coal production volumes at Severnaya Coal Mine;
- volumes of coal mine methane drainage and utilization by the existing consumers;
- volumes of methane utilization at GPHPPs;
- power and heat generation at GPHPPs;
- reduction in heat production by boilers of Vorkuta CHPP-2 as a result of the project;
- reduction in coal consumption by Vorkuta CHPP-2 as a result of the project;
- reduction in heat-consumption-based power generation at Vorkuta CHPP-2 as a result of the project;
- reduction in power generation in the grid as a result of the project;
- GHG emission factors; and
- relative power losses in external power grid.

Further below each factor is considered in detail.

Volumes of coal production at Severnaya Coal Mine

Coal production data are not used for calculation of GHG emission reductions. However the quantity of drained coal mine methane and, ultimately, of GHG emission reductions depends on coal production (this dependence is non-linear and is determined by numerous concurrent factors). It is reasonable to provide coal production data to demonstrate the company's development pattern.

Table B.1-1 shows actual coal production data for the years 2007-2010, as well as production volumes planned for the years 2011-2015. As is seen from the table, production volume may vary but within a relatively small range determined by the coal market conditions. If we compare the actual coal production data and gas drainage data (see below) there is no reason to believe that the quantity of coal mine methane at the mine will significantly change in the short term.

Table B.1-1. Coal production at Severnaya Coal Mine in 2007-2015

Severnaya Coal Mine	2007 fact	2008 fact	2009 fact	2010 fact	2011 projected	2012 projected	2013 projected	2014 projected	2015 projected
Production, thousand tonnes	2577	2068	2031	2036	2200	2200	3130	2540	2920

Volumes of coal mine methane drainage and utilization by the existing consumers

Table B.1-2 below shows actual quantities of drained methane/air mixture (MAM) and methane, as well as their respective temperatures and density for the period from 2007 to 2010. These data served as the basis for determination of the GPHPPs capacities.

Table B.1-2. Data on MAM and coal mine methane for the period 2007-2010

Parameter	Unit	2007	2008	2009	2010
MAM quantity at VPS -1	million m^3	94.443	82.970	74.073	72.595
MAM quantity at VPS-2	million m^3	88.880	77.558	52.253	
MAM quantity at VPS-3	million m^3				67.702
Average methane concentration at VPS-1	%	47	40	45	43
Average methane concentration at VPS-2	%	32	40	34	
Average methane concentration at VPS-3	%				43
Coal mine methane quantity at VPS-1	million m^3	44.388	33.188	33.333	31.216
Coal mine methane quantity at VPS-2	million m^3	28.797	31.023	17.766	
Coal mine methane quantity at VPS-3	million m^3				29.112
Total coal mine methane quantity	million m^3	73.185	64.211	51.099	60.328
Average temperature of methane at VPS-1	°C	43.0	43.4	42.5	43
Average temperature of methane at VPS-2	°C	32.4	34.8	35.3	
Average temperature of methane at VPS-3	°C				10
Average density of methane at VPS-1	kg/m^3	0.601	0.600	0.602	0.601
Average density of methane at VPS-2	kg/m^3	0.621	0.617	0.616	
Average density of methane at VPS-3	kg/m^3				0.671
Coal mine methane quantity at VPS-1	1000 tonnes	26.659	19.907	20.051	18.748
Coal mine methane quantity at VPS-2	1000 tonnes	17.895	19.128	10.936	
Coal mine methane quantity at VPS-3	1000 tonnes				19.523
Total coal mine methane quantity	**1000 tonnes**	**44.554**	**39.035**	**30.987**	**38.271**

Methane supplied to AGAH	million m^3	16.597	14.190	13.409	12.055
Methane supplied to CPP	million m^3	22.226	18.995	18.554	16.237
Methane supplied to AGAH	1000 tonnes	9.968	8.511	8.066	7.240
Methane supplied to CPP	1000 tonnes	13.349	11.394	11.161	9.752
Total supplied methane to AGAH and CPP	**1000 tonnes**	**23.316**	**19.905**	**19.227**	**16.992**
Residue (venting from VPSs)	**1000 tonnes**	**21.237**	**19.130**	**11.761**	**21.28**

It should be said that the methane volume at the mine is determined with allowance for its average temperature and is adjusted for 740 mmHg. Mass quantity of methane was determined based on its density, kg/m^3, which was calculated as: 16/22.41*(273)/(273+*t*)*740/760, where 16 is the molar mass of methane, g/mol; 22.41 is the molar volume of methane at standard conditions, l/mol, corresponding to temperature of 273 K and pressure of 760 mmHg; *t* – methane temperature, ^oC.

Supply of coal mine methane to AGAH and CPP as a result of the project will not go down. The project does not affect the system where air is heated before being supplied to the mine nor the coal drying system. These installations must be supplied with all required gas in any case in order to meet the mine's process needs. Besides, the comparative analysis of Table B.1-2. and Table B.1-3. below shows that even with the full loading of GPHPPs and with AGAH and CPP's loading being the same as in the past, it is most likely that some gas will be superfluous and will be therefore fed to the gas vent stack. Thus it is not necessary to monitor gas volumes for AGAH and CPP, and so these sources are excluded from the project boundaries.

Methane utilization at GPHPPs

As a result of the project, methane in addition to being utilized in AGAH and CPP is also utilized in GPHPP-1 and GPHPP-2. Below are the calculation and key parameters which determine methane utilization at both GPHPPs.

The quantity of methane utilized at GPHPP-1 during the year *y*, thousand tonnes:

$$MM_{GPHPP-1,y} = \frac{3.6 \cdot P_{GPHPP-1} \cdot T_{GPHPP-1,y} \cdot k_{GPHPP-1}}{1000 \cdot \eta^{el}_{GPHPP} \cdot NCV_{methane}}. \quad \text{(B.1-1)}$$

The quantity of methane utilized at GPHPP-2 during the year *y*, thousand tonnes:

$$MM_{GPHPP-2,y} = \frac{3.6 \cdot P_{GPHPP-2} \cdot T_{GPHPP-2,y} \cdot k_{GPHPP-2}}{1000 \cdot \eta^{el}_{GPHPP} \cdot NCV_{methane}}. \quad \text{(B.1-2)}$$

The parameters used in the above formulae are described in the Tables below:

Data/Parameter	$P_{GPHPP-1,y}$
Data unit	kW
Description	Installed electric capacity of GPHPP-1
Time of determination/monitoring	February 2011
Source of data (to be) used	Severnaya Coal Mine, OJSC "Vorkutaugol". GPHPP-1, GPHPP-2. Design Documentation. Section 1. Executive Summary. Volume 1. OJSC "Zvezda-Energetika", St.-Pet., 2010 [R6]
Value of data applied (for ex ante calculations/determinations)	11592
Justification of the choice of data or description of	Assumed as per the equipment manufacturer's data. GPHPP-1 consists of 6 gas-piston units with electric capacity of

measurement methods and procedures (to be) applied	1932 kW each, that is 6x1932=11592 kW
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is needed for estimation of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$P_{GPHPP-2,y}$
Data unit	kW
Description	Installed electric capacity of GPHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	Severnaya Coal Mine, OJSC “Vorkutaugol”. GPHPP-1, GPHPP-2. Design Documentation. Section 1. Executive Summary. Volume 1. OJSC “Zvezda-Energetika”, St.-Pet., 2010 [R6]
Value of data applied (for ex ante calculations/determinations)	5796
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Assumed as per the equipment manufacturer’s data. GPHPP-1 consists of 3 gas-piston units with electric capacity of 1932 kW each, that is 3x1932=5796 kW
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is needed for estimation of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$T_{GPHPP-1,y}$, $T_{GPHPP-2,y}$
Data unit	hour
Description	Number of running hours of GPHPP-1 and GPHPP-2 during the year *y*
Time of determination/monitoring	February 2011
Source of data (to be) used	Terms of Reference for the design of December 26, 2009 [R11].
Value of data applied (for ex ante calculations/determinations)	8064. In the first year of GPHPP operation the number of running hours is counted starting with the tentative commissioning date (October 01, 2011). That is for the year 2011 running hours are assumed to total 2016.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	According to the data of the terms of reference with allowance for the tentative commissioning date.
QA/QC procedures (to be) applied	Not required
Any comment	The assumed values are estimates and are needed for assessment of GHG emission reductions only. There is no need to monitor these parameters.

Data/Parameter	$k_{GPHPP-1,y}$, $k_{GPHPP-2,y}$
Data unit	-
Description	The plant factor for GPHPP-1 and GPHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	-
Value of data applied (for ex ante calculations/determinations)	0.825
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Expert evaluation taking into account data of the specialized company Green Gas[8] according to which the plant factor for technology of CMM use for electricity and heat is of 75-90%. This factor depends on many different circumstances, such as quality of supplied fuel, ensuring uninterrupted operation, capacity utilization. It is not possible in advance to determine the accurate value of this factor but we assumed the average value of indicated range.
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is an estimate and is needed for assessment of GHG emission reductions only. There is no need to monitor these parameters.

Data/Parameter	$NCV_{methane}$
Data unit	kJ/kg
Description	Net calorific value of methane
Time of determination/monitoring	February 2011
Source of data (to be) used	Thermal design of boiler units (Normative method). Publishing House NPO CKTI, St.-Pet., 1998. [R5], Table 2-6
Value of data applied (for ex ante calculations/determinations)	50254
Justification of the choice of data or description of measurement methods and procedures (to be) applied	According to [R5] volumetric net calorific value of methane is 35880 kJ/m^3. Since molar volume of gas is 22.41 l/mol, and molar mass of methane can be assumed at 16 g/mol, then: $35880 / \frac{16}{22.41} = 50254$ kJ/kg
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is necessary only for estimation of GHG emission reductions. There is no need to monitor this parameter.

Data/Parameter	η_{GPHPP}^{el}
Data unit	-
Description	Electric efficiency of a gas-piston unit

[8] http://www.globalmethane.org/documents/events_coal_20100830_vorholz.pdf

Time of determination/monitoring	February 2011
Source of data (to be) used	Severnaya Coal Mine, OJSC "Vorkutaugol". GPHPP-1, GPHPP-2. Design Documentation. Section 1. Executive Summary. Volume 1. OJSC "Zvezda-Energetika", St.-Pet., 2010 [R6]
Value of data applied (for ex ante calculations/determinations)	0.42
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Assumed according to the equipment manufacturer's data
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is an estimate and is necessary only for assessment of GHG emission reductions. There is no need to monitor this parameter.

Data/Parameter	$MM_{GPHPP-1,y}$
Data unit	thousand tonnes
Description	Quantity of methane utilized at GPHPP-1
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 3.288; **2012**: 13.154
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$MM_{GPHPP-1,y} = \frac{3.6 \cdot P_{GPHPP-1} \cdot T_{GPHPP-1,y} \cdot k_{GPHPP-1}}{1000 \cdot \eta^{el}_{GPHPP} \cdot NCV_{methane}}$ $P_{GPHPP-1,y}$ is the installed electric capacity of GPHPP-1; $T_{GPHPP-1,y}$ is the number of running hours of GPHPP-1 during the year *y*; $k_{GPHPP-1,y}$ is the plant factor for GPHPP-1; η^{el}_{GPHPP} is the electric efficiency of a gas-piston unit; $NCV_{methane}$ is the net calorific value of methane
QA/QC procedures (to be) applied	Not required
Any comment	-

Data/Parameter	$MM_{GPHPP-2,y}$
Data unit	thousand tonnes
Description	Quantity of methane utilized at GPHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante	**2011** **2012**

calculations/determinations)	1.644 | 6.577
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$MM_{GPHPP-2,y} = \frac{3.6 \cdot P_{GPHPP-2} \cdot T_{GPHPP-2,y} \cdot k_{GPHPP-2}}{1000 \cdot \eta^{el}_{GPHPP} \cdot NCV_{methane}}$ $P_{GPHPP-2,y}$ is the installed electric capacity of GPHPP-2; $T_{GPHPP-2,y}$ is the number of running hours of GPHPP-2 during the year *y*; $k_{GPHPP-2,y}$ is the plant factor for GPHPP-2; η^{el}_{GPHPP} is the electric efficiency of a gas-piston unit; $NCV_{methane}$ is the net calorific value of methane
QA/QC procedures (to be) applied	Not required
Any comment	-

Heat and power generation at GPHPPs

Table B.1-3 shows actual consumption of heat and power at Severnaya Coal Mine. It is assumed that energy resources consumption by the mine in 2011-2012 will remain at the previous level.

Table B.1-3. Consumption of heat and power at Severnaya Coal Mine in 2006 – 2010

Parameter	Unit	2006	2007	2008	2009	2010
Heat consumption	Gcal	109 561	103 275	125 989	109 126	93 136
	GJ	458 732	432 412	527 516	456 911	389 960
Power consumption	MWh	107 363	111 934	105 883	102 067	118 963

In-house generation of power and heat at the mine is envisaged only under the project scenario. The project covers installation of GPHPP-1 on the site of ventilation shaft No.2 and installation of GPHPP-2 on the main production site. The fuel for the plants will be coal mine methane. The mine's own power plants are to meet most of Severnaya Coal Mine's demand for heat and power.

