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

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Annexes

SECTION A. General description of the project

A.1. Title of the project:

Energy efficiency measures at the "Public Joint Stock Company Azovstal Iron & Steel Works"

Sectoral scope: (9) Metal production.
Version of the document: 2.5.
Date of the document: 14 June 2010.

A.2. Description of the project:

Azovstal Iron and Steel Works (hereinafter referred to as Azovstal) is one of the major Ukrainian integrated metallurgical enterprises. Its annual production capacity is approximately 6m tonnes of pig iron, over 7m tonnes of steel, and 4.65m tonnes of rolled steel. The plant is a large producer of pig iron, continuously casting slabs from basic oxygen furnaces' steel, steel heavy plates, shapes and bars, rails, and metallurgical slag products. Azovstal's products are shipped to many companies, including those involved in machine building, shipbuilding, carriage making, and power machine building. Its products comply with main world quality standards many leading certifying organisations and are marketed in over 30 countries.

The plant, related to this project, was founded in 1933. The plant has been developed into a fully integrated metallurgical plant comprised of workshops for coke production, sinter production, blast furnaces, steel making and rolling mills. The plant also has a highly developed transportation infrastructure, including its own seaport, capable of processing large-sized steel plates, slabs and other rolled steel products, as well as loose goods.

Pig iron production is a very intensive energy process and as a result Blast Furnace Workshop (BFW) is the major emitter of Greenhouse Gases (GHGs) at Azovstal. The share of the BFW in the total GHG emissions of the plant is about 30-35%.

The blast furnace is a counter flow kiln. A simplified schematic layout of the Blast Furnace is shown in Figure A.1. Iron bearing materials (iron ore, sinter, pellets), fluxes (lime, limestone) and reducing agents (coke) are continuously fed from the top of the furnace, while natural gas and hot blast air enriched by oxygen injected from the bottom. So the materials are descending top down whilst gases are ascending upwards.

Pig iron is a product of reduction of the iron bearing materials. The process of the iron reduction of oxides contains in pellets and sinter can be expressed by following chemical reactions:

$3Fe_2O_3 + CO = CO_2 + 2Fe_3O_4$	Begins at 450^0C;
$Fe_3O_4 + CO = CO_2 + 3FeO$	Begins at 600^0C;
$FeO + CO = Fe + CO_2$	or
$FeO + C = Fe + CO$	Begins at 700^0C.

As the result of the process, melted pig iron and slug are cast from the casthouse, hot gases are issued through the specially dedicated offtakes at the top of the furnace.

Emissions that occur during the pig iron production can be split into two categories, as follows:

I. Direct emissions occurring from:
   - Coke combustion;

- Natural gas combustion;
- Limestone calcination;

II. Indirect emissions occurring from:
- Coke production;
- Oxygen production;
- Hot blast production;
- Sinter production;
- Pellets production;
- Lime production.

