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:

Biomass wastes to energy at OJSC “Ilim Group” Branch in the town of Bratsk

Sectoral scopes: 1. Manufacturing industries[1] (4)

2. Waste handling and disposal (13)

Version number: 1.1

Date: 23 June 2009

A.2. Description of the project:

The project is aimed at efficient utilization of high-moisture biomass wastes for production of heat and electricity for auxiliary needs of OJSC “Ilim Group” Branch in the town of Bratsk.

The project envisages complex modernization of the energy system of Bratsk Pulp and Paperboard Mill (BPPM)[2] and switching of the boiler equipment to fluidized bed combustion of bark and wood wastes (BWW) and wastewater sludge (WWS).

The core business of BPPM is production of pulp and paperboard. Pulp chips are used for pulp cooking. The pulp chips production yields large quantities of BWW. Also some quantity of BWW is supplied to BPPM from the neighboring woodworking enterprises which do not have their own utilization capacities. WWS is generated at the biological treatment plant for the Mill’s industrial effluents.

Heat and electricity are produced at the Mill by the technological heat and power plant (THPP) consisting of three sites: CHPP-2, CHPP-3 and the boiler house interconnected by steam pipelines and power transmission lines. THPP uses residual fuel oil, BWW and black liquor[3] as fuel. Prior to the project implementation BWW have been combusted in utilizing boilers No. 9 and No.10 of CHPP-2 and in utilizing boiler No.15 of the boiler house. It was possible to achieve stable burning of BWW only by using residual fuel oil for flame stabilization. Basically only relatively dry wood wastes (sawdust and wood sliver) was used, whereas high-moisture bark (moisture content up to 70%) was mostly disposed at the dump[4]. WWS with even higher moisture content has never been utilized at all and the entire quantity of it is disposed at the dump.

The shortfall of heat and electricity at the Mill is covered by CHPP-6 of OJSC “Irkutskenergo” located in close vicinity to BPPM. The main fuel of CHPP-6 is lignite.

In the absence of the project the Branch management would have carried on with the existing practice of waste biomass handling, heat and electricity generation and purchase of energy from OJSC “Irkutskenergo” to bridge the shortfall.

The project envisages complex modernization of the energy system of BPPM in three stages.

The first stage:

- reconstruction of E-75-40K boiler unit No.16 for BWW combustion without residual fuel oil firing (or any other fossil fuel) for fuel stabilization due to implementation of fluidized bed combustion technology designed by “INECO”.

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

[2] BPPM is the main enterprise of OJSC “Ilim Group” Branch in the town of Bratsk.

[3] Black liquor which is a by-product of pulp production is also a biomass and is fired in special black liquor recovery boilers of CHPP-3 for sodium sulfate recovery and steam production. However this project does not cover black liquor.

[4] The dump shall mean sludge lagoon No.1.

The second stage:

- reconstruction of E-75-40K boiler unit No.14 for BWW combustion without residual fuel oil firing for fuel stabilization with increase of steam output to 90 t/h due to implementation of fluidized bed combustion technology designed by “INECO”.

The third stage:

- installation of a new E-90-3.9-440DFT boiler unit No.15 designed for fluidized bed combustion of BWW and WWS without residual fuel oil firing for fuel stabilization using “Kvaerner Power” technologies (Finland);
- modernization of BWW feed system of renewed utilizing boilers No.14, No.15 and No.16;
- modernization of the thermal flow diagram of THPP.

As a result of the project the following will be achieved:

- practically all BWW generated on the territory of the Branch (including BPPM and neighboring woodworking enterprises) will be utilized and BWW disposal at the dump will be almost completely avoided;
- a significant proportion of WWS will be utilized with a respective reduction of WWS disposal at the dump;
- in-house production of heat and electricity will increase;
- residual fuel oil consumption in the Mill’s fuel balance will reduce;
- the system of energy supply of the production will be optimized, its reliability and cost-efficiency will be improved;
- negative environmental impact will be reduced;
- the greenhouse gas (GHG) emissions will be reduced by 278 thousand tonnes of CO_2e/year, on average.

Implementation of the first stage began in April 2000 and was completed in June 2001. The required amount of investments into the first stage totaled to EUR 1.6 million. In many respects it was a pilot stage with the objective to study the possibility of applying new BWW combustion technologies and to check them.

The second stage builds on the results and findings of the first stage. Implementation of the second stage required by far more time and investments. The second stage was implemented from April 2002 till June 2004. The required investments into the second stage totaled to about EUR 4 million.

Implementation of the third stage began in June 2007. All construction and installation works are planned to be completed by the 1st of March, 2010. The required investments into the third stage amount to around EUR 24.6 million.

It should be noted that the project is clearly environment-oriented. Implementation of the project faces a number of serious technological, operational and financial barriers. The decision to go forward with the project was taken by the company management in view of the existing opportunity to cover some of its costs and to offset project risks by selling GHG emission reductions.

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: Russian Federation (Host Party)	Legal entity A1: Open Joint Stock Company "Ilim Group"	No
Party B: EC	Legal entity B1: To be determined within 12 months upon approval of the project by the Russian Government	No

Open Joint Stock Company "Ilim Group" (OJSC "Ilim Group") is the largest company of the Russian pulp and paper industry founded in 1992 as Closed Joint Stock Company "Ilim Pulp Enterprise". The strategic partner of OJSC "Ilim Group" and the holder of 50% of its shares is the world's largest pulp and paper company, "International Paper". The company's enterprises located in the Leningrad, Arkhangelsk and Irkutsk Regions account for 65% of Russia's overall market pulp production and for over 25% of paperboard production. The total annual production of pulp and paper by the company is over 2.5 million tonnes[1].

The OJSC "Ilim Group" Branch in the town of Bratsk was set up in 1997 by including Bratsk Timber Industry Complex (BTIC) into Closed Joint Stock Company "Ilim Pulp Enterprise". BTIC consists of Bratsk Pulp and Paperboard Mill (BPPM) and a number of neighboring woodworking and wood chemical enterprises.

BPPM is one of the largest producers of pulp and paperboard in Russia, the traditional supplier of South-East Asian markets. The Mill's total annual yield of pulp and paper products is over 715 000 tonnes.

A.4. Technical description of the project:

A.4.1. Location of the project:

A.4.1.1. Host Party(ies):

The Russian Federation

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

The Irkutsk Region

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

The Town of Bratsk

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

The town of Bratsk is a constituent of the Irkutsk Region, located in the central part of Angara Crest on the shore of Bratsk water reservoir, 618 km (by motor road) from Irkutsk (Fig. A.4-1). The federal roads Tulun–Bratsk–Ust-Kut and Bratsk–Ust-Ilimsk pass through Bratsk. The population is over 250 000 people[2].

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[1] For official information on OJSC "Ilim Group" and its branches please visit the company's web-site www.ilimgroup.ru.

[2] Please visit the official site of Bratsk Municipal Administration www.bratsk-city.ru.

The project activity is implemented on the site of Bratsk Pulp and Paperboard Mill located in the south part of the town (Fig. A.4-2).

Geographical latitude: 56°07'09"N. Geographical longitude: 101°36'50"E. Time zone: GMT +8:00.

Fig. A.4-1. Location of the town of Bratsk in the Russian Federation

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

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

Overview of BPPM

The core business of BPPM is production of sulfate bleached softwood and hardwood pulp, sulfate unbleached pulp and paperboard. Pulp is cooked at pulp and paperboard production lines. Heat and electricity are generated at the Mill by technological heat and power plant consisting of three main sites: CHPP-2, CHPP-3 and the boiler house. The shortfall of heat at the Mill is bridged by CHPP-6 of OJSC “Irkutskenergo” located in close vicinity to the Mill just several scores of meters from CHPP-2. The shortfall of electricity is bridged by supplies from CHPP-6 and also from the external power grid. All energy sources of BPPM are interconnected and connected with CHPP-6 by steam pipelines and power transmission lines.

The basic steam supply diagram of OJSC “Ilim Group” Branch in the town of Bratsk is given in Annex 4.

Key features of the production sites prior to the project

CHPP-3

CHPP-3 is an energy-generating and technological plant that produces heat and electricity from the steam generated in liquor recovery boilers (LRBs) that are a part of the regeneration cycle for the liquor produced during pulp cooking. The main fuel of LRBs is black liquor (a mixture of dissolved organic matters of wood and inorganic substances, mostly various sodium and sulfur salts). The supplementary fuel is residual fuel oil which is added to ensure stable combustion of liquors. BWW and WWS are not fired in CHPP-3. The quantity of generated heat and electricity entirely depends on the pulp cooking volumes. The project implementation will not affect operation of CHPP-3.

CHPP-2

CHPP-2 is an energy-generating plant that ensures wood wastes utilization and produces heat and electricity for production needs of the Mill and of the neighboring woodworking and wood chemical enterprises.

The main performance characteristics of the main operating equipment of the plant as of January 1, 2001 are given in Tables A.4-1 and A.4-2.

Table A.4-1. Main performance characteristics of CHPP-2 boiler equipment

Number	Type	Year of commissioning	Steam parameters	Nominal output, t/h	Main fuel
			Pressure / Temperature, MPa / °C		
9	KM-75-40	1972	3.9 / 440	75	wood wastes
10	KM-75-40	1974	3.9 / 440	75	wood wastes

Table A.4-2.Main performance characteristics of CHPP-2 turbine equipment

Number	Type	Year of commissioning	Steam parameters	Nominal capacity, MW
			Pressure / Temperature, MPa / °C	
1	R-6-35/5	1963	3.4 / 435	6
2	R-6-35/10	1965	3.4 / 435	6
3	R-6-35/10	1965	3.4 / 435	6
4	R-6-35/10	1965	3.4 / 435	6
5	R-6-35/10	1972	3.4 / 435	6
6	R-6-35/10	1972	3.4 / 435	6

CHPP-2 has only two boiler units of KM-75-40 type, these are No.9 and No.10. Boilers of this type are designed for combustion of debarking and sawmill wastes using residual fuel oil for flame stabilization. The boilers are fitted with mechanical chain grate and residual fuel oil burners. The design steam output from combustion of wood wastes with moisture content below 60% is 50 t/h, and when residual fuel oil is used for flame stabilization, the output is 75 t/h. The plant originally had six boilers of this type. Boilers No.5, No.6, No.7 and No.8 were decommissioned in the late 1990-s – in the early 2000 because they had reached their operational lifetime limit.

The main fuel fired in boilers No.9 and No.10 is wood wastes supplied from inside bark and chips storage No.1 (IBCS No.1). Residual fuel oil is used for flame stabilization.

Four SRKA-750 liquor recovery boilers were also installed at CHPP-2. The main fuel of the boilers was black liquor, residual fuel oil was added to ensure stable combustion. In 2002 all LRBs installed at CHPP-2 were decommissioned because all liquor began to be fired in more efficient renovated LRBs installed at CHPP-3. The implementation of the project does not affect operation of this type of boilers.

The steam produced by CHPP-2 boilers is mixed in the common steam header and is fed to the turbine hall less the steam fed to the wood chemical production (WCP) and to the high yield workshop (HYW) of pulp production No.1 (PP No.1) through pressure-reducing desuperheating units. Nominal parameters of live steam for all boilers are as follows: pressure – 3.9 MPa, temperature – 440 °C.

The plant has six back-pressure turbine units with total installed electric capacity of 36 MW: 5 turbines of R-6-35/10 type and one turbine of R-6-35/5 type. The waste steam after turbines at 1.3 MPa and 0.6 MPa is used for auxiliary needs of the plant and is fed to the common steam system of THPP where it is mixed with the steam produced by other energy sources.

Boiler house

Originally the boiler house was a part of the hydrolysis yeast plant (HYP) and was designed for combustion of lignin (hydrolysis production residue) for steam production to cover the plant’s auxiliary needs. The boiler house had three E-75-40K boiler units No.14, No.15 and No.16. The primary design fuel of the boilers was lignin. The design steam output of each boiler is 75 t/h. This type of boilers uses the technology of lignin combustion in low-temperature swirling-type furnace (LTS-furnace). The LTS-furnace was designed by V.V. Pomerantsev and the team of Leningrad Polytechnic University. The schematic diagram of LTS-furnace is given in Annex 5.

LTS-technology is based on multiple circulation of fuel particles in a chamber furnace. LTS-furnace has two combustion zones: one is swirling, the other is direct-flow. The swirling zone is created by interaction of two organized flows: the first flow is formed by fuel-and-air mixture fed to the furnace through burners; the second flow is hot air fed to the furnace through a bottom blast system. The flows are directed towards each other and form a couple of forces which create swirling motion in the lower compartment of the furnace.

Since HYP was decommissioned in 1992 the boiler house was included in the energy system of THPP. In 1991 and 1994 E-75-40K boilers No.15 and No.16, respectively, were switched to low-temperature swirl combustion of wood wastes without their prior pulverization whereas the existing LTS-furnaces were retained. This was one of the first experiences of carrying out reconstruction of such type. The lack of experience in operation of boilers with this furnace type was a barrier to achieving efficient combustion of wood wastes. It was not possible to fire wood wastes without using residual fuel oil for flame stabilization because the furnace design had some imperfections. The fuel bunkers of the boilers were not suitable for BWW, which caused clogging and destabilization of fuel feed to the boilers. Some positive results were achieved only when sawdust with low moisture content was combusted.

Boiler No.14 was laid up in 1995 because of the lack of the primary fuel – lignin. Boiler No.16 has not been operated since 1997. Only boiler No.15 is operated, its main fuel is sawdust supplied from outdoor sawdust storage No.5, residual fuel oil is used for flame stabilization. The nominal parameters of live steam for the boiler are: pressure – 3.9 MPa, temperature – 440 °C. The steam produced by boiler No.15 is fed to the common steam header and further to the pressure-reducing desuperheating units where its pressure is reduced to 1.3 MPa. This steam is further used for auxiliary needs of the boiler house and is fed to the steam pipeline system of THPP.

The main performance characteristics of the energy generation equipment as of January 1, 2001 are given in Table A.4-3.

Table A.4-3. Main performance characteristics of the boilers installed in the boiler house

Number	Type	Year of commissioning	Steam parameters Pressure / Temperature, MPa / °C	Nominal output, t\h	Main fuel
14*	E-75-40K	1986	3.9 / 440	75	lignin
15	E-75-40K	1986	3.9 / 440	75	sawdust
16*	E-75-40K	1986	3.9 / 440	75	sawdust

*not operated

<u>**Overview of the project activity**</u>

The project is implemented in three main stages.

The first stage

Implementation of the first stage began in April 2000.

At the first stage E-75-40K boiler No.16 was reconstructed.

The reconstruction included the following:

- fitting the boiler with an fluidized bed furnace extension without a tube waterwall designed by “INECO”;
- reconstruction of the BWW feed tract and installation of bark bunkers;
- overhaul of elements of the vapour and water tube system of the boiler;
- fitting the boiler with high-efficiency gas cleaning equipment: four BCU 200/110 multicyclones (wood ash collection efficiency not less than 95%);
- replacement of the boiler burners;
- reconstruction of gas-air ducts, residual fuel oil lines, pipelines for steam supplied for auxiliary needs and auxiliary pipelines within the boiler boundaries;
- installation and adjustment of an automated process control system (APCS) of the boiler.

All construction and installation works planned under the first stage had been completed by April 2001. On June 4, 2001 the boiler was put into operation after the required pre-commissioning run.

The basic process flow diagram of the reconstructed E-75-40K boiler No.16 is given in Annex 6.

The main fuel of the reconstructed boiler is BWW. The main design characteristics of BWW are given in Table A.4-4.

Table A.4-4. Main design characteristics of BWW [R1]

Parameter	Unit	Value
Moisture content	%	57
Ash content	%	2.4
Net calorific value	GJ/t	6.70

Installation of a fluidized bed furnace extension made it possible to employ a two-stage technology of bark and wood wastes combustion that provides for pre-gasification of fuel in the furnace extension and afterburning of gasification products in the boiler furnace.

The incomplete combustion process takes place at 700÷850 °C in a fluidized bed made of inert filler (quartz sand 0.5÷2 mm) in the furnace extension when the fuel particles come in contact with primary blast air. Primary blast air is blown onto the air-distributing grate with an excess air factor of 0.3÷0.4 (at nominal output of the boiler), which ensures nonslagging operation of the fluidized bed. The incomplete fuel combustion in the fluidized bed, accompanied by pyrolysis and gasification processes, produces a vapour-gas mixture of low calorific value which together with small-sized active wood semicoke particles fills the over bed section of the furnace extension. From the furnace extension the products of thermal treatment of fuel being mixed with the products of thermal treatment of back-blown small-size fuel particles (vapor-gas mixture and small-sized active semicoke) flow to the boiler furnace. In the furnace they are mixed with jets of secondary blast air. The secondary blast air nozzles are directed downwards towards the sloping bottom of the boiler. Therefore when the products of thermal treatment of fuel mix with the jets of secondary blast air a flame is produced, this flame is partially drawn into the sloping bottom. Unburnt particles of wood semicoke are separated together with fine sand carried from the furnace extension into the sloping bottom, where they burn up in the jets of tertiary air. Afterburning of wood semicoke particles takes place in the fluidized bed of separated fine sand particles.

The boiler reconstruction did not envisage any modification of the heating surfaces of the furnace, steam superheater, economizer or air heater.

The main performance characteristics of E-75-40K boiler No.16 after reconstruction are given in Table A.4-5. The reconstructed boiler maintains nominal steam load of 75 t/h when run on BWW with moisture content of 57% without residual fuel oil combustion for flame stabilization. Residual fuel oil is used only for lighting up the boiler.

Table A.4-5. Main performance characteristics of E-75-40K boiler No.16 after reconstruction [R1]

Parameter	Unit	Value
Nominal output	t/h	75
Steam parameters:		
Pressure	MPa	4.0
Temperature	°C	440
Feed water temperature	°C	104
Consumption of BWW (operation under nominal conditions)	t/h	37.55
Efficiency (operation under nominal conditions)	%	86.4

The first stage did not envisage reconstruction of the boiler house’s thermal flow diagram. All steam produced by boiler No.16 is fed to the boiler house’s common header for 3.9 MPa steam where it is mixed with steam produced by boiler No.15.

Implementation of the first stage of the project led to a sharp increase of bark combustion at the Mill.

The second stage

Implementation of the second stage began in April 2002.

The second stage included reconstruction of E-75-40K boiler No.14 which envisaged its full replacement with a boiler of a new design.

In the course of the reconstruction the following was implemented:

- replacement of the furnace chamber by a membrane furnace and installation of a membrane fluidized bed furnace extension designed by “INECO”;
- replacement of the water-wall surfaces and convection heating surfaces, tank cradle and boiler drum;
- replacement of the flue gas treatment unit and installation of multicyclones;
- reconstruction of the BWW feed tract and installation of BWW bunkers;
- replacement of the burners in the boiler furnace;

- replacement of the pneumatic ash handling system by scraper conveyors;
- replacement of the boiler draft system (forced draft fan, induced draft fan), installation of a high-pressure hot-blast fan;
- replacement of the gas-air ducts, residual fuel oil lines, steam pipelines within the boiler boundaries;
- installation of instrumentation and automated control systems, electric equipment, cables, process protection, safety interlocking, signalization based on APCS equipment.

All construction and installation works planned under the second stage had been completed by April 2004. On June 30, 2004 the boiler was put into operation after the required pre-commissioning run.

The basic process flow diagram of the reconstructed E-75-40K boiler No.14 is given in Annex 7.

The main fuel of the reconstructed boiler is BWW. The main design characteristics of BWW are given in Table A.4-4 above.

The reconstructed boiler No.14, similar to boiler No.16, uses a two-stage technology of BWW combustion with its pre-gasification in the furnace extension and afterburning of gasification products in the boiler furnace.

The main performance characteristics of E-75-40K boiler No.14 after reconstruction are given in Table A.4-6. The reconstructed boiler has a design steam output of 90 t/h when run on BWW with moisture content of 57% without using residual fuel oil for flame stabilization. Residual fuel oil is used only for lighting up the boiler.

Table A.4-6. Main performance characteristics of E-75-40K boiler No.14 after reconstruction [R2]

Parameter	Unit	Value
Nominal output	t/h	90
Steam parameters:		
Pressure	MPa	4.0
Temperature	°C	440
Feed water temperature	°C	104
Consumption of BWW (operation under nominal conditions)	t/h	46.30
Efficiency (operation under nominal conditions)	%	83.7

The second stage did not envisage reconstruction of the boiler house’s thermal flow diagram. All steam produced by boiler No.14 is fed to the boiler house’s common header for 3.9 MPa steam where it is mixed with steam produced by boiler No.15 and No.16.

After implementation of the second stage the old utilizing boilers No.10 and No.15 were decommissioned (2006). Of the old boilers only boiler No.9 remained in operation.

The third stage

Implementation of the third stage began in June 2007.

The third stage includes three actions:

- installation of a new E-90-3.9-440DFT boiler unit No.15;
- modernization of BWW feed system of renovated utilizing boilers No.14, No.15 and No.16;
- modernization of the thermal flow diagram of the THPP.

All construction and installation works are planned to be completed by the 1st of March, 2010.

Installation of a new E-90-3.9-440DFT boiler unit No.15

Within the framework of this action it is planned to install a new state-of-the-art boiler of E-90-3.9-440DFT type designed for fluidized bed co-combustion of BWW and WWS. The old boiler No.15 was dismantled. The main fuel characteristics are given in Table A.4-7. Residual fuel oil is used for lighting up the boiler. WWS account for not more than 8% of the total fuel combustion.

Table A.4-7. Main fuel characteristics [R3]

Parameter	Unit	Value	
		BWW	WWS
Moisture content	%	59	63.5
Net calorific value	GJ/t	6.09	3.82

The base design was developed by LLC “Industrial Company”, Belgorod. The manufacturer, supplier and developer of the detailed design of the boiler is OJSC “Energomashkorporacia “PK Sibenergomash”, Barnaul.

The basic process flow diagram of E-90-3.9-440DFT boiler No.15 is given in Annex 8.

The design of E-90-3.9-440DFT boiler envisages a fluidized bed grate, fuel feed system and a furnace bottom ash removal system by “Kvaerner Power”.

The fluidized bed grate consists of water-cooled tubes welded in the form of rectangle beams and of steel sheets that connect them. The tubes are included in the evaporating circuit and water is fed via these tubes to the distribution manifold of the rear water-wall. The advantage of such grate is efficient removal of coarse fraction of the fluidized bed material from the boiler. This reduces the number of unscheduled shutdowns of the boiler.

The fluidized bed is made of natural quartz sand with a specific particle size distribution which is made to behave like fluid by high-pressure jets of air. Blast air is blown upwards from under the fluidized bed grate. The fuel is fed into the heated bed of sand. The fuel burns in the fluidized bed with a deficit of oxygen and the burning process is accompanied by a fuel gasification process. Gasification products are fired in the over bed zone with secondary air being blown to this zone. The burning takes place partially inside the fluidized bed and partially above it. The blast air of the bed is the primary air for burning. The secondary air is fed through secondary and tertiary air nozzles. Secondary air nozzles are located on the front and rear water-walls within the fuel feeding zone. The tertiary air nozzles are located on the side water-walls above the fluidized bed, which ensures afterburning of unburnt fuel particles and fuel gasification products within the combustion chamber.

The sand pulverized by friction is partially carried away with flue gases. Large fraction of sand are regularly removed from the bed via a drainage system and are taken to the sand recovery unit, where the sand is cleaned from ash particles and returned to the furnace. The bed is replenished by feeding new sand to the combustion chamber.

The fuel feed system of the boiler includes two parallel feed lines with bunkers, conveyors and feeding devices. Each line has a wood waste throughput capacity of 120 m^3 per hour.

From the existing fuel feed conveyor wood wastes will be discharged into the newly installed fuel bunkers fitted with distributing and discharging devices.

The fuel feed system supplied by “Kvaerner Power” consists of distributing hoppers, located at both side water-walls, and screw feeders. The fuel is discharged into a distributing hopper and from there it is distributed by screw feeders in two directions. The level in the distributing hopper is controlled by a feeding device of the bunker.

The fuel bunkers holding 100 m^3 are supplied by LLC “Energomash – Eastern Siberia”, the distributing and discharging devices are supplied by “Metso Power”.

The boiler will be fitted with APCS, electric equipment, instrumentation and control systems supplied by “Metso”.

Two-stage electrostatic precipitator will be installed for flue gas treatment.

The main performance characteristics of E-90-3.9-440DFT boiler No.15 are given in Table A.4-8.

Table A.4-8. Main performance characteristics of E-90-3.9-440DFT boiler No.15 [R3]

Parameter	Unit	Value
Nominal output	t/h	90
Steam parameters:		
Pressure	MPa	3.9
Temperature	°C	440
Feed water temperature	°C	105
Consumption of BWW (operation under nominal conditions)	t/h	48.90
Efficiency (not less than)	%	85.5

The steam produced by boiler No.15 will be fed to the common 3.9 MPa steam header where it will be mixed with steam produced by boilers No.14 and No.16.

The estimated annual performance of E-90-3.9-440DFT boiler No.15 is given in Table A.4-9.

Table A.4-9. Estimated annual performance of E-90-3.9-440DFT boiler No.15 [R3]

Parameter	Unit	Value
Heat production	GJ/year	2 137 334
Mass consumption of BWW	t/year	347 760
Mass consumption of residual fuel oil	t/year	76.4

Together with the implementation of this action it is planned to decommission the old KM-75-40 boiler No.9 of CHPP-2.

Modernization of BWW feed system of renovated utilizing boilers No.14, No.15 and No.16.

The basic diagram of BWW feeding for combustion to THPP is given in Annex 9.

With the decommissioning of boilers No.9 and No.10 the wood wastes feeding for combustion to CHPP-2 via inside bark and chips storage No.1 will cease. Bark and wood wastes from the wood preparation workshop – 2 (WPW-2) will be supplied by the existing pneumatic lines to outdoor sawdust and bark storages No.5 and No.6. The sawdust produced from sorting of purchased chips and chips supplied from chips sorting section CS-900 at PP No.1 will be fed by the existing belt conveyor of IBCS No.1 to the new pneumatic sawdust feeding line to outdoor sawdust storage No.5. In order to enable the operation of the new pneumatic line a drum-type feeder will be installed at IBCS No.1, and a TV-type air blower will be installed in the room of blowing house No.9.

BWW will be supplied to the boiler house from outdoor sawdust and bark storages No.5 and No.6 by pressure via the two existing pneumatic lines 3a and 4a and a new pneumatic line 5a.

Sawdust from sawdust storage No.5 is supplied by pneumatic line 3a via charging unit No.4 to the cyclone No.1. Bark from bark storage No.6 is supplied via charging unit No.2 to cyclone No.2 by pneumatic line 4a. Charging unit No.1 consisting of a scraper conveyor and a feeder will be used for bark charging from the existing bark storage No.6 to pneumatic line 5a. Bark is charged by the scraper conveyor via a feeder to pneumatic line 5a. The pneumatic line is discharged via cyclone No.3.

It is planned to have a standby charger at sawdust storage No.5.

The planned scheme will ensure supply of sawdust and bark from the existing storages No.5 and No.6 to all three boilers under full loading conditions.

Modernization of the thermal flow diagram of THPP

Modernization of the thermal flow diagram of THPP aimed at increase of its operational reliability and efficiency envisages implementation of the following main actions:

- installation of an additional de-aeration unit for thermal de-aeration of water, which would ensure operation of the renovated utilizing boilers when the existing de-aerator DSA-300 fails;
- installation of new feed pumps;
- assembly of an automated load dropping line of feed pumps of the boiler house to rule out pressure buildup in the feed pumps above the standard value when feed water consumption by the boilers drops;
- assembly of a two-strand boiler feeding line to ensure reliable and safe operation of boilers of boiler house in all operation modes, including emergency shutdowns;
- installation of additional stop valves;
- installation of external live steam pipeline, 1200 m long, from the boiler house to CHPP-2.

The third stage also envisages reconstruction of the boiler house building and installation of a central boiler control panel.

Implementation of the three planned stages will lead to decommissioning of old utilizing boilers No.9 and No.10 of CHPP-2 and boiler No.15 of the boiler house, and therefore no operating boilers will be left in CHPP-2. A permanent partition wall will be assembled in the boiler room of CHPP-2 which will separate it from the turbine hall and evaporation workshop.