Power supply from GPHPP-1 during the year *y*, MWh:

$$ES_{GPHPP-1,y} = \frac{P_{GPHPP-1} \cdot T_{GPHPP-1,y} \cdot k_{GPHPP-1} \cdot (1-\varepsilon^{el}_{GPHPP})}{1000}. \quad (B.1-3)$$

Power supply from GPHPP-2 during the year *y*, MWh:

$$ES_{GPHPP-2,y} = \frac{P_{GPHPP-2} \cdot T_{GPHPP-2,y} \cdot k_{GPHPP-2} \cdot (1-\varepsilon^{el}_{GPHPP})}{1000}. \quad (B.1-4)$$

Heat supply from GPHPP-1 during the year *y*, GJ:

$$HS_{GPHPP-1,y} = \frac{3.6 \cdot k_{GPHPP-1} \cdot HP_{GPHPP-1} \cdot T_{HL,y}}{1000}. \quad (B.1-5)$$

Heat supply from GPHPP-2 during the year *y*, GJ:

$$HS_{GPHPP-2,y} = \frac{3.6 \cdot k_{GPHPP-2} \cdot HP_{GPHPP-2} \cdot T_{HL,y}}{1000}. \quad (B.1\text{-}6)$$

The description of the parameters used in the above formulae is given in the tabular form below:

Data/Parameter	ε^{el}_{GPHPP}
Data unit	-
Description	Relative power consumption for GPHPP-1's and GPHPP-2's auxiliary needs
Time of determination/monitoring	February 2011
Source of data (to be) used	Equipment supplier's data
Value of data applied (for ex ante calculations/determinations)	0.05
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended average value
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is an estimate and is needed for assessment of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$HP_{GPHPP-1}$
Data unit	kW
Description	Installed thermal capacity of GPHPP-1
Time of determination/monitoring	February 2011
Source of data (to be) used	Severnaya Coal Mine, OJSC "Vorkutaugol". GPHPP-1, GPHPP-2. Design Documentation. Section 1. Executive Summary. Volume 1. OJSC "Zvezda-Energetika", St.-Pet., 2010 [R6]
Value of data applied (for ex ante calculations/determinations)	11940
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Assumed according to the equipment manufacturer's data. GPHPP-1 consists of 6 gas-piston units with thermal capacity of 1990 kW each, that is 6x1990=11940kW
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is needed for assessment of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$HP_{GPHPP-2}$
Data unit	kW
Description	Installed thermal capacity of GPHPP-2
Time of determination/monitoring	February 2011

Source of data (to be) used	Severnaya Coal Mine, OJSC "Vorkutaugol". GPHPP-1, GPHPP-2. Design Documentation. Section 1. Executive Summary. Volume 1. OJSC "Zvezda-Energetika", St.-Pet., 2010 [R6]
Value of data applied (for ex ante calculations/determinations)	5970
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Assumed according to the equipment manufacturer's data. GPHPP-1 consists of 3 gas-piston units with thermal capacity of 1990 kW each, that is 3x1990=5970 kW
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is needed for assessment of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$T_{HL,y}$
Data unit	-
Description	Number of hours in the heating season in year *y*
Time of determination/monitoring	February 2011
Source of data (to be) used	Historical data on heat consumption at Severnaya Coal Mine
Value of data applied (for ex ante calculations/determinations)	7200
Justification of the choice of data or description of measurement methods and procedures (to be) applied	According to the historical data of Severnaya Coal Mine, heat is supplied to the mine around 7200 hours per year. In summer there is no heat load for about two months.
QA/QC procedures (to be) applied	Not required
Any comment	The assumed value is an estimate and is needed for assessment of GHG emission reductions only. There is no need to monitor this parameter.

Data/Parameter	$ES_{GPHPP-1,y}$
Data unit	MWh
Description	Power supply from GPHPP-1
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 18 316; **2012**: 73 263
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$ES_{GPHPP-1,y} = \frac{P_{GPHPP-1} \cdot T_{GPHPP-1,y} \cdot k_{GPHPP-1} \cdot (1-\varepsilon^{el}_{GPHPP})}{1000}$ $P_{GPHPP-1,y}$ is the installed electric capacity of GPHPP-1; $T_{GPHPP-1,y}$ is the number of running hours of GPHPP-1 during the year *y*;

	$k_{GPHPP-1,y}$ is the plant factor for GPHPP-1; ε^{el}_{GPHPP} is the relative power consumption for GPHPP-1's and GPHPP-2's auxiliary needs.
QA/QC procedures (to be) applied	Not required
Any comment	-

Data/Parameter	$HS_{GPHPP-1,y}$
Data unit	GJ
Description	Heat supply from GPHPP-1
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 63 834; **2012**: 255 337
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$HS_{GPHPP-1,y} = \frac{3.6 \cdot k_{GPHPP-1} \cdot HP_{GPHPP-1} \cdot T_{HL,y}}{1000}$ $k_{GPHPP-1,y}$ is the plant factor for GPHPP-1; $HP_{GPHPP-1}$ is the installed thermal capacity of GPHPP-1; $T_{HL,y}$ is the number of hours in the heating season in year *y*.
QA/QC procedures (to be) applied	Not required
Any comment	-

Data/Parameter	$ES_{GPHPP-2,y}$
Data unit	MWh
Description	Power supply from GPHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 9 158; **2012**: 36 632
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$ES_{GPHPP-2,y} = \frac{P_{GPHPP-2} \cdot T_{GPHPP-2,y} \cdot k_{GPHPP-2} \cdot (1-\varepsilon^{el}_{GPHPP})}{1000}$ $P_{GPHPP-2,y}$ is the installed electric capacity of GPHPP-2; $T_{GPHPP-2,y}$ is the number of running hours of GPHPP-2 during the year *y*; $k_{GPHPP-2,y}$ is the plant factor for GPHPP-2; ε^{el}_{GPHPP} is the relative power consumption for GPHPP-1's and GPHPP-2's auxiliary needs.
QA/QC procedures (to be) applied	Not required
Any comment	-

Data/Parameter	$HS_{GPHPP-2,y}$
Data unit	GJ
Description	Heat supply from GPHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 31 917; **2012**: 127 669
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$HS_{GPHPP-2,y} = \frac{3.6 \cdot k_{GPHPP-2} \cdot HP_{GPHPP-2} \cdot T_{HL,y}}{1000}$ $k_{GPHPP-2,y}$ is the plant factor for GPHPP-2; $HP_{GPHPP-2}$ is the installed thermal capacity of GPHPP-2; $T_{HL,y}$ is the number of hours in the heating season in year *y*.
QA/QC procedures (to be) applied	Not required
Any comment	-

It should be noted that production of electricity is proportional to production of heat in a cogeneration unit therefore the same value of plant factor can be applied for both electricity and heat supply.

Comparison of data from the tables above makes it clear that GPHPPs meet most heat and power requirements of the mine. In case of undergeneration the lacking amount of heat will be supplied from Vorkuta CHPP-2 and the rest of power – from the external power grid.

Reduction in heat production by Vorkuta CHPP-2's boilers as a result of the project

Apart from AGAH and CPP, where coal mine methane is used as fuel, the only other source of heat for the needs of Severnaya Coal Mine in the absence of the project is Vorkuta CHPP-2 which is a part of OJSC "TGC-9". Severnaya Coal Mine receives heat from Vorkuta CHPP-2 only in the form of hot water, ensuring heating, ventilation and hot water of the production facilities and office and amenities buildings.

Vorkuta CHPP-2 is the marginal energy source for Severnaya Coal Mine. Thus heat supplied under the project from GPHPP-1 and GPHPP-2 will replace heat supplies from Vorkuta CHPP-2. The main fuel of the plant is coal.

The project makes it possible to significantly reduce the heating steam extraction from the turbines of Vorkuta CHPP-2. In order to determine the reduction in coal consumption at the CHPP it is necessary to find the variation of fresh steam flow to the turbines.

The turbine hall of Vorkuta CHPP-2 has[9]:

- turbine unit of T-35-90-1M type (turbine with heating steam extraction);
- turbine unit of TG No.2 K-28-90 type (condensing turbine);
- turbine unit of PT-25-90/13 type (turbine with process and heating steam extraction);
- turbine unit of T-25-90-5 type (turbine with heating steam extraction);
- turbine unit of K-50-90-3 type (condensing turbine);

[9] http://www.tgc-9.ru/komi_rus.html

- turbine unit of PT-60-90/13 type (turbine with process and heating steam extraction); and
- turbine unit of T-47(55)-90-4M type (turbine with heating steam extraction).

All turbines at Vorkuta CHPP-2 are designed for the initial steam pressure of 90 atm. Extracted steam parameters are almost identical too. The project does not affect process steam extraction from the turbines. It is necessary to find how the variation in fresh steam flow to the turbine relates to the change in heating steam extraction from the turbines of PT and T type.

Based on the generalized equation presented in analytical form on p. 93 of [R2] we draw a specific equation applicable to steam parameters for the installed turbines which describes the variation of heat (fresh steam) supply to the turbine depending on the variation of heating steam extraction:

$$\Delta Q_0 = 1.4425 \cdot \Delta Q_h \qquad \text{(B.1-7)}$$

where ΔQ_0 is the variation of heat (fresh steam) flow to the turbine, GJ;

ΔQ_h is the variation of heating steam extraction, GJ;

1.4425 is the factor that shows a relationship between variation of heat (fresh steam) flow to the turbine and variation of heating steam extraction. The value of this factor depends on the pressure of the heating steam extraction. The absolute pressure of the heating steam extraction according to GOST 3618-69 varies between 0.7 and 2.5 atm. For conservative reasons we assume that the pressure of the heating steam extraction at Vorkuta CHPP-2 is 0.7 atm.

With allowance for heat network losses and heat flow factor the equation (B.1-7) is rearranged in the following form:

$$\Delta HG_{VCHPP,y} = \frac{1.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y} \right)}{(1-\varepsilon_{sl}) \cdot k_{HF}}, \qquad \text{(B.1-8)}$$

where $\Delta HG_{VCHPP,y}$ is the reduction in heat (fresh steam) production by boilers of Vorkuta CHPP-2 as a result of the project during the year *y*, GJ.

The parameters used in the formula (B.1-8) are described in the tabular form below:

Data/Parameter	ε_{sl}
Data unit	-
Description	Relative heat losses in the heat network from Vorkuta CHPP-2 to Severnaya Coal Mine
Time of determination/monitoring	February 2011
Source of data (to be) used	E.Y. Sokolov. Cogeneration-based district heating and heat networks. – M.: Publishing House MEI, 2001.[R3], p.33
Value of data applied (for ex ante calculations/determinations)	0.05
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended minimum value
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for the period 2011-2012

Data/Parameter	k_{HF}
Data unit	-
Description	Heat flow factor at Vorkuta CHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	V.Y. Ryzhkin. Thermal power station. – M.: Energoatomizdat, 1987 [R4], p. 135, Fig.10.2
Value of data applied (for ex ante calculations/determinations)	0.98
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended value at an average load of a steam boiler
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for the period 2011-2012

Data/Parameter	$\Delta HG_{VCHPP,y}$
Data unit	GJ
Description	Reduction in heat (fresh steam) production by boilers of Vorkuta CHPP-2 as a result of the project
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 148 354; **2012**: 593 417
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$\Delta HG_{VCHPP,y} = \frac{1.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y}\right)}{(1-\varepsilon_{sl}) \cdot k_{HF}}$ $HS_{GPHPP-1,y}$ is the heat supply from GPHPP-1; $HS_{GPHPP-2,y}$ is the heat supply from GPHPP-2; ε_{sl} is the relative heat losses in the heat network from Vorkuta CHPP-2 to Severnaya Coal Mine; k_{HF} is the heat flow factor at Vorkuta CHPP-2.
QA/QC procedures (to be) applied	Not required
Any comment	-

Reduction in coal consumption at Vorkuta CHPP-2 due to the project

Reduction in coal consumption at Vorkuta CHPP-2 as a result of the project during the year *y* is determined as follows, GJ:

$$\Delta FC_{coal,VCHPP,y} = \frac{\Delta HG_{VCHPP,y}}{\eta_{boiler,VCHPP}} \quad \text{(B.1-9)}$$

The parameter used in the formula (B.1-9) is described in the table below:

Data/Parameter	$\eta_{boiler,VCHPP}$
Data unit	-
Description	Efficiency of steam boilers of Vorkuta CHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	Reference Book on Heat Engineering. Volume 2. – M.: Energia, 1976. [R10], p.348
Value of data applied (for ex ante calculations/determinations)	0.916
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended nominal efficiency of coal-fired steam boilers of BKZ-220-100 type installed at Vorkuta CHPP-2. This is conservative since the average annual efficiency of boilers is knowingly lower than the nominal value
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for the period 2011-2012

Data/Parameter	$\Delta FC_{coal,VCHPP,y}$
Data unit	GJ
Description	Reduction in coal consumption at Vorkuta CHPP-2 as a result of the project
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 161 959; **2012**: 647 835
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$\Delta FC_{coal,VCHPP,y} = \frac{\Delta HG_{VCHPP,y}}{\eta_{boiler,VCHPP}}$ $\Delta HG_{VCHPP,y}$ is the reduction in heat (fresh steam) production by boilers of Vorkuta CHPP-2 as a result of the project; $\eta_{boiler,VCHPP}$ is the efficiency of steam boilers of Vorkuta CHPP-2.
QA/QC procedures (to be) applied	Not required
Any comment	-

Reduction in heat-consumption-based power generation at Vorkuta CHPP-2 due to the project

Project-related reduction in fresh steam flow to the turbines of Vorkuta CHPP-2 causes such undesirable effect as reduction in heat-consumption-based power generation at this plant. Undergeneration of power should be made up for by additional supplies from the grid (including, in general case, Vorkuta CHPP-2 too) which increases project GHG emissions.