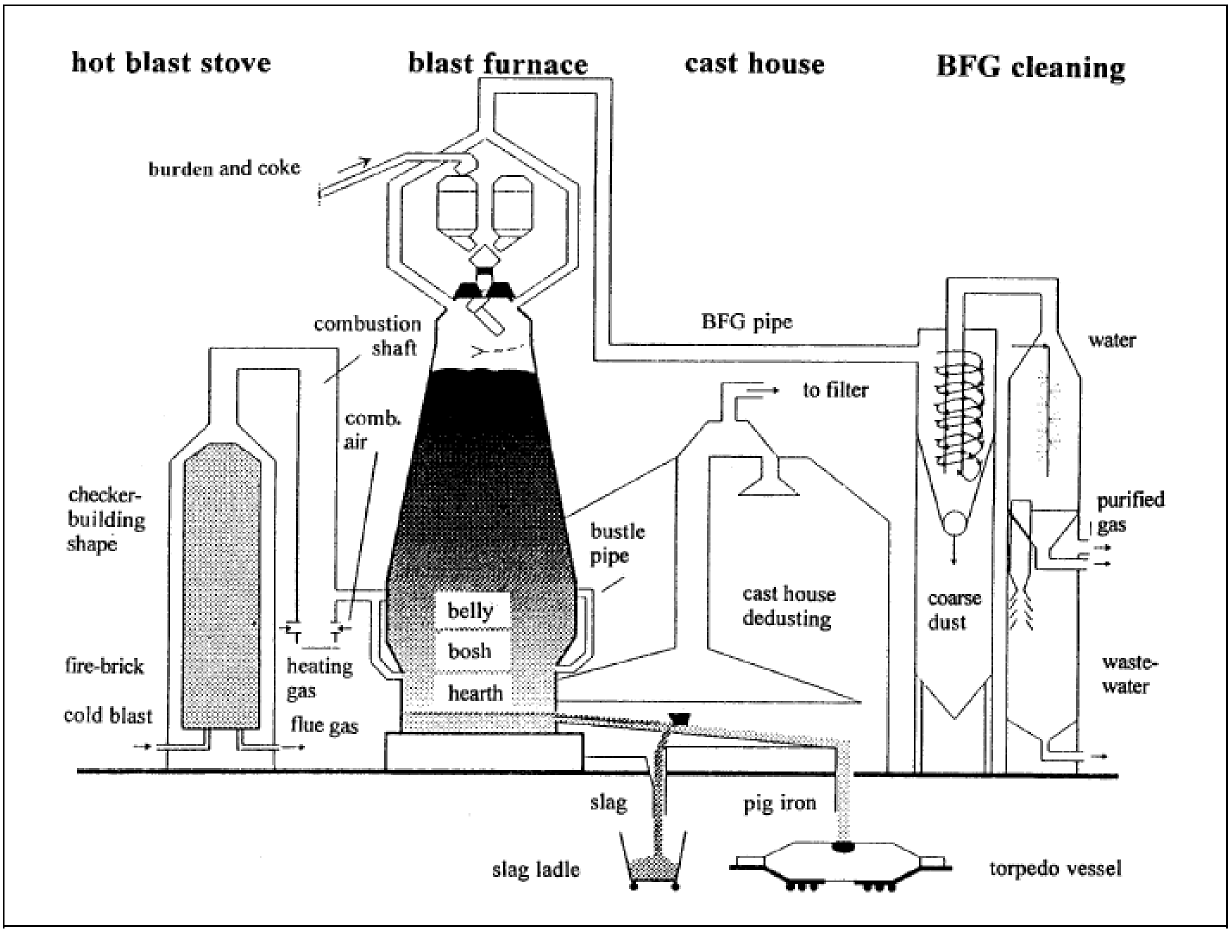

Figure A.1. Blast Furnace scheme. Source http://eippcb.jrc.es/reference/

In general, the main contribution to the emissions of GHG at BFW of Azovstal is from the coke (about 78% of total emissions).

The proposed project is aimed at the reduction of the CO_2 emissions (Goal) through the reduction of the coke consumption at BFW of Azovstal (Purpose). The project consists of several measures (or components) including the modernisation and reconstruction of the BFs and improvement and changing content of the raw materials and fuels charging into BFs.

Situation existing prior to starting date of the project

For the period prior to the project start Azovstal has operated five BFs with the capacity presents in the following table:

Design capacity of the BFs	Unit	Value
BF1	t/a	710 000
BF3	t/a	1 100 000
BF4	t/a	1 300 000
BF5	t/a	1 000 000
BF6	t/a	1 050 000
Total	**t/a**	**5 160 000**

Table A.1: Design capacity of the BFW prior to the project start

Coke consumption at that time has been varied from 580 to 600 kg/t of pig iron.

Baseline scenario

In the baseline scenario Azovstal would continue operation of the BFs indicated in the Table A.1 with the performance similar to the years prior to the project implementation. Only regular maintenances would perform without any reconstructions. Content and share of iron-ore materials and fluxes would remain the similar. As the result, specific coke consumption in the baseline scenario would remain similar to the level prior to the project implementation.

There are no recognized barriers that could prevent continuation of the situation prior to the starting date of the project. In the same time continuation of the existing situation is the most conservative scenario from all plausible and realistic ones (for more details, please refer to the Section B.1).

Project scenario

In the project scenario the set of subprojects and measures will be implemented (for more details, please refer to the Section A.4.2) that lead to the significant reduction of the specific coke consumption.

Implementation of the proposed project faces strong barriers that are alleviated by JI mechanism (for more details, please refer to the Section B.2).

History of JI component

Awareness concerning opportunities proposed by Kyoto flexible mechanisms was widely shared among Ukrainian enterprises at the end of the nineties and the beginning of the first decade of the 21st century. At that time a few international programs were launched. For example:

1. USAID programme “Climate Change Initiative in Ukraine”[1];
2. Governmental programme of the Netherlands (ERUPT and CERUPT)[2].

and other programmes either as technical assistance projects and/or governmental purchasing programmes.

USAID program

USAID program was directed to:

- the awareness increasing of Ukrainian enterprises in the area of JI through the workshops and conferences;
- case studies development.

ERUPT

[1] http://climatesch.ru/cci_briefua.html

[2] http://www.senternovem.nl/carboncredits/general_information/index.asp

ERUPT program consisted of five tenders where further JI projects were selected. Timeframe of the tenders was as follows:

	Publication date	Closing date
Tender 1	15/05/2000	17/07/2000
Tender 2	01/12/2001	04/04/2002
Tender 3	24/10/2002	28/08/2003
Tender 4	22/10/2003	27/05/2004
Tender 5	10/05/2004	05/04/2005

Table A.2: Schedule of ERUPT program tenders

Every tender was supported by promotion programme in Ukraine, where main industrial plants were approached.