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:

Implementation of the project will lead to reduction of GHG emissions from combustion of fossil fuel and anaerobic decomposition of biomass wastes at the dump.

The principal GHG released during combustion of fossil fuel is CO_2. Emissions of CH_4 and N_2O from combustion of fossil fuel are negligibly small as compared with CO_2 emissions and were neglected in development of this project [R7]. Anaerobic decomposition of biomass wastes at the dump is accompanied by release of methane which is a greenhouse gas with a global warming potential of 21. Emissions of CO_2 from biomass combustion are climatically neutral and are therefore assumed equal to zero.

Reduction of GHG emissions as a result of the project will be achieved due to the following:

- reduction of the proportion of residual fuel oil in the Mill’s fuel balance due to employment of fluidized bed combustion of biomass;
- reduction of lignite combustion at CHPP-6 due to increase of BPPM’s own heat production;
- reduction of biomass (BWW and WWS) disposal at the dump.

Alongside with the above mentioned, implementation of the project will lead to the growth of GHG emissions related to electricity consumption from the external power grid.

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

- given the technical condition of boilers No.9, No.10 and No.15 of THPP it was possible to continue their operation at the previous level for a number of years;
- the shortfall of heat and power is always available from CHPP-6 of OJSC “Irkutskenergo”, which has a sufficient capacity reserve (originally CHPP-6 was meant for energy supply to the enterprises of BTIC);
- no major changes to the Russian environmental regulation are foreseen so far that would force OJSC “Ilim Group” management to stop firing wood wastes in the existing boilers, using residual fuel oil for flame stabilization and disposing biomass wastes at dumps;
- there are no limits on GHG emissions set for the Russian enterprises, and such are not expected at least until 2012[1];
- in the absence of the project it could have been possible to avoid additional and very risky investments of internal resources.

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

	Years
Length of the crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2e
2008	193 792
2009	211 284
2010	293 005
2011	334 188
2012	359 011
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**1 391 280**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	278 256

A.5. Project approval by the Parties involved:

The letters of approval will be received later.

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[1] http://www.economy.gov.ru/wps/wcm/connect/economylib/mert/welcome/economy/kiorealize/doc1143621403750

SECTION B. Baseline

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

Description and justification of the baseline chosen

For the baseline setting and GHG emission reductions calculation the PDD developer proposes his own approach without having to agree it with any CDM methodologies, but he certainly makes his approach consistent with the requirements of *Decision 9/CMP.1, Appendix B* [R6]. The GHG emission estimation is sufficiently described and justified.

The peculiarity of this project is that all construction and installation works under the first and the second stages have been completed by now. The project right now is a reality and is already generating physical reductions of GHG emissions. In this context it is reasonable to develop the most likely baseline scenario on the basis of data available and projected till the year 2012 related to the already implemented stages. In other words, it is reasonable to, first, establish the project scenario taking into account all facts and data and only then, building on the project scenario, justify all that is related to the baseline scenario.

All key data, factors, presuppositions that affect GHG emissions reductions are considered further.

The main actual performance parameters of BPPM's energy system over the period 2001-2007 are given in Annex 2-1.

The project scenario

The key factors that characterize the project scenario are:

- combustion of BWW and WWS;
- heat production;
- fossil fuel combustion;
- heat supply;
- electricity supply.

Each factor is considered in detail further below.

Combustion of BWW and WWS

The project scenario presupposes combustion of BWW and WWS in reconstructed utilizing boilers No.14 and No.16 of E-75-40K type and in the new utilizing boiler No.15 of E-90-3.9-440DFT type. The old boiler units No.10 of KM-75-40 type and No.15 of E-75-40K type were decommissioned in mid-2006. The boiler No.9 of KM-75-40 type, the last one of the surviving utilizing boilers of the old type, is planned to be decommissioned in the first quarter of 2010.

The mass BWW consumption in the utilizing boilers under the project during the year *y* is determined as follows:

$$FC^{m}_{BWW,PJ,y} = BWW^{m}_{own,y} + BWW^{m}_{side,PJ,y}, \qquad \text{(B.1-1)}$$

where $FC^{m}_{BWW,PJ,y}$ is the mass BWW consumption in the utilizing boilers under the project during the year *y*, t;

$BWW^{m}_{own,y}$ is the quantity of BWW generated within BTIC[1] (for combustion) during the year *y*, t;

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[1] BTIC includes BPPM and neighboring wood chemical and woodworking enterprises.

$BWW^{m}_{side,PJ,y}$ is the quantity of BWW supplied to BPPM (for combustion) from outside companies[1] under the project during the year *y*, t.

The plan of BWW generation (for combustion) within BTIC for 2008-2012 is given in Table B.1-1.

The quantity of BWW supplied to BPPM (for combustion) from outside companies under the project during the year *y*, is assumed equal to 21 621 tonnes, which corresponds to the average value over the last three years (2005-2007)[2].

Table B.1-1. The plan of BWW generation (for combustion) within BTIC for 2008-2012 [R5]

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
BWW generation (for combustion)	t	683 744	683 744	683 744	683 744	683 744	3 418 720

Let us project how much BWW will be fired in each boiler under the project.

We shall assume that prior to decommissioning of boiler No.9 it had been combusting the maximum quantity of BWW, the remaining proportion had been distributed between boilers No.14 and No.16. The distribution is such because at CHPP-2, where boiler No.9 is installed, the fuel energy is used more efficiently than in the boiler house. CHPP-2 ensures co-generation of heat and electricity relying on steam-turbine cycle whereas the boiler house produces heat only.

The maximum quantity of BWW which can be fired in boiler No.9 is assumed equal to 189 830 tonnes, which corresponds to the maximum value over the last three years of the boiler operation (2005-2007).

As soon as boiler No.15 of E-90-3.9-440DFT type is commissioned as planned by the 1st of March, 2010, it will fire the maximum BWW quantity of 347 760 t/year according to the design data [R3]. The remaining quantity of BWW will be distributed between boilers No.14 and No.16 in the same proportion as before the implementation of the third stage: 57% of the total mass of BWW fed for combustion to boilers No.14 and No.16 will be fired in boiler No.14 and 43% - in boiler No.16. The proportions were calculated according to the actual boiler performance data for the last three years (2005-2007).

The mass BWW consumption in boiler No.14 under the project during the year *y* is determined as follows:

$$FC^{m}_{BWW,14,PJ,y} = 0.57 \times (FC^{m}_{BWW,PJ,y} - FC^{m}_{BWW,15,PJ,y} - FC^{m}_{BWW,9,PJ,y}), \qquad \text{(B.1-2)}$$

where $FC^{m}_{BWW,14,PJ,y}$ is the mass BWW consumption in boiler No.14 under the project during the year *y*, t;

$FC^{m}_{BWW,15,PJ,y}$ is the mass BWW consumption in boiler No.15 under the project during the year *y*, t;

$FC^{m}_{BWW,9,PJ,y}$ is the mass BWW consumption in boiler No.9 under the project during the year *y*, t.

The mass BWW consumption in boiler No.16 under the project during the year *y* is determined as follows:

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[1] Outside companies shall mean the enterprises that are located outside the boundaries of BTIC and not to belonging to OJSC “Ilim Group”.

[2] Three years average (2005-2007) values of key parameters shall be used for the project scenario, accurate values shall be determined in the course of monitoring.

$$FC^{m}_{BWW,16,PJ,y} = 0.43 \times (FC^{m}_{BWW,PJ,y} - FC^{m}_{BWW,15,PJ,y} - FC^{m}_{BWW,9,PJ,y}), \qquad (B.1\text{-}3)$$

where $FC^{m}_{BWW,16,PJ,y}$ is the mass BWW consumption in boiler No.16 under the project during the year y, t.

The quantity of absolutely dry WWS fired under the project during the year y is determined as follows:

$$FC^{dry}_{WWS,PJ,y} = FC^{dry}_{WWS,BH,PJ,y}, \qquad (B.1\text{-}4)$$

where $FC^{dry}_{WWS,PJ,y}$ is the quantity of absolutely dry WWS fired under the project during the year y, t a.d.m.[1];

$FC^{dry}_{WWS,BH,PJ,y}$ is the absolutely dry WWS consumption in the boiler house under the project during the year y, t a.d.m.

Until E-90-3.9-440DFT boiler No.15 is commissioned, all WWS generated at the Mill’s wastewater treatment plant will be disposed at the dump.

The absolutely dry WWS consumption in the boiler house under the project during the year y is assumed equal to 24 146 tonnes of a.d.m., which corresponds to the average value of WWS generation over the last three years (2005-2007).

The distribution of the quantities of BWW and WWS fired in the utilizing boilers under the project in 2008-2012 is shown in Table B.1-2.

Table B.1-2. Distribution of the quantities of BWW and WWS fired in the utilizing boilers under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
BWW generation (for combustion)	t	683 744	683 744	683 744	683 744	683 744	3 418 720
Supply of BWW (for combustion) from the outside	t	21 621	21 621	21 621	21 621	21 621	108 105
Mass BWW consumption under the project							
Boiler No.9	t	189 830	189 830	35 962	0	0	415 622
Boiler No.14	t	293 855	293 855	216 374	203 835	203 835	1 211 754
Boiler No.15	t	0	0	289 800	347 760	347 760	985 320
Boiler No.16	t	221 680	221 680	163 229	153 770	153 770	914 130
Total combustion	t	705 365	705 365	705 365	705 365	705 365	3 526 825
Absolutely dry WWS consumption under the project							
Boiler house	t a.d.m.	0	0	20 122	24 146	24 146	68 414
Total combustion	t a.d.m.	0	0	20 122	24 146	24 146	68 414

Heat production

The project scenario envisages heat production (in the form of steam) in the reconstructed utilizing boilers No.14 and No.16 of E-75-40K type and in the new utilizing boiler No.15 of E-90-3.9-440DFT type. Heat production by boiler No.10 of KM-75-40 type and by boiler No.15 of E-75-40K type was stopped in mid-2006. Heat production by boiler No.9 of KM-75-40 type will continue until it is decommissioned which is planned for the first quarter of 2010.

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[1] a.d.m. – absolutely dry matter

The heat production by the utilizing boilers under the project during the year *y* is determined as follows:

$$HG_{PJ,y} = HG_{CHPP2,PJ,y} + HG_{BH,PJ,y}\,, \tag{B.1-5}$$

where $HG_{PJ,y}$ is the heat production by the utilizing boilers under the project during the year *y*, GJ;

$HG_{CHPP2,PJ,y}$ is the heat production by boilers of CHPP-2 under the project during the year *y*, GJ;

$HG_{BH,PJ,y}$ is the heat production by boilers of the boiler house under the project during the year *y*, GJ.

The heat production by boilers of CHPP-2 under the project during the year *y* is determined as follows:

$$HG_{CHPP2,PJ,y} = HG_{9,PJ,y}\,, \tag{B.1-6}$$

where $HG_{9,PJ,y}$ is the heat generation by boiler No.9 under the project during the year *y*, GJ.

The heat production by boilers of the boiler house under the project during the year *y* is determined as follows:

$$HG_{BH,PJ,y} = HG_{14,PJ,y} + HG_{15,PJ,y} + HG_{16,PJ,y}\,, \tag{B.1-7}$$

where $HG_{14,PJ,y}$ is the heat generation by boiler No.14 under the project during the year *y*, GJ;

$HG_{15,PJ,y}$ is the heat generation by boiler No.15 under the project during the year *y*, GJ;

$HG_{16,PJ,y}$ is the heat generation by boiler No.16 under the project during the year *y*, GJ.

As soon as E-90-3.9-440DFT boiler No.15 is commissioned as planned by the 1st of March, 2010, it will generate 2 137 334 GJ of heat per year according to the design data [R3].

The heat generation by boilers No.9, No.14 and No.16 under the project during the year *y* is determined as follows:

$$HG_{j,PJ,y} = \frac{FC^{m}_{BWW,j,PJ,y}}{SFC^{m}_{BWW,j}}\,, \tag{B.1-8}$$

where $HG_{j,PJ,y}$ is the heat generation by boiler *j* under the project during the year *y*, GJ;

$FC^{m}_{BWW,j,PJ,y}$ is the mass BWW consumption in boiler *j* under the project during the year *y*, t;

$SFC^{m}_{BWW,j}$ is the specific mass BWW consumption for generation of 1 GJ of heat in boiler *j*, t/GJ;

j is the utilizing boiler operating under the project during the year *y*.

The specific mass BWW consumption for generation of 1 GJ of heat in boilers, for estimation purposes are assumed equal to the average values over the last three years of the boilers operation (2005-2007). We shall assume: $SFC^{m}_{BWW,9}$ = 0.166 t/GJ, $SFC^{m}_{BWW,14}$ = 0.180 t/GJ, $SFC^{m}_{BWW,16}$ = 0.165 t/GJ.

The heat production by utilizing boilers under the project in 2008-2012 is given in Table B.1-3.

Table B.1-3. Heat production by the utilizing boilers under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat production							
CHPP-2							
Boiler No.9	GJ	1 143 554	1 143 554	216 636	0	0	2 503 744
Total for CHPP-2	GJ	1 143 554	1 143 554	216 636	0	0	2 503 744
Boiler house							
Boiler No.14	GJ	1 632 528	1 632 528	1 202 077	1 132 416	1 132 416	6 731 964
Boiler No.15	GJ	0	0	1 781 112	2 137 334	2 137 334	6 055 780
Boiler No.16	GJ	1 343 515	1 343 515	989 270	931 940	931 940	5 540 181
Total for the boiler house	GJ	2 976 043	2 976 043	3 972 459	4 201 690	4 201 690	18 327 925
Total production	GJ	4 119 597	4 119 597	4 189 095	4 201 690	4 201 690	20 831 669

Fossil fuel combustion

The project scenario assumes that residual fuel oil is combusted in the utilizing boilers for lighting them up. An additional small amount of residual fuel oil will be fired in boilers No.14 and No.16 to meet the required steam demand (similar to the way it has been in the previous years of THPP operation). In boiler No.9 residual fuel oil will be used constantly for flame stabilization to ensure self-sustaining combustion of wood wastes.

The mass residual fuel oil consumption in the utilizing boilers under the project during the year *y* is determined as follows:

$$FC^{m}_{RFO,PJ,y} = \sum_{j} FC^{m}_{RFO,j,PJ,y}\ , \qquad \text{(B.1-9)}$$

where $FC^{m}_{RFO,PJ,y}$ is the mass residual fuel oil consumption in the utilizing boilers under the project during the year *y*, t;

$FC^{m}_{RFO,j,PJ,y}$ is the mass residual fuel oil consumption in boiler *j* under the project during the year *y*, t.

In E-90-3.9-440DFT boiler No.15 residual fuel oil will be used only for lighting up the boiler in the amount of 76.4 t/year according to the design data [R3].

The mass residual fuel oil consumption in boilers No.9, No.14 and No.16 under the project during the year *y* is determined as follows:

$$FC^{m}_{RFO,j,PJ,y} = HG_{j,PJ,y} \times SFC^{m}_{RFO,j}\ , \qquad \text{(B.1-10)}$$

where $SFC^{m}_{RFO,j}$ is the specific mass residual fuel oil consumption for generation of 1 GJ of heat in boiler *j*, t/GJ.

The specific mass residual fuel oil consumption for generation of 1 GJ of heat in boilers, for estimation purposes, are assumed equal to the average values over the last three years of the boilers operation (2005-2007). We shall assume: $SFC^{m}_{RFO,9}$ = 0.00143 t/GJ, $SFC^{m}_{RFO,14}$ = 0.00261 t/GJ, $SFC^{m}_{RFO,16}$ = = 0.00307 t/GJ.

The mass residual fuel oil consumption in the utilizing boilers under the project in 2008-2012 is shown in Table B.1-4.

Table B.1-4. Mass residual fuel oil consumption in the utilizing boilers under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Residual fuel oil combustion							
Boiler No.9	t	1 635	1 635	310	0	0	3 580
Boiler No.14	t	4 261	4 261	3 137	2 956	2 956	17 570
Boiler No.15	t	0	0	64	76	76	216
Boiler No.16	t	4 125	4 125	3 037	2 861	2 861	17 008
Total combustion	t	10 021	10 021	6 548	5 893	5 893	38 376

Heat supply

The heat produced by the utilizing boilers is used for electricity generation and for auxiliary needs of THPP, is partially lost in the interplant steam pipelines and supplied to end-users within BTIC.

Until modernization of the thermal flow diagram of the THPP is carried out, all steam produced by boilers in the boiler house, less the auxiliary needs, will be supplied to end-users directly via the THPP’s network of steam pipelines. As soon as the thermal flow diagram modernization is completed, the steam produced by boilers in the boiler house will be in the first place fed to the CHPP-2’s turbines for electricity generation and then supplied to end-users.

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

$$HS_{PJ,y} = \left(HG_{CHPP2,PJ,y} + HG_{BH,PJ,y} \times k^{heat}_{BH\_CHPP2} \right) \times SHS_{THPP,PJ,y}, \qquad \text{(B.1-11)}$$

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

$SHS_{THPP,PJ,y}$ is the factor of heat supply from THPP under the project during the year *y*;

$k^{heat}_{BH\_CHPP2}$ is the correction factor for heat losses in the live steam pipeline connecting the boiler house and CHPP-2.

The factor of heat supply from THPP is determined as a ratio between heat supply to end-users and the total heat production by all THPP boilers (including boilers of CHPP-2, CHPP-3 and the boiler house)[1]. In our estimations this factor under the project during the year *y* is assumed equal to the average value over the last three years of THPP operation (2005-2007). We shall assume: $SHS_{THPP,PJ,y}$ = 0.696.

According to the design data [R4] the relative losses in the live steam pipeline from the boiler house to CHPP-2 amount to 2%. Considering that the live steam pipeline from the boiler house to CHPP-2 is planned to be commissioned only in the first quarter of 2010 (it is planned that by this time all project measures will have been completed), the correction factor for heat losses for 2008 and for 2009 will be equal to 1, and from 2010 onwards – to 0.98.

The results of calculation of heat supply to end-users under the project in 2008-2012 are given in Table B.1-5.

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[1] It is not possible to determine the factor of heat supply excluding the operation of CHPP-3 because all steam supplied from the three energy generating sites is mixed in the common network, and steam consumption is measured on the demand side.

Table B.1-5. Heat supply to end-users due to operation of the utilizing boilers under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat supply to end-users	GJ	2 867 240	2 867 240	2 869 529	2 865 889	2 865 889	14 335 786

Electricity supply

The project scenario presupposes electricity generation by the turbines of CHPP-2 on the basis of heat produced by the utilizing boilers.

Until modernization of the thermal flow diagram of THPP is carried out, electricity will be generated at CHPP-2 by using the heat of the steam produced by boiler No.9. As soon as the thermal flow diagram modernization is completed, electricity will be generated at CHPP-2 by using the heat of the steam supplied via a new live steam pipeline from the boiler house.

The electricity supply due to operation of the utilizing boilers under the project during the year *y* is determined as follows:

$$ES_{PJ,y} = ES_{CHPP2,PJ,y} - EC_{BH,PJ,y}, \qquad (B.1\text{-}12)$$

where $ES_{PJ,y}$ is the electricity supply due to operation of the utilizing boilers under the project during the year *y*, MWh;

$ES_{CHPP2,PJ,y}$ is the electricity supply from CHPP-2 under the project during the year *y*, MWh;

$EC_{BH,PJ,y}$ is the electricity consumption for auxiliary needs of the boiler house under the project during the year *y*, MWh.

The electricity supply from CHPP-2 under the project during the year *y* is determined as follows:

$$ES_{CHPP2,PJ,y} = EG_{CHPP2,PJ,y} - EC_{CHPP2,PJ,y}, \qquad (B.1\text{-}13)$$

where $EG_{CHPP2,PJ,y}$ is the electricity generation at CHPP-2 under the project during the year *y*, MWh;

$EC_{CHPP2,PJ,y}$ is the electricity consumption for auxiliary needs of CHPP-2 under the project during the year *y*, MWh.

The electricity generation at CHPP-2 under the project during the year *y* is determined as follows:

$$EG_{CHPP2,PJ,y} = \left(HG_{CHPP2,PJ,y} + HG_{BH,PJ,y} \times k^{electricity}_{BH\_CHPP2} \times k^{heat}_{BH\_CHPP2}\right) \times \chi_{CHPP2,PJ}, \qquad (B.1\text{-}14)$$

where $k^{electricity}_{BH\_CHPP2}$ is the correction factor for the period of modernisation of the THPP’s thermal flow diagram;

$\chi_{CHPP2,PJ}$ is the factor of heat-production-based electricity generation at CHPP-2 under the project, MWh/GJ.

The electricity consumption for auxiliary needs of CHPP-2 under the project during the year *y* is assumed constant and equal to the *minimum* value over the last three years of the plant operation, namely $EC_{CHPP2,PJ,y}$ = 17 386 MWh/year. This approach is fairly conservative because as soon as heat is no longer produced at CHPP-2, which is planned for the first quarter of 2010, electricity consumption for auxiliary needs of the plant will drop. It is fairly difficult to project exactly the rate of reduction; however in the course of monitoring the exact value will be determined. Excessive understatement of electricity consumption for auxiliary needs may lead to overstatement of the estimated amount of GHG emission reductions.

The factor of heat-production-based electricity generation at CHPP-2 under the project is assumed equal to the average value over the last three years of CHPP-2 operation (2005-2007). Thus: $\chi_{CHPP2,PJ}$ = = 0.0360 MWh/GJ.

The modernization of the THPP's thermal flow diagram is planned to be completed by the 1st of March, 2010, therefore the correction factor for the period of modernization of the THPP's thermal flow diagram is assumed equal to 0 in 2008 and in 2009, to 0.83 – in 2010, and to 1 – from 2010 onwards.

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

$$EC_{BH,PJ,y} = HG_{BH,PJ,y} \times SEC_{HG,BH,PJ}\,, \tag{B.1-15}$$

where $SEC_{HG,BH,PJ}$ is the specific electricity consumption for production of 1 GJ of heat in the boiler house under the project, MWh/GJ.

The specific electricity consumption for production of 1 GJ of heat in the boiler house under the project is assumed equal to the average value over the last three years of the boiler house operation (2005-2007). It was assumed: $SEC_{HG,BH,PJ}$ = 0.00733 MWh/GJ.

The calculation of the electricity supply under the project in 2008-2012 is given in Table B.1-6.

Table B.1-6. Calculation of the electricity supply due to operation of the utilizing boilers under the project in 2008-2012

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Electricity generation at CHPP-2	MWh	41 168	41 168	124 856	148 236	148 236	503 664
Electricity consumption for auxiliary needs of CHPP-2	MWh	17 386	17 386	17 386	17 386	17 386	86 930
Electricity supply from CHPP-2	MWh	23 782	23 782	107 470	130 850	130 850	416 734
Electricity consumption for auxiliary needs of the boiler house	MWh	21 814	21 814	29 118	30 798	30 798	134 344
Electricity supply	MWh	1 968	1 968	78 352	100 051	100 051	282 390

The baseline scenario

The baseline was chosen by analyzing a number of alternatives (See Section B.2) that would make it possible for the enterprise to get the same quantity of heat and electricity that is generated through increase in BWW combustion volume and efficiency resulting from the project.

The baseline envisages continuation of the existing practice of firing bark and wood wastes generated within BTIC in the utilizing boilers of CHPP-2 and the boiler house. The biomass wastes that are not utilized will be disposed at the dump. The shortfall of heat and electricity will be supplied from CHPP-6 and from the external power grid.

The baseline scenario is business as usual within the framework of the existing standards and rules which do not prohibit combustion of BWW by BPPM in the existing boilers using residual fuel oil (or any other fossil fuel) for flame stabilization nor are there any restrictions as to biomass disposal at dump. The baseline scenario is reasonably conservative and is by far less expensive than the project activity. It should be also noted that there are no GHG emission caps in Russia for individual companies and according to projections such are not expected at least until 2012.

The key factors that determine GHG emissions under the baseline scenario are as follows:

- heat production;
- heat supply;
- fossil fuel combustion;
- electricity supply;
- electricity consumption from the external power grid;
- BWW and WWS disposal at the dump.

Each factor is considered in detail further below.

Heat production

The baseline scenario envisages that heat (in the form of steam) is produced by KM-75-40 utilizing boilers No.9 and No.10 of CHPP-2 and by E-75-40K utilizing boiler No.15 of the boiler house. The main fuel will be wood wastes; residual fuel oil will be used for flame stabilization.

The heat production by utilizing boilers under the baseline scenario during the year *y* is determined as follows:

$$HG_{BL,y} = HG_{CHPP2,BL,y} + HG_{BH,BL,y}\,, \tag{B.1-16}$$

where $HG_{BL,y}$ is the heat production by utilizing boilers under the baseline scenario during the year *y*, GJ;

$HG_{CHPP2,BL,y}$ is the heat production by boilers of CHPP-2 under the baseline scenario during the year *y*, GJ;

$HG_{BH,BL,y}$ is the heat production by boilers of the boiler house under the baseline scenario during the year *y*, GJ.

The heat production by boilers of CHPP-2 under the baseline scenario during the year *y* is determined as follows:

$$HG_{CHPP2,BL,y} = HG_{9,BL,y} + HG_{10,BL,y}\,, \tag{B.1-17}$$

where $HG_{9,BL,y}$ is the heat generation by boiler No.9 under the baseline scenario during the year *y*, GJ;

$HG_{10,BL,y}$ is the heat generation by boiler No.10 under the baseline scenario during the year *y*, GJ.

The heat production by boilers of the boiler house under the baseline scenario during the year *y* is determined as follows:

$$HG_{BH,BL,y} = HG_{15,BL,y}\,, \tag{B.1-18}$$

where $HG_{15,BL,y}$ is the heat generation by boiler No.15 under the baseline scenario during the year *y*, GJ.

The heat generation by utilizing boilers under the baseline scenario will be determined proceeding from their maximum annual output.

If the total heat production by the utilizing boilers under the project during the year turns out to be less than the maximum annual quantity of heat that can be produced under the baseline scenario, then in distributing heat production between CHPP-2 and the boiler house we shall be guided by the principle that the maximum quantity of heat will be produced by CHPP-2 boilers. The remaining quantity of heat will be produced by the boilers of the boiler house. The distribution is such because fuel energy is used more efficiently in CHPP-2 than in the boiler house. CHPP-2 ensures co-generation of heat and electricity relying on steam-turbine cycle whereas the boiler house produces heat only.

In distributing heat production between boilers No.9 and No.10 of CHPP-2 we shall be guided by the principle that boiler No.9 produces the maximum quantity of heat. This is the most conservative principle, because the rate of flame stabilization by residual fuel oil in boiler No.9 is lower than in boiler No.10. The remaining quantity of heat will be produced by boiler No.10.

The heat generation by boiler No.9 under the baseline scenario during the year *y* is determined as follows:

$$HG_{9,BL,y} = MIN\left(HG_{PJ,y}; HG_{9}^{\max}\right), \tag{B.1-19}$$

where $HG_{9}^{\max}$ is the maximum quantity of heat that can be produced by boiler No.9 during the year, GJ.

The heat generation by boiler No.10 under the baseline scenario during the year *y* is determined as follows:

$$HG_{10,BL,y} = MIN\left((HG_{PJ,y} - HG_{9,BL,y}); HG_{10}^{\max}\right), \tag{B.1-20}$$

where $HG_{10}^{\max}$ is the maximum quantity of heat that can be produced by boiler No.10 during the year, GJ.

The heat generation by boiler No.15 under the baseline scenario during the year *y* is determined as follows:

$$HG_{15,BL,y} = MIN\left((HG_{PJ,y} - HG_{CHPP2,BL,y}); HG_{15}^{\max}\right), \tag{B.1-21}$$

where $HG_{15}^{\max}$ is the maximum quantity of heat that can be produced by old boiler No.15 during the year, GJ.

Heat supply

The heat supply to end-users due to operation of the utilizing boilers under the baseline scenario during the year *y* is determined as follows:

$$HS_{BL,y} = HG_{BL,y} \times SHS_{THPP,BL}, \tag{B.1-22}$$

where $HS_{BL,y}$ is the heat supply to end-users due to operation of the utilizing boilers under the baseline scenario during the year *y*, GJ;

$SHS_{THPP,BL}$ is the factor of heat supply from THPP under the baseline scenario.