Based on the afore-mentioned generalized equation, presented in analytical form on page 93 of [R2], we obtained another specific equation applicable to steam parameters for the installed turbines, which describes the variation of heat-consumption-based power generation depending on the variation of heating steam extraction from the turbines:

$$\Delta N_t = \frac{0.4425 \cdot \Delta Q_h}{3.6}, \quad \text{(B.1-10)}$$

where ΔN_t is the variation of heat-consumption-based power generation, MWh;

0.4425 is the factor that describes a relation between the variation of heat-consumption-based power generation and the variation of heating steam extraction from the turbines. For conservative reasons, this factor was calculated on the assumption that the steam pressure of the heating steam extraction has the minimum value of 0.7 atm;

3.6 is the conversion factor for GJ to MWh.

With allowance for heat network losses and power consumption for auxiliary needs of Vorkuta CHPP-2, the equation (B.1-11) is rearranged in the following form:

$$\Delta ES_{VCHPP,y} = \frac{0.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y}\right) \cdot (1-\varepsilon_{el}^{aux})}{3.6 \cdot (1-\varepsilon_{sl})} \quad \text{(B.1-11)}$$

where $\Delta ES_{VCHPP,y}$ is the reduction in heat-consumption-based power supply from Vorkuta CHPP-2 due to the project during the year *y*, MWh.

The parameters used in the formula (B.1-11) are described above and in the table below:

Data/Parameter	ε_{el}^{aux}
Data unit	-
Description	Relative power consumption for auxiliary needs of Vorkuta CHPP-2
Time of determination/monitoring	February 2011
Source of data (to be) used	V.Y. Ryzhkin. Thermal power station. – M.: Energoatomizdat, 1987 [R4], p. 18
Value of data applied (for ex ante calculations/determinations)	0.05
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended average value
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for the period 2011-2012

Data/Parameter	$\Delta ES_{VCHPP,y}$
Data unit	MWh
Description	Reduction in heat-consumption-based power supply from Vorkuta CHPP-2 due to the project
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation

Value of data applied (for ex ante calculations/determinations)	**2011**: 11 768; **2012**: 47 074
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$\Delta ES_{VCHPP,y} = \frac{0.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y}\right) \cdot (1-\varepsilon_{el}^{aux})}{3.6 \cdot (1-\varepsilon_{sl})}$ $HS_{GPHPP-1,y}$ is the heat supply from GPHPP-1; $HS_{GPHPP-2,y}$ is the heat supply from GPHPP-2; ε_{el}^{aux} is the relative power consumption for auxiliary needs of Vorkuta CHPP-2; ε_{sl} is the relative heat losses in the heat network from Vorkuta CHPP-2 to Severnaya Coal Mine.
QA/QC procedures (to be) applied	Not required
Any comment	-

Reduction in power generation in the grid due to the project

Taking into account the aforesaid, the reduction of power supply to the grid from external power plants as a result of the project during the year *y* is calculated as follows, MWh:

$$ES_{grid,y} = ES_{GPHPP-1,y} + ES_{GPHPP-2,y} - \Delta ES_{VCHPP,y}, \quad \text{(B.1-12)}$$

Data/Parameter	$ES_{grid,y}$
Data unit	MWh
Description	Reduction in power supply to the grid from external power plants due to the project
Time of determination/monitoring	February 2011
Source of data (to be) used	Formula evaluation
Value of data applied (for ex ante calculations/determinations)	**2011**: 15 705; **2012**: 62 821
Justification of the choice of data or description of measurement methods and procedures (to be) applied	$ES_{grid,y} = ES_{GPHPP-1,y} + ES_{GPHPP-2,y} - \Delta ES_{VCHPP,y}$ $ES_{GPHPP-1,y}$ is the power supply from GPHPP-1; $ES_{GPHPP-2,y}$ is the power supply from GPHPP-2; $\Delta ES_{VCHPP,y}$ is reduction in heat-consumption-based power supply from Vorkuta CHPP-2 due to the project.
QA/QC procedures (to be) applied	Not required
Any comment	-

GHG emission factors

Estimation of GHG emissions is given in Section E. The following emission factors are used in calculations:

Data/Parameter	$EF_{CO_2,coal}$

Data unit	kg CO_2/GJ
Description	CO_2 emission factor for coal combustion
Time of determination/monitoring	February 2011
Source of data (to be) used	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2, Energy, Chapter 2, 2006. Table 2.2 [R8]
Value of data applied (for ex ante calculations/determinations)	94.6
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended default value
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and for monitoring for the period 2011-2012

Data/Parameter	$EF_{CO2,grid}$
Data unit	tCO_2/MWh
Description	CO_2 emission factor for grid electricity
Time of determination/monitoring	February 2011
Source of data (to be) used	This parameter is assumed in accordance with Annex 2.3.
Value of data applied (for ex ante calculations/determinations)	0.537
Justification of the choice of data or description of measurement methods and procedures (to be) applied	See Annex 2.3.
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for 2011-2012

Relative power losses in the external grid

For emission reduction calculation in order to adjust for power losses during power transmission via grid we use the relative power losses parameter.

Data/Parameter	TDL_{TL}
Data unit	%
Description	Relative power losses in external power grid
Time of determination/monitoring	February 2011
Source of data (to be) used	Methodological tool to calculate baseline, project and/or leakage emissions from electricity consumption. Version 01. CDM Executive Board. [R13]
Value of data applied	3

(for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Recommended default value
QA/QC procedures (to be) applied	Reference data
Any comment	Assumed as a constant value both in estimations and in monitoring for 2011-2012

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

The approach described in paragraph 2 (a) of Annex 1 to the "Guidelines on criteria for baseline setting and monitoring" [R9] was chosen to demonstrate that the emission reductions achieved by the project are additional to those that might have occurred in the absence of the project.

Within the framework of the selected approach the project additionality was analyzed using the analysis of the project alternatives, the investment analysis and the common practice analysis.

The analysis of the project alternatives

The drained methane handling alternatives and the heat and power production alternatives were considered separately. The description of the alternatives and their analysis are given in Section B.1.

Based on the analysis of the project alternatives it was concluded that the most likely scenario is the continuation of the current situation which suggests venting of drained methane and purchase of heat and power from third party suppliers.

In this analysis we referred to the investment analysis following below which shows that the project activity without the joint implementation mechanism can be considered as the baseline scenario.

The investment analysis

The main economic parameters were identified for the following two alternatives:

Alternative A. The project activity without sale of GHG emission reductions;

Alternative B. The project activity with sale of GHG emission reductions.

For each alternative we identified the internal rate of return (IRR) and the net present value (NPV).

The volume of capital investments in implementation of the specified alternatives is RUR 652 222 thousand.

The alternatives are financed by the company's equity.

The selling price of ERU (2010-2012) was assumed at 430 RUR/tCO_2e.

The time horizon of the investment analysis is limited to the period 2008-2018.

Amount of investments, the cost of raw material and resources, and the expected project effects on the cash flow value were assumed on the basis of the data valid as of 2007 for the situation prior to the commencement of the project.

The calculations were made in projected prices adjusted for inflation.

The discount rate was determined with the help of the "Methodological recommendations on evaluation of investment projects efficiency…"[10]. According to this methodology the discount rate in efficiency calculations takes into account the risk-free rate of return and may include an adjustment for risk.

Freed from inflation or real risk-free rate of return p_{real}, which is used for estimation of commercial efficiency of the project on the whole, can be set in accordance with "Methodological recommendations on evaluation of investment projects efficiency…" to the minimum allowable future return on investments, in practice 4-6%. Let us assume the real rate at the minimum level of 4%.

By using Fisher's formula $1+p_{nom}=(1+p_{real})\cdot(1+i)$ we obtain a formula to determine the sought nominal risk-free rate of return with allowance for inflation:

$$p_{nom}=(1+p_{real})\cdot(1+i)-1. \quad \text{(B.2-1)}$$

where p_{nom} is the nominal risk-free rate of return with allowance for inflation, %;

p_{real} is the real risk-free rate of return, freed from inflation, R_f =4%;

i is the inflation rate, $i=10.5\%$.

The rate of inflation as of the time of the decision making was set according to the Federal Law "On Federal Budget for 2008 and for the planned period of 2009 and 2010"[11] and is 10.5%.

Thus, the nominal risk-free rate of return p_{nom}= (1+0.04)·(1+0.105)-1=14.92%.

The risk of not getting the expected project income is assessed not less than medium (in accordance with Table 11.1 from the "Methodological recommendations on evaluation of investment projects efficiency…"). The recommended premium for this risk is between 8% and 10%. It was decided to neglect other risks.

For conservative reasons, the discount rate was finally assumed at 20%.

The calculation results are given in Table B.2-1, the detailed calculations are given in Annex 2-1.

Table B.2-1. Investments, NPV and IRR for the two alternatives

Parameter	Unit	Alternative A	Alternative B
Investments	Thousand RUR	652 222	652 222
NPV	Thousand RUR	-76 432	102 541
IRR	%	16.40	25.2

The economic parameters of the project alternative without sale of GHG emission reductions (Alternative A) is unacceptably low (NPV<0, IRR<20%).

The revenues to be received from sale of emission reductions up until 2012 amount to almost half of the total required project investments. Due to these revenues the project activity (Alternative B) becomes commercially attractive (NPV>0, IRR>20%).

The possibility of generating ERUs in the post-Kyoto period up until 2020 should not be ruled out either. This will allow to fully offset the project implementation costs.

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[10] Methodological recommendations on evaluation of investment projects efficiency. Approved by Ministry of Economy of the RF, Ministry of Finance of the RF, State Committee of the RF on Construction, Architecture and Housing Policy of the RF 21.06.1999 N ВК 477

[11] http://www.kadis.ru/texts/index.phtml?id=16603

Further below there is the analysis of sensitivity of the two alternatives to the changes in main parameters (See Table B.2-2).

Table B.2-2. The sensitivity analysis of the main economic parameters for the two alternatives

Parameter	Unit	Alternative A	Alternative B
1) Increase in investment costs by 10%			
NPV	Thousand RUR	-133 940	45 033
IRR	%	14.12	22.13
2) Reduction in investment costs by 10%			
NPV	Thousand RUR	-18 924	160 049
IRR	%	19.03	28.91
3) Increase in heat production by 10%			
NPV	Thousand RUR	-61 032	117 942
IRR	%	17.14	25.99
4) Reduction in heat production by 10%			
NPV	Thousand RUR	-91 833	87 141
IRR	%	15.64	24.49
5) Increase in power generation by 10%			
NPV	Thousand RUR	-16 221	162 753
IRR	%	19.25	28.10
6) Reduction in power generation by 10%			
NPV	Thousand RUR	-136 644	42 329
IRR	%	13.37	22.23
7) Increase in current costs by 10%			
NPV	Thousand RUR	-90 799	88 174
IRR	%	15.69	24.54
8) Reduction in current costs by 10%			
NPV	Thousand RUR	-62 065	116 908
IRR	%	17.09	25.94
9) Increase in power cost by 10%			
NPV	Thousand RUR	-16 221	162 753
IRR	%	19.25	28.10
10) Reduction in power costs by 10%			
NPV	Thousand RUR	-136 644	42 329
IRR	%	13.37	22.23
11) Increase in heat cost by 10%			
NPV	Thousand RUR	-61 032	117 942
IRR	%	17.14	25.99
12) Reduction in heat costs by 10%			
NPV	Thousand RUR	-91 833	87 141
IRR	%	15.64	24.49
13) Increase in discount rate by 10%			
NPV	Thousand RUR	-111 175	59 496
IRR	%	16.40	25.2
14) Reduction in discount rate by 10%			
NPV	Thousand RUR	-36 468	151 397
IRR	%	16.40	25.2

The alternative of the project without carbon financing is not attractive in terms of investments in all cases considered, whereas additional revenues from sale of emission reductions up to the year 2012 ensure low sensitivity to changes in cost (in all cases NPV is still >0 and IRR>20%).