A few conferences and workshops were organized within the framework of the USAID program. One of the conferences[3] was attended by representatives of all mayor Ukrainian industrial plants from the Donbass region and the current employee of the JI project developer Global Carbon BV.

At that time the employee worked with JSC "Technological Park Uglemash" (Uglemash). Since 2002 Uglemash had a programme aimed at increasing of awareness of Ukrainian enterprises in the area of JI. Its programme manager was responsible for approaching industrial plants and local authorities in Donetsk region. So, the first proposal to develop JI project at Asovstal was made by Uglemash in 2002.

The project development was implemented by Global Carbon BV including an estimation of the reduction potential.

All the abovementioned shows that Azovstal's management was aware of opportunities proposed by the JI mechanism.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host party)	JSC Azovstal Iron & Steel Works	No
The Netherlands	Global Carbon BV	No

Table A.3: Project participants

JSC Azovstal Iron & Steel Works is the project host and Project Participant.
Global Carbon BV is the developer of this JI project and Project Participant

A.4. Technical description of the project:

[3] http://climatesch.ru/conf/conf_inf.html

A.4.1. Location of the project:

Premises of Azovstal.

A.4.1.1. Host Party(ies):

Ukraine

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

Donetsk region.

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

City of Mariupol.

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

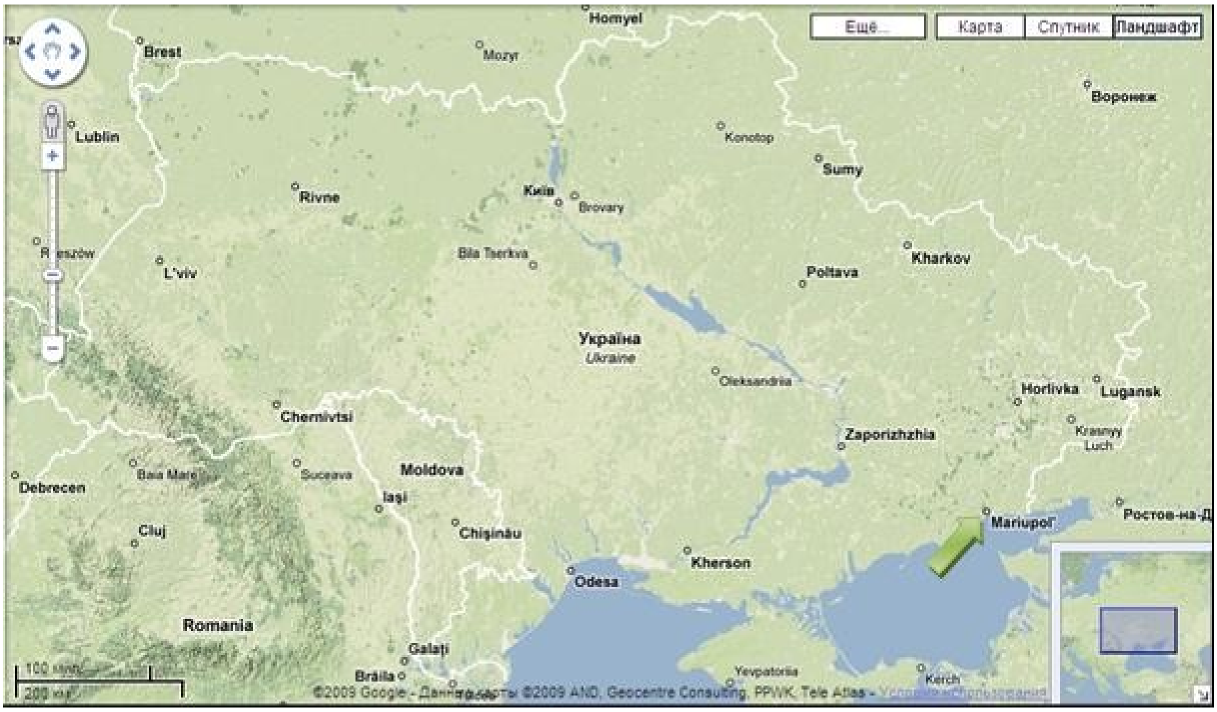

Figure A.2. Map of Ukraine and location of the city of Mariupol

The physical location of the project is at the premises of Azovstal located in the city of Mariupol, Donetsk region, Ukraine. Location of the Donetsk region and location of the city of Mariupol are shown on the previous figure. The coordinates of the city of Mariupol are 47° 5'51.60"N 37°35'52.14"E.