Fossil fuel combustion

The project implementation will lead to growth of own heat production at BPPM and to reduction of heat supplies from CHPP-6. Reduction of heat supply from CHPP-6 will lead to reduction of 1.3 MPa steam supply, to reduction of live steam production by the plant's boilers and to reduction of fuel consumption.

CHPP-6 operates 5 steam turbines: two of PT-60-130/13 type and three of R-50-130/13 type. The turbine of PT-60-130/13 type has process and heating steam extractions. It is fitted with a steam condenser. The nominal capacity of the turbine unit is 60MW. The steam pressure of process steam extraction is 1.3 MPa. The turbine of R-50-130/13 type is a back-pressure turbine. The backpressure is 1.3 MPa.

As a rule, back-pressure turbines operate in the base mode under stable process steam demand (this demand depends on a number of consumers connected to CHPP-6), and heat and power loads are managed by turbines with less rigid operation modes, in this case by PT turbines.

Thus, the task is to determine the variation of live steam heat flow to PT-60-130/13 turbine.

The variation of steam flow to a turbine can be determined using its graphic steam-consumption diagram. However we used a more accurate energy characteristic of PT-60-130/13 turbines presented in an analytical form [R8]:

$$Q_{tur} = 16.3 + 2.33N - 1.314N_h + Q_h + Q_p; \qquad \text{(B.1-23)}$$

$$N_h = 0.529Q_h(0.12/p_h)^{0.14} + 0.305Q_p(1.3/p_p)^{0.34} - (9.9 - 0.048Q_h), \qquad \text{(B.1-24)}$$

where Q_{tur} is the heat consumption by the turbine, MW;

N is the current turbine capacity, MW;

N_h is the capacity achieved on the basis of heat consumption, MW;

Q_h is the heat load of the heating steam extraction of the turbine, MW;

Q_p is the heat load of the process steam extraction of the turbine, MW;

p_h is the pressure in the heating steam extraction, MPa;

p_p is the pressure in the process steam extraction, MPa.

In order to determine the reduction of fuel consumption at CHPP-6 caused by the reduction of heat supply, we shall analyze how the live steam flow to the turbine is going to change due to variation of the process steam extraction at 1.3 MPa. Meanwhile the extraction of heating steam which serves for delivery water heating will remain constant both with the project and without the project.

In order to determine the variation of steam flow to the turbine caused by the variation of the process steam extraction, the energy characteristic of the turbine was rearranged by means of mathematical transformations in the following form:

$$\Delta Q_{tur} = 1.310\Delta Q_p, \qquad \text{(B.1-25)}$$

where ΔQ_{tur} is the variation of the steam flow to the turbine, MW;

ΔQ_p is the variation of the process steam extraction, MW.

Simultaneously with the variation of the process steam extraction, heat-production-based electricity generation will change by the following value:

$$\Delta N_h = 0.305\Delta Q_p, \qquad \text{(B.1-26)}$$

where ΔN_h is the variation of heat-production-based electricity generation, MW.

According to the available data CHPP-6 operates boilers of BKZ-320-140PT type designed for firing lignite. The main fuel of the plant is lignite of 2BR grade.

The additional quantity of lignite fired at CHPP-6 under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$FC_{lignite,BL,y}^{add} = \frac{HS_{CHPP6,BL,y}^{add} \times K_{turbine}^{heat}}{\eta_{boiler} \times (1 - HA_{boiler}) \times K_{HF}}, \tag{B.1-27}$$

where $FC_{lignite,BL,y}^{add}$ is the additional lignite consumption at CHPP-6 under the baseline scenario as compared with the project scenario during the year *y*, GJ;

$HS_{CHPP6,BL,y}^{add}$ is the additional heat supply from CHPP-6 to end-users under the baseline scenario as compared with the project scenario during the year *y*, GJ;

$K_{turbine}^{heat}$ is the factor of variation of live steam flow to the turbine caused by the variation of the process steam extraction. In accordance with the energy characteristic of the turbine the following was assumed: $K_{turbine}^{heat}$ = 1.310;

η_{boiler} is the efficiency factor of CHPP-6 boilers;

HA_{boiler} is the proportion of heat for auxiliary needs of CHPP-6 boilers;

K_{HF} is the heat flow factor at CHPP-6.

The additional heat supply from CHPP-6 to end-users under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$HS_{CHPP6,BL,y}^{add} = HS_{PJ,y} - HS_{BL,y}. \tag{B.1-28}$$

The combustion of BWW in the utilizing boilers operating under the baseline scenario requires consumption of residual fuel oil for flame stabilization.

The residual fuel oil consumption in the utilizing boilers under the baseline scenario during the year *y* is determined as follows:

$$FC_{RFO,BL,y} = \sum_{i} FC_{RFO,i,BL,y}, \tag{B.1-29}$$

where $FC_{RFO,BL,y}$ is the residual fuel oil consumption in the utilizing boilers under the baseline scenario during the year *y*, GJ;

$FC_{RFO,i,BL,y}$ is the residual fuel oil consumption in boiler *i* under the baseline scenario during the year *y*, GJ;

i is the utilizing boiler operating under the baseline scenario during the year *y*.

The residual fuel oil consumption in boiler *i* under the baseline scenario during the year *y* is determined as follows:

$$FC_{RFO,i,BL,y} = HG_{i,BL,y} \times SFC_{RFO,i}, \tag{B.1-30}$$

where $HG_{i,BL,y}$ is the heat generation by boiler *i* under the baseline scenario during the year *y*, GJ;

$SFC_{RFO,i}$ is the specific residual fuel oil consumption for generation of 1 GJ of heat in boiler *i*, GJ/GJ.

Electricity supply

The baseline scenario envisages electricity generation by CHPP-2 turbines on the basis of heat produced by utilizing boilers No.9 and No.10.

The electricity supply due to operation of the utilizing boilers under the baseline scenario during the year *y* is determined as follows:

$$ES_{BL,y} = ES_{CHPP2,BL,y} - EC_{BH,BL,y}, \tag{B.1-31}$$

where $ES_{BL,y}$ is the electricity supply due to operation of the utilizing boilers under the baseline scenario during the year *y*, MWh;

$ES_{CHPP2,BL,y}$ is the electricity supply from CHPP-2 under the baseline scenario during the year *y*, MWh;

$EC_{BH,BL,y}$ is the electricity consumption for auxiliary needs of the boiler house under the baseline scenario during the year *y*, MWh.

The electricity supply from CHPP-2 under the baseline scenario during the year *y* is determined as follows:

$$ES_{CHPP2,BL,y} = EG_{CHPP2,BL,y} - EC_{CHPP2,BL,y}, \tag{B.1-32}$$

where $EG_{CHPP2,BL,y}$ is the electricity generation at CHPP-2 under the baseline scenario during the year *y*, MWh;

$EC_{CHPP2,BL,y}$ is the electricity consumption for auxiliary needs of CHPP-2 under the baseline scenario during the year *y*, MWh.

The electricity generation at CHPP-2 under the baseline scenario during the year *y* is determined as follows:

$$EG_{CHPP2,BL,y} = HG_{CHPP2,BL,y} \times \chi_{CHPP2,BL}, \tag{B.1-33}$$

where $\chi_{CHPP2,BL}$ is the factor of heat-production-based electricity generation at CHPP-2 under the baseline scenario, MWh/GJ.

The electricity consumption for auxiliary needs of CHPP-2 under the baseline scenario during the year *y* is determined as follows:

$$EC_{CHPP2,BL,y} = HG_{CHPP2,BL,y} \times SEC_{HG,CHPP2,BL}, \tag{B.1-34}$$

where $SEC_{HG,CHPP2,BL}$ is the specific electricity consumption for production of 1 GJ of heat at CHPP-2 under the baseline scenario, MWh/GJ.

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

$$EC_{BH,BL,y} = HG_{BH,BL,y} \times SEC_{HG,BH,BL}, \tag{B.1-35}$$

where $SEC_{HG,BH,BL}$ is the specific electricity consumption for production of 1 GJ of heat in the boiler house under the baseline scenario, MWh/GJ.

Electricity consumption from the external power grid

As a result of the project implementation BPPM's own power generation will increase thus substituting electricity supply from the grid. At the same time heat-production-based electricity generation at CHPP-6 will decrease due to reduction of the process steam extraction from the turbines, which in general case has to be offset by additional electricity generation by the grid power plants.

The additional electricity consumption from the external power grid under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$EC_{grid,BL,y}^{add} = ES_{PJ,y} - ES_{BL,y} - ES_{CHPP6,BL,y}^{add}, \tag{B.1-36}$$

where $EC_{grid,BL,y}^{add}$ is the additional electricity consumption from the external power grid under the baseline scenario as compared with the project scenario during the year *y*, MWh;

$ES_{CHPP6,BL,y}^{add}$ is the additional heat-production-based electricity supply from CHPP-6 under the baseline scenario as compared with the project scenario during the year *y*, MWh.

The additional heat-production-based electricity supply from CHPP-6 under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$ES_{CHPP6,BL,y}^{add} = \frac{HS_{CHPP6,BL,y}^{add} \times K_{turbine}^{electricity} \times \left(1 - SEC_{auxiliary,CHPP6}\right)}{3.6}, \tag{B.1-37}$$

where $K_{turbine}^{electricity}$ is the factor of variation of electricity generation by the turbine caused by the variation of the process steam extraction. In accordance with the energy characteristic of the turbines the following was assumed: $K_{turbine}^{electricity} = 0.305$;

$SEC_{auxiliary,CHPP6}$ is the specific electricity consumption for auxiliary needs of CHPP-6.

BWW and WWS disposal at the dump

As a result of the project the biomass combustion will increase which will make it possible to reduce BWW and WWS disposal at the dump. The project implementation will not affect methane emissions from the dump related to biomass wastes that have been disposed at the dump prior to the project implementation.

The BWW disposal at the dump will reduce by the same quantity as will be additionally combusted in the utilizing boilers due to the project less BWW supplied to BPPM (for combustion) from the outside under the project scenario. Under the baseline scenario BWW supplies for combustion from the outside are assumed equal to zero because in the absence of the project the existing capacities of BPPM would be insufficient for utilization of its very own wastes. And it can hardly be asserted positively that in this case the excess BWW quantity of outside companies would be disposed at the dump. This supposition agrees with the conservative approach.

Thus, the additional disposal of BWW at the dump under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$BWW_{dump,BL,y}^{m,add} = MAX\left(0; FC_{BWW,PJ,y}^{m} - FC_{BWW,BL}^{m,\max} - BWW_{side,PJ,y}^{m}\right),^{1} \tag{B.1-38}$$

where $BWW_{dump,BL,y}^{m,add}$ is the additional disposal of BWW at the dump under the baseline scenario as compared with the project scenario during the year *y*, t;

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[1] The value $BWW_{dump,BL,y}^{m,add}$ cannot be negative.

$FC_{BWW,BL}^{m,\max}$ is the maximum quantity of BWW that can be fired in the utilizing boilers under the baseline scenario during the year, t.

The maximum quantity of BWW that can be fired in the utilizing boilers under the baseline scenario during the year is determined as follows:

$$FC_{BWW,BL}^{m,\max} = FC_{BWW,9}^{m,\max} + FC_{BWW,10}^{m,\max} + FC_{BWW,15}^{m,\max}, \qquad \text{(B.1-39)}$$

where $FC_{BWW,9}^{m,\max}$ is the maximum quantity of BWW that can be fired in boiler No.9 during the year, t;

$FC_{BWW,10}^{m,\max}$ is the maximum quantity of BWW that can be fired in boiler No.10 during the year, t;

$FC_{BWW,15}^{m,\max}$ is the maximum quantity of BWW that can be fired in boiler No.15 during the year, t.

The WWS disposal at the dump will reduce by the same quantity as will be fired due to the project.

Thus, the additional disposal of absolutely dry WWS at the dump under the baseline scenario as compared with the project scenario during the year *y* is determined as follows:

$$WWS_{dump,BL,y}^{dry,add} = FC_{WWS,PJ,y}^{dry}, \qquad \text{(B.1-40)}$$

where $WWS_{dump,BL,y}^{dry,add}$ is the additional disposal of absolutely dry WWS at the dump under the baseline scenario as compared with the project scenario during the year *y*, t a.d.m.

Application of the chosen approach for the baseline scenario

All factors required for the baseline scenario were calculated according to the above mentioned methodology with an allowance for actual project scenario data. The results of calculations for the period 2008-2012 are given in Annex 2-2.

The key data used for calculation of the baseline scenario parameters are given in the tables below.

Data / Parameter:	$HG_{9}^{\max}$
Data unit:	GJ
Description:	Maximum quantity of heat that can be produced by boiler No.9 during the year
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	1 125 026
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	$HG_{10}^{\max}$
Data unit:	GJ
Description:	Maximum quantity of heat that can be produced by boiler No.10 during the year
Time of determination:	Determined once at the stage of PDD preparation

Source of data used:	Internal data of THPP
Value of data applied:	614 488
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	$HG_{15}^{\max}$
Data unit:	GJ
Description:	Maximum quantity of heat that can be produced by old boiler No.15 during the year
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	1 339 346
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	$SHS_{THPP,BL}$
Data unit:	-
Description:	Factor of heat supply from THPP under the baseline scenario
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Reports on the results of heat utilization by product
Value of data applied:	0.705
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	η_{boiler}
Data unit:	-
Description:	Efficiency factor of CHPP-6 boilers
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Reference book on heat engineering/Edited by V.N.Yurenev and P.D.Lebedev. In 2 volumes. Volume 2. M.: Energia, 1976
Value of data applied:	0.902
Justification of the choice of data or description of measurement methods and procedures applied:	Nominal value for boiler units installed at CHPP-6
Any comment:	-

Data / Parameter:	HA_{boiler}
Data unit:	-
Description:	Proportion of heat for auxiliary needs of CHPP-6 boilers
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Methodology for determination of fuel, electricity and water requirements for production and transportation of heat and heat carriers in public heating systems. MDK 4-05.2004. Moscow, 2004
Value of data applied:	0.0233
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value for lignite-fired boilers
Any comment:	-

Data / Parameter:	K_{HF}
Data unit:	-
Description:	Heat flow factor at CHPP-6
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	V.Y.Ryzhkin. Thermal power plants. – M.: Energoatomizdat, 1987
Value of data applied:	0.98
Justification of the choice of data or description of measurement methods and procedures applied:	Recommended value at average steam boiler loading
Any comment:	-

Data / Parameter:	$SFC_{RFO,9}$
Data unit:	GJ/GJ
Description:	Specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.9
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	0.0347
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value over 2001-2007
Any comment:	-

Data / Parameter:	$SFC_{RFO,10}$
Data unit:	GJ/GJ
Description:	Specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.10
Time of determination:	Determined once at the stage of PDD preparation

Source of data used:	Internal data of THPP
Value of data applied:	0.3672
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value over 2001-2007
Any comment:	-

Data / Parameter:	$SFC_{RFO,15}$
Data unit:	GJ/GJ
Description:	Specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.15
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	0.2810
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value over 2001-2007
Any comment:	-

Data / Parameter:	$\chi_{CHPP2,BL}$
Data unit:	MWh/GJ
Description:	Factor of heat-production-based electricity generation at CHPP-2 under the baseline scenario
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	0.0372
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	$SEC_{HG,CHPP2,BL}$
Data unit:	MWh/GJ
Description:	Specific electricity consumption for production of 1 GJ of heat at CHPP-2 under the baseline scenario
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	0.0141
Justification of the choice of data or description of	Minimum value over 2001-2007

measurement methods and procedures applied:	
Any comment:	-

Data / Parameter:	$SEC_{HG,BH,BL}$
Data unit:	MWh/GJ
Description:	Specific electricity consumption for production of 1 GJ of heat in the boiler house under the baseline scenario
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	E.F.Buznikov. Process and heating boiler houses. M.: Energoatomizdat, 1984
Value of data applied:	0.007
Justification of the choice of data or description of measurement methods and procedures applied:	Conservative value for process boiler houses for chamber combustion of solid fuel
Any comment:	-

Data / Parameter:	$SEC_{auxiliary,CHPP6}$
Data unit:	-
Description:	Specific electricity consumption for auxiliary needs of CHPP-6
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	V.Y.Ryzhkin. Thermal power plants. – M.: Energoatomizdat, 1987
Value of data applied:	0.04
Justification of the choice of data or description of measurement methods and procedures applied:	Minimum value for power plants
Any comment:	-

Data / Parameter:	$FC_{BWW,9}^{m,\max}$
Data unit:	t
Description:	Maximum quantity of BWW that can be fired in boiler No.9 during the year
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	189 830
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	

Data / Parameter:	$FC_{BWW,10}^{m,\max}$

Data unit:	t
Description:	Maximum quantity of BWW that can be fired in boiler No.10 during the year
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	60 003
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

Data / Parameter:	$FC_{BWW,15}^{m,\max}$
Data unit:	t
Description:	Maximum quantity of BWW that can be fired in boiler No.15 during the year
Time of determination:	Determined once at the stage of PDD preparation
Source of data used:	Internal data of THPP
Value of data applied:	130 230
Justification of the choice of data or description of measurement methods and procedures applied:	Maximum value over 2001-2007
Any comment:	-

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

The project additionality was analyzed separately for each stage using the analysis of project alternatives, investment and barrier analyses. The common practice analysis was applied to the project on the whole.

The first stage

Analysis of project alternatives

The analysis has identified the following alternatives for this project stage that enable the enterprise to meet its heat demand:

Alternative 1.1. Continuation of the current situation

Alternative 1.2. Installation of new boilers running on fossil fuel

Alternative 1.3. The project activity without JI mechanism

Let us further consider each alternative in detail.

Alternative 1.1. Continuation of the current situation

This alternative presupposes continuation of the situation that had existed prior to the implementation of the first stage of the project.

The enterprise would have covered its heat demand by supplies from its own THPP from combustion of black liquor, BWW and residual fuel oil, and also from CHPP-6. CHPP-6 has a sufficient capacity margin and was designed for the purpose of energy supply of BTIC enterprises.

Almost all wood wastes available (sawdust, wood sliver), as well as some quantity of bark mixed with wood wastes would have been combusted together with residual fuel oil used for flame stabilization in boilers No.9 and No.10 of CHPP-2 and No.15 of the boiler house. The technical condition of the above mentioned boilers would make it possible to keep their performance at the previous level for a number of years provided that routine maintenance was carried out.

The surplus of bark that couldn't be utilized in the above mentioned boilers would have been disposed at the dump which does not come in conflict with any environmental regulations and is a common practice for Russian pulp and paper industry. Bark stockpiling at the dump is not a problem; the enterprise has all the required permissions to operate the dump.

The advantage of Alternative 1.1 is that it doesn't require any additional investments into construction of new BWW utilization and heat production capacities.

Alternative 1.1 is quite realistic and can be considered as the most likely baseline scenario.

Alternative 1.2. Installation of new boilers running on fossil fuel

This alternative presupposes installation of new boilers running on fossil fuel at THPP. That quantity of heat, which is produced due to increase of BWW combustion volume and higher efficiency under the first stage, would have been produced by firing fossil fuel in the new boilers.

Installation of new boilers running on fossil fuel would lead to significant reconstruction of the Mill's energy system associated with installation of new boiler equipment, construction or expansion of fuel handling, storage and preparation systems, etc.; it would require sizable investments comparable with investments into the waste biomass utilization project, and probably, even higher. Moreover the cost of fossil fuel is by far higher than the cost of BWW generated within BTIC.

Economically this alternative is knowingly less attractive as compared to the project activity.

Alternative 1.2 is not realistic and was excluded from consideration.

Alternative 1.3. The project activity without JI mechanism

This alternative presupposes reconstruction of E-75-40K boiler No.16, decommissioned in 1997, for BWW combustion using fluidized bed combustion technology.

Wood wastes would be combusted in boilers No.9 and No.10 of CHPP-2 and in boiler No.15 of the boiler house. A significant proportion of bark that was previously disposed at the dump would be combusted in the reconstructed boiler No.16 of the boiler house. Heat supplies from CHPP-6 would be scaled down.

This alternative requires significant capital investments. The first stage of the project without JI mechanism faces a number of serious barriers (See Barrier analysis below).

Implementation of Alternative 1.3 as the baseline scenario is unlikely.

Summarizing the analysis of project alternatives, and also considering the results of the Barrier analysis, Alternative 1.1 that envisages continuation of the current situation was chosen as the baseline scenario for the first stage of the project.

Barrier analysis

Implementation of the first project stage at BPPM faced significant barriers, namely technological, operational and financial barriers.

Technological barriers

Fluidized bed combustion of BWW is a more complex technology than those applied in the existing boilers. A lot of requirements set to organization of air feeding process, particle size distribution of the bed material and fuel characteristic have to be met to organize sustainable fuel combustion and to maintain performance efficiency of a fluidized bed.

Bark and wood wastes are a type of fuel which is difficult to combust because of its non-uniform fractional composition and high moisture content.

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

BWW fluidized bed combustion technologies require more advanced and expensive automated process control systems. For this reason the project includes installation of an integrated automated process control system, which provides possibility to control BWW feeding and combustion stages from one centralized panel. Otherwise there is a risk of a boiler breakdown.

The main fuel combusted in boiler No.16 is bark. The high moisture content (moisture content of bark may reach 70%) reduces the calorific value of the BWW mixture, adiabatic combustion temperature, stability of burning process and, finally, the overall output of the boiler.

The existing boilers of KM-75-40 and E-75-40K types could not be used for utilization of additional bark quantities because due to its moisture content bark is not suitable for combustion in this type of boilers.

The technologies of fluidized bed combustion of BWW without using fossil fuel for flame stabilization were scarcely used in Russia in 2000 and were not familiar. At that time in Russia there were only two examples of boiler modernization using fluidized bed technology (See Common practice analysis below). And both of them were associated with reconstruction of boilers that were originally designed for wood wastes bed firing (boilers of KM-75-40 type).

The uniqueness of this project is that it is the first in Russia experience of switching E-75-40K boiler that was originally designed for lignin combustion in a low-temperature swirl to fluidized bed combustion of BWW without using fossil fuel for flame stabilization.

It should be noted that in the early 1990s some attempts were made to modify boilers No.15 and No.16 so as to enable them to fire BWW in a low-temperature swirl whereas the existing furnaces were retained (Please see the details in Section A.4.2). However these attempts failed. The imperfections in the furnace design did not allow to burn wood wastes without using residual fuel oil for flame stabilization, and the existing fuel bunkers could not ensure consistent feeding of BWW into the boiler. Positive results were achieved only when sawdust with low moisture content were burned. From this negative experience it became clear that there weren’t any easy and cheap solutions there.

No boilers using fluidized bed technologies have ever been built or operated at BPPM, or at any other enterprise of CJSC “Ilim Pulp Enterprise” for that matter.

Therefore in terms of technology the implementation of the first stage was a real challenge for the enterprise.

Operational barriers

BPPM had to overcome certain difficulties not only at the stage of equipment installation but also during operation the boiler equipment. It was necessary to take on staff, train them and have them get certificates for operation of boiler No.16, which took time and certain expenses. Furthermore operation of energy equipment and technology of such level requires high motivation, moral, skills and knowledge from all technical staff: workers, engineers and managers. It should be also noted that a high moisture content and low calorific value of bark presents a problem that calls to constant attention of the maintenance personnel.

Financial barriers

Among the financial barriers the following should be mentioned:

- high initial capital expenditure – about EUR 1.6 million;

- high opportunity cost of capital. Investments in upgrade and expansion of main production capacities including introduction of advanced energy saving technologies could have brought much more profit to the project owners as compared with the investments into construction of own energy generating sources, more so that any additional supplies of energy can be always provided by the nearby CHPPP-6;
- operation and maintenance of the boiler is associated with additional operating costs.

Because of these barriers the company's management has been seeking opportunities to sell emission reduction units (ERUs), and also early emission reductions that had been achieved before the year 2008. This issue was discussed with the "Center of Environmental Investments" as early as 2000. In 2006 discussions were held with LLC "AF-Enprima" and, eventually, in 2008 – with LLC "CCGS", the company that was chosen from among others as a partner for developing all necessary documentation and selling GHG emission reductions in the international market.

The second stage

Analysis of project alternatives

The analysis has identified the following alternatives for this project stage that enable the enterprise to meet its heat demand:

Alternative 2.1. Continuation of the current situation
Alternative 2.2. Installation of new boilers running on fossil fuel
Alternative 2.3. The project activity without JI mechanism

Let us further consider each alternative in detail.

Alternative 2.1. Continuation of the current situation

This alternative presupposes continuation of the situation that had existed prior to the implementation of the second stage of the project.

The enterprise would have covered its heat demand by supplies from its own THPP from combustion of black liquor, BWW and residual fuel oil, and also from CHPP-6.

Considerable quantity of BWW would have been fired in boilers No.9 and No.10 of CHPP-2 and No.15 and No.16 of the boiler house. Boiler No.16 was reconstructed earlier on and its operating lifetime expires long after 2012. Boilers No.9, No.10 and No.15 are in satisfactory condition and can be operated for a number of years provided that proper maintenance is carried out.

The advantage of Alternative 2.1 is that no additional investments into construction of new BWW utilization and heat production capacities are required.

Alternative 2.1 is quite realistic and can be considered as the most likely baseline scenario.

Alternative 2.2. Installation of new boilers running on fossil fuel

This alternative presupposes installation of new boilers running on fossil fuel at THPP. That quantity of heat, which is produced due to increase of BWW combustion volume and higher efficiency under the second stage, would have been produced by firing fossil fuel in the new boilers.

Similarly to Alternative 1.2 *Alternative 2.2 is not realistic and was therefore excluded from further consideration.*

Alternative 2.3. The project activity without JI mechanism

This alternative presupposes reconstruction of E-75-40K boiler No.14, decommissioned in the early 1990s, for BWW combustion using fluidized bed technology.

BWW would be fired in boiler No.9 of CHPP-2 and in boilers No.14 and No.16 of the boiler house. The above mentioned boilers would be capable of utilizing almost the entire volume of BWW generated within BTIC. Heat supplies from CHPP-6 and residual fuel oil consumption at the Mill's own THPP would be scaled down.

Boilers No.10 and No.15 as less efficient (having the highest rate of specific residual fuel oil consumption for flame stabilization), would be decommissioned quite soon after the implementation of the second stage.

This alternative requires significant capital investments. Economic parameters of the second stage without sale of GHG emission reductions would be unacceptably low (See Investment analysis below).

Implementation of Alternative 2.3 as the baseline scenario is unlikely.

Summarizing the analysis of project alternatives, and also considering the results of the Investment Analysis, Alternative 2.1 that envisages continuation of the current situation was chosen as the baseline scenario for the second stage of the project.

Investment analysis

Main economic indicators of the second stage were compared for the two project implementation options:

(a) without selling GHG emission reductions; and

(b) with selling GHG emission reductions.

Internal rate of return (IRR) and net present value (NPV) were determined for each option. NPV was chosen as the main benchmark parameter.

The capital investments into the second stage amount to EUR 3.96 million [R2]. The second stage was financed by the company's internal resources.

The average RUR/EUR exchange rate in 2002 was 29.69 RUR/EUR[1].

The selling price of ERU (2008-2012) was assumed equal to 8 EUR/t CO_2e, the selling price of early emission reductions (2003-2007) – 2 EUR/t CO_2e.

The time horizon for the analysis is limited by the latter half of 2018 (15 years – operating lifetime of the equipment).

The cost of feedstock and resources and the expected effects from implementation of the second stage of the project that influence the cash flow value were assumed as per the project documentation [R2].

The discount rate was determined with the help of one of the most widely used methods, namely cumulative method of risk premium assessment[2]. This method is based on the following formula:

$$R = R_f + R_1 + ... + R_n , \qquad \text{(B.2-1)}$$

where R is the sought discount rate;

R_f is the risk-free rate of return;

$R_1,...,R_n$ is the risk premium for different risk factors.

Generally, government securities are considered to be (conditionally) risk-free assets. In Russia such assets could be Russia 2030 Eurobonds with maturity date in 2030. Thus in the first six months of 2002 the rate of return on these bonds was around 10.09÷12.50% p.a.[1].