The common practice analysis

Venting of drained CMM is common practice in the Russian coal industry. The first and furthermost requirement of the current legislation is to ensure safety of mining operations, in which connection the development of mine gas drainage and ventilation systems is encouraged. There are no legal requirements as to treatment and utilization of removed gas, therefore its venting is common practice in Russia. Pechorsky coal basin stands out against this picture, since part of methane is utilized at OJSC "Vorkutaugol" mines for heat production. Whereas power generation is a totally new type of activity for the company.

In Kuzbass OJSC "SEUK-Kuzbass" is implementing a large-scale joint implementation project at its mines that is aimed at utilization of drained coal mine methane. The project has passed all determination and approval stages and was approved by the expert council of Sberbank of Russia within the framework of the first JI project tender[12]. Another gas recovery unit installation project was implemented in Kuzbass at Chertinskaya-Koksovaya Coal Mine[13] also using joint implementation mechanism.

The PDD developer does not know of any examples in the Russian Federation when a coal mine methane power plant construction project would have been implemented without joint implementation mechanism.

Thus, the project under consideration is not common practice.

The final conclusion

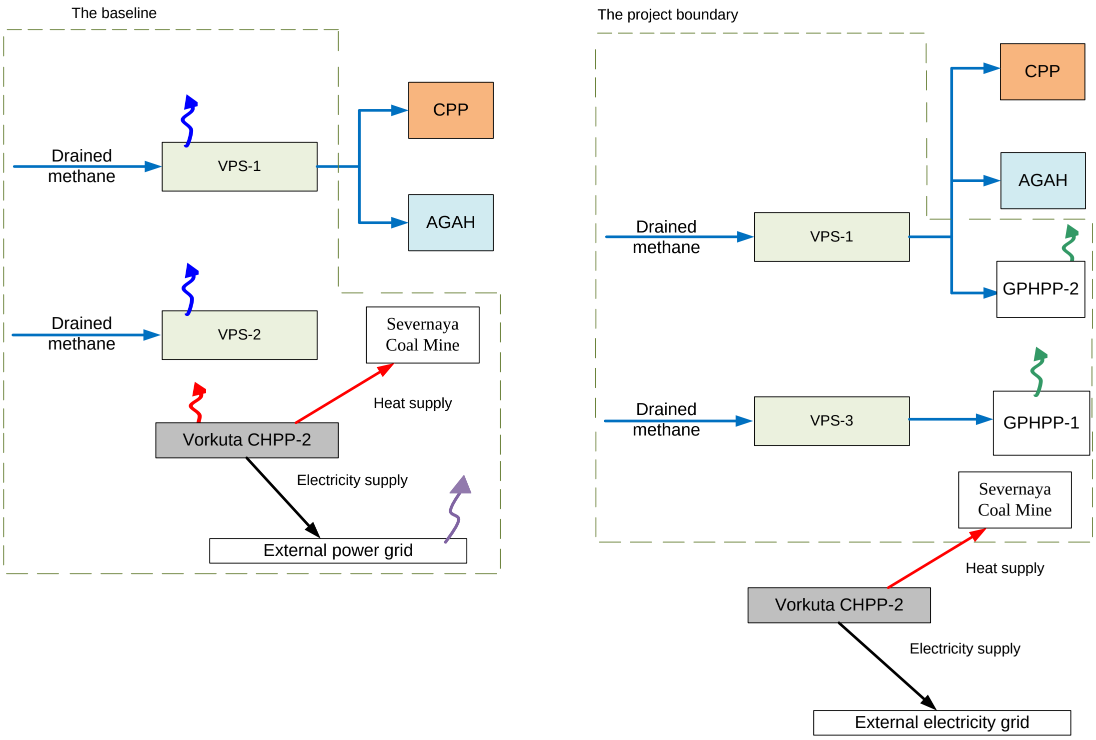
In our opinion, the above given reasons are sufficient to consider that the continuation of the current situation is the most likely baseline scenario and that the GHG emission reductions achieved due to the project are additional to those that might have otherwise occurred.

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

Table B.3-1 shows which sources and gases are included in and which are excluded from the project boundaries. Fig. B.3-1 shows main components for the baseline and project scenarios.

[12] http://ccgs.ru/system/system/archives/presentations/MED_Order326.pdf

[13] http://www.noven.ru/document/26.html



Methane emissions to atmosphere

Emissions from combustion of methane and non-methane hydrocarbons

Emissions from coal combustion for heat production

Emissions from fuel combustion for power generation in the grid

Fig. B.3-1. Main components for baseline and project scenarios

Table B.3-1. Emission sources included in and excluded from the project boundaries

	Source	**Gas**	**Incl./ Excl.**	**Justification / Explanation**
Baseline	Methane emissions from the coal mine gas drainage	**CH_4**	**Included**	**Main emission source** Methane emissions prevented due to the project activity are taken into account
	Emissions from combustion of coal mine methane in AGAH and CPP*	CO_2	Excluded	Since the project activity does not affect the volumes of gas combustion at AGAH and CPP, these emissions under the baseline scenario are equal to the project scenario
		CH_4	Excluded	
		N_2O	Excluded	
	Emissions from fuel combustion at grid power plants	**CO_2**	**Included**	**Main emission source** Grid electricity which is equal to net power supply from GPHPP-1 and GPHPP-2 with adjustment for undergeneration of heat-consumption-based power due to the project
		CH_4	Excluded	Excluded for the sake of simplicity. This is conservative
		N_2O	Excluded	Excluded for the sake of simplicity. This is conservative

	Emissions from coal combustion at Vorkuta CHPP-2	**CO_2**	**Included**	**Main emission source** Heat from Vorkuta CHPP-2 substituted due to the project by heat from GPHPP-1 and GPHPP-2 is taken into account
		CH_4	Excluded	Excluded for the sake of simplicity. This is conservative
		N_2O	Excluded	Excluded for the sake of simplicity. This is conservative
Project activity	Methane emissions from the coal mine gas drainage	CH_4	Excluded	Only that change in methane emissions to the atmosphere which can be attributed to the baseline scenario is taken into account
	Emissions from combustion of coal mine methane in AGAH and CPP	CO_2	Excluded	Since the project activity does not affect the volumes of gas combustion at AGAH and CPP, these emissions under the project scenario are equal to the baseline scenario
		CH_4	Excluded	
		N_2O	Excluded	
	Emissions from combustion of coal mine methane in GPHPP-1 and GPHPP-2	**CO_2**	**Included**	**Main emission source**
		CH_4	Excluded **	Excluded for the sake of simplicity. These emissions are insignificant
		N_2O	Excluded	Excluded for the sake of simplicity. These emissions are insignificant
	Emissions from combustion of non-methane hydrocarbons in GPHPP-1 and GPHPP-2	**CO_2**	**Included**	**May turn out to be a noticeable emission source** Currently the quantity of non-methane hydrocarbons accounts for less than 1% of the drained mine gas volume. Therefore in our estimations these emissions are neglected. Nonetheless non-methane hydrocarbons concentration shall be monitored on an annual basis and emissions from their combustion shall be taken into account if their concentration exceeds 1%***
	Emissions from fuel combustion for implementation of the project activity, including gas transportation	CO_2	Excluded	Power and heat consumption for auxiliary needs of GPHPP-1 and GPHPP-2 are excluded as net energy supply is used for calulation. Energy consumption of VPSs is considered identical in both scenarios
		CH_4	Excluded	
		N_2O	Excluded	
	Fugitive methane emissions from local equipment and gas supply pipe	CH_4	Excluded ****	Excluded for the sake of simplicity. Emission quantity is insignificant

* Supply of coal mine methane to AGAH and CPP as a result of the project does not decrease. These installations must be supplied with gas in full to meet the process needs. Neither the system for heating of air before supplying it to the mine nor the coal drying system change due to the project, which means that reduction of heat supply shall not happen. Moreover the analysis of the gas balance shows that even with methane supply to GPHPPs some gas will still remain superfluous

and will be fed to the gas vent stack. Thus there is no need to monitor gas volumes for AGAH and CPP, and these sources are excluded from the project boundaries.

**Annex T to the "List of Environmental Measures" [R14] the overall methane emissions with exhaust gases from GPHPP-1 and GPHPP-2 amount to 6.85 tonnes per year or 6.85*21=144 tonnes of CO_2e per year < 2000 tonnes of CO_2e per year. This value is 144/469963*100%=0,031% < 1%. In accordance with paragraph 14 (a) (iii) of the "Guidelines on criteria for baseline setting and monitoring" [R9] this source can be considered as insignificant.

*** According to ACM0008 methodology (Version 07) [R15] these emissions should be included if concentration of NMHCs exceeds 1%, the corresponding procedure is described in the monitoring plan. NMHC emissions are neglected in preliminary estimations because NMHCs concentration is less than 1% according to results of the laboratory analysis of a MAM samples at the time of PDD development.

**** According to Annex T to the "List of environmental measures" [R14] the overall supply of MAM to the vent stack from GPHPP-1 and GPHPP-2, attributed to blowing off of gas supplying equipment, will amount to 0.105 tonnes per year. Even if we consider that methane accounts for 50% of MAM by mass, GHG emissions into the atmosphere will be equal to 0.105*0.5*21= 1.1 tonnes of CO_2e per year, which is very insignificant.

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 the baseline setting: 16/02/2011

The baseline was developed by CCGS LLC (CCGS LLC is not the project participant and is not listed in Annex 1 of this PDD)

Contact person: Egor Ershov

E-mail: e.ershov@ccgs.ru

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

24/12/2007 (the date of contract for VPS-3 construction with LLC "Pechoruglerazvedka")

C.2. Expected operational lifetime of the project:

30 years/360 months

C.3. Length of the crediting period:

1.25 years / 15 months (from October 1, 2011 till December 31, 2012)

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

In development of the monitoring plan the PDD developer applied JI specific approach based on paragraph 9 (a) of the "Guidelines on criteria for baseline setting and monitoring" [R9].

The data required for determination of GHG emission reductions are collected in accordance with the best industry standards and practices of fuel, energy and environmental impact monitoring.

All data required for monitoring will be kept in the company's archive in paper and electronic form for at least two years after the end of the crediting period or after the last transfer of ERUs.

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

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. $MM_{GPHPP-1,y}$	The quantity of methane fired in GPHPP-1	GPHPP-1	t	m, c	Continuously	100 %	Electronic and paper	Determined automatically based on the measurements of MAM parameters: flow, pressure, temperature and concentration of methane
2. $MM_{GPHPP-2,y}$	The quantity of methane fired in GPHPP-2	GPHPP-2	t	m, c	Continuously	100 %	Electronic and paper	Determined automatically based on the measurements of MAM

								parameters: flow, pressure, temperature and concentration of methane
3. $PC_{NMHC-1,i}$	Mass concentration of *i* non-methane hydrocarbon in MAM fed to GPHPP-1	Control and test laboratory	%	m, c	Annually	100 %	Electronic and paper	Determined on wet gas mass basis as per the results of the laboratory analysis of a MAM sample. This value will be taken into account in calculations if according to laboratory analyses NMHC accounts for more than 1% by volume of extracted coal mine gas
4. PC_{CH4-1}	Mass concentration of methane in MAM fed to GPHPP-1	Control and test laboratory	%	m, c	Annually	100 %	Electronic and paper	Determined on wet gas mass basis as per the results of the laboratory analysis of a MAM sample
5. $PC_{NMHC-2,i}$	Mass concentration of *i* non-methane	Control and test laboratory	%	m, c	Annually	100 %	Electronic and paper	Determined on wet gas mass basis as per the results of the

	hydrocarbon in MAM fed to GPHPP-2							laboratory analysis of a MAM sample. This value will be taken into account in calculations if according to laboratory analyses NMHC accounts for more than 1% by volume of extracted coal mine gas
6. PC_{CH4-2}	Mass concentration of methane in MAM fed to GPHPP-2	Control and test laboratory	%	m, c	Annually	100 %	Electronic and paper	Determined on wet gas mass basis as per the results of the laboratory analysis of a MAM sample

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

The project GHG emissions during the year *y*, tCO_2e:

$$PE_y = PE_{MC,y} + PE_{NMHCC,y}, \quad \text{(D.1-1)}$$

where $PE_{MC,y}$ is the emissions of CO_2 from methane combustion in GPHPPs during the year *y*, tCO_2;

$PE_{NMHCC,y}$ is the emissions of CO_2 from combustion on non-methane hydrocarbons (NMHCs) in GPHPPs during the year *y*, tCO_2. These emissions are taken into account if the total volumetric concentration of non-methane hydrocarbons in MAM exceeds 1%.

$$PE_{MC,y} = \frac{44}{16} \cdot (MM_{GPHPP-1,y} + MM_{GPHPP-2,y}), \qquad (D.1\text{-}2)$$

where 44/16 is the CO_2 emission factor for methane combustion (44/16=2.75), tCO_2/tCH_4;