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

Azovstal operates six BFs with the design capacity more than 6m tonnes of pig iron per year. Table A.2. below shows the design capacity of the BFs. Each furnace is a typical for the Ukrainian metallurgical plants and pig iron producing by one technology. Technology for the pig iron production is not likely to be substituted by other technologies (like direct reduction iron DRI) because of the following main reasons:

- BFW is a core workshop at Azovstal, so substitution of the main technology mean construction of the new metallurgical plant;
- Azovstal is a part of the integrated holding with a own raw materials recourses which is suitable for the BF technology mainly.

Design capacity of the BFs	**Unit**	**Value**
BF1	t/a	710 000
BF2	t/a	1 100 000
BF3	t/a	1 100 000
BF4	t/a	1 300 000
BF5	t/a	1 000 000
BF6	t/a	1 050 000
Total	**t/a**	**6 260 000**

Table A.4: Design capacity of the BFs at Azovstal

Each BF uses coke as the main reducing and energy carrier agent. Coke is charged from the top of the BFs together with a mix of iron-ore materials and flux. Specific coke consumption depends on many factors and for the BFW it is about 580-610kg/t of pig iron. In order to proceed with the reducing reaction inside of the BF, hot blast and natural gas are injected into the bottom of the furnace.

Each BF has a set of cowpers (sometimes called “hot blast stove”) to heat the blast. Cowper is a cycling type heat exchanger. Heat is provided by the combustion of a Blast Furnace Gas (BFG).

Air to the cowpers is provided by turbo compressors located at two stations called “Teploelectrocentral” or TEC and “paroelectrovozdushnaya stancia” or PEVS (hereinafter referred to as CHP1 and CHP2). The turbo compressors are driven by steam turbines. Steam is generated in the boilers by the combustion of a mix of natural gas, BFG and Coke Oven Gas (COG).

The hot blast is enriched with oxygen at turbo compressors before being injected into the BFs.

About 2,000m^3 of hot blast and 120m^3 of oxygen is needed to produce one ton of pig iron.

Emissions of GHG that occur during pig iron production can be estimated as the sum of the different components. Coke, being the main source of the GHG emissions, accounts for approximately 78%.

The proposed project aims at reduction of the amount of CHG emissions (goal of the project) by reducing the specific coke consumption through an integrated energy efficiency program (purpose of the project). The project consists of several components or measures. It is necessary to stress that the project design engineering reflects current good practices and some of engineering solutions is being used at BFW for the first time in Ukraine.

A detailed description of the program’s measures is presented below:

1. **Modernisation and reconstruction of the BFs**

According to the standards and norms, regular *maintenance and overhauling* of the main equipment of the BFW is planned to be performed within certain time periods (see Table B.2). The purpose of maintenance is to sustain the working condition of the furnace and to extend the technical lifetime. Some of the proposed project measures could not be implemented whilst maintaining the original technical characteristics of the furnaces' layout. That is why the *modernisation* of the blast furnaces was planned. Modernisation in the context of this project is defined as measures that exceed those that would be normally included during regular maintenance. To reduce the downtime of the furnaces, these modernisations are combined with the so-called 'first category' maintenance of furnaces. See Table B.2 for an overview of the different categories of regular maintenance. In this context the purpose and activities for maintenance should not be confused with modernisations.

Modernisations at the BFW mainly include:

- Introduction of the brickwork of the furnace's stack and hearth made from composite refractory body ($Si\text{-}SiC\text{-}Al_2O_3$). This measure is directed to the decreasing of the heat losses from the hearth, adjustment of the heat balance of the furnace and coke savings as a consequence. In addition introduction of the new brickwork's materials will prolong lifetime of the furnace in comparison with regular materials used in Ukraine.
- Introduction of the automatic control systems in order to control and manage:
  - Tuyere failure;
  - Natural gas flow distribution over the tuyeres;
  - Temperature field over the surface of charging materials;
  - Cooling of the furnace's stack;
  - Heat load at heat exchangers at hearth;
  - Charging process.
- Reconstruction of the BF2.

BF2 was initially constructed in 1934 with the pay-load volume 930m^3. In the 1949 it was reconstructed with the pay-load volume of 1233m^3 and work till the 1998 with the regular maintenances. In 1998 BF2 was mothballed. At the end of 2003 reconstruction of BF2 was started. Reconstruction includes the following engineering solutions:

a. Total dismantling of the existing BF2 including furnace's bed;
b. Construction of the BF with the pay-load volume of 1719m^3;
c. Dismantling of the existing cast house with the construction of the new one;
d. Dismantling of the existing cowpers with the construction of the new ones;
e. Construction of the new facilities such as:
   - Electrical equipment of the charging system;
   - Air cooling station of the hearth bottom;
   - Suction cleaning system of the cast house's emissions;
   - Gas-treating system of the charging unit emission.