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

[2] http://www.bizeducation.ru/library/fin/invest/sinadsky.htm

Potential risk factors can be country risk, risk of partner unreliability, risk of not getting the income envisaged by the project. Thus, if the project envisages production based on a well-known technology then the recommended risk premium is between 3% and 5%. Other risk premiums are altogether estimated at the level of 5%.

The final discount rate was assumed at 20%. This roughly matches up with the hurdle rate of return on investments into pulp and paperboard production which is the core business for BPPM.

Detailed information on the Investment analysis of the second stage of the project is given in Annex 2-5.

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

Table B.2-1. Investments, NPV and IRR for the second stage of the project

Indicator	Unit	Without selling GHG emission reductions	With selling GHG emission reductions
Investment	thousand EUR	3 956	3 956
NPV	thousand EUR	-238	294
IRR	%	18.66	21.59

The economic indicators of the second stage of the project without selling GHG emission reductions are unacceptably low (NPV<0). The revenues from selling ERUs amount to around 45% of the total required investments. Due to these revenues the second stage of the project becomes more commercially attractive and NPV rises above zero. Moreover the second stage becomes less sensitive to risks (See results of the Sensitivity analysis in Table B.2-2).

Table B.2-2. The Sensitivity analysis of the main economic indicators of the second stage of the project

Indicator	Unit	Without selling GHG emission reductions	With selling GHG emission reductions
1) Growth of investment costs by 10%			
NPV	thousand EUR	-608	-76
IRR	%	16.85	19.62
2) Reduction of heat production by 10%			
NPV	thousand EUR	-584	-269
IRR	%	16.66	18.50
3) Growth of current costs by 10%			
NPV	thousand EUR	-344	188
IRR	%	18.06	21.02
4) Reduction of the price of emission reduction units by 10%			
NPV	thousand EUR	-238	241
IRR	%	18.66	21.31

It is important to note that the second stage of the project is aimed at reduction of anthropogenic impact on the environment. The second stage of the project could not take place within the framework of common business practice without selling emission reduction units.

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[1] http://www.vedi.ru/mfm_r.htm

The third stage

Analysis of project alternatives

For this project stage the analysis has identified the following alternatives that enable the enterprise to meet its heat and electricity demand:

Alternative 3.1. Continuation of the current situation

Alternative 3.2. Decommissioning of CHPP-2 boiler equipment, increase of energy purchase from the outside

Alternative 3.3. Installation of new boilers running on fossil fuel

Alternative 3.4. The project activity without JI mechanism

Let us further consider each alternative in detail.

Alternative 3.1. Continuation of the current situation

This alternative presupposes continuation of the situation that had existed prior to the implementation of the third stage of the project.

The enterprise would have covered its heat and electricity demand by supplies from its own THPP from combustion of black liquor, BWW and residual fuel oil, and also from CHPP-6 and from the external power grid.

BWW would be fired in boilers No.9 of CHPP-2 and No.14 and No.16 of the boiler house. Boilers No.14 and No.16 were reconstructed earlier on and their operating lifetime expires long after 2012. Boiler No.9 overhauled in 1999 is in satisfactory condition and can be operated for a number of years provided that proper maintenance is carried out.

Boiler No.15 is in satisfactory condition but was put out of operation after implementation of the second stage, because all sawdust previously utilized in this boiler is now fired in reconstructed boilers No.14 and No.16. Boiler No.10 was also put out of operation in mid-2006 as a result of implementation of the second stage. Further operation of boilers No.10 and No.15 is, in principle, possible but not practical.

This alternative option provides possibility to utilize all BWW generated within BTIC. The entire quantity of WWS is stockpiled at the dump which does not come in conflict with any environmental regulations and is a common practice for Russian industrial enterprises.

The advantage of Alternative 3.1 is that no additional investments into construction of new capacities for waste biomass utilization and heat and electricity production are required.

Alternative 3.1 is quite realistic and can be considered as the most likely baseline scenario.

Alternative 3.2. Decommissioning of CHPP-2 boiler equipment, increase of energy purchase from the outside

This alternative presupposes decommissioning of the only remaining boiler No.9 of CHPP-2 and shutting down the turbine hall of CHPP-2. The required amount of energy will be supplied to the enterprise by the boilers of CHPP-3 and the boiler house, and by the turbines of CHPP-3; energy will be also supplied from CHPP-6 and from the external power grid.

Boiler No.9 overhauled in 1999 is in satisfactory condition and could be operated for a number of years provided that proper maintenance is carried out. However the entire clumsy wood waste feeding system would have to be operated and the building of CHPP-2 will have to be heated and maintained just because of this one boiler, which is not considered practical.

The advantage of this alternative is that no investments are required and operating costs are reduced. However decommissioning of boiler No.9 means that heat and electricity will no longer be produced by CHPP-2 and energy supplies from the outside will have to be increased. Decommissioning of one of its own sources of heat and electricity will increase the enterprise's dependence on energy supplies from the outside, which will make the Mill more sensitive to the fluctuations of heat and electricity tariffs.

The GHG emissions for this alternative will be higher as compared to Alternative 3.1. It is not conservative to adopt Alternative 3.2 as the baseline scenario; and therefore *Alternative 3.2 was excluded from further consideration*.

Alternative 3.3. Installation of new boilers running on fossil fuel

This alternative presupposes installation of new boilers running on fossil fuel at THPP. That quantity of heat, which is produced due to increase of waste biomass combustion volume and higher efficiency under the third stage, would have been produced by firing fossil fuel in the new boilers.

Similarly to Alternatives 1.2 and 2.2 *Alternative 3.3 is not realistic and was therefore excluded from further consideration.*

Alternative 3.4. The project activity without JI mechanism

This alternative presupposes installation of a new E-90-3.9-440DFT boiler No.15 in the boiler house, modernization of THPP's thermal flow diagram and modernization of BWW feeding system of the renewed boilers No.14, No.15 and No.16. Furthermore this alternative provides possibility to burn WWS mixed with BWW.

Waste biomass would be fired in boilers No.14, No.15 and No.16 of the boiler house. The steam from the said boilers would be supplied via a specially built steam pipeline to the turbines of CHPP-2. Boiler No.9 will be decommissioned after implementation of the third stage of the project. The implementation of this alternative would make it possible to reduce heat and electricity supplies from the outside, optimize the flow diagram of THPP and not only utilize the entire quantity of on-site produced BWW and WWS but also increase BWW supplies from outside companies.

This alternative requires quite large capital investments. Economic indicators of the third stage without JI mechanism would be unacceptably low (See Investment analysis below).

Implementation of Alternative 3.4 as the baseline scenario is unlikely.

Summarizing the analysis of project alternatives, and also considering the results of the Investment and Barrier Analyses, Alternative 3.1 that envisages continuation of the current situation was chosen as the baseline scenario for the third stage of the project.

Investment analysis

Main economic indicators of the third stage were compared for the two project implementation options:

(a) without selling GHG emission reductions; and

(b) with selling GHG emission reductions.

IRR and NPV were determined for each option. NPV was chosen as the main benchmark parameter.

The capital investments into the third stage amount to EUR 24.2 million [R5]. The indicated amount is required for implementation of the stage in 2007-2009. The third stage is financed by the internal resources of OJSC "Ilim Group".

The average RUR/EUR exchange rate in 2007 was 35.03 RUR/EUR[1].

The selling price of ERU (2009-2012) was assumed equal to 15 EUR/t CO_2e.

The time horizon for the analysis is limited by the latter half of 2024 (15 years – operating lifetime of the equipment).

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

The cost of feedstock and resources and the expected effects from implementation of the third stage of the project that influence the cash flow value were assumed as per the Project application [R5].

The discount rate was determined with the help of cumulative method of risk premium assessment (See Formula B.2-1).

In the first six months of 2008 the rate of return on Russia 2030 Eurobonds was at the level of 5.3÷5.7% p.a. [1]. Risk premium for investments into new technology based production is at the level of 10÷13%. Other risk premiums amount to 5%.

The final discount rate was assumed at 20%.

Detailed information on the Investment analysis of the third stage of the project is given in Annex 2-6.

Table B.2-3 shows the main economic indicators of the third stage of the project for the two implementation options.

Table B.2-3. Investments, NPV and IRR for the third stage of the project

Indicator	Unit	Without selling GHG emission reductions	With selling GHG emission reductions
Investments	thousand EUR	24 247	24 247
NPV	thousand EUR	-2 300	2 504
IRR	%	17.28	23.42

The economic indicators of the third stage of the project without JI mechanism are unacceptably low (NPV<0). The revenues from selling ERUs amount to around 32% of the total required investments. Due to these revenues the third stage of the project becomes more commercially attractive and NPV rises above zero. Moreover the third stage becomes less sensitive to risks (See results of the Sensitivity analysis in Table B.2-4).

Table B.2-4. The Sensitivity analysis of the main economic indicators of the third stage of the project

Indicator	Unit	Without selling GHG emission reductions	With selling GHG emission reductions
1) Growth of investment costs by 10%			
NPV	thousand EUR	-4 210	595
IRR	%	15.41	20.74
2) Reduction of heat production by 10%			
NPV	thousand EUR	-3 545	549
IRR	%	15.76	20.74
3) Reduction of electricity generation by 10%			
NPV	thousand EUR	-3 051	1 434
IRR	%	16.37	21.96
4) Growth of current costs by 10%			
NPV	thousand EUR	-2 402	2 403
IRR	%	17.16	23.29
5) Reduction of the price of ERU by 10%			
NPV	thousand EUR	-2 300	2 024
IRR	%	17.28	22.72

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[1] http://www.veb.ru/ru/analytics/review

It is important to note that the third stage of the project is aimed at mitigation of anthropogenic impact on the environment. The third stage of the project could not take place within the framework of common business practice without selling ERUs.

Barrier analysis

Implementation of the third project stage at BPPM faces significant barriers, namely technological, operational and financial barriers.

Technological barriers

The technologies for fluidized bed co-combustion of BWW and WWS are more sophisticated than the technologies applied in the existing boilers. This is attributed not only to the non-uniform fractional composition and high moisture content of BWW (See the analysis of technological barrier for the first stage), but also to the high moisture content of WWS which is even higher than that of BWW.

Abruptly variable moisture content and fractional composition of the BWW and WWS mixture make the automation of the burning process more complicated and less reliable. To ensure stable operation of the boilers it is necessary that BWW and WWS should be uniformly mixed, which is extremely difficult (and sometimes not possible) to achieve in practice.

Since WWS contains mineral impurities, which when combusted produce fly ash and furnace bottom ash, it is necessary to fit the boiler with a high-efficiency ash collecting equipment. To this end the enterprise is going to install a two-stage electrostatic precipitator within the framework of the project. Because of its large size the electrostatic precipitator will be mounted outside the boiler room, which requires additional metal supporting structure and additional conveyor to be mounted. This makes the project more complicated and expensive.

The new boiler is larger than the old one, therefore additional dismantling works are needed to accommodate it. Thus, it is necessary to raise the roof of the boiler room because the new boiler is higher.

Financial barriers

In addition to the fact that the third stage of the project has high capital expenditure (around EUR 24.2 million), it is implemented against the background of world's drop in demand for paper, caused by the global financial crisis. The main consumers of BPPM' produce are located in China. Pulp consumption there is dwindling because of the falling demand at the US goods markets.

All over the globe enterprises of pulp and paper industry are suffering losses, major companies are curtailing their investment projects in order to redirect the available cash flows to support their core business and preserve production. In this context the overriding argument for OJSC "Ilim Group" in favour of completing the project today is the possibility to sell ERUs.

Common practice analysis

The common practice for Russian pulp and paper mills is production of heat and electricity at energy generating sources (such as CHPP, boiler houses) with a high rate of fossil fuel consumption (natural gas, coal, residual fuel oil). At those mills where pulp is cooked black liquor is also used as fuel. The wood wastes used as fuel are sawdust and off-grade chips, debarking and sawmilling residues.

Considerable quantities of high moisture bark are generally stockpiled at a dump because it is very difficult to burn it and much fossil fuel is consumed for flame stabilization. Moisture content of WWS is even higher and its calorific value is lower than those of BWW. Generally, WWS is not considered as fuel at all. WWS from wastewater treatment plants are traditionally stockpiled in special dumps (lagoons) for liquid wastes. Disposal of bark and WWS at dumps is permitted by Russian environmental regulations.

As of the beginning of the project implementation (April 2000) almost all pulp and paper mills were equipped with utilizing boilers that combusted wood wastes using residual fuel oil or natural gas for flame stabilization. Utilizing boilers using fluidized bed technology at that moment were installed only at two pulp and paper mills: one in Syktyvkar, the Komi Republic, and one at Baikal PPM, the Irkutsk Region.

The uniqueness of the project is that this is the first in Russia experience of switching E-75-40K boilers designed for lignin combustion in a low-temperature swirl to fluidized bed combustion of BWW without using residual fuel oil for flame stabilization. Baikal and Syktyvkar PPMs reconstructed their KM-75-40 boilers that were originally designed for bed firing of wood wastes.

BWW and WWS mixture is successfully fired in fluidized bed boilers for the purpose of energy production only by one enterprise in Russia – Arkhangelsk PPM.

In 2008 OJSC “Volga” (former Balakhna PPM, Nizhny Novgorod Region) commissioned a boiler manufactured by “Wellons” that utilizes WWS and BWW mixture for the purpose of steam production. “Wellons” technology is different from the fluidized bed technology.

Therefore this project is not a common practice.

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

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

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

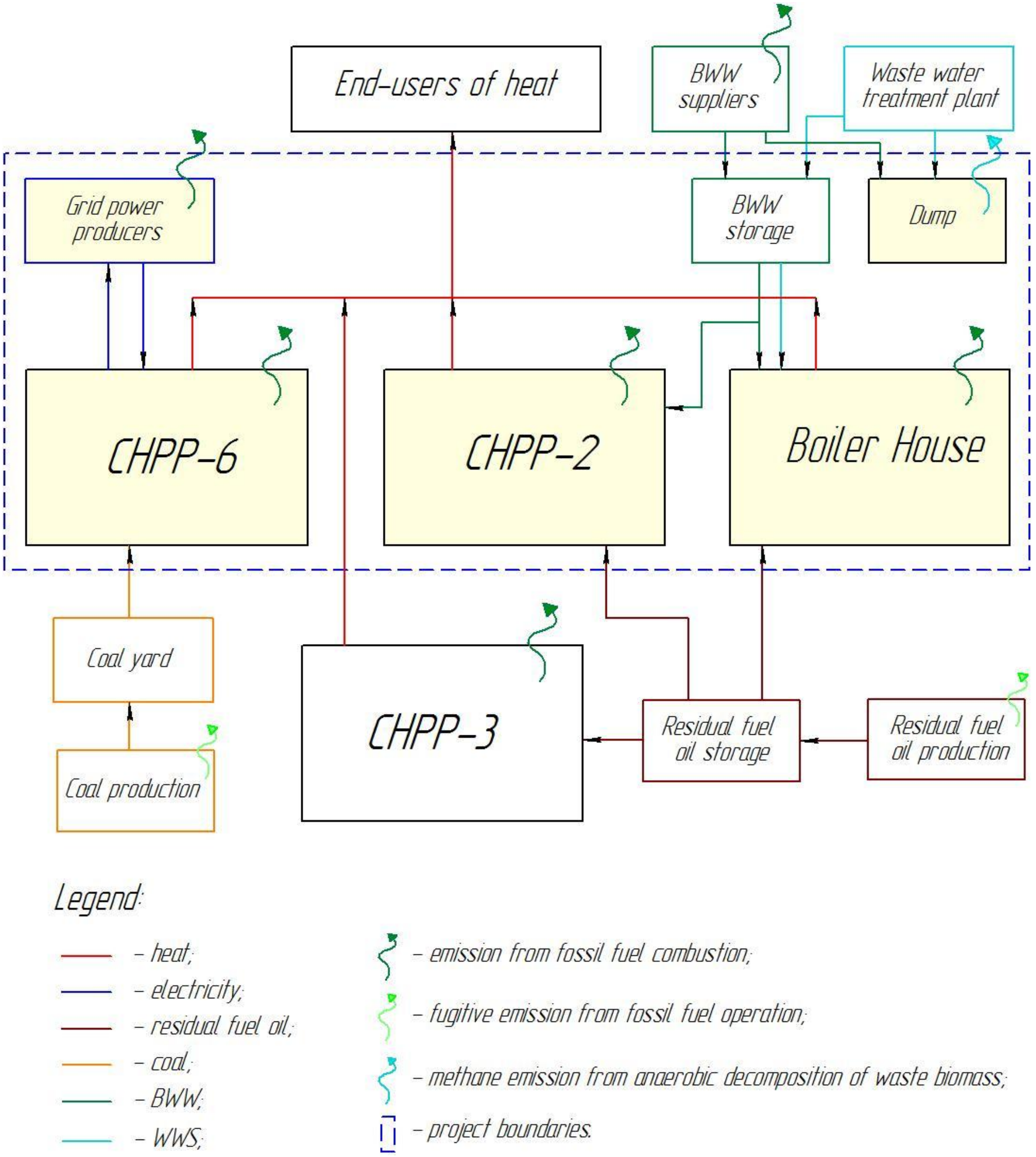

Fig. B.3-1. Main project components and boundaries

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

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

	Source	Gas	Incl./Excl.	Justification / explanation
Baseline	The boiler house, combustion of residual fuel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small. Conservative
		N_2O	Excl.	Considered negligibly small. Conservative
	CHPP-2, combustion of residual fuel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small. Conservative
		N_2O	Excl.	Considered negligibly small. Conservative
	CHPP-3, combustion of residual fuel oil	CO_2	Excl.	Does not depend on the project
		CH_4	Excl.	Does not depend on the project
		N_2O	Excl.	Does not depend on the project
	CHPP-6, combustion of lignite (additional as compared with the project)	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small. Conservative
		N_2O	Excl.	Considered negligibly small. Conservative
	Grid power producers, combustion of fossil fuel (additional as compared with the project)	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small. Conservative
		N_2O	Excl.	Considered negligibly small. Conservative
	Industrial waste dump, anaerobic decomposition of BWW and WWS (additional as compared with the project)	CO_2	Excl.	Considered equal to zero
		CH_4	**Incl.**	**Main emission source**
		N_2O	Excl.	Considered negligibly small. Conservative
The project activity	The boiler house, combustion of residual fuel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small
	CHPP-2, combustion of residual fuel oil	**CO_2**	**Incl.**	**Main emission source**
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small
	CHPP-3, combustion of residual fuel oil	CO_2	Excl.	Does not depend on the project
		CH_4	Excl.	Does not depend on the project
		N_2O	Excl.	Does not depend on the project
Leakages	Reduction of production, processing, storage, transportation and distribution of fossil fuel	CO_2	Excl.	Considered negligibly small. Conservative
		CH_4	Excl.	Neglected because the project owner can not monitor those. Conservative
		N_2O	Excl.	Considered negligibly small. Conservative
	Increase of BWW supplies from the outside	CO_2	Excl.	Considered negligibly small *
		CH_4	Excl.	Considered negligibly small
		N_2O	Excl.	Considered negligibly small

* It is expected that additional supplies of BWW to BPPM from the outside under the project will amount to 22 000 tonnes per year. BWW will be delivered by motor transport from over 100 km away. Therefore one trip is a 200 km haul. It is assumed that the most typical Russian truck-tractor MAZ with a semitrailer will transport 10 tonnes of freight (about 20 bilk m^3), using around 40 l of diesel fuel per 100 km. Thus, the total consumption of diesel fuel in one year will amount to 22 000/10×200/100×40 = 176 000 l/year. According to WRI 2001d [R16] net calorific value and emission factor for diesel fuel can be assumed at 0.0371 GJ/l and 74.01 kg CO_2/GJ, respectively. Therefore annual emissions will total to 176×0.0371×74.01 = 483 t CO_2/year. The resulting value does not exceed 0.3% of the annual GHG emission reductions.

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

Date of baseline setting: 01/02/2009

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

Contact person: Ilya Goryashin

E-mail: i.goryashin@ccgs.ru

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

28 April 2000

C.2. Expected operational lifetime of the project:

15 years/180 months

C.3. Length of the crediting period:

Length of the crediting period – 5 years/60 months (from January 1, 2008 till December 31, 2012)

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The monitoring plan was developed following our own approach in accordance with the project specifics and requirements of *Decision 9/CMP.1, Appendix B* [R6] without using any approved CDM methodologies.

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

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. $FC^{m}_{RFO,9,PJ,y}$	Mass residual fuel oil consumption in boiler No.9 under the project during the year *y*	The Mill's energy service	t	m	Continuously	100 %	Electronic and paper	Readings of flow meters in the forward and return residual fuel oil feeding lines of the boiler
2. $FC^{m}_{RFO,14,PJ,y}$	Mass residual fuel oil consumption in boiler No.14 under the project during the year *y*	The Mill's energy service	t	m	Continuously	100 %	Electronic and paper	Readings of flow meters in the forward and return residual fuel oil feeding lines of the boiler

3. $FC^{m}_{RFO,15,PJ,y}$	Mass residual fuel oil consumption in boiler No.15 under the project during the year *y*	The Mill's energy service	t	m	Continuously	100 %	Electronic and paper	Readings of flow meters in the forward and return residual fuel oil feeding lines of the boiler
4. $FC^{m}_{RFO,16,PJ,y}$	Mass residual fuel oil consumption in boiler No.16 under the project during the year *y*	The Mill's energy service	t	m	Continuously	100 %	Electronic and paper	Readings of flow meters in the forward and return residual fuel oil feeding lines of the boiler
5. $NCV_{RFO,y}$	Average net calorific value of residual fuel oil in the year *y*	The Mill's energy service	GJ/t	m	Once per week	100 %	Electronic and paper	Average value determined at the end of the year *y*

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

$$PE_{y} = PE_{RFO,y}, \qquad \text{(D.1-1)}$$

where $PE_{RFO,y}$ is the project emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y*, t CO_2e;

$$PE_{RFO,y} = FC^{m}_{RFO,PJ,y} \times NCV_{RFO,y} \times EF_{CO2,RFO}, \qquad \text{(D.1-2)}$$

where $FC^{m}_{RFO,PJ,y}$ is the mass residual fuel oil consumption in the utilizing boilers under the project during the year *y*, t;

$$FC^{m}_{RFO,PJ,y} = FC^{m}_{RFO,9,PJ,y} + FC^{m}_{RFO,14,PJ,y} + FC^{m}_{RFO,15,PJ,y} + FC^{m}_{RFO,16,PJ,y}, \qquad \text{(D.1-3)}$$

where $FC^{m}_{RFO,9,PJ,y}$ is the mass residual fuel oil consumption in boiler No.9 under the project during the year *y*, t;

$FC^{m}_{RFO,14,PJ,y}$ is the mass residual fuel oil consumption in boiler No.14 under the project during the year *y*, t;

$FC^{m}_{RFO,15,PJ,y}$ is the mass residual fuel oil consumption in boiler No.15 under the project during the year y, t;

$FC^{m}_{RFO,16,PJ,y}$ is the mass residual fuel oil consumption in boiler No.16 under the project during the year y, t.

$NCV_{RFO,y}$ is the average net calorific value of residual fuel oil in the year y, GJ/t;

$EF_{CO2,RFO}$ is the CO_2 emission factor for residual fuel oil combustion, t CO_2e/GJ. According to 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R7] for the entire project period is assumed as follows: $EF_{CO2,RFO} = 0.0774$ t CO_2e/GJ.

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
6. $HG_{9,PJ,y}$	Heat generation by boiler No.9 under the project during the year *y*	The Mill's energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings
7. $HG_{14,PJ,y}$	Heat generation by boiler No.14 under the project during the year *y*	The Mill's energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings
8. $HG_{15,PJ,y}$	Heat generation by boiler No.15 under the project during the year *y*	The Mill's energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings
9. $HG_{16,PJ,y}$	Heat generation by boiler No.16 under the project during the year *y*	The Mill's energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings

10. HS_y^{total}	Total heat supply (in the form of steam) to end-users from THPP and CHPP-6 during the year *y*	The Mill’s energy service	GJ	m	Continuously	100 %	Electronic and paper	Readings of heat meters
11. $HS_{CHPP6,PJ,y}$	Heat supply (in the form of steam) to end-users from CHPP-6 under the project during the year *y*	The Mill’s energy service	GJ	m	Continuously	100 %	Electronic and paper	Readings of heat meters
12. $HG_{11,y}$	Heat generation by boiler No.11 during the year *y*	The Mill’s energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings
13. $HG_{12,y}$	Heat generation by boiler No.12 during the year *y*	The Mill’s energy service	GJ	m	Continuously	100 %	Electronic and paper	Heat meter readings
14. $EG_{CHPP2,PJ,y}$	Electricity generation at CHPP-2 under the project during the year *y*	The Mill’s energy service	MWh	m	Continuously	100 %	Electronic and paper	Reading of electricity meters
15. $EC_{CHPP2,PJ,y}$	Electricity consumption for auxiliary needs of CHPP-2 under the project during the year *y*	The Mill’s energy service	MWh	m	Continuously	100 %	Electronic and paper	Reading of electricity meters

16. $EC_{BH,PJ,y}$	Electricity consumption for auxiliary needs of the boiler house under the project during the year *y*	The Mill's energy service	MWh	m	Continuously	100 %	Electronic and paper	Reading of electricity meters
17. $FC^{m}_{BWW,9,PJ,x}$	Mass BWW consumption in boiler No.9 under the project during the year *x*	The Mill's energy service	t	c	Continuously	100 %	Electronic and paper	Determined using calculating algorithm
18. $FC^{m}_{BWW,14,PJ,x}$	Mass BWW consumption in boiler No.14 under the project during the year *x*	The Mill's energy service	t	c	Continuously	100 %	Electronic and paper	Determined by automatic system as per the set algorithm
19. $FC^{m}_{BWW,15,PJ,x}$	Mass BWW consumption in boiler No.15 under the project during the year *x*	The Mill's energy service	t	c	Continuously	100 %	Electronic and paper	Determined by automatic system as per the set algorithm
20. $FC^{m}_{BWW,16,PJ,x}$	Mass BWW consumption in boiler No.16 under the project during the year *x*	The Mill's energy service	t	c	Continuously	100 %	Electronic and paper	Determined by automatic system as per the set algorithm
21. $BWW^{m}_{side,PJ,x}$	Quantity of BWW supplied to BPPM (for combustion) from outside companies under the project during the year *x*	The Mill's energy service	t	m	As BWW is supplied	100 %	Electronic and paper	Determined by the number of vehicles. Controlled based on contracts and delivery certificates signed with outside companies supplying BWW

22. $FC^{m}_{WWS,BH,PJ,x}$	Mass WWS consumption in the boiler house under the project during the year *x*	The Mill's energy service	t	m	With each batch of WWS	100 %	Electronic and paper	Determined by the number of vehicles
23. $W_{WWS,PJ,x}$	Average moisture content of WWS under the project in the year *x*	The Mill's energy service	%	m	Daily	100 %	Electronic and paper	Average value is determined at the year-end

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

$$BE_y = BE_{RFO,y} + BE_{lignite,y} + BE_{grid,y} + BE_{BWW,dump,y} + BE_{WWS,dump,y}, \qquad \text{(D.1-4)}$$

where $BE_{RFO,y}$ is the baseline emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y*, t CO_2e;

$$BE_{RFO,y} = FC_{RFO,BL,y} \times EF_{CO2,RFO}, \qquad \text{(D.1-5)}$$

where $FC_{RFO,BL,y}$ is the residual fuel oil consumption in the utilizing boilers under the baseline scenario during the year *y*, GJ;

$$FC_{RFO,BL,y} = FC_{RFO,9,BL,y} + FC_{RFO,10,BL,y} + FC_{RFO,15,BL,y}, \qquad \text{(D.1-6)}$$

where $FC_{RFO,9,BL,y}$ is the residual fuel oil consumption in boiler No.9 under the baseline scenario during the year *y*, GJ;

$$FC_{RFO,9,BL,y} = HG_{9,BL,y} \times SFC_{RFO,9}, \qquad \text{(D.1-7)}$$

where $HG_{9,BL,y}$ is the heat generation by boiler No.9 under the baseline scenario during the year *y*, GJ;

$$HG_{9,BL,y} = MIN\left(HG_{PJ,y}; HG_9^{\max}\right), \qquad \text{(D.1-8)}$$

where $HG_{PJ,y}$ is the heat production by the utilizing boilers under the project during the year *y*, GJ;

$$HG_{PJ,y} = HG_{9,PJ,y} + HG_{14,PJ,y} + HG_{15,PJ,y} + HG_{16,PJ,y}, \qquad \text{(D.1-9)}$$

where $HG_{9,PJ,y}$ is the heat generation by boiler No.9 under the project during the year *y*, GJ;

$HG_{14,PJ,y}$ is the heat generation by boiler No.14 under the project during the year *y*, GJ;

$HG_{15,PJ,y}$ is the heat generation by boiler No.15 under the project during the year *y*, GJ;

$HG_{16,PJ,y}$ is the heat generation by boiler No.16 under the project during the year *y*, GJ.