$MM_{GPHPP-1,y}$ is the quantity of methane fed for combustion to GPHPP-1 during the year y, tCH_4;

$MM_{GPHPP-2,y}$ is the quantity of methane fed for combustion to GPHPP-2 during the year y, tCH_4.

$$PE_{NMHCC,y} = MM_{GPHPP-1,y} \cdot \sum_i (r_{GPHPP-1,i} \cdot EF_{NMHC,i}) + MM_{GPHPP-2,y} \cdot \sum_i (r_{GPHPP-2,i} \cdot EF_{NMHC,i}), \qquad (D.1\text{-}3)$$

where $r_{GPHPP-1,i}$ is the ratio of i non-methane hydrocarbon and methane contents in MAM fed to GPHPP-1;

$r_{GPHPP-2,i}$ is the ratio of i non-methane hydrocarbon and methane contents in MAM fed to GPHPP-2;

$EF_{NMHC,i}$ is the CO_2 emission factor for combustion of i non-methane hydrocarbon, tCO_2/tNMHC.

$$r_{GPHPP-1,i} = PC_{NMHC-1,i} / PC_{CH4-1}, \qquad (D.1\text{-}4)$$

$$r_{GPHPP-2,i} = PC_{NMHC-2,i} / PC_{CH4-2}, \qquad (D.1\text{-}5)$$

where $PC_{NMHC-1,i}$ is the mass concentration of i non-methane hydrocarbon in MAM fed to GPHPP-1, determined on wet gas mass basis, %;

PC_{NMHC-2} is the mass concentration of i non-methane hydrocarbon in MAM fed to GPHPP-2, determined on wet gas mass basis, %;

PC_{CH4-1} is the mass concentration of methane in MAM fed to GPHPP-1, determined on wet gas mass basis, %;

PC_{CH4-2} is the mass concentration of methane in MAM fed to GPHPP-2, determined on wet gas mass basis, %.

$$EF_{NMHC,i} = \frac{44 \cdot m}{12 \cdot m + n}, \qquad (D.1\text{-}6)$$

where **44** is the molecular mass of CO_2;

12 is the molecular mass of carbon;

m is the number of carbon atoms in molecule of *i* non-methane hydrocarbon;

n is the number of hydrogen atoms in molecule of *i* non-methane hydrocarbon.

This formula was obtained from the mass conservation law.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
7. $ES_{GPHPP-1,y}$	Supply of electric power from GPHPP-1	GPHPP-1	MWh	m	Continuously	100 %	Electronic and paper	Measured by electric meters
8. $ES_{GPHPP-2,y}$	Supply of electric power from GPHPP-2	GPHPP-2	MWh	m	Continuously	100 %	Electronic and paper	Measured by electric meters
9. $HS_{GPHPP-1,y}$	Supply of heat from GPHPP-1	GPHPP-1	GJ	m, c	Continuously	100 %	Electronic and paper	Measured by heat meters
10. $HS_{GPHPP-2,y}$	Supply of heat from GPHPP-2	GPHPP-2	GJ	m, c	Continuously	100 %	Electronic and paper	Measured by heat meters

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

The baseline GHG emissions during the year *y*, tCO_2e:

$$BE_y = BE_{MR,y} + BE_{grid,y} + BE_{coal,VCHPP,y}\,, \qquad \text{(D.1-7)}$$

where $BE_{MR,y}$ is the prevented (due to the project) emissions of methane into the atmosphere during the year *y*, tCO_2e;

$BE_{grid,y}$ is the prevented (due to the project) emissions of greenhouse gases from generation of electricity by the external grid power plants during the year *y*, tCO_2e;

$BE_{coal,VCHPP,y}$ is the prevented (due to the project) emissions of greenhouse gases from coal combustion at Vorkuta CHPP-2 during the year *y*, tCO_2e.

$$BE_{MR,y} = GWP_{CH4} \cdot (MM_{GPHPP-1,y} + MM_{GPHPP-2,y})\,, \qquad \text{(D.1-8)}$$

where GWP_{CH4} is the global warming potential for methane, GWP_{CH4} = 21 tCO_2e/ tCH_4.

$$BE_{grid,y} = \frac{100}{100 - TDL_{TL}} \cdot (ES_{GPHPP-1,y} + ES_{GPHPP-2,y} - \Delta ES_{VCHPP,y}) \cdot EF_{CO2,grid}\,, \qquad \text{(D.1-9)}$$

where TDL_{TL} is the relative losses of power in the external power grid, %. According to [R13] the assumed default value is TDL_{TL} = 3%;

$ES_{GPHPP-1,y}$ is the supply of power from GPHPP-1 during the year *y*, MWh;

$ES_{GPHPP-2,y}$ is the supply of power from GPHPP-2 during the year *y*, MWh;

$\Delta ES_{VCHPP,y}$ is the reduction in heat-consumption-based power supply from Vorkuta CHPP-2 as a result of the project during the year *y*, MWh;

$EF_{CO2,grid}$ is the CO_2 emission factor for grid electricity, tCO_2/MWh. According to Annex 2.3 $EF_{CO2,grid}$ = 0.537 tCO_2/MWh.

$$\Delta ES_{VCHPP,y} = \frac{0.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y}\right) \cdot (1 - \varepsilon_{el}^{aux})}{3.6 \cdot (1 - \varepsilon_{sl})}\,, \qquad \text{(D.1-10)}$$

where 0.4425 is the factor that describes a relation between the variation of heat-consumption-based power generation and the variation of heating steam extraction from the turbine. See Section B.1;

3.6 is the conversion factor for GJ to MWh;

ε_{el}^{aux} is the relative consumption of power for auxiliary needs of Vorkuta CHPP-2. According to [R4] this value was assumed equal to ε_{el}^{aux} = 0.05. See Section B.1;

ε_{sl} is the relative heat losses in the heating network from Vorkuta CHPP-2 to Severnaya Coal Mine. According to [R3] this value was assumed at ε_{sl} = 0.05. See Section B.1;

$HS_{GPHPP-1,y}$ is the supply of heat from GPHPP-1 during the year *y*, GJ;

$HS_{GPHPP-2,y}$ is the supply of heat from GPHPP-2 during the year *y*, GJ.

$$BE_{coal,VCHPP,y} = \Delta FC_{coal,VCHPP,y} \cdot EF_{CO_2,coal} \cdot 10^{-3}, \quad \text{(D.1-11)}$$

where $\Delta FC_{coal,VCHPP,y}$ is the reduction in coal consumption at Vorkuta CHPP-2 as a result of the project during the year *y*, GJ;

$EF_{CO_2,coal}$ is the CO_2 emission factor for coal combustion, $kgCO_2/GJ$. According to [C8] $EF_{CO_2,coal}$ = 94.6 $kgCO_2/GJ$.

$$\Delta FC_{coal,VCHPP,y} = \frac{\Delta HG_{VCHPP,y}}{\eta_{boiler,VCHPP}} \quad \text{(D.1-12)}$$

where $\eta_{boiler,VCHPP}$ is the efficiency of steam boilers at Vorkuta CHPP-2. According to [R10] this value was assumed at $\eta_{boiler,VCHPP} = 0.916$. See Section B.1;

$\Delta HG_{VCHPP,y}$ is the reduction in heat production by boilers of Vorkuta CHPP-2 as a result of the project during the year *y*, GJ.

$$\Delta HG_{VCHPP,y} = \frac{1.4425 \cdot \left(HS_{GPHPP-1,y} + HS_{GPHPP-2,y}\right)}{(1-\varepsilon_{sl}) \cdot k_{HF}} \quad \text{(D.1-13)}$$

where 1.4425 is the factor that describes a relation between the variation of heat flow to the turbine and the variation of heating steam extraction. See Section B.1;

k_{HF} is the heat flow factor at Vorkuta CHPP-2. According to [R4] this value was assumed at k_{HF} =0.98. See Section B.1.

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

This option is not applied.

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

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

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

There are no leakages.

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

There are no leakages.

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

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

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

There are no leakages.

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

Reduction in greenhouse gas emissions during the year *y*, tCO_2e:

$$ER_y = BE_y - PE_y. \quad \text{(D.1-14)}$$

where BE_y is the baseline GHG emissions during the year *y*, tCO_2e;

PE_y is the project GHG emissions during the year *y*, tCO_2e.

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

The industrial environmental monitoring at OJSC “Vorkutaugol” is carried out as per the annually developed and duly approved “Programme of industrial and environmental monitoring” of air, water and land resources. The monitoring is carried out by in-house specialists and also on a contract basis by accredited laboratories and centres.

At the present time the Environmental Service of OJSC “Vorkutaugol” is a part of the Industrial Control and Health Protection Service of the Technical Direction of OJSC “Vorkutaugol”.

The environmental specialists of the Industrial Control and Health Protection Service are responsible for observance of the requirements of the Russian environmental legislation within all structural divisions of OJSC “Vorkutaugol”, in particular:

- timely drawing up and duly submission of state statistic reports on environmental protection;
- timely drawing up and submission of quarterly and annual environmental protection reports to CJSC “Severstal-Resource”;
- timely development and agreement of the environmental protection plan;
- timely submission of regular reporting on implementation of the environmental protection plan;
- timely development, approval and agreement of the charts of laboratory monitoring of pollutants discharge to water and pollutants emission into the atmosphere;
- estimation of pollutants emissions and discharges and calculation of payments for negative environmental impact;
- preparation of documents and obtaining permits and limits for discharges, emissions and disposal of industrial and domestic waste;
- development of estimates of permissible discharges, maximum permissible emissions, estimates of waste generation and waste disposal limits;

– drawing up, development and approval by the relevant regulatory and supervisory authorities of process procedures and analytical monitoring plans, passports, instructions, practical guidelines and other necessary documentation related to environmental protection;
– industrial control and monitoring of observance and compliance with the requirements of the environmental regulations;
– control over observance and implementation of prescriptions and instructions of regulatory and supervisory authorities.

The enterprise has the following reporting obligations as per official annual statistic forms:

– 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;
– 2-tp (water) "Data on Water Use", containing information on water consumption from natural sources, discharges of effluents and their pollutant content, capacity of wastewater treatment facilities, etc.;
– 2-tp (wastes) "Data on generation, utilization, destruction, transportation and disposal of production and consumption wastes", containing an annual balance of wastes flows by their types and hazard classes;
– 2-tp (recultivation) "Report on soil recultivation, removal and use of fertile soil layer";
– 71-tp (benefication) "Information on integrated use of mineral resources in beneficiation and metal conversion, overburden and industrial wastes".

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Table D.1.1.1. ID number 1	Low	The quantity of methane fed for combustion to GPHPP-1 is determined with a help of a measuring complex. Monitoring of MAM is carried out using a gas metering unit on the basis of a meter and a flow calculation block consisting of: - gas meter, - corrector, - power supply unit. Methane concentration in MAM is calculated with a help of a concentration meter. Signals from the metering unit are transmitted to the Automatic Process Control System (APCS). The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.

Table D.1.1.1. ID number 2	Low	The quantity of methane fed for combustion to GPHPP-2 is determined with a help of a measuring complex. Monitoring of MAM is carried out using a gas metering unit on the basis of a meter and a flow calculation block consisting of: - gas meter, - corrector, - power supply unit. Methane concentration in MAM is calculated with a help of a concentration meter. Signals from the metering unit are transmitted to the APCS. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.1. ID number 3	Low	The mass concentration of *i* non-methane hydrocarbons in MAM fed to GPHPP-1 is measured by a gas analyzer. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.1. ID number 4	Low	The mass concentration of methane in MAM fed to GPHPP -1 is measured by a gas analyzer. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.1. ID number 5	Low	The mass concentration of *i* non-methane hydrocarbons in MAM fed to GPHPP-2 is measured by a gas analyzer. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.1. ID number 6	Low	The mass concentration of methane in MAM fed to GPHPP -2 is measured by a gas analyzer. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.3. ID number 7	Low	Power supply from GPHPP-1 is measured by electric meters. Signals from the instrument are transmitted to the APCS. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.

Table D.1.1.3. ID number 8	Low	Power supply from GPHPP-2 is measured by electric meters. Signals from the instrument are transmitted to the APCS. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.3. ID number 9	Low	Heat supply from GPHPP-1 is measured by a heat metering unit. Signals from the instrument are transmitted to the APCS. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.
Table D.1.1.3. ID number 10	Low	Heat supply from GPHPP-2 is measured by a heat metering unit. Signals from the instrument are transmitted to the APCS. The instruments are regularly checked in accordance with the adopted schedule and procedure for checkout of instrumentation and control equipment.

Actions undertaken during calibration of measuring instruments

The measuring instruments are calibrated during the periods of scheduled shutdown of the equipment. If necessary the removed measuring device is replaced with a backup calibrated instrument. Operation of the equipment without instrumentation and control equipment is not allowed.

Troubleshooting procedure

If the measurement processes do not comply with the standards specified in the design documentation the situation shall be analyzed, alternative monitoring and measuring procedures shall be developed for the period of non-compliance, as well as corrective actions which allow to remedy the identified non-compliance.