The main difference in techno-economic indicators between existing and reconstructed furnaces presents in the following table.

Indicator	Unit	Before reconstruction	After reconstruction
Pay-load volume	m^3	1233	1719
Design capacity	1000t/a	614.8	1100
Iron content in the iron-ore materials	%	54.67	56…58.5
Specific slag output per ton of pig iron	kg/t	554	387
Pressure of blast	MPa	0.195	0.33
Temperature of blast	^{0}C	890	1200
Pressure of gas under the furnace mouth	MPa	0.098	0.18
Specific coke consumption per ton of pig iron	kg/t	672	504

Table A.5: Techno-economic indicators before and after reconstruction

Some of engineering solutions, such as ceramic package of the brickwork, control system of the gas flow is being used in Ukraine for the first time.

The schedule of the modernisations is shown in the following table.

	Start of activities	Commissioning date
Modernisation of BF6	06/02/2003	11/06/2003
Reconstruction of BF2	12/12/2003	20/04/2006
Modernisation of BF3	21/01/2008	10/04/2008

Table A.6 Schedule of reconstructions and modernisations at BFW

Implementation of the modernisations and reconstruction requires extensive initial trainings as well as regular training in order to keep the level of proficiency.[4]

2. **Increasing the iron content in the iron-ore materials.**

BFs at Azovstal are charged with sinter, pellets, and iron ore as iron-ore materials. The average iron content is about 54-55%. This means that in order to produce one ton of pig iron almost two tons of iron-ore material need to be charged into BF and melted, using coke and natural gas as a fuel. The objective of this measure is to increase iron content up to 60%. This measure allows the same amount of pig iron to be produced by using fewer raw material, hence, reducing the consumption of coke per ton of iron. According to "Pig Iron production. Technological Instruction", increase of iron content in the iron bearing materials on every 1% gives from 1% up to 1.4% of coke savings (see Table A.7).

The actual savings of coke due to this measure in comparison to the base years could be evaluated by following formula:

$$SC_{coke}^{savings} = \frac{(IC_p - IC_b) \times F_{coke} \times SC_{coke}^{base}}{100}$$

Where,

$SC_{coke}^{savings}$	Specific savings of coke due to the iron content increasing in the project year y [kg/t];
IC_p	Iron content in the iron-ore materials in the project year y [%];
IC_b	Iron content in the iron-ore materials in the base period [%];
F_{coke}	Factor of coke saving (see Table A.7) [%];
SC_{coke}^{base}	Specific coke consumption in the base year [kg/t].

Emission reductions of the proposed JI project calculation is based on overall reduction of coke consumption, so this measure is not monitored separately.

This measure is achievable by increasing iron-ore material content of the pellets. The measure is gradually implemented in the period from 2003 to 2006.

3. **Decreasing the silicon content in the pig iron**

The reduction of the silicon (Si) from the silicon begins at 1450^{0}C and is processed, as follows:

$SiO_2 + 2C = Si + 2CO – Q$

[4] Detailed information about trainings provided to AIE during the determination

Therefore, a reduction of the Si content will reduce coke required.

According to the "Pig Iron production. Technological Instruction", reduction of the silicon content on every 0.1% gives 1.2% of coke savings (see Table A.7). The actual savings of coke due to this measure in comparison to the base years could be evaluate by following formula:

$$SC_{coke}^{savings} = \frac{(Si_b - Si_p) \times F_{coke} \times SC_{coke}^{base}}{100}$$

Where,

$SC_{coke}^{savings}$	Specific savings of coke due to the silicon content decreasing in the project year y [kg/t];
Si_p	Silicon content in the pig iron in the project year y [%];
Si_b	Silicon content in the pig iron in the base period [%];
F_{coke}	Factor of coke saving (see Table A.7) [%];
SC_{coke}^{base}	Specific coke consumption in the base year [kg/t].

Similar to the previous measure, ERUs due to this particular measure is not monitored separately. In addition it needs to be stressed that a temperature of pig iron less than 1450^{0}C could be achieved by usage of well maintained equipment, otherwise BF could be frozen up to the solidification of the pig iron. Therefore, the modernisation of the BFs is required.

Prior to the start of the project the silicon content in the pig iron is about 1%, but Azovstal plans to decrease it to 0.75%.This measure is gradually implemented in the period from 2003 to 2008.

4. **Decreasing the BFs idle times**

Blast Furnace's are in continuous operation, only interrupted for maintenance. Any idle time requires that the BF's hearth is kept at a high temperature, which is achieved by burning coke. Therefore, any measures focused on decreasing idle times will reduce the coke consumption.

Idle times at BFs are divided on the following categories:
1. Regular maintenances and preventive maintenances;
2. Major maintenances (I, II, III categories) (for more details see Table B.2);
3. Operational idle times.