$HG_{9}^{\max}$ is the maximum quantity of heat that can be produced by boiler No.9 during the year, GJ. According to Section B.1 it was assumed: $HG_{9}^{\max}$ = 1 125 026 GJ.

$SFC_{RFO,9}$ is the specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.9, GJ/GJ. According to Section B.1 it was assumed: $SFC_{RFO,9}$ = 0.0347 GJ/GJ.

$FC_{RFO,10,BL,y}$ is the residual fuel oil consumption in boiler No.10 under the baseline scenario during the year *y*, GJ;

$$FC_{RFO,10,BL,y} = HG_{10,BL,y} \times SFC_{RFO,10}, \qquad \text{(D.1-10)}$$

where $HG_{10,BL,y}$ is the heat generation by boiler No.10 under the baseline scenario during the year *y*, GJ;

$$HG_{10,BL,y} = MIN\left((HG_{PJ,y} - HG_{9,BL,y}); HG_{10}^{\max}\right), \qquad \text{(D.1-11)}$$

where $HG_{10}^{\max}$ is the maximum quantity of heat that can be produced by boiler No.10 during the year, GJ. According to Section B.1 it was assumed: $HG_{10}^{\max}$ = 614 488 GJ.

$SFC_{RFO,10}$ is the specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.10, GJ/GJ. According to Section B.1 it was assumed: $SFC_{RFO,10}$ = 0.3672 GJ/GJ.

$FC_{RFO,15,BL,y}$ is the residual fuel oil consumption in boiler No.15 under the baseline scenario during the year *y*, GJ;

$$FC_{RFO,15,BL,y} = HG_{15,BL,y} \times SFC_{RFO,15}, \qquad (D.1\text{-}12)$$

where $HG_{15,BL,y}$ is the heat generation by boiler No.15 under the baseline scenario during the year *y*, GJ;

$$HG_{15,BL,y} = MIN\left((HG_{PJ,y} - HG_{CHPP2,BL,y}); HG_{15}^{\max}\right), \qquad (D.1\text{-}13)$$

where $HG_{CHPP2,BL,y}$ is the heat production by the boilers of CHPP-2 under the baseline scenario during the year *y*, GJ;

$$HG_{CHPP2,BL,y} = HG_{9,BL,y} + HG_{10,BL,y}. \qquad (D.1\text{-}14)$$

$HG_{15}^{\max}$ is the maximum quantity of heat that can be produced by old boiler No.15 during the year, GJ. According to Section B.1 is assumed: $HG_{15}^{\max}$ = 1 339 346 GJ.

$SFC_{RFO,15}$ is the specific residual fuel oil consumption for generation of 1 GJ of heat in boiler No.15, GJ/GJ. According to Section B.1 it was assumed: $SFC_{RFO,15}$ = 0.2810 GJ/GJ.

$BE_{lignite,y}$ is the baseline emissions of CO_2 from additional combustion of lignite in the boilers of CHPP-6 during the year *y*, t CO_2e;

$$BE_{lignite,y} = FC_{lignite,BL,y}^{add} \times EF_{CO2,lignite}, \qquad (D.1\text{-}15)$$

where $FC_{lignite,BL,y}^{add}$ is the additional lignite consumption at CHPP-6 under the baseline scenario as compared with the project scenario during the year *y*, GJ;

$$FC_{lignite,BL,y}^{add} = \frac{HS_{CHPP6,BL,y}^{add} \times K_{turbine}^{heat}}{\eta_{boiler} \times (1 - HA_{boiler}) \times K_{HF}}, \qquad (D.1\text{-}16)$$

where $HS_{CHPP6,BL,y}^{add}$ is the additional heat supply from CHPP-6 to end-users under the baseline scenario as compared with the project scenario during the year *y*, GJ;

$$HS_{CHPP6,y}^{add} = HS_{PJ,y} - HS_{BL,y}, \qquad (D.1\text{-}17)$$

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

$$HS_{PJ,y} = HG_{PJ,y} \times SHS_{THPP,PJ,y}\,, \tag{D.1-18}$$

where $SHS_{THPP,PJ,y}$ is the factor of heat supply from THPP under the project during the year *y*;

$$SHS_{THPP,PJ,y} = \frac{HS_{THPP,PJ,y}}{HG_{THPP,PJ,y}}\,, \tag{D.1-19}$$

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

$$HS_{THPP,PJ,y} = HS_{y}^{total} - HS_{CHPP6,PJ,y}\,, \tag{D.1-20}$$

where HS_{y}^{total} is the total heat supply (in the form of steam) to end-users from THPP and CHPP-6 during the year *y*, GJ;

$HS_{CHPP6,PJ,y}$ is the heat supply (in the form of steam) to end-users from CHPP-6 under the project during the year *y*, GJ.

$HG_{THPP,PJ,y}$ is the heat production by the boilers of THPP under the project during the year *y*, GJ;

$$HG_{THPP,PJ,y} = HG_{PJ,y} + HG_{CHPP3,y}\,, \tag{D.1-21}$$

where $HG_{CHPP3,y}$ is the heat production by the boilers of CHPP-3 during the year *y*, GJ;

$$HG_{CHPP3,y} = HG_{11,y} + HG_{12,y}\,, \tag{D.1-22}$$

where $HG_{11,y}$ is the heat generation by boiler No.11 during the year *y*, GJ;

$HG_{12,y}$ is the heat generation by boiler No.12 during the year *y*, GJ.

$HS_{BL,y}$ is the heat supply to end-users due to operation of the utilizing boilers under the baseline scenario during the year *y*, GJ;

$$HS_{BL,y} = HG_{BL,y} \times SHS_{THPP,BL}\,, \tag{D.1-23}$$

where $HG_{BL,y}$ is the heat production by the utilizing boilers under the baseline scenario during the year *y*, GJ;

$$HG_{BL,y} = HG_{9,BL,y} + HG_{10,BL,y} + HG_{15,BL,y}\,. \qquad \text{(D.1-24)}$$

$SHS_{THPP,BL}$ is the factor of heat supply from THPP under the baseline scenario. According to Section B.1 it was assumed: $SHS_{THPP,BL}$ = 0.705.

$K^{heat}_{turbine}$ is the factor of variation of live steam flow to the turbine caused by the variation of the process steam extraction. According to energy characteristic of the turbines it was assumed: $K^{heat}_{turbine}$ = 1.310;

η_{boiler} is the efficiency factor of CHPP-6 boilers. According to Section B.1 it was assumed: η_{boiler} = 0.902;

HA_{boiler} the proportion of heat for auxiliary needs of CHPP-6 boilers. According to Section B.1 it is assumed: HA_{boiler} = = 0.0233;

K_{HF} is the heat flow factor at CHPP-6. According to Section B.1 it is assumed: K_{HF} = 0.98.

$EF_{CO2,lignite}$ is the CO_2 emission factor for lignite combustion, t CO_2e/GJ. According to 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R7] for the entire project period it was assumed: $EF_{CO2,lignite}$ = 0.101 t CO_2e /GJ.

$BE_{grid,y}$ is the baseline emissions of CO_2 from additional electricity consumption from the external power grid during the year *y*, t CO_2e;

$$BE_{grid,y} = EC^{add}_{grid,BL,y} \times EF_{CO2,grid,y}\,, \qquad \text{(D.1-25)}$$

where $EC^{add}_{grid,BL,y}$ is the additional electricity consumption from the external power grid under the baseline scenario as compared with the project scenario during the year *y*, MWh;

$$EC^{add}_{grid,BL,y} = ES_{PJ,y} - ES_{BL,y} - ES^{add}_{CHPP6,BL,y}\,, \qquad \text{(D.1-26)}$$

where $ES_{PJ,y}$ is the electricity supply due to operation of the utilizing boilers under the project during the year *y*, MWh;

$$ES_{PJ,y} = ES_{CHPP2,PJ,y} - EC_{BH,PJ,y}\,, \qquad \text{(D.1-27)}$$

where $ES_{CHPP2,PJ,y}$ is the electricity supply from CHPP-2 under the project during the year *y*, MWh;

$$ES_{CHPP2,PJ,y} = EG_{CHPP2,PJ,y} - EC_{CHPP2,PJ,y}, \qquad (D.1\text{-}28)$$

where $EG_{CHPP2,PJ,y}$ is the electricity generation at CHPP-2 under the project during the year *y*, MWh;

$EC_{CHPP2,PJ,y}$ is the electricity consumption for auxiliary needs of CHPP-2 under the project during the year *y*, MWh.

$EC_{BH,PJ,y}$ is the electricity consumption for auxiliary needs of the boiler house under the project during the year *y*, MWh.

$ES_{BL,y}$ is the electricity supply due to operation of the utilizing boilers under the baseline scenario during the year *y*, MWh;

$$ES_{BL,y} = ES_{CHPP2,BL,y} - EC_{BH,BL,y}, \qquad (D.1\text{-}29)$$

where $ES_{CHPP2,BL,y}$ is the electricity supply from CHPP-2 under the baseline scenario during the year *y*, MWh;

$$ES_{CHPP2,BL,y} = EG_{CHPP2,BL,y} - EC_{CHPP2,BL,y}, \qquad (D.1\text{-}30)$$

where $EG_{CHPP2,BL,y}$ is the electricity generation at CHPP-2 under the baseline scenario during the year *y*, MWh;

$$EG_{CHPP2,BL,y} = HG_{CHPP2,BL,y} \times \chi_{CHPP2,BL}, \qquad (D.1\text{-}31)$$

where $\chi_{CHPP2,BL}$ is the factor of heat-production-based electricity generation at CHPP-2 under the baseline scenario, MWh/GJ. According to Section B.1 it is assumed: $\chi_{CHPP2,BL}$ = = 0.0372 MWh/GJ.

$EC_{CHPP2,BL,y}$ is the electricity consumption for auxiliary needs of CHPP-2 under the baseline scenario during the year *y*, MWh;

$$EC_{CHPP2,BL,y} = HG_{CHPP2,BL,y} \times SEC_{HG,CHPP2,BL}, \qquad (D.1\text{-}32)$$

where $SEC_{HG,CHPP2,BL}$ is the specific electricity consumption for production of 1 GJ of heat at CHPP-2 under the baseline scenario, MWh/GJ. According to Section B.1 it is assumed: $SEC_{HG,CHPP2,BL}$ = = 0.0141 MWh/GJ.

$EC_{BH,BL,y}$ is the electricity consumption for auxiliary needs of the boiler house under the baseline scenario during the year *y*, MWh;

$$EC_{BH,BL,y} = HG_{BH,BL,y} \times SEC_{HG,BH,BL}, \qquad \text{(D.1-33)}$$

where $HG_{BH,BL,y}$ is the heat production by boilers of the boiler house under the baseline scenario during the year *y*, GJ;

$$HG_{BH,BL,y} = HG_{15,BL,y}. \qquad \text{(D.1-34)}$$

$SEC_{HG,BH,BL}$ is the specific electricity consumption for production of 1 GJ of heat in the boiler house under the baseline scenario, MWh/GJ. According to Section B.1 it is assumed: $SEC_{HG,BH,BL}$ = 0.007 MWh/GJ.

$ES^{add}_{CHPP6,BL,y}$ is the additional heat-production-based electricity supply from CHPP-6 under the baseline scenario as compared with the project scenario during the year y, MWh;

$$ES^{add}_{CHPP6,BL,y} = \frac{HS^{add}_{CHPP6,BL,y} \times K^{electricity}_{turbine} \times \left(1 - SEC_{auxiliary,CHPP6}\right)}{3.6}, \qquad \text{(D.1-35)}$$

where $K^{electricity}_{turbine}$ is the factor of variation of electricity generation by the turbine caused by the variation of the process steam extraction. In accordance with the energy characteristic of the turbine it was assumed: $K^{electricity}_{turbine}$ = 0.305;

$SEC_{auxiliary,CHPP6}$ is the specific electricity consumption for auxiliary needs of CHPP-6. According to Section B.1 it is assumed: $SEC_{auxiliary,CHPP6}$ = 0.04.

$EF_{CO2,grid,y}$ is the CO_2 emission factor for electricity consumed from the external power grid during the year *y*, t CO_2e/MWh. According to Guidelines for Project Design Documents of Joint Implementation Projects [R13] the CO_2 emission factors for electricity consumed from the power grid in Russia depending on the year are assumed equal to: $EF_{CO2,grid,y}^{2008}$ = 0.565 t CO_2e/MWh, $EF_{CO2,grid,y}^{2009}$ = 0.557 t CO_2e/MWh, $EF_{CO2,grid,y}^{2010}$ = 0.550 t CO_2e/MWh, $EF_{CO2,grid,y}^{2011}$ = 0.542 t CO_2e/MWh, $EF_{CO2,grid,y}^{2012}$ = = 0.534 t CO_2e/MWh.

$BE_{BWW,dump,y}$ is the baseline emissions of CH_4 from decomposition of an additional quantity of BWW at the dump during the year *y*, t CO_2e;

The numerical value of $BE_{BWW,dump,y}$ is determined using the model "*Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles*" developed by "*BTG biomass technology group B.V.*" based on [R14] (See Section E.4 and Annex 2-3).

$$BE_{BWW,dump,y} = \left(1 - w_{lignin,BWW}\right) \times k_{BWW} \times \frac{C_{BWW}^{db}}{100} \times \left(1 - \frac{W_{BWW}}{100}\right) \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \rho_{CH4} \times GWP_{CH4} \times \times \sum_{x=2001}^{x=y} \left(BWW_{dump,BL,x}^{m,add} \times e^{-k_{BWW}(y-x)}\right), \quad (D.1\text{-}36)$$

where $BWW_{dump,BL,x}^{m,add}$ is the additional disposal of BWW at the dump under the baseline scenario as compared with the project scenario (amount of fresh biomass utilized) during the year *x*, t;

$$BWW_{dump,BL,x}^{m,add} = MAX\left(0; FC_{BWW,PJ,x}^{m} - FC_{BWW,BL}^{m,\max} - BWW_{side,PJ,x}^{m}\right), \quad (D.1\text{-}37)$$

where $FC_{BWW,PJ,x}^{m}$ is the mass BWW consumption in the utilizing boilers under the project during the year *x*, t;

$$FC_{BWW,PJ,x}^{m} = FC_{BWW,9,PJ,x}^{m} + FC_{BWW,14,PJ,x}^{m} + FC_{BWW,15,PJ,x}^{m} + FC_{BWW,16,PJ,x}^{m}, \quad (D.1\text{-}38)$$

where $FC_{BWW,9,PJ,x}^{m}$ is the mass BWW consumption in boiler No.9 under the project during the year *x*, t;

$FC_{BWW,14,PJ,x}^{m}$ is the mass BWW consumption in boiler No.14 under the project during the year *x*, t;

$FC_{BWW,15,PJ,x}^{m}$ is the mass BWW consumption in boiler No.15 under the project during the year *x*, t;

$FC_{BWW,16,PJ,x}^{m}$ is the mass BWW consumption in boiler No.16 under the project during the year *x*, t.

$FC^{m,\max}_{BWW,BL}$ is the maximum quantity of BWW that can be fired in the utilizing boilers under the baseline scenario during the year, t;

$$FC^{m,\max}_{BWW,BL} = FC^{m,\max}_{BWW,9} + FC^{m,\max}_{BWW,10} + FC^{m,\max}_{BWW,15}, \quad (D.1\text{-}39)$$

where $FC^{m,\max}_{BWW,9}$ is the maximum quantity of BWW that can be fired in boiler No.9 during the year, t. According to Section B.1 it is assumed: $FC^{m,\max}_{BWW,9}$ = 189 830 t;

$FC^{m,\max}_{BWW,10}$ is the maximum quantity of BWW that can be fired in boiler No.10 during the year, t. According to Section B.1 it is assumed: $FC^{m,\max}_{BWW,10}$ = 60 003 t;

$FC^{m,\max}_{BWW,15}$ is the maximum quantity of BWW that can be fired in boiler No.15 during the year, t. According to Section B.1 it is assumed: $FC^{m,\max}_{BWW,15}$ = 130 230 t.

$BWW^{m}_{side,PJ,x}$ is the quantity of BWW supplied to BPPM (for combustion) from the outside companies under the project during the year *x*, t.

$w_{lignin,BWW}$ is the lignin fraction of C for BWW. According to Section E.4 it is assumed: $w_{lignin,BWW}$ = 0.25;

k_{BWW} is the decomposition rate constant for BWW, year^{-1}. According to Section E.4 it is assumed: k_{BWW} = ln(1/2)/15 = 0.046 year^{-1};

C^{db}_{BWW} is the organic carbon content in BWW on dry basis, %. According to Section E.4 it is assumed: C^{db}_{BWW} = 50%;

W_{BWW} is the moisture content of BWW, %. According to Section E.4 it is assumed: W_{BWW} = 60%;

a is the conversion factor from kg carbon to landfill gas quantity, m^3/kg carbon. According to Section E.4 it is assumed: a = 1.87 m^3/kg carbon;

ζ is the generation factor. According to Section E.4 it is assumed: ζ = 0.77;

φ is the percentage of the stockpile under aerobic conditions, %. According to Section E.4 it is assumed: φ = 10%;

ζ_{OX} is the methane oxidation factor. According to Section E.4 it is assumed: ζ_{OX} = 0.10;

V_m is the methane concentration biogas, %. According to Section E.4 it is assumed: V_m = 60%;

ρ_{CH4} is the density of methane, kg/m^3. According to Section E.4 it is assumed: ρ_{CH4} = 0.714 kg/m^3;

GWP_{CH4} is the global warming potential of methane, t CO_2e/t CH_4. According to Section E.4 it is assumed: GWP_{CH4} = = 21 t CO_2e/t CH_4;

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

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

It should be noted that calculation of methane emissions for each year *y* uses additional BWW stockpiling data from 2001 onwards. Additional BWW stockpiling data for 2001-2007 were determined as of the date of baseline setting (see Annex 2-1). These data will be used for calculation of the baseline emissions of CH_4 from decomposition of an additional quantity of BWW at the dump during the year *y*. Mass BWW consumptions in the boilers were determined using a calculation algorithm. The uncertainty of calculations of additional BWW disposal at the dump in 2001-2007 is close to zero, as for the sake of conservatism maximum values of mass BWW consumption in 2001-2007 were used to determine mass consumption of BWW in boilers No.9. 10 and 15 under the baseline scenario (see Formula D.1-39). Additional BWW stockpiling data over 2008-2012 will be determined in the course of monitoring.

$BE_{WWS,dump,y}$ is the baseline emissions of CH_4 from decomposition of an additional quantity of WWS at the dump during the year *y*, t CO_2e;

The numerical value of $BE_{WWS,dump,y}$ is determined using the model "*Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles*" developed by "*BTG biomass technology group B.V.*" based on [R14] (See Section E.4 and Annex 2-4).

$$BE_{WWS,dump,y} = \left(1 - w_{lignin,WWS}\right) \times k_{WWS} \times \frac{C^{db}_{WWS}}{100} \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \rho_{CH4} \times GWP_{CH4} \times \times \sum_{x=2010}^{x=y} \left(WWS^{dry,add}_{dump,BL,x} \times e^{-k_{WWS}(y-x)}\right), \quad \text{(D.1-40)}$$

where $WWS^{dry,add}_{dump,BL,x}$ is the additional disposal of absolutely dry WWS at the dump under the baseline scenario as compared with the project scenario (amount of fresh biomass utilized) during the year *x*, t a.d.m.;

$$WWS^{dry,add}_{dump,BL,x} = FC^{dry}_{WWS,PJ,x}, \quad \text{(D.1-41)}$$

where $FC^{dry}_{WWS,PJ,x}$ is the quantity of absolutely dry WWS fired under the project during the year *x*, t a.d.m.;

$$FC^{dry}_{WWS,PJ,x} = FC^{dry}_{WWS,BH,PJ,x}\,, \tag{D.1-42}$$

where $FC^{dry}_{WWS,BH,PJ,x}$ is the absolutely dry WWS consumption in the boiler house under the project during the year *x*, t a.d.m.;

$$FC^{dry}_{WWS,BH,PJ,x} = FC^{m}_{WWS,BH,PJ,x} \times \frac{100 - W_{WWS,PJ,x}}{100}\,, \tag{D.1-43}$$

where $FC^{m}_{WWS,BH,PJ,x}$ is the mass WWS consumption in the boiler house under the project during the year *x*, t;

$W_{WWS,PJ,x}$ is the average moisture content of WWS under the project in the year *x*, %.

$w_{lignin,WWS}$ is the lignin fraction of C for the WWS. According to Section E.4 it is assumed: $w_{lignin,WWS}$ = 0.25;

k_{WWS} is the decomposition rate constant for the WWS, year^{-1}. According to Section E.4 it is assumed: k_{WWS} = 0.185;

C^{db}_{WWS} is the organic carbon content in the WWS on dry basis, %. According to Section E.4 it is assumed: C^{db}_{WWS} = 41%.

It should be noted that calculation of methane emissions for each year *y* uses additional WWS stockpiling data from 2010 onwards.

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 applicable to the project monitoring.

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):

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

As shown in Section B.3 leakages are conservatively assumed equal to zero.

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):

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):

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

$$ER_y = BE_y - PE_y \tag{D.1-44}$$

or

$$ER_y = ER_{CO2,y} + ER_{CH4,y}, \tag{D.1-45}$$

where $ER_{CO2,y}$ is the reduction of carbon dioxide emissions during the year *y*, t CO_2e;

$$ER_{CO2,y} = ER_{CO2,RFO,y} + ER_{CO2,lignite,y} + ER_{CO2,grid,y}, \tag{D.1-46}$$

where $ER_{CO2,RFO,y}$ is the reduction of carbon dioxide emissions from combustion of residual fuel oil in the utilizing boilers during the year *y*, t CO_2e;

$$ER_{CO2,RFO,y} = BE_{RFO,y} - PE_{RFO,y}\,. \qquad \text{(D.1-47)}$$

$ER_{CO2,lignite,y}$ is the reduction of carbon dioxide emissions from combustion of lignite in CHPP-6 boilers during the year *y*, t CO_2e;

$$ER_{CO2,lignite,y} = BE_{lignite,y}\,. \qquad \text{(D.1-48)}$$

$ER_{CO2,grid,y}$ is the reduction of carbon dioxide emissions from combustion of fossil fuel at grid power plants during the year *y*, t CO_2e;

$$ER_{CO2,grid,y} = BE_{grid,y}\,. \qquad \text{(D.1-49)}$$

$ER_{CH4,y}$ is the reduction of methane emissions during the year *y*, t CO_2e;

$$ER_{CH4,y} = ER_{CH4,BWW,dump,y} + ER_{CH4,WWS,dump,y}\,, \qquad \text{(D.1-50)}$$

where $ER_{CH4,BWW,dump,y}$ is the reduction of methane emissions from BWW decomposition at the dump during the year *y*, t CO_2e;

$$ER_{CH4,BWW,dump,y} = BE_{BWW,dump,y}\,. \qquad \text{(D.1-51)}$$

$ER_{CH4,WWS,dump,y}$ is the reduction of methane emissions from WWS decomposition at the dump during the year *y*, t CO_2e;

$$ER_{CH4,WWS,dump,y} = BE_{WWS,dump,y}\,. \qquad \text{(D.1-52)}$$

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 enterprise has an environmental control and management department. The work of the department is guided by the current law, orders and decrees of the director general, and instructions of the state environmental control service, the committee for natural resources of the Irkutsk Region. The department employs qualified staff and is able to ensure proper industrial environmental monitoring under the project.

The department is responsible for monitoring of:

- emission of pollutants into the atmosphere;
- wastewater quality;
- utilization, stockpiling, transportation and disposal of industrial wastes.

During the project implementation the analytical monitoring of various environmental impacts will be carried out in accordance with the existing rules and schedule. The data obtained by the analytical laboratory are processed and summarized in monthly and annual reports which contain all required detailed information including data by production sites covered by this project.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Table D.1.1.1 ID 1-4	low	Residual fuel oil flow meters are regularly calibrated. Readings of the flow meters are cross-checked with readings of level gages in the residual fuel oil storage tank.
Table D.1.1.1 ID 5	low	Laboratory equipment is regularly calibrated. Results of laboratory analysis are cross-checked with the fuel supplier's certificates.
Table D.1.1.3 ID 6-13	low	Heat meters are regularly calibrated; readings are cross-checked with balance data.
Table D.1.1.3 ID 14-16	low	Electricity meters are regularly calibrated.
Table D.1.1.3 ID 17-20	low	The algorithm for calculation of BWW consumption is constantly updated based on boiler performance data.
Table D.1.1.3 ID 21	low	The BWW transportation vehicles undergo control weighing every six months. Arrival of each vehicle is recorded in an operating log at the handling and metering point. If any doubts arise as to the compliance of the vehicle loading with the data indicated in the transportation documents (waybills, bills of landing, contracts and delivery certificates for BWW), the personnel of the handling and metering point take check measurement of the BWW volume in this vehicle.
Table D.1.1.3 ID 22	low	The WWS transportation vehicles undergo control weighing every six months. Arrival of each vehicle is recorded in an operating log at the handling and metering point. If any doubts arise as to the compliance of the vehicle loading with the data indicated in the transportation documents, the personnel of the handling and metering point take check measurement of the WWS volume in this vehicle.
Table D.1.1.3 ID 23	low	Laboratory equipment is regularly calibrated.

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

The operational and management structure of the monitoring is as follows:

1. Data and sources

The project envisages reconstruction of the boiler house with installation of a central boiler control panel and connection of the boilers to the automatic process control system of the Mill. APCS of the Mill ensures automated primary data collection and processing. Readings of heat and electricity meters and residual fuel oil flow meters are transferred to the control units for further processing and archiving.

1.1. Mass residual fuel oil consumption in the utilizing boilers under the project during the year *y* will be determined based on readings of residual fuel oil flow meters. Readings of flow meters will be cross-checked with readings of level gages in the residual fuel oil storage tank. Mass residual fuel oil consumption in boilers No.9, No.14, No.15 and No.16 under the project during the year *y* (ID 1-4) will be determined on based on readings of the residual fuel oil meters, installed at the forward and return residual fuel oil feeding lines of the boilers.

1.2. The analysis of net calorific value of residual fuel oil will be conducted on a weekly basis by THPP laboratory. The results of the laboratory analysis will be cross-checked with the fuel suppliers' certificates. Average net calorific value of residual fuel oil in the year *y* (ID 5) will be determined as an average value at the end of the year *y*.

1.3. Heat generation by THPP boilers under the project during the year *y* (ID 6-9, 12-13) will be determined based on reading of the heat meters installed at each boiler. Heat generation data will be regularly transferred to control units and archived.

1.4. Total heat supply (in the form of steam) to end-users from THPP and CHPP-6 during the year *y* (ID 10) and heat supply (in the form of steam) to end-users from CHPP-6 under the project during the year *y* (ID 11) will be determined on the basis of readings of heat meters installed at THPP, CHPP-6, and on the demand side. The list of major heat consumers is given in Annex 3-1, the basic steam supply diagram of OJSC "Ilim Group" Branch in the town of Bratsk is given in Annex 4. Heat supply data will be collected on a weekly basis and archived.

1.5. Electricity generation at CHPP-2 under the project during the year *y* (ID 14) and electricity consumption for auxiliary needs of CHPP-2 under the project during the year *y* (ID 15) will be determined on the basis of readings of electricity meters installed at CHPP-2. Electricity generation data and data on electricity consumption for auxiliary needs of CHPP-2 will be regularly transferred to the control unit and archived.