If any measuring instrument fails, the parameter shall be metered with the help of a duplicate instrument or if there is no duplicate instrument, the failed device is substituted by a backup calibrated instrument. Operation of the equipment without instrumentation and control equipment is not allowed.

Internal check

Internal check by the company includes checking primary data provided during information collection period as well as checking the project monitoring reports.

Training

The staff shall be trained to operate GPHPPs by specialists of OJSC “Zvezda-Energetika” according to the General Contractor Contract for design and construction of heat and power plants No.496/10 of 18.05.2010.

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

Collection and recording of data necessary for calculation of GHG emission reductions will be carried out in accordance with the monitoring points location scheme as shown in Fig. D.3-1.

Readings of measuring instruments necessary for GHG emission reductions monitoring are recorded by methane meters, electric and heat meters and are displayed on the motors of all computers which have necessary software. These data shall be stored in the mine's archive in paper and electronic form for at least two years after the end of the crediting period or after the last transfer of ERUs.

The person responsible for collection and processing of monitoring data is the Chief Environmental Specialist of OJSC "Vorkutaugol".

The person responsible for collection of information on the supply of drained CMM to GPHPPs as well as for component analysis of MAM is the Deputy Head of the VOS Division[14] for gas drainage of Severnaya Coal Mine of OJSC "Vorkutaugol".

The person responsible for collection of information on power supply is the Chief Power Engineer of Severnaya Coal Mine of OJSC "Vorkutaugol".

The person responsible for collection of information on heat supply is the Head of SPS Division[15] of Severnaya Coal Mine of OJSC "Vorkutaugol".

Specialists of the Environmental Service shall use the collected data to calculate GHG emission reductions and draw up a monitoring report at the end of each reporting year. In case there is any doubt about accuracy of the input data they shall be checked and corrected by specialists of Severnaya Coal Mine. The preliminary project monitoring report shall be submitted to the management of OJSC "Vorkutaugol" for checking. If any mistakes are found, the report shall be corrected accordingly. The final version of the monitoring report shall be submitted for verification to an accredited independent entity. The data transfer scheme is shown in Fig. D.3-2.

[14] ventilation and operational safety

[15] steam power system

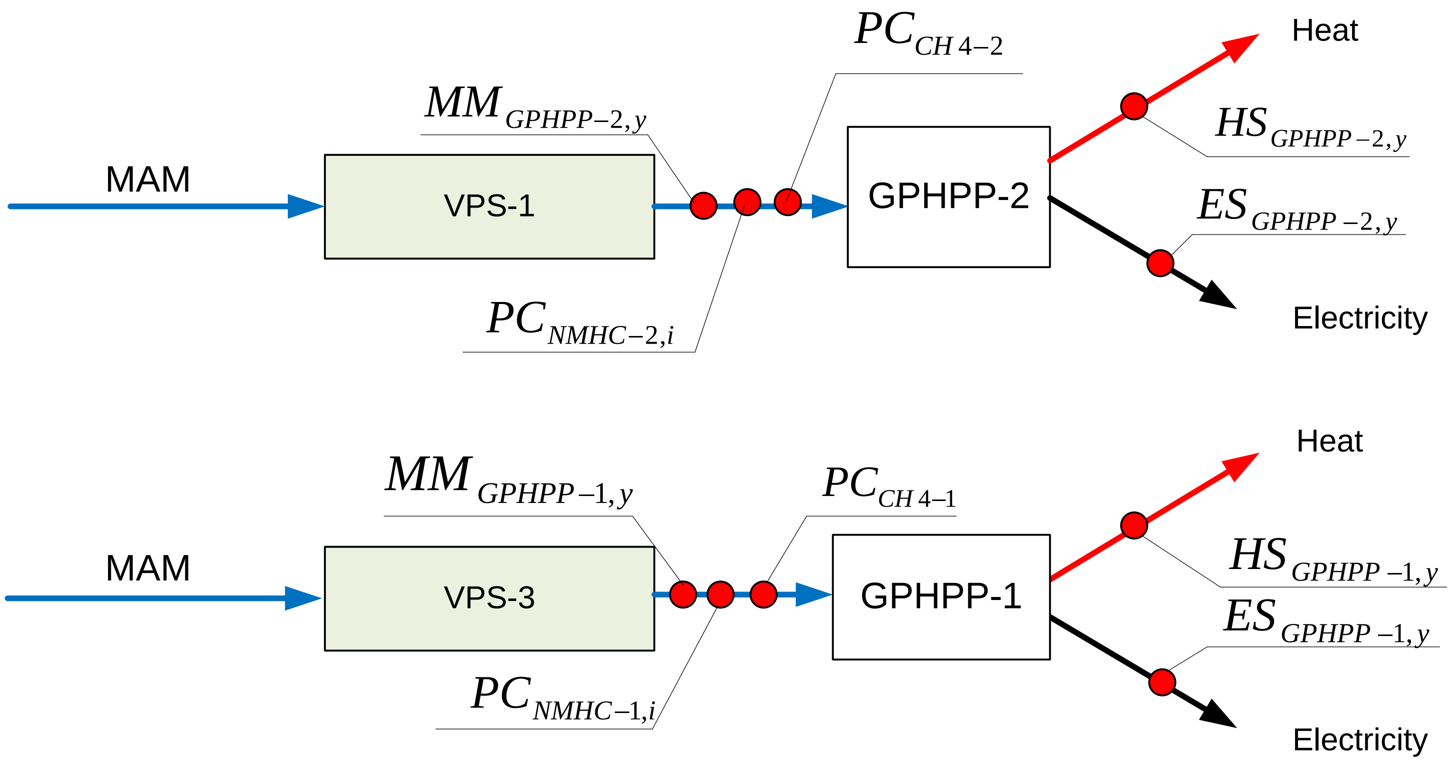


Fig. D.3-1. Location of the monitoring points

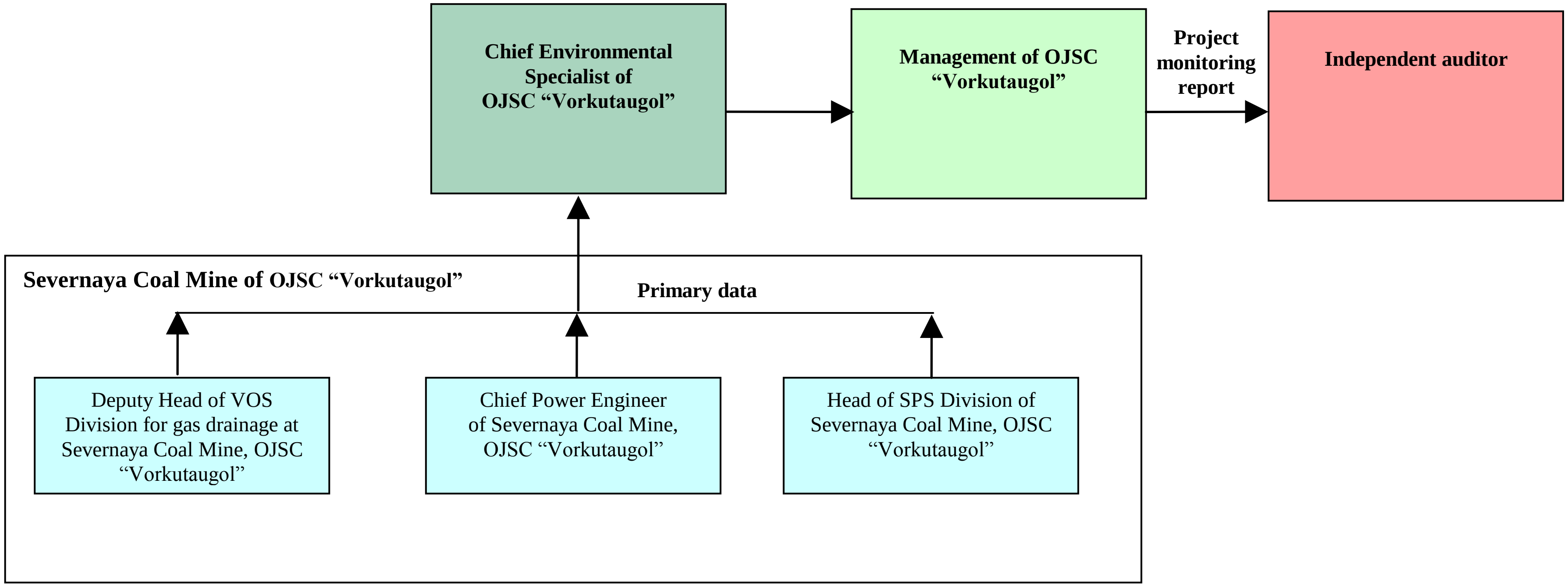


Fig. D.3-2. Data Transfer Scheme (from primary data to the monitoring report)

APCS

Automated process control system (APCS) is used to control and manage technological processes. This system provides the operational and technical personnel with all required information regarding the equipment condition and technological processes parameters. The signals from all sensors are transmitted to the main control room – to the operator's automated workstation.

Gas metering unit

The gas metering unit has the following functions:
- measuring the flow rate (m^3/h) and volume (m^3) of gas at operating conditions;

- measuring temperature of gas in ^{o}C;
- measuring gas pressure in MPa;
- measuring methane concentration in %;
- measuring running time with switched on power supply and indication of real time clock;
- calculation of mass consumption of methane (in kg);
- calculation of average hourly values of gas flow parameters (pressure, temperature, mass consumption at operating and adjusted to standard conditions);
- accumulation of methane mass information;
- display of current average hourly and resulting gas flows via controlled gas pipeline on the screen;
- registration (every hour) of average hourly and resulting parameters and storage of this information in non-volatile memory;
- emergency saving of current parameters when the power supply is switched off;
- recording of information on a MMC memory card on the operator's demand;
- transfer of information to the higher level (APCS) with the help of standard RS232 or RS485 interface;
- self-diagnostic and testing of blocks and units which constitute the meter.

Heat metering unit

Heat metering unit (HMU) is installed on the common header in the heating substation block module. HMU is designed for measuring and monitoring of the GPHPPs' heat quantity. HMU is constituted by a heat meter and a calculator. Information on the delivery water parameters is transmitted from the heat meter to the APCS.

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

The monitoring plan was developed by CCGS LLC (CCGS LLC is not the project participant and is not listed in Annex 1 to this PDD).

The contact person: Egor Ershov

E-mail: e.ershov@ccgs.ru

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

For projection estimates the project GHG emissions during the year *y* include only CO_2 emissions from methane combustion in GPHPPs[16], t CO_2e:

$$PE_y = PE_{MC,y}, \qquad \text{(E.1-1)}$$

where $PE_{MC,y}$ is the CO_2 emissions from methane combustion in GPHPPs during the year *y*, tCO_2.

$$PE_{MC,y} = \frac{44}{16} \cdot (MM_{GPHPP-1,y} + MM_{GPHPP-2,y}), \qquad \text{(E.1-2)}$$

where 44/16 is the emission factor for methane combustion (44/16=2.75), tCO_2/tCH_4;

$MM_{GPHPP-1,y}$ is the quantity of methane fed for combustion to GPHPP-1 during the year *y*, tCH_4. See Section B.1;

$MM_{GPHPP-2,y}$ is the quantity of methane fed for combustion to GPHPP-2 during the year *y*, tCH_4. See Section B.1.