Proposed measure dealing with operational idle times that divided into the following categories:
1. Technological idle times;
2. Mechanical equipment bugs fixing;
3. Electrical equipment bugs fixing.

So modernisations of BFs with the introduction of the modern automatic and control systems allow preventing strong fails/bugs of equipment by detection of the deviation from the normal operational conditions and reducing the time fixing.

According to the "Pig Iron production. Technological Instruction", decreasing of the idle times on every 1% giving 0.5% of coke savings (see Table A.7). The actual savings of coke due to this measure in comparison to the base years could be evaluate by following formula:

$$SC_{coke}^{savings} = \frac{(IT_b - IT_p) \times F_{coke} \times SC_{coke}^{base}}{100}$$

Where,

$SC_{coke}^{savings}$	Specific savings of coke due to idle time decreasing in the project year y [kg/t];
IT_p	Idle time in the project year y [%];
IT_b	Idle time in the base period [%];
F_{coke}	Factor of coke saving (see Table A.7) [%];
SC_{coke}^{base}	Specific coke consumption in the base year [kg/t].

Similar to the previous measure, ERUs due to this particular measure is not monitored separately.

According to the plan, Azovstal aims to reduce operational idle time from 5% to 2%.This measure is gradually implemented in the period from 2003 to 2006.

5. Partial substitution of the limestone by lime.

Limestone that is charged into BF is calcinated through the reaction:

$CaCO_3 = CaO + CO_2$;

This reaction requires heat. The same reaction takes place in the special kilns for the lime production using regular coal as a fuel. Therefore, charging lime in the BF will save coke that would be consumed for the calcination. Emission factor for the lime production will be taken into account in the calculation of emission reductions.

According to the "Pig Iron production. Technological Instruction", decreasing of the limestone and lime on every 10kg/t giving 0.5% and 0.4% of coke savings correspondingly (see Table A.7). The actual savings of coke due to this measure in comparison to the base years could be evaluate by following formula:

$$SC_{coke}^{savings} = \frac{\left(\left(LS_b - LS_p\right) \times \frac{F_{coke}^{LS}}{10} \times SC_{coke}^{base}\right) - \left(\left(L_p - L_b\right) \times \frac{F_{coke}^{L}}{10} \times SC_{coke}^{base}\right)}{100}$$

Where,

$SC_{coke}^{savings}$	Specific savings of coke due to idle time decreasing in the project year y [kg/t];
LS_p	Specific limestone consumption in the project year y [kg/t];
LS_b	Specific limestone consumption in the base period [kg/t];
F_{coke}^{LS}	Factor of coke saving due to limestone consumption (see Table A.7) [%];
SC_{coke}^{base}	Specific coke consumption in the base year [kg/t].
L_p	Specific lime consumption in the project year y [kg/t];
L_b	Specific lime consumption in the base period [kg/t];
F_{coke}^{L}	Factor of coke saving due to lime consumption (see Table A.7) [%];

Similar to the previous measure, ERUs due to this particular measure is not monitored separately.

It is planned to use 70 kg of lime per ton of pig iron.

Please note that emissions associated with lime production will be taken into account.

The measure is gradually implemented in the period from 2003 to 2008.

As mentioned in Section A.2, pig iron production is a complex thermodynamic and chemical process where any changes in charging materials/fuels/layout of BF should be compensated or/and adjusted by other measures. So, in order to decrease the risks associated with the proposed project implementation, an energy efficiency program is implemented on a gradual basis.

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

The objective of the proposed project is reduction of coke consumption during the pig iron production at the BFW of Azovstal. Using of coke is associated with two sources of emissions of GHGs:

1. During coke production. IPCC[5] set the value of the emission factor for the coke production at the level 0.56 tCO_2/t of coke, and
2. Coke processing in the BF. The emission factor for coke processing is 3.043 tCO_2/t, assuming that the carbon content of the coke is 83%[6].

The following table shows the reduction in coke consumption by the measures proposed above:

Factor/measure	Unit	Coke consumption
Increasing of the iron content in the iron-ore materials on every 1% within the limits:		
Up to 50%	%	-1.4
From 50% to 55%	%	-1.2
From 55% to 60%	%	-1.0
Silicon content decreasing in the pig iron on every 0.1%	%	-1.2
Decreasing of the idle time on every 1%	%	-0.5
Consumption decreasing on every 10kg/t of the pig iron of:		
Limestone	%	-0.5
Lime	%	-0.4

Table A.7: Dependence of coke consumption. Source: "Pig Iron production. Technological Instruction" Azovstal

It should be noted that factors presented in the table A.4 are indicative and have empirical nature. Nevertheless, we can see that the proposed measures will lead to the reduction of coke consumption that would not have occurred in case of absence of the project.