1.6. Electricity consumption for auxiliary needs of the boiler house under the project during the year *y* (ID 16) will be determined on the basis of readings of electricity meters installed in the boiler house. Data on electricity consumption for auxiliary needs of the boiler house will be regularly transferred to the control unit and archived.

1.7. Mass BWW consumption in boiler No.9 under the project during the year *x* (ID 17) will be determined using the calculating algorithm. Mass BWW consumption in boilers No.14, No.15 and No.16 under the project during the year *x* (ID 18-20) will be determined by the automation system as per the preset algorithm. BWW combustion data will be regularly transferred to the control unit and archived.

1.8. The quantity of BWW supplied (for combustion) from outside companies will be determined at the special handling and metering point based on the number of vehicles passing through it. Data on the quantity of supplied BWW will be cross-checked with waybills, bills of landing, contracts and delivery certificates. The quantity of BWW supplied to BPPM (for combustion) from outside companies under the project during the year *x* (ID 21) will be determined as a sum of mass BWW quantities supplied during the year *x*.

1.9. Mass WWS consumption in the boiler house under the project during the year *x* (ID 22) will be determined at the special handling and metering point based on the number of vehicles passing through it.

1.10. The analysis of WWS will be conducted on a daily basis by THPP laboratory. Average moisture content of WWS under the project in the year *x* (ID 23) will be determined as an average value at the end of the year *x*.

The data sources for calculation of GHG emission reductions in the course of the monitoring during the year will be: internal data of THPP, statistical report form No.6-TP “Thermal power plant performance data”, “Report on heat utilization by product type”, “Wood wastes generation and utilization balance of Bratsk industrial site”.

Location of monitoring points is shown in Fig. D.3-1.

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

2. Monitoring Management

2.1. Monitoring Team

The THPP personnel whose work will be connected with operation of the reconstructed boilers will undergo training organized by the equipment manufacturer. All maintenance personnel have the required qualification and valid permits to operate THPP’s main equipment. New employees and personnel who need to confirm their admission group are required to undergo respective training, pass a test and obtain a permission certificate in accordance with the Federal law “On industrial safety of hazardous facilities”. The person responsible for the personnel training is the director for health, environment and safety. His responsibilities shall include:

1. Receipt of training applications.
2. Drawing up training schedules.
3. Concluding contracts for training and submission to the accounting department for payment.
4. Control over training documents.

The maintenance personnel of THPP and chips production are responsible for daily control over the monitoring plan implementation.

The chief metrologist of OJSC “Ilim Group” Branch in the town of Bratsk is responsible for timely calibration of all instrumentation in accordance with the manufacturer’s requirements.

The management of OJSC “Ilim Group” Branch in the town of Bratsk is responsible for normal operation of the THPP equipment, pollutant estimation and for collection of all data required for calculation of GHG emission reductions.

The Management of OJSC “Ilim Group” bears full responsibility for the project implementation and overall control.

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

Regularly, minimum once a year, specialists of LLC “CCGS” shall carry out test verification with the purpose of checking out the observance of the monitoring plan at OJSC “Ilim Group” Branch in the town of Bratsk.

2.2. Instrumentation calibration

The instrumentation calibration and check-out shall be carried out by contracted specialized organizations licensed for this type of activity in accordance with the Federal law “On uniformity of measurements”. The evaluation of potential uncertainties and revision of data shall be also carried out by the metrology engineer proceeding from the rated instrumental error of each type of instrumentation.

The required calibration of all instrumentation shall be carried out by LLC “Automation Enterprise” in accordance with the schedule developed by the metrology department.

2.3. Data storage

The maintenance personnel of THPP and chips production are responsible for daily data collection and archiving according to the internal rules and regulations.

Every day shift fitters of instrumentation and automation department (of CHPP-2, CHPP-3 and the boiler house) shall print out readings of daily heat generation meters, heat supply meters and fuel flow meters recorded in the APCS and shall submit these data to the production and technical department (PTD). Shift electricians (of CHPP-2 and the boiler house) shall take readings of electricity meters and enter those into the logs. The logs are submitted to the PTD.

Specialists of THPP laboratory shall enter into reports the results of the analysis of residual fuel oil NCV (every week) and WWS moisture content (every day). The reports are submitted to the PTD.

Specialists of the chips production shall keep daily operating logs, in which they shall record on a daily basis the data on quantity of BWW supplied from outside companies, and on quantity of WWS fired in the boiler house. The daily operating logs are submitted to the PTD.

Energy resources monitoring engineer of the PTD shall summarize the provided data (some data are taken from the plant’s overall energy monitoring system APCS), fill in the logs and draw up reports. The reports shall be submitted to the department of the chief energy engineer, accounting department and economics department.

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

3. Emergency situations

If any instrument that is used in the monitoring process fails, the instrumentation and automation service shall remedy the situation as soon as possible and if necessary shall replace the instrument.

In case of malfunctioning of the equipment for measurement of residual fuel oil calorific value, this value shall be determined as per the fuel suppliers' certificates.

In case of any breakdown of the utilizing boilers, heat and electricity generation will go down, whereas heat supply from CHPP-6 and electricity consumption from the power grid will increase. If the process of BWW and WWS combustion in the boilers becomes less stable, additional consumption of residual fuel oil will increase. Any variation of fuel consumption in the utilizing boilers or reduction of heat and electricity supply as a result of emergency situations will be automatically recorded by the meters.

All incidents that take place at the Mill shall be recorded by the department of the chief energy engineer and by the technical supervision service of the health, environment and safety department in the prescribed order. Information on major incidents shall be recorded in the monitoring report.

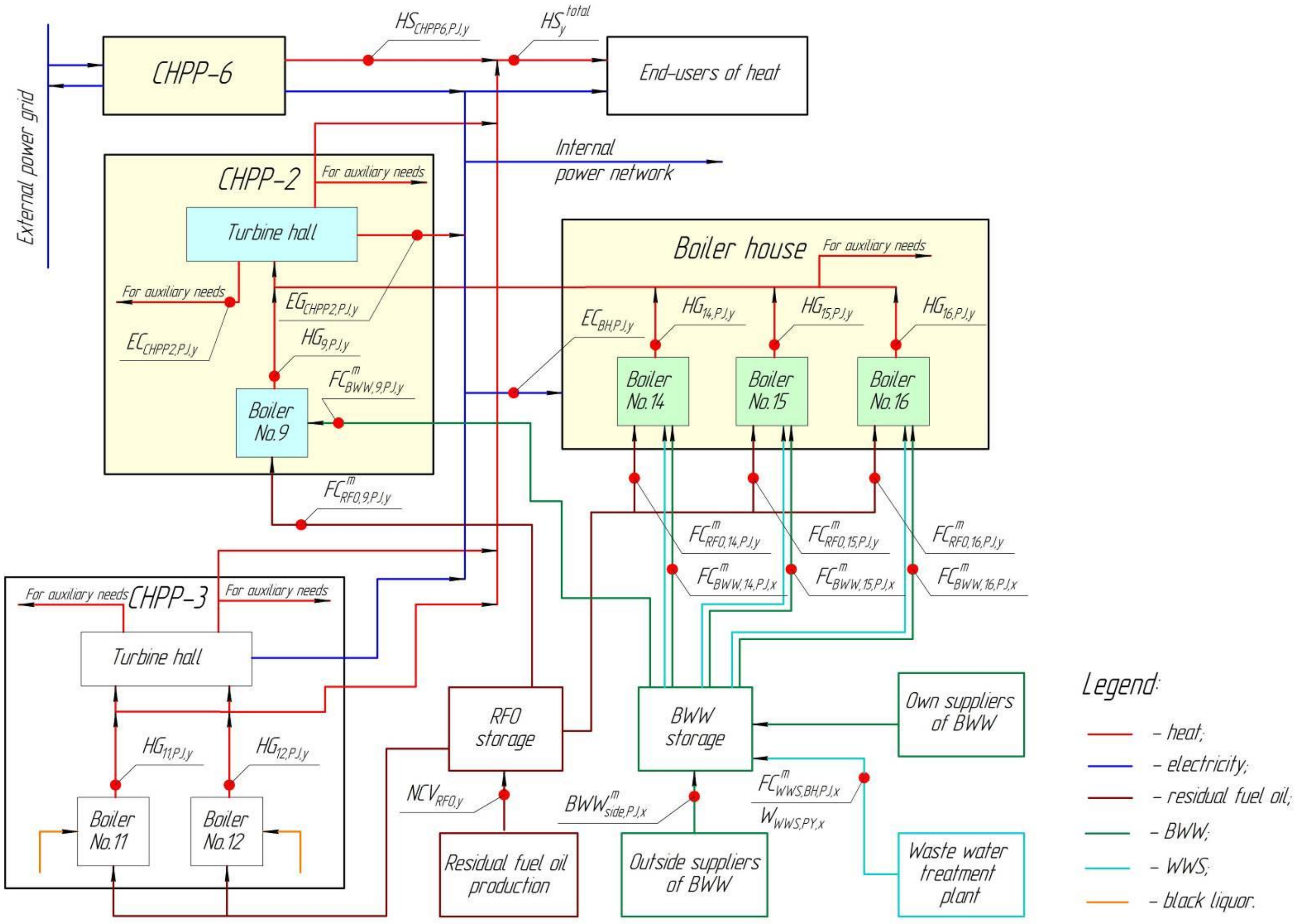

Fig. D.3-1. Location of monitoring points

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

The monitoring plan was developed by LLC “CCGS”

Contact person: Ilya Goryashin

E-mail: i.goryashin@ccgs.ru

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

The project GHG emissions include only emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers. Emissions of CH_4 and N_2O from combustion of residual fuel oil are negligibly small. Emissions of CO_2 from combustion of biomass are climatically neutral.

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

$$PE_y = PE_{RFO,y}, \tag{E.1-1}$$

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

$PE_{RFO,y}$ is the project emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y*, t CO_2e.

The project emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y* are determined as follows:

$$PE_{RFO,y} = FC^m_{RFO,PJ,y} \times NCV_{RFO,y} \times EF_{CO2,RFO}, \tag{E.1-2}$$

where $FC^m_{RFO,PJ,y}$ is the mass residual fuel oil consumption in the utilizing boilers under the project during the year *y*, t (See Table B.1-4);

$NCV_{RFO,y}$ is the average net calorific value of residual fuel oil in the year *y*, GJ/t;

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

The average net calorific value of residual fuel oil in the year *y* for estimation purposes are assumed equal to the average value over the last three years of THPP operation (2005-2007, See Annex 2-1). It is assumed: $NCV_{RFO,y}$ = 40.187 GJ/t.

The CO_2 emission factor for residual fuel oil combustion is assumed as per 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R7]. The following was assumed for the entire term of the project: $EF_{CO2,RFO}$ = 0.0774 t CO_2e/GJ.

The results of calculation of the project GHG emissions are given in Table E.1-1.

Table E.1-1. The project GHG emissions, t CO_2e

Name	Reporting years					2008-2012
	2008	2009	2010	2011	2012	
CO_2 from combustion of residual fuel oil	31 169	31 169	20 367	18 330	18 330	119 366
Total project GHG emissions	**31 169**	**31 169**	**20 367**	**18 330**	**18 330**	**119 366**

E.2. Estimated leakage:

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

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

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

E.4. Estimated baseline emissions:

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

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

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

$BE_{RFO,y}$ is the baseline emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y*, t CO_2e;

$BE_{lignite,y}$ is the baseline emissions of CO_2 from additional combustion of lignite in the boilers of CHPP-6 during the year *y*, t CO_2e;

$BE_{grid,y}$ is the baseline emissions of CO_2 from additional electricity consumption from the external power grid during the year *y*, t CO_2e;

$BE_{BWW,dump,y}$ is the baseline emissions of CH_4 from decomposition of an additional quantity of BWW at the dump during the year *y*, t CO_2e;

$BE_{WWS,dump,y}$ is the baseline emissions of CH_4 from decomposition of an additional quantity of WWS at the dump during the year *y*, t CO_2e.

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

The baseline emissions of CO_2 from combustion of residual fuel oil in the utilizing boilers during the year *y* are determined as follows:

$$BE_{RFO,y} = FC_{RFO,BL,y} \times EF_{CO2,RFO}, \qquad \text{(E.4-2)}$$

where $FC_{RFO,BL,y}$ is the residual fuel oil consumption in the utilizing boilers under the baseline scenario during the year *y*, GJ (See Annex 2-2).

The baseline emissions of CO_2 from additional combustion of lignite in the boilers of CHPP-6 during the year *y* are determined as follows:

$$BE_{lignite,y} = FC^{add}_{lignite,BL,y} \times EF_{CO2,lignite}, \qquad \text{(E.4-3)}$$

where $FC^{add}_{lignite,BL,y}$ is the additional lignite consumption at CHPP-6 under the baseline scenario as compared with the project scenario during the year *y*, GJ (See Annex 2-2);

$EF_{CO2,lignite}$ is the CO_2 emission factor for lignite combustion, t CO_2e/GJ.

The CO_2 emission factor for lignite combustion is assumed as per 2006 IPCC Guidelines for National Greenhouse Gas Inventories [R7]. The following was assumed for the entire term of the project: $EF_{CO2,lignite}$ = 0.101 t CO_2e/GJ.

The baseline emissions of CO_2 from additional electricity consumption from the external power grid during the year *y* are determined as follows:

$$BE_{grid,y} = EC^{add}_{grid,BL,y} \times EF_{CO2,grid,y}, \qquad \text{(E.4-4)}$$

where $EC^{add}_{grid,BL,y}$ is the additional electricity consumption from the external power grid under the baseline scenario during the year *y*, MWh (See Annex 2-2);

$EF_{CO2,grid,y}$ is the CO_2 emission factor for electricity consumed from the external power grid during the year, t CO_2e/MWh.

According to Guidelines for Project Design Documents of Joint Implementation Projects [R13] the CO_2 emission factors for electricity consumed from the external power grid in Russia depending on the year are assumed equal to: $EF^{2008}_{CO2,grid,y}$ = 0.565 t CO_2e/MWh, $EF^{2009}_{CO2,grid,y}$ = 0.557 t CO_2e/MWh, $EF^{2010}_{CO2,grid,y}$ = 0.550 t CO_2e/MWh, $EF^{2011}_{CO2,grid,y}$ = 0.542 t CO_2e/MWh, $EF^{2012}_{CO2,grid,y}$ = 0.534 t CO_2e/MWh.

Numerical estimations of avoided methane emissions from anaerobic decomposition of BWW and WWS disposed at the dump are developed using the model "*Calculation of CO_2-equivalent emission reductions from biomass prevented from stockpiling or taken from stockpiles"* developed by "*BTG biomass technology group B.V."* for the World Bank [R14]. The model is built on the *First Order Decay method* with experimental specification of a number of parameters for waste wood dumps. The model can be also applied to other biomass provided that specification of its key parameters is available.

The baseline emissions of CH_4 from decomposition of an additional quantity of BWW at the dump during the year *y* are determined as follows:

$$BE_{BWW,dump,y} = \left(1 - w_{lignin,BWW}\right) \times k_{BWW} \times \frac{C^{db}_{BWW}}{100} \times \left(1 - \frac{W_{BWW}}{100}\right) \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times$$
$$\times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \rho_{CH4} \times GWP_{CH4} \times \sum_{x=2001}^{x=y} \left(BWW^{m,add}_{dump,BL,x} \times e^{-k_{BWW}(y-x)}\right), \qquad \text{(E.4-5)}$$

where $BWW^{m,add}_{dump,BL,x}$ is the additional disposal of BWW at the dump under the baseline scenario as compared with the project scenario (amount of fresh biomass utilized) during the year *x*, t;

$w_{lignin,BWW}$ is the lignin fraction of C for the BWW;

k_{BWW} is the decomposition rate constant for the BWW, year^{-1};

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

W_{BWW} is the moisture content of BWW, %;

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

ζ is the generation factor;

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

ζ_{OX} is the methane oxidation factor;

V_m is the methane concentration biogas, %;

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

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

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

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

The baseline emissions of CH_4 from decomposition of an additional quantity of WWS at the dump during the year *y* are determined as follows:

$$BE_{WWS,dump,y} = \left(1 - w_{lignin,WWS}\right) \times k_{WWS} \times \frac{C_{WWS}^{db}}{100} \times a \times \zeta \times \left(1 - \frac{\varphi}{100}\right) \times$$
$$\times \left(1 - \zeta_{OX}\right) \times \frac{V_m}{100} \times \rho_{CH4} \times GWP_{CH4} \times \sum_{x=2010}^{x=y} \left(WWS_{dump,BL,x}^{dry,add} \times e^{-k_{WWS}(y-x)}\right), \qquad \text{(E.4-6)}$$

where $WWS_{dump,BL,x}^{dry,add}$ is the additional disposal of absolutely dry WWS at the dump under the baseline scenario as compared with the project scenario (amount of fresh biomass utilized) during the year *x*, t a.d.m.;

$w_{lignin,WWS}$ is the lignin fraction of C for the WWS;

k_{WWS} is the decomposition rate constant for the WWS, year^{-1};

C_{WWS}^{db} is the organic carbon content in the WWS on dry basis, %.

The following input values for estimation of methane emission reductions are allowed to be changed (or accepted on default) in this model [R14]:

1. *Amount of fresh biomass utilized.* Annual data on additional quantities of bark and wood wastes ($BWW_{dump,BL,x}^{m,add}$) and wastewater sludge ($WWS_{dump,BL,x}^{dry,add}$) stockpiled at the dump under the baseline scenario as compared with the project scenario for the period till 2012 were put into the model (See Annex 2-2).
2. *Lignin fraction of C.* The adopted recommended default value for BWW and WWS: $w_{lignin,BWW} = w_{lignin,WWS} = 0.25$.
3. *Decomposition rate constant*. The adopted recommended default value for BWW: k_{BWW} = ln(1/2)/15 = 0.046 year^{-1}, where 15 is recommended default value for half-life of wood, years. The value adopted for WWS is default one for sludge according to 2006 IPCC Guidelines [R17]: k_{WWS} = 0.185 year^{-1}.
4. *Organic carbon content on dry basis.* The default value proposed for BWW is 53.6%; we adopted a more conservative value: C_{BWW}^{db} = 50%. The value adopted for WWS according to [R4]: C_{WWS}^{db} = 41%.
5. *Moisture content.* The default value proposed for BWW is 50%; we adopted a more conservative value: W_{BWW} = 60%. Moisture content for WWS is 0% as its quantity is set on absolutely dry basis.
6. *Conversion factor from kg carbon to landfill gas quantity*. The adopted recommended default value: a = 22.4/12 = 1.87 m^3/kg carbon, where 22.4 is molar volume of gas at normal conditions, l/mol; 12 is molar mass of C, g/mol.
7. *Generation factor*. The adopted recommended default value: ζ = 0.77.
8. *Percentage of the stockpile under aerobic conditions.* The adopted recommended default value: φ = 10%.
9. *Methane oxidation factor.* The adopted recommended default value: ζ_{OX} = 0.10.

10. *Methane concentration biogas*. The adopted recommended default value: V_m = 60%.
11. *Density of methane.* The adopted value: ρ_{CH4} = 16/22.4 = 0.714 kg/m^3, where 16 is molar mass of CH_4, g/mol.
12. *Global warning potential of methane.* The adopted recommended default value: GWP_{CH4} = 21 t CO_2e/t CH_4.
13. *Year for which to calculate the CO_2-equivalent reduction.* For BWW: *y* = 2008-2012. For WWS: *y* = 2010-2012.
14. *Year in which fresh biomass is utilized instead of stockpiled.* For BBW and WWS we adopted the respective years in which the baseline stockpiled quantity becomes higher than the project stockpiled quantity (See Annex 2-2). For BWW: *x* = 2001-2012. For WWS: *x* = 2010-2012.

The results of calculations of the baseline GHG emissions are given in Table E.4-1, Annexes 2-3 and 2-4.

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

Name	Reporting years					2008-2012
	2008	2009	2010	2011	2012	
CO_2 from combustion of residual fuel oil	49 616	49 616	49 616	49 616	49 616	248 080
CO_2 from combustion of lignite	106 760	106 760	107 111	106 553	106 553	533 738
CO_2 from consumption of grid power	-48 308	-47 624	-5 116	6 880	6 778	-87 389
CH_4 from BWW decomposition at the dump	116 893	133 701	149 750	165 074	179 706	745 124
CH_4 from WWS decomposition at the dump	0	0	12 011	24 395	34 688	71 093
Total baseline GHG emissions	**224 962**	**242 454**	**313 372**	**352 518**	**377 341**	**1 510 646**

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

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

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

Name	Reporting years					2008-2012
	2008	2009	2010	2011	2012	
CO_2 from combustion of residual fuel oil	18 447	18 447	29 249	31 286	31 286	128 714
CO_2 from combustion of lignite	106 760	106 760	107 111	106 553	106 553	533 738
CO_2 from consumption of grid power	-48 308	-47 624	-5 116	6 880	6 778	-87 389
CH_4 from BWW decomposition at the dump	116 893	133 701	149 750	165 074	179 706	745 124
CH_4 from WWS decomposition at the dump	0	0	12 011	24 395	34 688	71 093
Total GHG emission reductions	**193 792**	**211 284**	**293 005**	**334 188**	**359 011**	**1 391 280**

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

Year	Estimated project emissions (t CO_2e)	Estimated leakages (t CO_2e)	Estimated baseline emissions (t CO_2e)	Estimated emission reductions (t CO_2e)
2008	31 169	0	224 962	193 792
2009	31 169	0	242 454	211 284
2010	20 367	0	313 372	293 005
2011	18 330	0	352 518	334 188
2012	18 330	0	377 341	359 011
Total (t CO_2e)	**119 366**	**0**	**1 510 646**	**1 391 280**

SECTION F. Environmental impacts

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

The environmental impact assessment of the project was carried out in accordance with the Russian legislation within the framework of the design documentation development for reconstruction of boilers No.16 [R1] and No.14 [R2], and for installation of boiler No.15 [R3].

Switching of E-75-40K boiler No.16 to fluidized bed combustion of BWW has led to increased fly ash emissions into the atmosphere because the real volume of fuel combustion has increased, meanwhile the demand for land area for BWW stockpiling has reduced. Installation of efficient ash collecting equipment helped to reduce ash content in flue gases down to the technically attainable level of 250 mg/Nm^3.

The reconstruction of E-75-40K boiler No.14 did not lead to increase of pollutant emissions into the atmosphere and in general mitigated negative impact upon the environment.

Arrangement of two-stage low-temperature combustion of BWW created favourable conditions for significant limitation of thermal NO$_x$ generation. This process was facilitated by reducing conditions of the first combustion stage (furnace extension) and by relatively low flame temperatures of the second stage (boiler furnace).

Commissioning of new E-90-3.9-440DFT boiler No.15 will not lead to increase of pollutant emissions into the atmosphere. The level of impact upon air, surface waters and land resources is within the permissible limits.

The project implementation will lead to reduction of lignite combustion at CHPP-6, which produces a large quantity of harmful emissions, and to reduction of fossil fuel combustion at grid power plants.

In general, the project implementation will lead to mitigation of negative environmental impacts.

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 any significant environmental impact.

The project has the following permits and positive expert opinions:

- Permit issued by Gosgortekhnadzor for operation of boiler No.16 dated 28.06.2001;
- Permit issued by Gosgortekhnadzor for operation of boiler No.14 dated 21.05.2004;
- Opinion of industrial safety expert examination of the project “Reconstruction of E-75-40K boiler No.14 with increase of steam output to 90 t/h, installation of fluidized bed furnace extension and replacement of ash collecting equipment at THPP of OJSC “Pulp and paperboard mill” No. 320.EB.002-04 dated 19.05.2004;
- Opinion of industrial safety expert examination of the project “Installation of E-90-3.9-440DFT No.15 for fluidized bed combustion of wood wastes at THPP of OJSC “Ilim Group” Branch in the town of Bratsk” No. 67-PD-04856-2008 dated 13.10.2008.

SECTION G. Stakeholders' comments

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

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

The project has the following permits and positive expert opinions:

- Permit issued by Gosgortekhnadzor for operation of boiler No.16 dated 28.06.2001;
- Permit issued by Gosgortekhnadzor for operation of boiler No.14 dated 21.05.2004;
- Opinion of industrial safety expert examination of the project "Reconstruction of E-75-40K boiler No.14 with increase of steam output to 90 t/h, installation of fluidized bed furnace extension and replacement of ash collecting equipment at THPP of OJSC "Pulp and paperboard mill" No. 320.EB.002-04 dated 19.05.2004;
- Opinion of industrial safety expert examination of the project "Installation of E-90-3.9-440DFT No.15 for fluidized bed combustion of wood wastes at THPP of OJSC "Ilim Group" Branch in the town of Bratsk" No. 67-PD-04856-2008 dated 13.10.2008.

State expert examinations confirmed that the design documentation complies with the industrial safety requirements and can be applied in production.

The town's community was informed about the planned implementation of the project through the local mass media: "Bratskyi Lesokhimik" No.37 dated 15 May 2002 and No.89 dated 15 November 2002; "Rabochaya Smena" No.1 dated 14 January 2008, No.27 dated 18.07.2008 and No.38 dated 3 October 2008. No comments from the town's community were received.

REFERENCES

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[R3] Design “Installation of E-90-3.9-440DFT No.15 for fluidized bed combustion of wood wastes at THPP of OJSC “Ilim Group” Branch in the town of Bratsk”, Irkutsk, 2008.

[R4] Feasibility study “Energy generating unit modernization” Stage III. Executive summary. Development of process flow diagrams and layout solutions. Irkutsk, 2006.

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[R7] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2, Energy (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.htm).

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[R14] Methane and Nitrogen Oxide Emissions from Biomass Waste Stockpiles, PCFplus Research, World Bank, August 2002.

[R15] Guidance on Criteria for Baseline Setting and Monitoring, Version 01. Report of the 4th Meeting of JI Supervisory Committee - Annex 6, 2006. (http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf).

[R16] The World Resources Institute (WRI) and World Business Council for Sustainable Development. 2001. Calculating CO_2 emissions from mobile sources - Guide to calculation worksheets. Washington, DC: World Resources Institute.

[R17] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5, Waste (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html).