Table E.1-1. GHG emissions from methane combustion in GPHPPs

Year	Estimation of project GHG emissions, tCO_2e
2011	13 565
2012	54 258
Total for the period 2011-2012	**67 823**

E.2. Estimated leakage:

There are no leakages due to the project implementation, thus:

$$LE_y = 0 \qquad \text{(E.2-1)}$$

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

Table E.3-1. The sum of project GHG emissions and leakages

Year	Estimation of project GHG emissions and leakages, tCO_2e
2011	13 565
2012	54 258
Total for the period 2011-2012	**67 823**

E.4. Estimated baseline emissions:

The baseline GHG emissions during the year *y*, tCO_2e:

$$BE_y = BE_{MR,y} + BE_{grid,y} + BE_{coal,VCHPP,y}, \qquad \text{(E.4-1)}$$

[16] CO_2 emissions from combustion of non-methane hydrocarbons (NMHCs) in GPHPPs will be also considered during monitoring if the total volume concentration of non-methane hydrocarbons in MAM exceeds 1%.

where $BE_{MR,y}$ is the prevented (due to the project) emissions of methane during the year *y*, tCO_2e;

$BE_{grid,y}$ is the prevented (due to the project) GHG emissions from power generation by the external grid power plants during the year *y*, tCO_2e;

$BE_{coal,VCHPP,y}$ is the prevented (due to the project) GHG emissions from coal combustion at Vorkuta CHPP-2 during the year *y*, tCO_2e.

$$BE_{MR,y} = GWP_{CH4} \cdot (MM_{GPHPP-1,y} + MM_{GPHPP-2,y}), \qquad \text{(E.4-2)}$$

where GWP_{CH4} is the Global Warming Potential for methane, GWP_{CH4} = 21 tCO_2e / tCH_4.

$$BE_{grid,y} = \frac{100}{100 - TDL_{TL}} \cdot (ES_{GPHPP-1,y} + ES_{GPHPP-2,y} - \Delta ES_{VCHPP,y}) \cdot EF_{CO2,grid}, \qquad \text{(E.4-3)}$$

where TDL_{TL} is the relative power losses in the external power grid, %. According to [R13] the assumed default value is TDL_{TL} = 3%;

$ES_{GPHPP-1,y}$ is the power supply from GPHPP-1 during the year *y*, MWh. See Section B.1;

$ES_{GPHPP-2,y}$ is the power supply from GPHPP-2 during the year *y*, MWh. See Section B.1;

$\Delta ES_{VCHPP,y}$ is the reduction in heat-consumption-based power supply from Vorkuta CHPP-2 as a result of the project during the year *y*, MWh. See Section B.1;

$EF_{CO2,grid}$ is the CO_2 emission factor for grid electricity, tCO_2/MWh. According to Annex 2.3 $EF_{CO2,grid}$ = 0.537 tCO_2/MWh.

$$BE_{coal,VCHPP,y} = \Delta FC_{coal,VCHPP,y} \cdot EF_{CO_2,coal} \cdot 10^{-3}, \qquad \text{(E.4-4)}$$

where $\Delta FC_{coal,VCHPP,y}$ is the reduction in coal consumption at Vorkuta CHPP-2 as a result of the project during the year *y*, GJ. See Section B.1;

$EF_{CO_2,coal}$ is the CO_2 emission factor for coal combustion, $kgCO_2$/GJ. According to [R8] $EF_{CO_2,coal}$ = 94.6 $kgCO_2$/GJ.

Emissions of CH_4 and N_2O from combustion of fossil fuel according to [R8] are considered to be negligible.

Table E.4-1. The baseline GHG emissions

Year	$BE_{MR,y}$, tCO_2e	$BE_{grid,y}$, tCO_2e	$BE_{coal,VCHPP,y}$, tCO_2e	Estimation of baseline GHG emissions, tCO_2e
2011	103 584	8 695	15 321	127 600
2012	414 336	34 778	61 285	510 399
Total for the period 2011-2012	**517 920**	**43 473**	**76 607**	**637 999**

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

Table E.5-1. Estimation of GHG emission reductions

Year	**Estimation of GHG emission reductions, tCO_2e**
2011	114 035
2012	456 141
Total for the period 2011-2012	**570 176**

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)
2011	13 565	0	127 600	114 035
2012	54 258	0	510 399	456 141
Total (tonnes of CO_2 equivalent)	**67 823**	0	**637 999**	**570 176**

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:

All energy generating units that are put into operation must be registered and must obtain a permit from relevant agencies. In this case it is the local territorial department of the Federal Service for Environmental, Technological and Nuclear Inspection[17], as well as the Directorate of Rosprirodnadzor (the Federal Service for Supervision in the sphere of Nature Management) [18] for the Komi Republic.

Permits include a license for operation of hazardous industrial sites, for deployment of specific types of technical installations.

The Directorate of Rosprirodnadzor for the Komi Republic issues permits for emission and discharge of pollutants into the environment and permits for harmful impact upon the air, and specifies maximum permitted concentrations of pollutants.

Before issuing permits the Federal Service determines whether it is necessary to have a thorough environmental impact assessment or it will suffice to go through a simplified procedure. Applications for permits are submitted shortly before mounting the equipment. Before commissioning of the site all permits and licenses would have been obtained.

The document "Severnaya Coal Mine of OJSC "Vorkutaugol". GPHPP-1, GPHPP-2. Design Documentation" also features Section 8 "List of Environmental Measures" [R14]. Section 8, as a part of the design documentation, will have to undergo state expert review.

Impact upon the land resources

Construction of the site has an impact upon the terrain and geological environment.

The impact is represented by allocation of land for the industrial facility, change in the terrain by construction and leveling works, increase in foundation soil loading by the weight of the designed structures, change in geological characteristics and surface run-off conditions.

Changes in surface-to-atmosphere heat exchange conditions, surface and soil characteristics, and snow cover are accompanied by changes in temperature conditions of soil.

Nature and climate conditions in the area and whether the construction site is located on permafrost grounds determine the specific conditions of work and site buildup. Underestimation of potential changes in the temperature conditions of soil caused by technogenic disturbance may spur freeze-and-thaw processes and affect stability of engineering structures. Subsidence of melting ground and development of heaving processes lead to deformation of structural foundations and may cause emergency situations at infrastructure facilities.

The main condition for safe construction and operation of a facility is to preserve soil in permafrost condition. Mechanical disturbance of heat-insulating top soil may upset the thermal balance of the surface and will increase the positive annual temperatures in soil, which is the main reason for development of thermokarst. Therefore construction works should be undertaken solely in winter months after the snow cover of sufficient strength is formed to preserve the moss and vegetation layer.

The soil is contaminated with pollutants contained in industrial wastes: sewage, domestic effluents, construction debris and household rubbish. In this case soil contamination with chemicals will be controlled within the allowable limits by organized collection of solid and paste-like wastes in special

[17] http://www.gosnadzor.ru

[18] http://www.rpnadzor.ru/office/structure/territorial/item172.html

containers (tanks) and by their further processing or disposal at specialized landfills. In this case the scope of impact will be localized within the backfilled sites.

To protect the land during operation of the industrial facility the design documentation envisages organizational and technological measures.

The organizational and technological measures include:

- preservation of soil in permafrost condition, execution of works which excludes disruption of the natural cover of the area and mitigates the risk of mechanical damage and thermal impact on frozen soil, thus increasing the stability of structures;

- the master plan and positioning of designed buildings and structures by elevation points which ensure safe operation;

- intrasite and access roads are to have PDN concrete slabs paving against a bed of sand cement and crushed stone;

- formation of the area surface in compliance with the surface runoff requirements, the drainage is connected to the existing offtake gutters and ditches;

- in order to protect the area from underflooding interception ditches with high barriers are provided from the west of the site;

- if the engineering services are laid above ground, then in the points of their intersection with roads overhead bridges are installed on high supports (distance from the road surface to the bottom of the engineering structures is not less than 5.0 m) which shall ensure free passage of motor vehicles;

- surface pattern formation and leveling works all over the territory;

- collection and treatment of surface water run-off with further diversion of effluents to the mine's treatment facilities;

- landscaping after completion of all construction and installation works;

- to ensure sanitary and health conditions the sites shall be planted with perennial grasses in the areas free from driveways and buildings.

Environmental measures will make it possible to minimize contamination of land resources and will ensure protection of soil and land resources from pollution during operation of the site.

<u>Impact upon atmospheric ground layer during operation</u>

GPHPPs fitted with power generating sets manufactured by MWM (Germany) meet all current environmental protection standards. The technically improved antidetonant system together with Altronic Deutz ignition system operates individually for each cylinder. Patented spark plugs ensure optimum ignition which provides for NO_x emission reduction (standard level of NO_x emissions is 500 mg/m^3).

Pollutant emissions from the installed process equipment are subject to regulation, the list of pollutants is given in Table F.1-1.

In order to determine atmospheric air pollution in the territory adjacent to GPHPPs and in the nearby residential area and in order to determine the maximum permissible pollutants emission level a dispersion modeling was carried out according to OND-86 (general normative document) "Tool for calculating atmospheric concentration of pollutants contained in plant emissions" using UPRZA "Ecolog" software, Version 3.0, developed by SPO "Integral", Saint-Petersburg.

Dispersion modelling was made with allowance for the existing environment pollution sources of the existing enterprise (in accordance with the MPE volume developed by LLC "SLAD-project" in 2009) under normal operation of GPHPPs at full load.

The calculation of ground-level concentrations was made for summer months because they have worse dispersion conditions.

The results of calculation of ground-level concentrations are given in Table F.1-2.

Table F.1-1. The list of pollutants emitted into the atmosphere from GPHPPs

Name	MPCmo[19] TSEL[20], mg/m^3	MPCad[21], mg/m^3	Hazard class	Emission source
Nitrogen dioxide (Nitrogen (IV) oxide)	0.2	0.04	3	GPHPPs
Nitrogen (II) oxide (nitrogen oxide)	0.4	0.06	3	
Carbon oxide	5	3	4	
Methane	50.0			
Carbon (soot)				The existing sources of industrial facilities
Sulphur dioxide (sulfurous anhydride)	0.5	0.05	3	
Kerosene	1.2			
Suspended solids	0.5			

Table F.1-2. The results of calculation of ground-level concentrations

Name of pollutant	Hazard class	MPCmo TSEL, mg/m^3	MPCoa[22], mg/m^3	Estimated maximum concentration in calculation points,		
				At the boundary of the residential development	On production site	
				In proportions of MPCmo	In proportions of MPCmo	In proportions of MPCoa
Nitrogen dioxide (Nitrogen (IV) oxide)	3	0.2	2	0.56	0.82	0.082
Nitrogen (II) oxide (nitrogen oxide)	3	0.4	5	0.11	0.13	0.0104
Carbon (soot)	3	0.15	4	0.01	0.03	0.0011
Sulphur dioxide (sulfurous anhydride)	3	0.5	10	0.02	0.08	0.0040
Carbon oxide	4	5	20	0.8	0.81	0.2025
Methane	-	50.0	7000	0.16	1.42	0.01014
Kerosene	-	1.2	300	0.0056	0.02	0.00008

[19] Maximum permissible concentration (MPC), maximum one-time (mo)
[20] Tentative safe exposure levels (TSEL)
[21] Maximum permissible concentration (MPC), average daily (ad)
[22] Maximum permissible concentration (MPC) of operating area (oa)

Suspended particles	3	0.5	-	0.77	1.15	-

Proceeding from the analysis of results of pollutant dispersion calculation the following conclusion was made: as a result of the project MPCmo will not be exceeded in the existing residential zone and neither will be exceeded the MPCoa of pollutants emitted into the atmosphere from the designed emission sources with allowance for the existing production and with allowance for background pollution.

Estimation of pollutant emission reductions due to the project implementation

The project implementation allows to reduce methane emissions to the atmosphere from VPS-1 and VPS-3 of Severnaya Coal Mine as well as pollutant emissions from coal combustion at Vorkuta CHPP-2.

Table F.1-3 shows estimated changes in quantities of pollutants emitted into the atmosphere as a result of the project implementation. The reduction in pollutant emissions from coal combustion was calculated in accordance with Regulatory Document (RD) 34.02.305-98 "Methodology for estimation of gross pollutant emissions to the atmosphere from boiler units of HPPs" published by All-Russian Thermotechnical Institute [R12].

As a result of the project coal consumption at Vorkuta CHPP-2 is reduced by approx. of 28 thousand tonnes/year. Thereby the emissions of sulphur dioxide are reduced by 575 t/year, carbon oxides – by 306 t/year, nitrogen oxides (calculated as nitrogen dioxide) – by 143 t/year, suspended solids – by 95 t/year. The overall reduction in gross pollutant emissions from coal combustion totals 1119 t/year.

Due to the project methane emissions to the atmosphere are reduced by 20.3 thousand tonnes per year.

The total effect from the project implementation is shown in Table F.1-3.

Table F.1-3. Change in pollutant emissions to the atmosphere due to the project implementation, t/year

Pollutant emissions	Change in emissions from Vorkuta CHPP-2 and VPS-1, VPS-3	Project emissions (from GPHPP-1 and GPHPP-2)	Total change in emissions
Suspended solids	-95	-	-95.0
Sulphur dioxide (SO_2)	-575	-	-575.0
Nitrogen oxide (NO_X)	-143	1.8	-141.2
Carbon oxide (CO)	-306	4.2	-301.8
Methane	-20 328	6,9	-20 321,1
Total emissions	**-21 447**	**12,9**	**-21 434,1**

Production and utilization of waste water

Water consumption will not change as a result of the power plant construction at Severnaya Coal Mine. During operation of the newly designed facility only surface water run-off is produced.

Since operation of the designed GPHPP-1 and 2 does not require permanent maintenance personnel these industrial facilities do not have any domestic sewage.

Surface water run-off is produced in the territory of the enterprise. The volume of annual collected effluents amounts to 973.7 m^3 – at GPHPP-1, and to 646.5 m^3 – at GPHPP-2.

Surface water run-off is collected in the existing offtake gutters and ditches. Rainfall run-off after treatment in the treatment facilities is utilized according to the scheme existing at the enterprise.

Generation and utilization of solid wastes

The sources of production and consumption wastes generated during operation of the designed facilities are:

- GPHPPs' oil system section,
- servicing of mechanisms and equipment.

The main types of wastes generated in the process of operation of the designed facility are:

- spent engine oils,
- wiping rags contaminated with oils (oil content less than 15%).