Emissions that occur during pig iron production at Azovstal are calculated based on the specific emission factor (EF) for pig iron production. The EF is a sum of emission components associated with different carbon-bearing material flows taking part in the BFs operations.

[5] Volume 3, Chapter 4 "Metal Industry", table 4.1, p.4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

[6] Volume 3, Chapter 4 "Metal Industry", table 4.3, p.4.27 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

In the absence of the proposed project, the BFW of Azovstal will continue operations without implementation of the set of measures described in Section A.3., so the structure of the EF for the pig iron production will be kept at the level shown in Figure A.3 below:

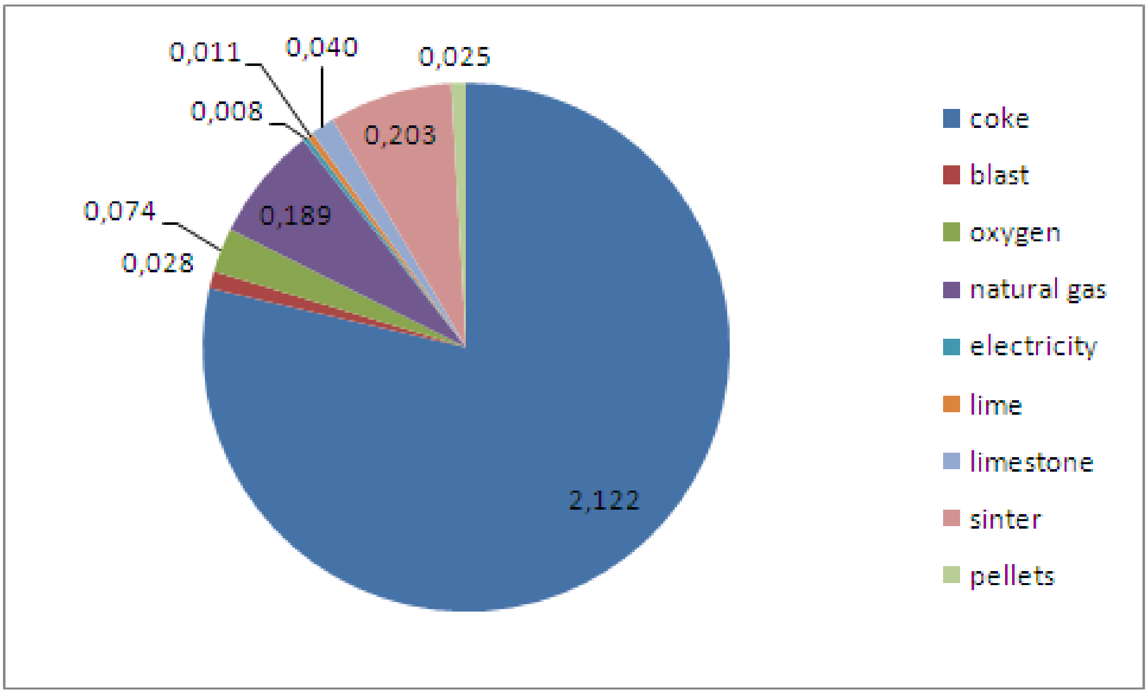

Figure A.3. Structure of the emission factor without the project.

After the project's implementation the specific coke consumption per ton of pig iron will be reduced significantly. The input of coke into the EF for the pig iron production will be also reduced.

The structure of the EF after the project implementation is shown at Figure A.4. As seen in the figure, some of the components increase their input in the emission factor in comparison with what would have occured in the absence of the project.