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Open Joint Stock Company “Ilim Group”
Street/P.O.Box:	Marat
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Annex 2

BASELINE INFORMATION

Annex 2-1. Main actual performance parameters of BPPM's energy system over the period 2001-2007

Balance of heat production and consumption

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
Heat production at THPP								
CHPP-2								
Boiler No.9	GJ	836 337	851 188	1 001 409	1 125 026	1 012 324	1 117 770	1 041 839
Boiler No.10	GJ	471 448	369 201	614 488	583 701	482 359	111 429	0
Total for CHPP-2	GJ	1 307 784	1 220 389	1 615 897	1 708 727	1 494 684	1 229 199	1 041 839
Boiler house								
Boiler No.14	GJ	0	0	0	1 097 568	1 441 739	1 557 924	1 561 504
Boiler No.15	GJ	1 050 857	1 339 346	1 101 018	1 209 214	215 597	121 385	0
Boiler No.16	GJ	556 004	818 889	763 956	1 004 847	1 130 021	1 254 618	1 387 970
Total for the boiler house	GJ	1 606 862	2 158 235	1 864 974	3 311 628	2 787 357	2 933 927	2 949 474
CHPP-3	GJ	9 492 691	10 268 592	10 401 634	10 803 134	10 527 759	10 311 584	10 148 132
Total heat production at THPP	GJ	12 407 337	13 647 217	13 882 505	15 823 489	14 809 800	14 474 710	14 139 445
Heat supply from THPP to end-users	GJ	7 669 793	8 732 587	9 262 800	11 053 395	10 303 579	10 207 512	9 722 474
Supply of heat (in the form of steam) from CHPP-6	GJ	11 170 811	10 854 584	10 546 764	8 838 694	9 522 193	10 033 911	9 864 266
Total heat supply (in the form of steam) from THPP and CHPP-6	GJ	18 840 604	19 587 171	19 809 564	19 892 089	19 825 772	20 241 423	19 586 740

Residual fuel oil combustion in the utilizing boilers

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
Residual fuel oil combustion								
CHPP-2								
Boiler No.9	t	3 798	1 510	1 374	1 184	876	1 582	2 091
Boiler No.10	t	5 335	3 744	5 600	6 117	5 689	1 874	0
Total for CHPP-2	t	9 133	5 254	6 974	7 301	6 565	3 456	2 091
Boiler house								
Boiler No.14	t	0	0	0	1 792	3 558	3 284	5 101
Boiler No.15	t	8 674	9 773	8 369	9 746	1 922	847	0
Boiler No.16	t	1 298	1 111	1 197	1 911	2 920	3 302	5 560
Total for the boiler house	t	9 972	10 884	9 566	13 449	8 400	7 433	10 662

Annex 2-1. Main actual performance parameters of BPPM's energy system over the period 2001-2007 (continuation)

BWW combustion

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
BWW combustion								
CHPP-2								
Boiler No.9	t	142 290	131 360	158 093	186 365	153 206	182 763	189 830
Boiler No.10	t	51 112	41 714	60 003	59 289	51 985	11 823	0
Total for CHPP-2	t	193 402	173 074	218 096	245 654	205 191	194 586	189 830
Boiler house								
Boiler No.14	t	0	0	0	215 999	263 572	287 278	271 974
Boiler No.15	t	101 194	122 560	114 575	130 230	23 877	11 122	0
Boiler No.16	t	115 834	182 691	167 665	186 763	186 060	217 500	217 028
Total for the boiler house	t	217 028	305 251	282 240	532 992	473 509	515 900	489 002
Total BWW combustion	t	410 430	478 325	500 336	778 646	678 700	710 486	678 832

BWW supply (for combustion) from the outside

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
BWW supply (for combustion) from the outside	t	0	0	0	7 127	10 144	18 920	35 798

Electricity generation, electricity consumption for auxiliary needs

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
Electricity generation at CHPP-2	MWh	42 065	42 316	56 164	62 732	50 889	45 199	38 735
Electricity consumption for auxiliary needs of CHPP-2	MWh	19 109	18 408	23 632	24 176	22 718	20 224	17 386
Electricity consumption for auxiliary needs of the boiler house	MWh	N/A*	N/A	12 998	23 470	21 059	21 884	20 609

*no data available

Average net calorific value of residual fuel oil

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
Average net calorific value	GJ/t	39.860	39.927	40.292	40.342	40.111	40.258	40.191

WWS generation

Parameter	Unit	Years						
		2001	2002	2003	2004	2005	2006	2007
WWS generation	t a.d.m.	N/R*	N/R	N/R	N/R	25 386	26 863	20 188

*not requested

Annex 2-1. Main actual performance parameters of BPPM’s energy system over the period 2001-2007 (ending)

Specific parameters

Parameter	Symbol	Unit	Years						
			2001	2002	2003	2004	2005	2006	2007
Specific mass BWW consumption for generation of 1 GJ of heat									
Boiler No.9	$SFC^{m}_{BWW,9}$	t/GJ	0.170	0.154	0.158	0.166	0.151	0.164	0.182
Boiler No.14	$SFC^{m}_{BWW,14}$	t/GJ	-	-	-	0.197	0.183	0.184	0.174
Boiler No.16	$SFC^{m}_{BWW,16}$	t/GJ	0.208	0.223	0.219	0.186	0.165	0.173	0.156
Specific mass residual fuel oil consumption for generation of 1 GJ of heat									
Boiler No.9	$SFC^{m}_{RFO,9}$	t/GJ	0.00454	0.00177	0.00137	0.00105	0.00087	0.00142	0.00201
Boiler No.14	$SFC^{m}_{RFO,14}$	t/GJ	-	-	-	0.00163	0.00247	0.00211	0.00327
Boiler No.16	$SFC^{m}_{RFO,16}$	t/GJ	0.00233	0.00136	0.00157	0.00190	0.00258	0.00263	0.00401
Factor of heat supply from THPP	SHS_{THPP}	-	0.618	0.640	0.667	0.699	0.696	0.705	0.688
Factor of heat-production-based electricity generation at CHPP-2	χ_{CHPP2}	MWh/GJ	0.0322	0.0347	0.0348	0.0367	0.0340	0.0368	0.0372
Specific electricity consumption for production of 1 GJ of heat at CHPP-2	$SEC_{HG,CHPP2}$	MWh/GJ	0.0146	0.0151	0.0146	0.0141	0.0152	0.0165	0.0167
Specific electricity consumption for production of 1 GJ of heat in the boiler house	$SEC_{HG,BH}$	MWh/GJ	N/A*	N/A*	0.00697	0.00709	0.00756	0.00746	0.00699
Specific residual fuel oil consumption for generation of 1 GJ of heat									
Boiler No.9	$SFC_{RFO,9}$	GJ/GJ	0.1810	0.0708	0.0553	0.0425	0.0347	0.0570	0.0807
Boiler No.10	$SFC_{RFO,10}$	GJ/GJ	0.4511	0.4049	0.3672	0.4228	0.4731	0.6772	-
Boiler No.14	$SFC_{RFO,14}$	GJ/GJ	-	-	-	0.0659	0.0990	0.0849	0.1313
Boiler No.15	$SFC_{RFO,15}$	GJ/GJ	0.3290	0.2913	0.3063	0.3251	0.3576	0.2810	-
Boiler No.16	$SFC_{RFO,16}$	GJ/GJ	0.0931	0.0542	0.0631	0.0767	0.1036	0.1059	0.1610

*no data available

Annex 2-2. Results of calculation of main baseline parameters

Heat production by the utilizing boilers

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat production							
CHPP-2							
Boiler No.9	GJ	1 125 026	1 125 026	1 125 026	1 125 026	1 125 026	5 625 130
Boiler No.10	GJ	614 488	614 488	614 488	614 488	614 488	3 072 440
Total for CHPP-2	GJ	1 739 514	1 739 514	1 739 514	1 739 514	1 739 514	8 697 570
Boiler house							
Boiler No.15	GJ	1 339 346	1 339 346	1 339 346	1 339 346	1 339 346	6 696 730
Total for boiler house	GJ	1 339 346	1 339 346	1 339 346	1 339 346	1 339 346	6 696 730
Total production	GJ	3 078 860	3 078 860	3 078 860	3 078 860	3 078 860	15 394 300

Heat supply to end-users due to operation of the utilizing boilers

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Heat supply to end-users	GJ	2 170 596	2 170 596	2 170 596	2 170 596	2 170 596	10 852 982

Calculation of additional lignite combustion at CHPP-6

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Additional heat supply to end-users	GJ	696 643	696 643	698 933	695 293	695 293	3 482 805
Additional lignite consumption	GJ	1 057 032	1 057 032	1 060 506	1 054 982	1 054 982	5 284 533

Residual fuel oil combustion in the utilizing boilers

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Residual fuel oil combustion							
Boiler No.9	GJ	39 038	39 038	39 038	39 038	39 038	195 192
Boiler No.10	GJ	225 640	225 640	225 640	225 640	225 640	1 128 200
Boiler No.15	GJ	376 356	376 356	376 356	376 356	376 356	1 881 781
Total combustion	GJ	641 035	641 035	641 035	641 035	641 035	3 205 173

Annex 2-2. Results of calculation of main baseline parameters (ending)

Calculation of electricity supply due to operation of the utilizing boilers

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Electricity generation at CHPP-2	MWh	64 710	64 710	64 710	64 710	64 710	323 550
Electricity consumption for auxiliary needs of CHPP-2	MWh	24 527	24 527	24 527	24 527	24 527	122 636
Electricity supply from CHPP-2	MWh	40 183	40 183	40 183	40 183	40 183	200 914
Electricity consumption for auxiliary needs of the boiler house	MWh	9 375	9 375	9 375	9 375	9 375	46 877
Electricity supply	MWh	30 807	30 807	30 807	30 807	30 807	154 037

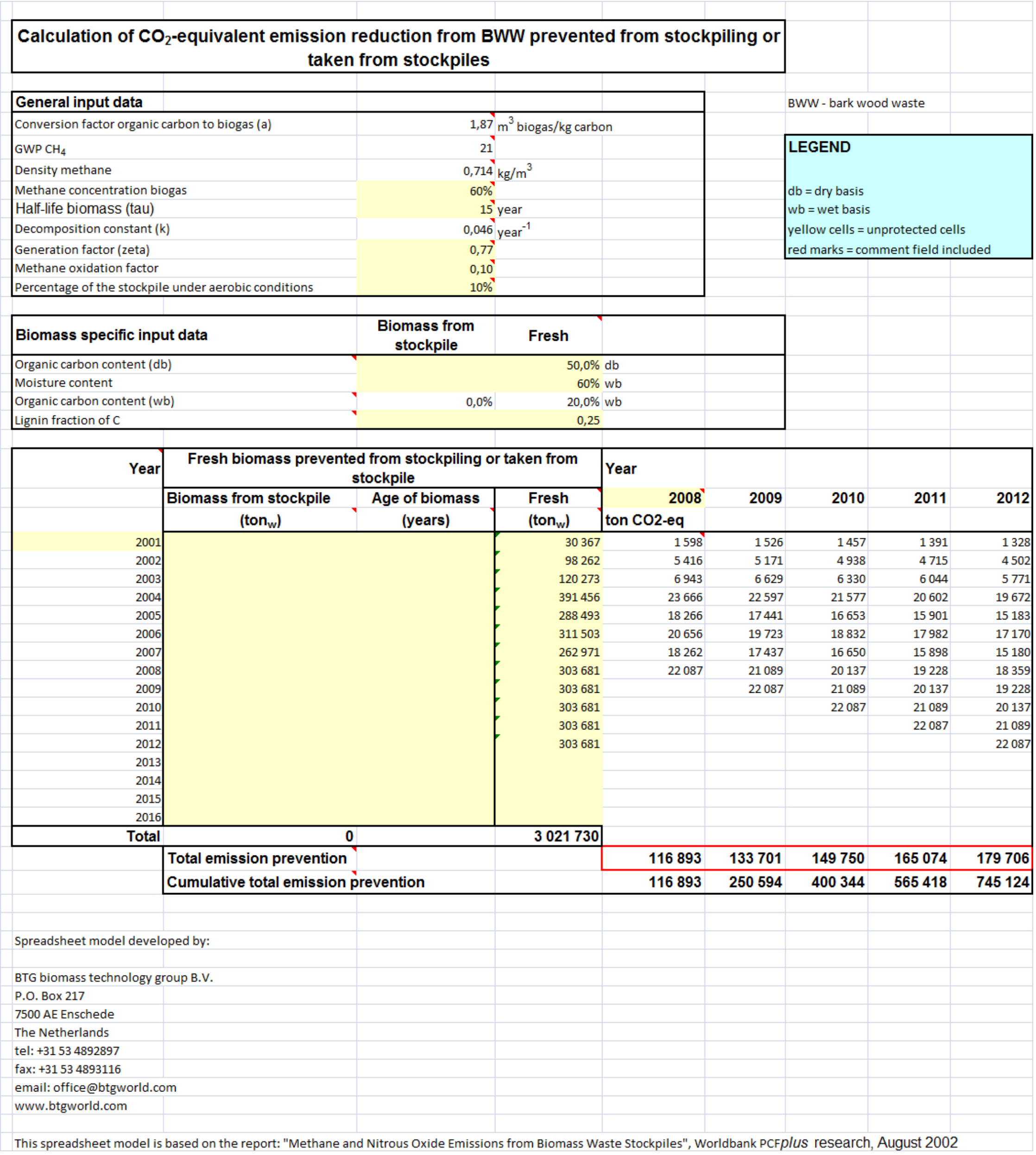
Calculation of additional electricity consumption from the external power grid

Parameter	Unit	Years					2008 - 2012
		2008	2009	2010	2011	2012	
Additional electricity supply from CHPP-6	MWh	56 660	56 660	56 847	56 550	56 550	283 268
Additional electricity consumption from the external power grid	MWh	-85 500	-85 500	-9 302	12 693	12 693	-154 915

Additional disposal of BWW and WWS at the dump

Parameter	Unit	Years												2008 - 2012
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Additional quantity of BWW stockpiled at the dump	t	30 367	98 262	120 273	391 456	288 493	311 503	262 971	303 681	303 681	303 681	303 681	303 681	1 518 405
Additional quantity of WWS stockpiled at the dump	t a.d.m.	0	0	0	0	0	0	0	0	0	20 122	24 146	24 146	68 414

Annex 2-3. Calculation of methane emissions from anaerobic decomposition of BWW at the dump



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

BWW - bark wood waste

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

LEGEND

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

Biomass specific input data	Biomass from stockpile	Fresh	
Organic carbon content (db)		50,0%	db
Moisture content		60%	wb
Organic carbon content (wb)	0,0%	20,0%	wb
Lignin fraction of C		0,25	

Year	Fresh biomass prevented from stockpiling or taken from stockpile			Year				
	Biomass from stockpile (ton$_w$)	Age of biomass (years)	Fresh (ton$_w$)	2008 ton CO2-eq	2009	2010	2011	2012
2001			30 367	1 598	1 526	1 457	1 391	1 328
2002			98 262	5 416	5 171	4 938	4 715	4 502
2003			120 273	6 943	6 629	6 330	6 044	5 771
2004			391 456	23 666	22 597	21 577	20 602	19 672
2005			288 493	18 266	17 441	16 653	15 901	15 183
2006			311 503	20 656	19 723	18 832	17 982	17 170
2007			262 971	18 262	17 437	16 650	15 898	15 180
2008			303 681	22 087	21 089	20 137	19 228	18 359
2009			303 681		22 087	21 089	20 137	19 228
2010			303 681			22 087	21 089	20 137
2011			303 681				22 087	21 089
2012			303 681					22 087
2013								
2014								
2015								
2016								
Total	**0**		**3 021 730**					
	Total emission prevention			**116 893**	**133 701**	**149 750**	**165 074**	**179 706**
	Cumulative total emission prevention			**116 893**	**250 594**	**400 344**	**565 418**	**745 124**

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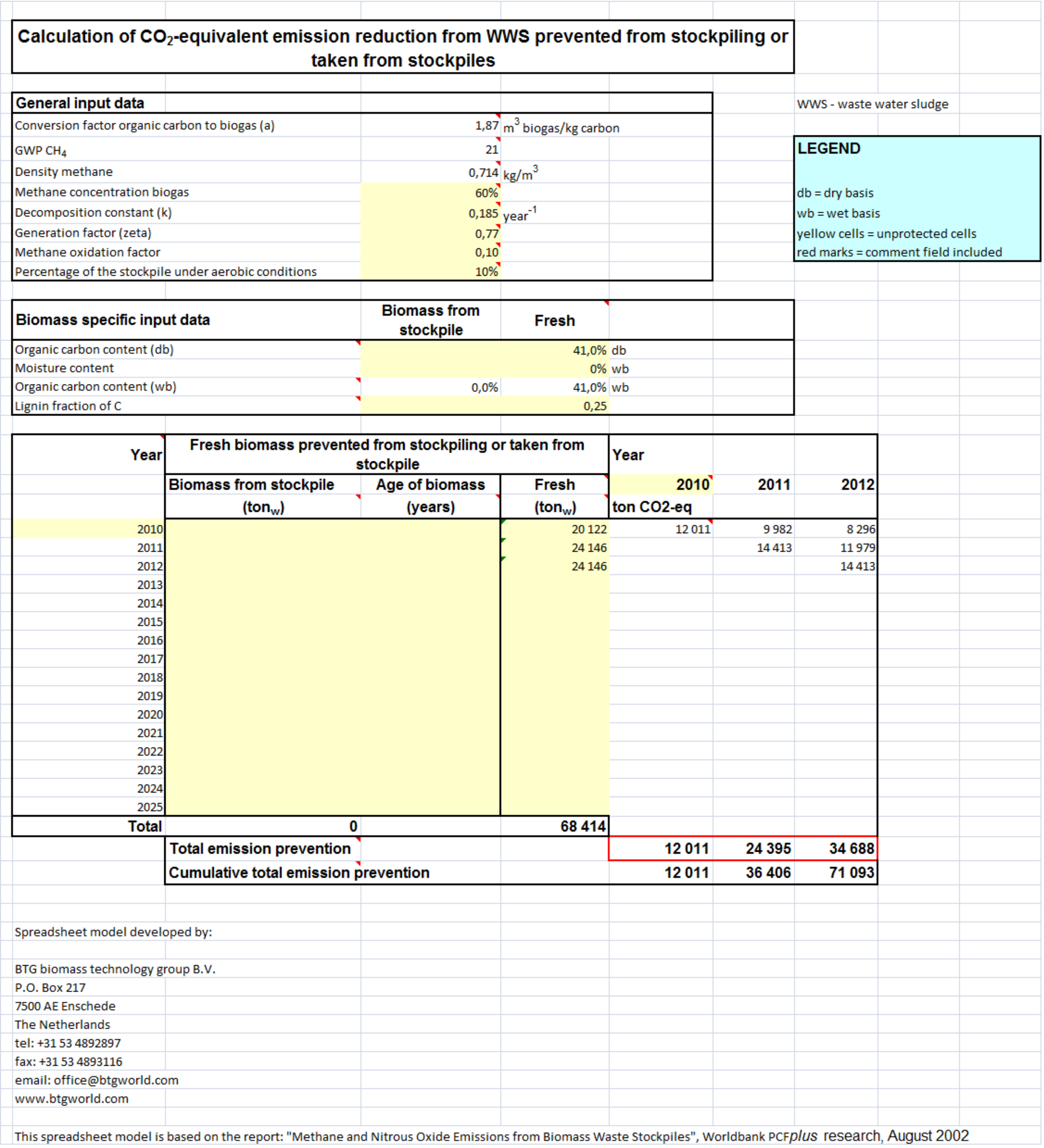
This spreadsheet model is based on the report: "Methane and Nitrous Oxide Emissions from Biomass Waste Stockpiles", Worldbank PCF*plus* research, August 2002

Annex 2-4. Calculation of methane emissions from anaerobic decomposition of WWS at the dump



Calculation of CO$_2$-equivalent emission reduction from WWS prevented from stockpiling or taken from stockpiles

WWS - waste water sludge

General input data		
Conversion factor organic carbon to biogas (a)	1,87	m^3 biogas/kg carbon
GWP CH$_4$	21	
Density methane	0,714	kg/m^3
Methane concentration biogas	60%	
Decomposition constant (k)	0,185	year^{-1}
Generation factor (zeta)	0,77	
Methane oxidation factor	0,10	
Percentage of the stockpile under aerobic conditions	10%	

LEGEND

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

Biomass specific input data	**Biomass from stockpile**	**Fresh**	
Organic carbon content (db)		41,0%	db
Moisture content		0%	wb
Organic carbon content (wb)	0,0%	41,0%	wb
Lignin fraction of C		0,25	

Year	**Fresh biomass prevented from stockpiling or taken from stockpile**			**Year**		
	Biomass from stockpile (ton$_w$)	**Age of biomass (years)**	**Fresh (ton$_w$)**	**2010**	**2011**	**2012**
				ton CO2-eq		
2010			20 122	12 011	9 982	8 296
2011			24 146		14 413	11 979
2012			24 146			14 413
2013						
2014						
2015						
2016						
2017						
2018						
2019						
2020						
2021						
2022						
2023						
2024						
2025						
Total	**0**		**68 414**			
	Total emission prevention			**12 011**	**24 395**	**34 688**
	Cumulative total emission prevention			**12 011**	**36 406**	**71 093**

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

Annex 2-5. Calculation of main economic indicators of the second stage of the project for the two implementation options

Input data

Parameter	Unit	Value
Heat generation		
- boiler No.14	GJ	1 969 314
EUR exchange rate	RUR/EUR	29,69
Heat (purchased)	RUR/Gcal	147,19
Operating costs	RUR/Gcal	24,01
Discount rate	%	20
Price of early reductions	€/tCO2e	2
Price of ERU	€/tCO2e	8

Annual boiler output

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Heat generation (boiler No.14)	GJ		984 657	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	1 969 314	984 657

Commissioning of boiler No.14

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Additional heat supply to end-users	GJ		685 321	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	1 370 642	685 321

Prices of feedstock and resources

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Heat (purchased)	EUR/GJ		1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18	1,18

Annual increase of costs owing to commissioning of boiler No.14

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Annual operating costs	1000 EUR		-190,20	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-190,20
Total increase of costs	1000 EUR		-190,20	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-380,40	-190,20

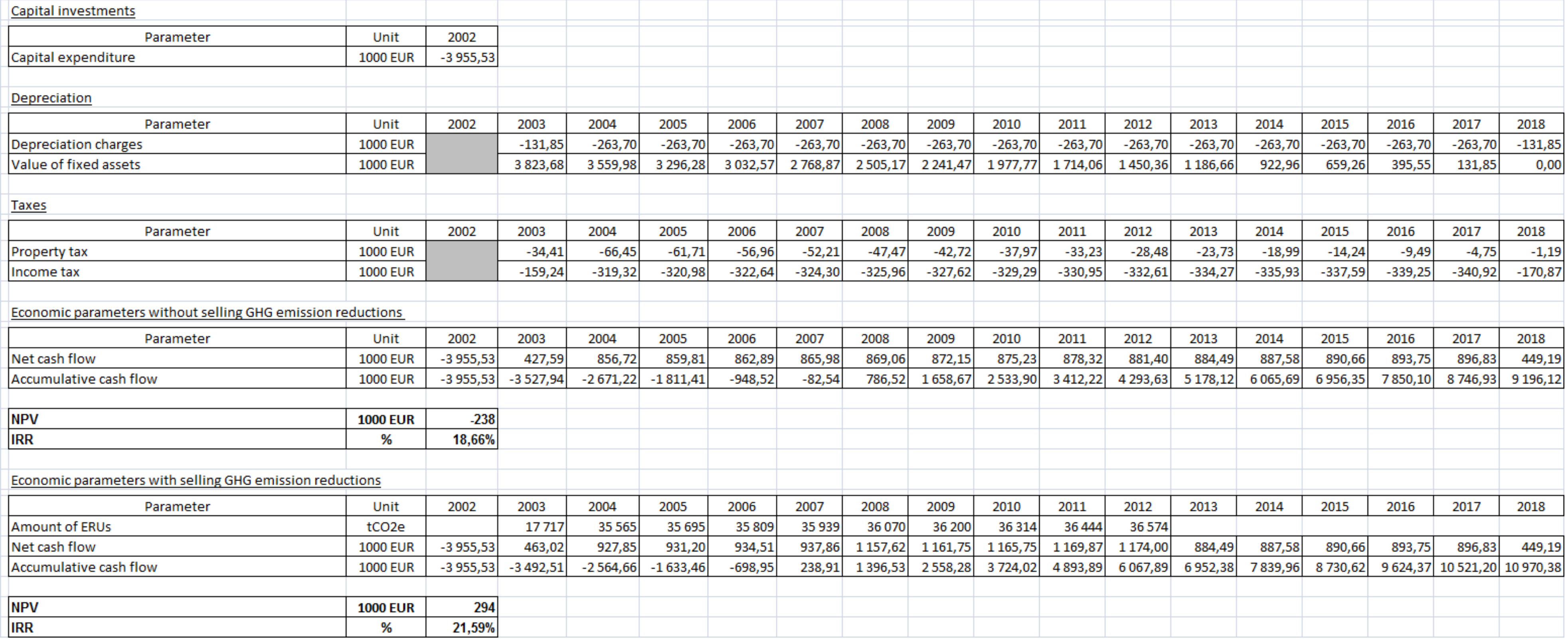
Annual reduction of costs owing to commissioning of boiler No.14

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Costs of heat purchase from CHPP-6	1000 EUR		811,45	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	811,45
Total reduction of costs	1000 EUR		811,45	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	1 622,89	811,45

Total income from the project implementation

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total income	1000 EUR		621,25	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	1 242,49	621,25

Annex 2-5. Calculation of main economic indicators of the second stage of the project for the two implementation options (ending)



Capital investments

Parameter	Unit	2002
Capital expenditure	1000 EUR	-3 955,53

Depreciation

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Depreciation charges	1000 EUR		-131,85	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-263,70	-131,85
Value of fixed assets	1000 EUR		3 823,68	3 559,98	3 296,28	3 032,57	2 768,87	2 505,17	2 241,47	1 977,77	1 714,06	1 450,36	1 186,66	922,96	659,26	395,55	131,85	0,00

Taxes

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Property tax	1000 EUR		-34,41	-66,45	-61,71	-56,96	-52,21	-47,47	-42,72	-37,97	-33,23	-28,48	-23,73	-18,99	-14,24	-9,49	-4,75	-1,19
Income tax	1000 EUR		-159,24	-319,32	-320,98	-322,64	-324,30	-325,96	-327,62	-329,29	-330,95	-332,61	-334,27	-335,93	-337,59	-339,25	-340,92	-170,87

Economic parameters without selling GHG emission reductions

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net cash flow	1000 EUR	-3 955,53	427,59	856,72	859,81	862,89	865,98	869,06	872,15	875,23	878,32	881,40	884,49	887,58	890,66	893,75	896,83	449,19
Accumulative cash flow	1000 EUR	-3 955,53	-3 527,94	-2 671,22	-1 811,41	-948,52	-82,54	786,52	1 658,67	2 533,90	3 412,22	4 293,63	5 178,12	6 065,69	6 956,35	7 850,10	8 746,93	9 196,12

NPV	**1000 EUR**	**-238**
IRR	**%**	**18,66%**

Economic parameters with selling GHG emission reductions

Parameter	Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Amount of ERUs	tCO2e		17 717	35 565	35 695	35 809	35 939	36 070	36 200	36 314	36 444	36 574						
Net cash flow	1000 EUR	-3 955,53	463,02	927,85	931,20	934,51	937,86	1 157,62	1 161,75	1 165,75	1 169,87	1 174,00	884,49	887,58	890,66	893,75	896,83	449,19
Accumulative cash flow	1000 EUR	-3 955,53	-3 492,51	-2 564,66	-1 633,46	-698,95	238,91	1 396,53	2 558,28	3 724,02	4 893,89	6 067,89	6 952,38	7 839,96	8 730,62	9 624,37	10 521,20	10 970,38

NPV	**1000 EUR**	**294**
IRR	**%**	**21,59%**

Annex 2-6. Calculation of main economic indicators of the third stage of the project for the two implementation options

Annual working time fund

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Running hours of boiler No.15	h	0	0	4 140	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	8 280	4 140

Input data

Parameter	Unit	Value
Heat generation		
- boiler No.14	GJ	1 561 504
- boiler No.16	GJ	1 387 970
- total	GJ	2 949 474
Boiler No.15 performance parameters		
- electricity consumption	MWh	19 333,8
- sand consumption	t	172,5
- consumption of chemically treated water	1000 m3	683,1
- consumption of cold filtered water	1000 m3	73,28
Correction factor	-	0,98
Heat consumption for heating of CHPP-2 boiler room building	Gcal	26 460

Annual boiler output

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Heat generation (boilers No.14 and No.16)	GJ			1 474 737	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	2 949 474	1 474 737
Heat generation (boilers No.15)	GJ			1 068 667	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	2 137 334	1 068 667
Total	GJ			2 543 404	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	5 086 808	2 543 404

Commissioning of boiler No.15

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Additional heat supply to end-users	GJ			728 916	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	1 457 833	728 916
Electricity consumption	MWh			9 667	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	19 334	9 667
Residual fuel oil consumption	t			38	76	76	76	76	76	76	76	76	76	76	76	76	76	76	38
Sand consumption	t			86	173	173	173	173	173	173	173	173	173	173	173	173	173	173	86
Consumption of chemically treated water	1000 m3			342	683	683	683	683	683	683	683	683	683	683	683	683	683	683	342
Consumption of cold filtered water	1000 m3			37	73	73	73	73	73	73	73	73	73	73	73	73	73	73	37

Steam pipeline construction

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Electricity generation based on the steam produced by boilers No.14-No.16	MWh			89 731	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	179 463	89 731
Electricity consumption for auxiliary needs of CHPP-2	MWh			8 693	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	17 386	8 693
Additional electricity supply	MWh			81 038	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	162 077	81 038
Reduction of purchased heat consumption for heating of CHPP-2 boiler room building	GJ			55 394	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	110 788	55 394

Annex 2-6. Calculation of main economic indicators of the third stage of the project for the two implementation options (continuation)