The overall estimated waste generation at both GPHPPs totals 26.1 tonnes which is quite negligible compared to the total quantity of wastes generated at Severnaya Coal Mine according to the existing Waste Generation Standards and Waste Disposal Limits (824 608.178 t/year).

The wastes will be utilized according to the scheme practiced at the enterprise. Severnaya Coal Mine does not have its own waste disposal sites. The wastes are delivered over to special-purpose organizations.

Noise pollution

Since GPHPPs are installed on the mine's site, they are located far away from the nearest residential quarters and there is no noise pollution.

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

The project does not have significant impact upon the environment. According to [R14] during operation and execution of works the environmental impact will be within the allowable standard provided that all energy protection measures are implemented and the sustainability of ecosystems will not be disturbed.

Moreover, the project leads to reduction in methane emissions to the atmosphere and to decrease in fossil fuel combustion, and therefore to reduction in pollutants and greenhouse gas emissions to the atmosphere.

SECTION G. Stakeholders' comments

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

The public hearings were not held since they are not required for this type of projects. The project is implemented on the mine's site, the gas piston heat and power plants are located far from residential areas.

The project measures got a wide coverage both in local mass media and in the internet. See for instance http://www.mvgazeta.ru/14-2/ruka-na-pulse-ekologii/.

The project received positive comments from the enterprise's employees.

There have been no negative comments or criticism of the project.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

Annex 2.1. Calculation of the project profitability for two implementation options

GPHPPs CONSTRUCTION

Constant parameters

Parameter	Unit	Value
Discount	%	20
ERU price	RUR/tCO2e	430
Depreciation period	year	10
Property tax rate	%	2,2
Profit tax rate	%	24,0

GPHPPs performance parameters

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Power generation	MWh			61 296	61 296	61 296	61 296	61 296	61 296	61 296	61 296	61 296
Heat production	Gcal			38 652	38 652	38 652	38 652	38 652	38 652	38 652	38 652	38 652
Methane consumption	thousand t			11,29	11,29	11,29	11,29	11,29	11,29	11,29	11,29	11,29

Cost of energy resources

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Price of 1 MWh of electricity	thousand RUR	1,922	2,220	2,531	2,669	2,807	2,946	3,086	3,224	3,361	3,503	3,651
Price of 1 Gcal	thousand RUR	0,772	0,892	1,017	1,072	1,128	1,205	1,262	1,319	1,375	1,433	1,494

Current costs

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Operational costs	thousand RUR			-37 029	-39 040	-41 071	-43 104	-45 144	-47 168	-49 164	-51 172	-53 262

Reduction in costs due to the project

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Reduction in power purchase costs	thousand RUR			155 142	163 571	172 077	180 595	189 143	197 623	205 989	214 709	223 798
Reduction in heat purchase costs	thousand RUR			39 304	41 440	43 594	46 587	48 792	50 979	53 137	55 387	57 732
Total reduction in costs	thousand RUR			194 446	205 011	215 671	227 181	237 935	248 602	259 126	270 096	281 530

Investments

Parameter	Unit	2008	2009
Total investments	thousand RUR	**-189 365**	**-462 857**

Depreciation

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Depreciation charges	thousand RUR		-18 937	-65 222	-65 222	-65 222	-65 222	-65 222	-65 222	-65 222	-65 222	-65 222
Cost of fixed assets	thousand RUR	189 365	633 286	568 063	502 841	437 619	372 397	307 175	241 952	176 730	111 508	46 286

Taxes

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Property tax	thousand RUR	-2 083	-9 049	-13 215	-11 780	-10 345	-8 910	-7 475	-6 040	-4 606	-3 171	-1 736
Profit tax	thousand RUR	500	6 717	-18 955	-21 352	-23 768	-26 387	-28 822	-31 241	-33 632	-36 127	-38 715

Economic parameters

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net cash flow	thousand RUR	-190 948	-465 190	125 247	132 838	140 488	148 781	156 493	164 153	171 724	179 626	234 104
Accumulated cash flow	thousand RUR	-190 948	-656 138	-530 891	-398 053	-257 565	-108 784	47 709	211 862	383 586	563 211	797 315

NPV	thousand RUR	**-76 432**
IRR	%	**16,4%**

Quantity of ERUs	tCO2e			237 107	237 107	237 107						
Revenues from sale of ERUs	thousand RUR			101 956	101 956	101 956						

Parameter	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net cash flow	thousand RUR	-190 948	-465 190	227 203	234 794	242 444	148 781	156 493	164 153	171 724	179 626	234 104
Accumulated cash flow	thousand RUR	-190 948	-656 138	-428 935	-194 141	48 303	197 084	353 577	517 729	689 453	869 079	1 103 183

NPV	thousand RUR	**102 541**
IRR	%	**25,2%**

Annex 2.2. Calculation sheet with key parameters and data

Parameter	Unit	Value
Operating hours of GPHPPs	h/year	8064
Hours of heating season	h/year	7200
Number of GP units at GPHPP-1	nos.	6
Number of GP units at GPHPP-2	nos.	3
GP unit characteristic		
Installed electric capacity	kW	1932
Installed thermal capacity	kW	1990
Capacity untilization factor		0,825
Electric efficiency		0,42
Calorific value of methane	kJ/kg	50254
Relative electricity consumption for auxiliary needs		0,05
Vorkuta CHPP-2 characteristic		
Losses in heating network from VCHPP-2 to Severnaya CM		0,05
Heat flow factor		0,98
Relative electricity consumption for auxiliary needs		0,05
Efficiency of boiler BKZ-220-100-4		0,916
Emission factor for coal	tCO2/GJ	0,0946
External power grid characteristic		
Emission factor of grid	tCO2/MWh	0,537
Grid losses		0,03

Parameter	Unit	Year					
		2007	2008	2009	2010	2011	2012
PROJECT							
Coal mining at "Severnaya Coal Mine"							
Coal volume	thousand t	2 577	2 068	2 031	2 036	2 200	2 200
Drained methane handling							
Quantity of drained methane VPS-1	million m3	44,388	33,188	33,333	31,216	31,216	31,216
Quantity of drained methane VPS-2	million m3	28,797	31,023	17,766	VPS-2 shut down		
Quantity of drained methane VPS-3	million m3	VPS-3 not commissioned			29,112	29,112	29,112
Overall quantity of drained methane	million m3	*73,185*	*64,211*	*51,099*	60,328	*60,328*	*60,328*
Average methane temperature at VPS-1	°c	43,0	43,4	42,5	43,0	43,0	43,0
Average methane temperature at VPS-2	°c	32,4	34,8	35,3	VPS-2 shut down		
Average methane temperature at VPS-3	°c	VPS-3 not commissioned			10,0	10,0	10,0
Average methane density at VPS-1	kg/m3	0,601	0,600	0,602	0,601	0,601	0,601
Average methane density at VPS-2	kg/m3	0,621	0,617	0,616	VPS-2 shut down		
Average methane density at VPS-3	kg/m3	VPS-3 not commissioned			0,671	0,671	0,671
Quantity of drained methane VPS-1	thousand t	26,659	19,907	20,051	18,748	18,748	18,748
Quantity of drained methane VPS-2	thousand t	17,895	19,128	10,936	VPS-2 shut down		
Quantity of drained methane VPS-3	thousand t	VPS-3 not commissioned			19,523	19,523	19,523
Total quantity of drained methane	**thousand t**	**44,554**	**39,035**	**30,987**	**38,271**	**38,271**	**38,271**
Methane utilization at GPHPP-1 (from VPS-3)	**thousand t**					**3,288**	**13,154**
Methane utilization at GPHPP-2 (from VPS-1)	**thousand t**					**1,644**	**6,577**
Total utilized at GPHPPs	**thousand t**	**0,000**	**0,000**	**0,000**	**0,000**	**4,933**	**19,730**
Methane supplied to AGAH	million m3	16,597	14,190	13,409	12,055	12,055	12,055
Methane supplied to CPP	million m3	22,226	18,995	18,554	16,237	16,237	16,237
Methane supplied to AGAH	**thousand t**	**9,968**	**8,511**	**8,066**	**7,240**	**7,240**	**7,240**
Methane supplied to CPP	**thousand t**	**13,349**	**11,394**	**11,161**	**9,752**	**9,752**	**9,752**
Total methane supplied to AGAH and CPP	**thousand t**	**23,316**	**19,905**	**19,227**	**16,992**	**16,992**	**16,992**
Remaining quantity (released into the atmosphere from VPSs)	**thousand t**	**21,237**	**19,130**	**11,761**	**21,279**	**16,346**	**1,549**

Internal energy production							
Power supply from GPHPP-1	MWh	0	0	0	0	18 316	73 263
Heat supply from GPHPP-1	Gcal	0	0	0	0	15 246	60 983
	GJ	0	0	0	0	63 834	255 337
Power supply from GPHPP-2	MWh	0	0	0	0	9 158	36 632
Heat supply from GPHPP-2	Gcal	0	0	0	0	7 623	30 492
	GJ	0	0	0	0	31 917	127 669
Total power supply from GPHPPs	MWh	0	0	0	0	27 474	109 895
Total heat supply from GPHPPs	Gcal	0	0	0	0	22 869	91 475
	GJ	0	0	0	0	95 751	383 006
GHG emissions							
GHG emissions from methane combustion in GPHPPs	tCO2e	0	0	0	0	13 565	54 258
BASELINE							
Coal mining at "Severnaya Coal Mine"							
Coal volume	thousand t	2 577	2 068	2 031	2 036	2 200	2 200
Drained methane handling							
Total quantity of drained methane	**thousand t**	**44,554**	**39,035**	**30,987**	**38,271**	**38,271**	**38,271**
Methane supplied to AGAH	**thousand t**	**9,968**	**8,511**	**8,066**	**7,240**	**7,240**	**7,240**
Methane supplied to CPP	**thousand t**	**13,349**	**11,394**	**11,161**	**9,752**	**9,752**	**9,752**
Total methane supplied to AGAH and CPP	**thousand t**	**23,316**	**19,905**	**19,227**	**16,992**	**16,992**	**16,992**
Remaining quantity (released into the atmosphere from VPSs)	**thousand t**	**21,237**	**19,130**	**11,761**	**21,279**	**21,279**	**21,279**
Additional release into the atmosphere compared to the project (equivalent to methane consumption at GPHPP -1, 2)	**thousand t**	**0,000**	**0,000**	**0,000**	**0,000**	**4,933**	**19,730**
Steam output and coal consumption at Vorkuta CHPP-2							
Additional output of live steam at Vorkuta CHPP-2 compared to the project (reduction in live steam output by boilers of Vorkuta CHPP-2 due to the project)	Gcal	0	0	0	0	35 432	141 728
	GJ	0	0	0	0	148 354	593 417
Additional coal combustion at Vorkuta CHPP-2 compared to the project (reduciton in coal consumption at Vorkuta CHPP-2 due to the project)	Gcal	0	0	0	0	38 681	154 725
	GJ	**0**	**0**	**0**	**0**	**161 959**	**647 835**
Power supply to the grid							
Additional power supply from the grid to Severnaya Coal Mine compared to the project (equivalent to power supply from GPHPP-1,2)	**MWh**	0	0	0	0	27 474	109 895
Additional power supply to the grid from Vorkuta CHPP-2 compared to the project (reduction in heat-consumption-based power supply from Vorkuta CHPP-2 due to the project)	GJ	0	0	0	0	42 366	169 466
	MWh	0	0	0	0	11 768	47 074
Total additional supply of power from grid power plants compared to the project (reduction in power supply from external power plants due to the project implementation)	**MWh**	**0**	**0**	**0**	**0**	**15 705**	**62 821**
GHG emissions							
Prevented (due to the project) methane emissions	tCO2e	0	0	0	0	103 584	414 336
Prevented (due to the project) GHG emissions from coal combustion at Vorkuta CHPP-2	tCO2e	0	0	0	0	15 321	61 285
Prevented (due to the project) GHG emissions from power generation at external grid power plants	tCO2e	0	0	0	0	8 695	34 778
Total	tCO2e	0	0	0	0	127 600	510 399
REDUCTIONS							
GHG emission reductions due to the project	tCO2e	0	0	0	0	**114 035**	**456 141**

Annex 2.3. Information for determining the emission factor for grid power

The emission factor for grid power was assumed equal to the estimated combined emission factor for the Integrated Power System (IPS) "North-West"[23], $EF_{CO2,grid,CM,y}$ = 0.548 tCO_2/MWh. The calculation of emission factor was made in accordance with the "Tool to calculate the emission factor for an electricity system. Version 2"[24].

With allowance for the uncertainty factor, the definitive emission factor for calculation of the baseline GHG emissions and project leakages was assumed equal to:

$$EF_{CO2,grid} = EF_{\mathrm{CO2,grid,CM,y}} \times 0.98 = 0.537 \ \mathrm{tCO_2/MWh}.$$

[23] http://www.sbrf.ru/common/img/uploaded/files/tender/kioto2/58_TGK1_Pervomayskaya.pdf

[24] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf

Annex 3

MONITORING PLAN

See section D for details.

Annex 4

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