Input data

Parameter	Unit	Value
EUR exchange rate	RUR/EUR	35,03
Heat (purchased)	RUR/Gcal	380,00
Residual fuel oil	RUR/t	10 490,00
Electricity (purchased)	RUR/MWh	540,00
Quartz sand	RUR/t	4 266,00
Chemically treated water	RUR/1000 m3	1 283,50
Cold filtered water	RUR/1000 m3	286,00
Discount rate	%	20
ERU price	€/tCO2e	15

Prices of feedstock and resources

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Heat (purchased)	EUR/GJ	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59	2,59
Residual fuel oil	EUR/t	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46	299,46
Electricity (purchased)	EUR/MWh	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42	15,42
Quartz sand	EUR/t	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78	121,78
Chemically treated water	EUR/1000 m3	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64	36,64
Cold filtered water	EUR/1000 m3	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16	8,16

Annual increase of costs owing to commissioning of boiler No.15

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Residual fuel oil	1000 EUR			-11,44	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-22,88	-11,44
Electricity	1000 EUR			-149,02	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-298,04	-149,02
Sand to replenish the fluidized bed	1000 EUR			-10,50	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-21,01	-10,50
Chemically treated water	1000 EUR			-12,51	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-25,03	-12,51
Cold filtered water	1000 EUR			-0,30	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,60	-0,30
Ash disposal charges, waste water treatment costs	1000 EUR			-3,55	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-7,10	-3,55
Total increase of costs	1000 EUR			-187,33	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-374,65	-187,33

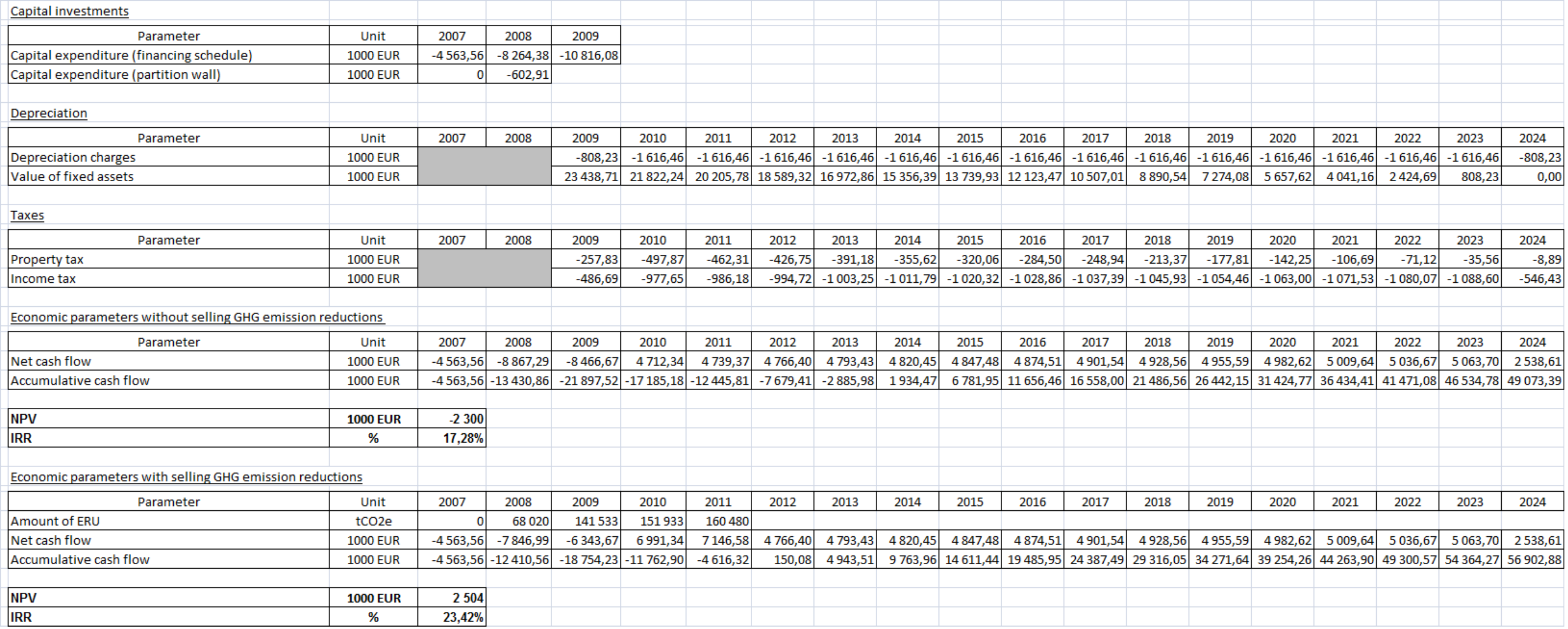
Annual reduction of costs owing to commissioning of boiler No.15

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Costs of heat purchase from CHPP-6	1000 EUR			2 032,02	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	4 064,04	2 032,02
Costs of electricity purchase from the outside	1000 EUR			1 249,23	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	2 498,47	1 249,23
Total reduction of costs	1000 EUR			3 281,26	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	6 562,51	3 281,26

Total income from the project implementation

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total income	1000 EUR			3 093,93	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	6 187,86	3 093,93

Annex 2-6. Calculation of main economic indicators of the third stage of the project for the two implementation options (ending)



Capital investments

Parameter	Unit	2007	2008	2009
Capital expenditure (financing schedule)	1000 EUR	-4 563,56	-8 264,38	-10 816,08
Capital expenditure (partition wall)	1000 EUR	0	-602,91	

Depreciation

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Depreciation charges	1000 EUR			-808,23	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-1 616,46	-808,23
Value of fixed assets	1000 EUR			23 438,71	21 822,24	20 205,78	18 589,32	16 972,86	15 356,39	13 739,93	12 123,47	10 507,01	8 890,54	7 274,08	5 657,62	4 041,16	2 424,69	808,23	0,00

Taxes

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Property tax	1000 EUR			-257,83	-497,87	-462,31	-426,75	-391,18	-355,62	-320,06	-284,50	-248,94	-213,37	-177,81	-142,25	-106,69	-71,12	-35,56	-8,89
Income tax	1000 EUR			-486,69	-977,65	-986,18	-994,72	-1 003,25	-1 011,79	-1 020,32	-1 028,86	-1 037,39	-1 045,93	-1 054,46	-1 063,00	-1 071,53	-1 080,07	-1 088,60	-546,43

Economic parameters without selling GHG emission reductions

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Net cash flow	1000 EUR	-4 563,56	-8 867,29	-8 466,67	4 712,34	4 739,37	4 766,40	4 793,43	4 820,45	4 847,48	4 874,51	4 901,54	4 928,56	4 955,59	4 982,62	5 009,64	5 036,67	5 063,70	2 538,61
Accumulative cash flow	1000 EUR	-4 563,56	-13 430,86	-21 897,52	-17 185,18	-12 445,81	-7 679,41	-2 885,98	1 934,47	6 781,95	11 656,46	16 558,00	21 486,56	26 442,15	31 424,77	36 434,41	41 471,08	46 534,78	49 073,39

NPV	**1000 EUR**	**-2 300**
IRR	**%**	**17,28%**

Economic parameters with selling GHG emission reductions

Parameter	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Amount of ERU	tCO2e	0	68 020	141 533	151 933	160 480													
Net cash flow	1000 EUR	-4 563,56	-7 846,99	-6 343,67	6 991,34	7 146,58	4 766,40	4 793,43	4 820,45	4 847,48	4 874,51	4 901,54	4 928,56	4 955,59	4 982,62	5 009,64	5 036,67	5 063,70	2 538,61
Accumulative cash flow	1000 EUR	-4 563,56	-12 410,56	-18 754,23	-11 762,90	-4 616,32	150,08	4 943,51	9 763,96	14 611,44	19 485,95	24 387,49	29 316,05	34 271,64	39 254,26	44 263,90	49 300,57	54 364,27	56 902,88

NPV	**1000 EUR**	**2 504**
IRR	**%**	**23,42%**

Annex 3

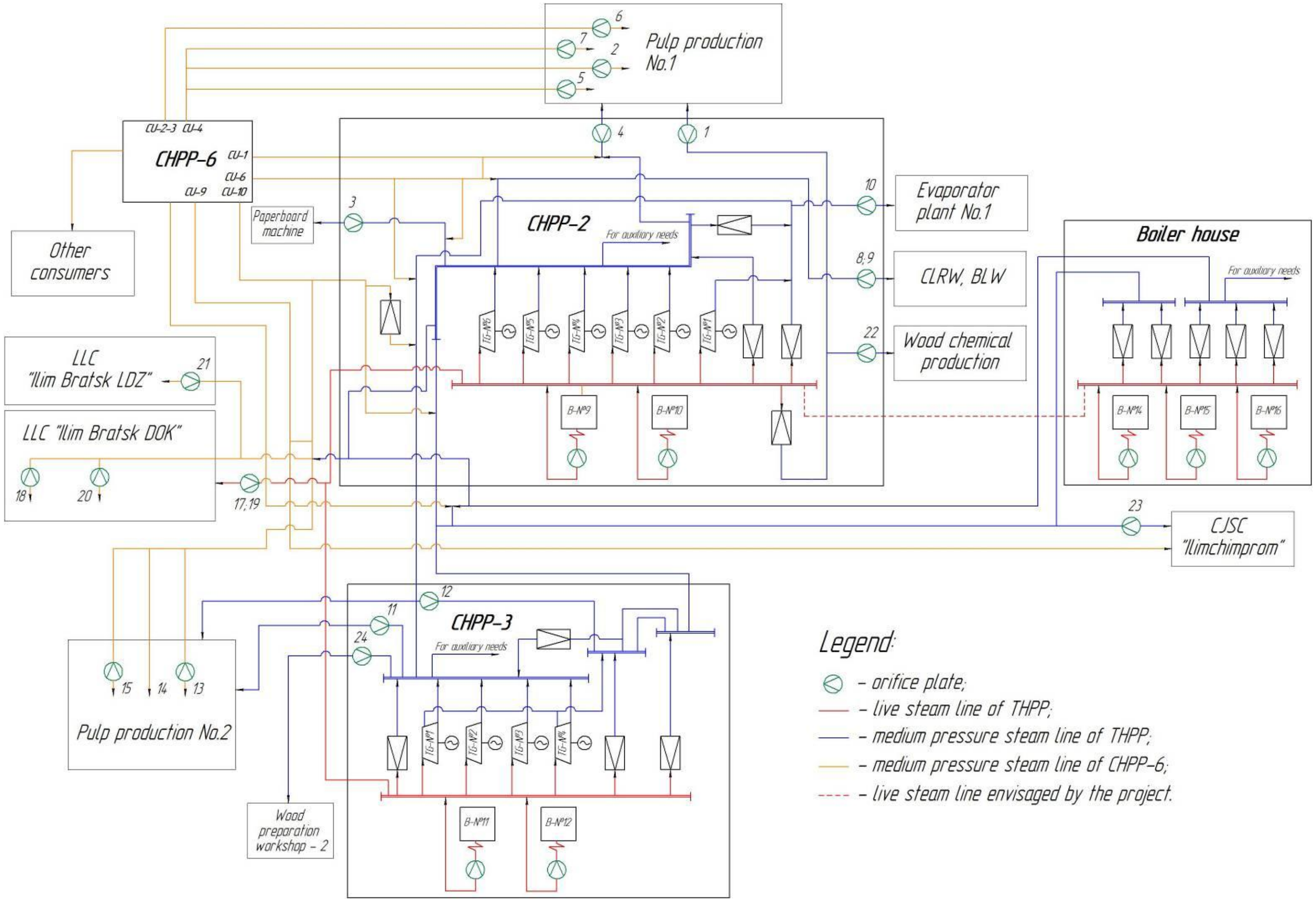
MONITORING PLAN

Annex 3-1. List of major heat consumers

No.	Consumer	The source of steam
1	High yield cooking workshop	CHPP-2
2	High yield cooking workshop	Cooler Unit (CU)-4
3	Paperboard machine	CU-6, CHPP-2
4	Cooking workshop of cordage flow	CU-1, CHPP-2
5	Bleaching workshop of pulp production No.1	CU-4
6	Drying workshop of pulp production No.1	CU-2,3; CHPP-2
7	Flect	CU-4
8	Causticization and lime reburning workshop (CLRW)	CU-6, CHPP-2
9	Bleaching liquid workshop (BLW)	CU-6, CHPP-2
10	Evaporation workshop No.1	CHPP-2
11	Evaporation workshop No.2	CHPP-3
12	Cooking workshop of pulp production No.2	THPP
13	Cooking workshop of pulp production No.2	CU-10,12; THPP
14	Bleaching workshop of pulp production No.2	CU-10,12; THPP
15	Drying workshop of pulp production No.2	CU-10,12; THPP
16	Feed water to pulp production No.2	CHPP-3
17	Wood fiberboard production	THPP
18	Wood fiberboard production	CU-10,12; CHPP-2
19	Plywood production	CHPP-3
20	Plywood production	CU-10,12; CHPP-2
21	Timber factory	CU-10,12; CHPP-2
22	Wood chemical production	CHPP-2
23	Chlorine production	CU-9,10
24	Wood preparation workshop - 2	CHPP-3

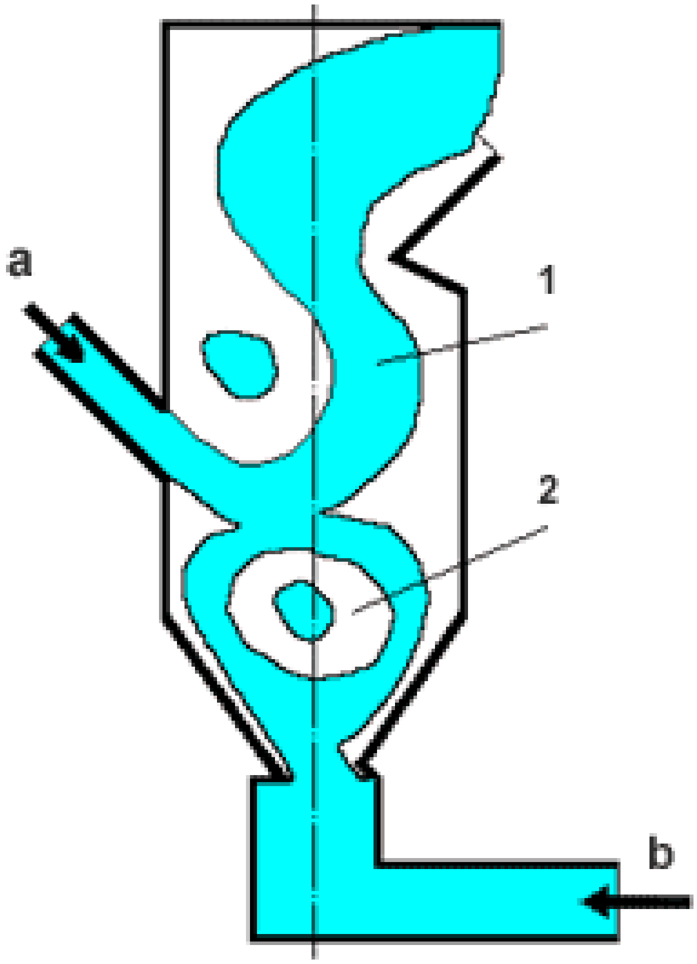
Annex 4

Basic steam supply diagram of OJSC “Ilim Group” Branch in the town of Bratsk



Annex 5

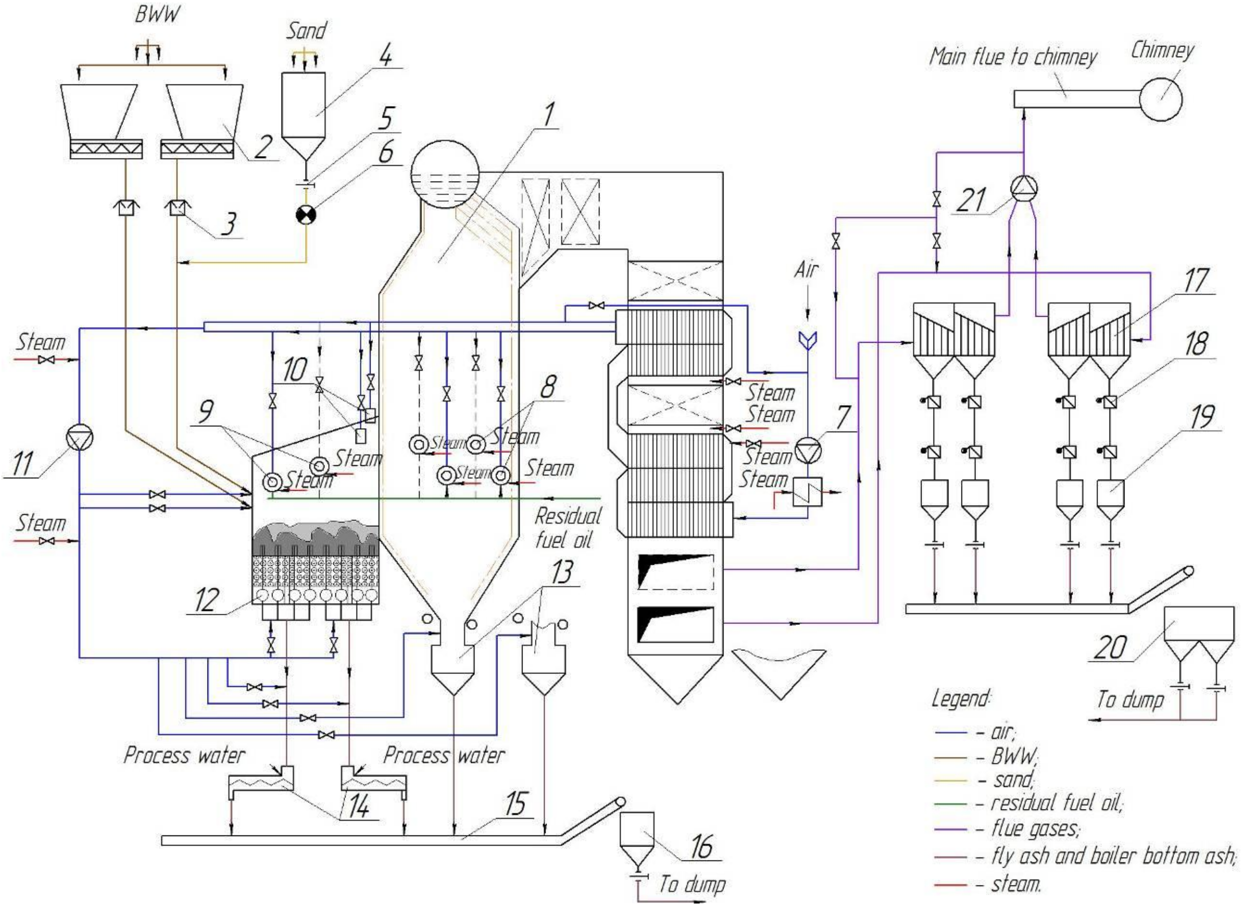
Schematic diagram of LTS-furnace



a – fuel-air mixture; b – bottom blast air;
1 – direct-flow flame; 2 – swirl flame.

Annex 6

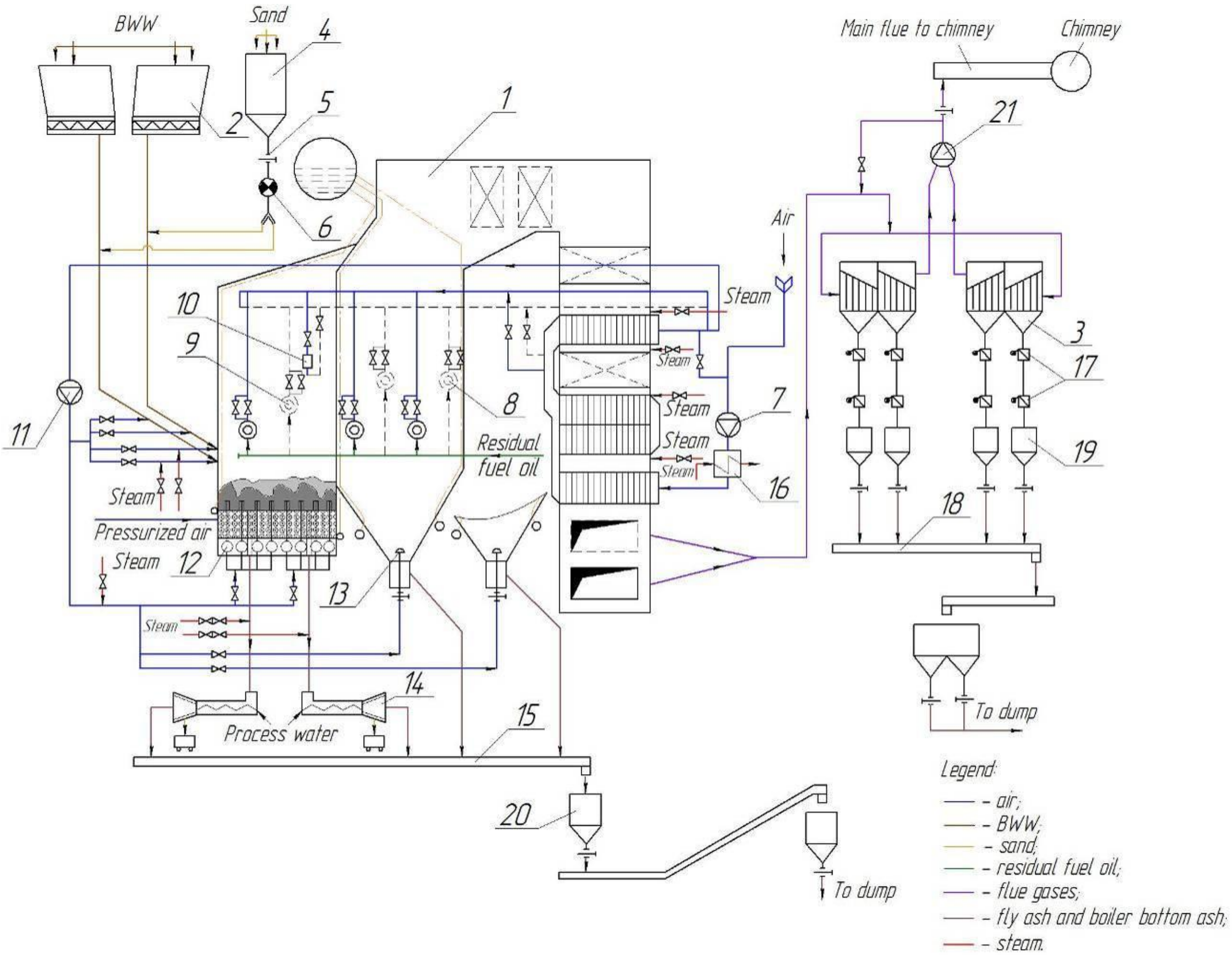
Basic process flow diagram of reconstructed E-75-40K boiler No.16



1 – E-75-40K boiler unit; 2 – BWW bunker with “traveling floor”; 3 – two-blade discharge unit; 4 – sand bunker; 5 – slide shutter; 6 – sand feeder; 7 – induced draft fan (forced draft fan); 8 – boiler burner (furnace); 9 – boiler burner (furnace extension); 10 – secondary blast air nozzles; 11 – high-pressure hot air blast fan; 12 – air-distributing grate; 13 – bottom blast device; 14 – furnace bottom ash screw feeder; 15 – furnace bottom ash scraper conveyor; 16 – furnace bottom ash bunker; 17 – multicyclone; 18 – cone-type discharge disc; 19 – under-cyclone fly ash bunker; 20 – fly ash bunker; 21 – induced draft fan.

Annex 7

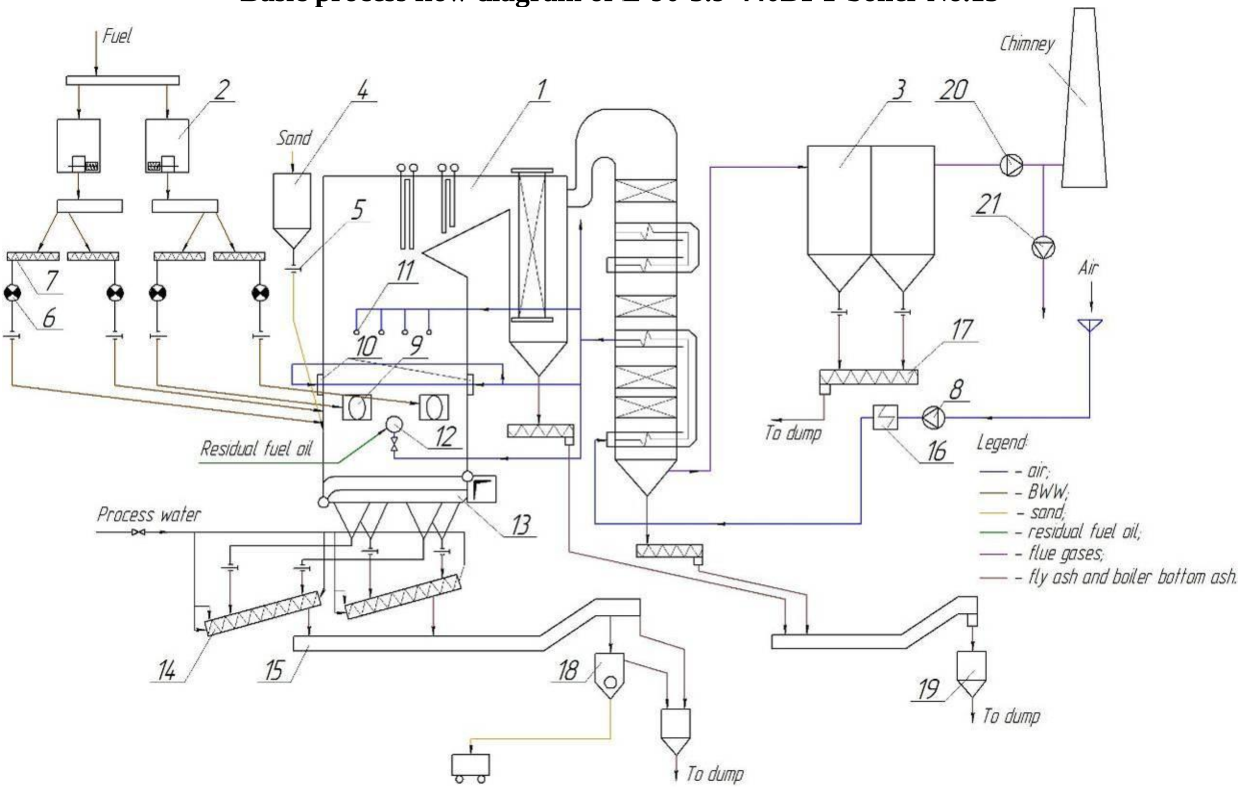
Basic process flow diagram of reconstructed E-75-40K boiler No.14



1 – E-75-40K boiler unit; 2 – BWW bunker with “traveling bed”; 3 – multicyclone; 4 – sand bunker; 5 – slide shutter; 6 – sand feeder; 7 – induced draft fan (forced draft fan); 8 – boiler burner (furnace); 9 – boiler burner (furnace extension); 10 – secondary blast air nozzles; 11 – high-pressure hot air blast fan; 12 – air-distributing grate; 13 – bottom blast device; 14 – furnace bottom ash screw feeder (with a sift); 15 – furnace bottom ash scraper conveyor; 16 – steam calorifier; 17 – cone-type discharge disc; 18 – fly ash scraper conveyor; 19 – under-cyclone fly ash bunker; 20 – intermediate furnace bottom ash bunker; 21 – induced draft fan.

Annex 8

Basic process flow diagram of E-90-3.9-440DFT boiler No.15



1 – E-90-3.9-440DFT boiler; 2 – fuel feed bunker with screw discharge module; 3 – electrostatic precipitator; 4 – sand bunker; 5 – slide shutter; 6 – drum feeder; 7 – screw discharger; 8 – induced draft fan (forced draft fan); 9 – fuel inlet; 10 – secondary blast air nozzles; 11 – tertiary blast air nozzles; 12 – lighting-up burner; 13 – fluidized bed grate; 14 – spiral conveyor; 15 – furnace bottom ash scraper conveyor; 16 – steam calorifier; 17 – fly ash screw conveyor; 18 – rotary sieve; 19 – fly ash bunker; 20 – induced draft fan; 21 – recycling induced draft fan.

Annex 9

Basic diagram of BWW feeding for combustion to THPP