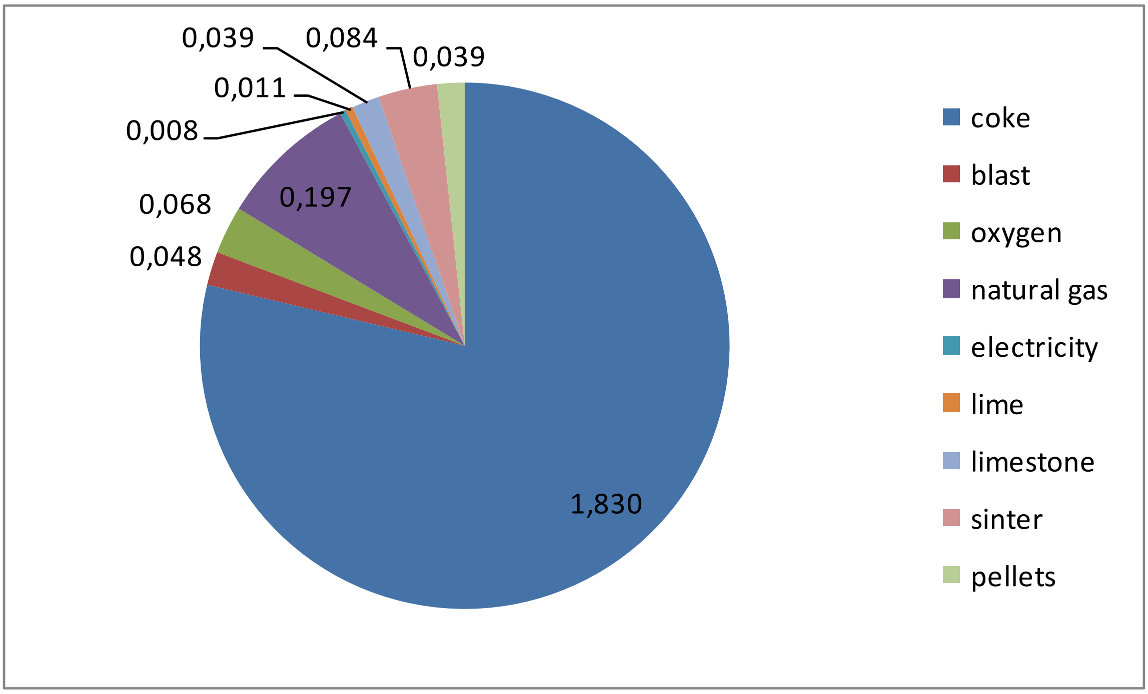

Figure A.4. Structure of the emission factor after project implementation.

The changes in the structure of the emission factor can be explained as follows:

- The emissions component associated with limestone calcination has decreased due to the partial substitution of limestone by lime. As a result, the component associated with lime production has risen.
- The iron-ore component's weight changed due to the measure to increase iron content resulting in the decrease of the emissions component for the sinter and increase in the component for pellet production.

The figure A.5 below shows the final comparison of the emission factors, with the Baseline EF representing the situation in the absence of the proposed project, and the Project EF should represent the emission factor that will be achieved after the project implementation.

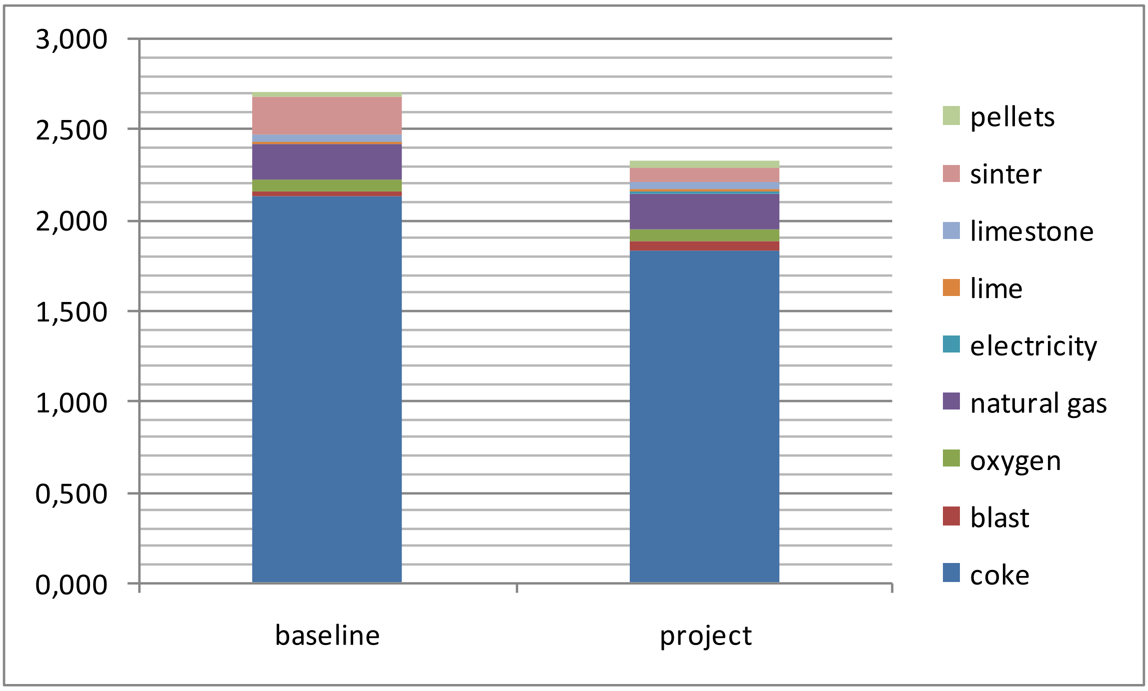

Figure A.5. Emission factors for the baseline and project

The difference between baseline and project EF shows that reduction of the emissions will take place as a result of the project implementation.

A detailed description of baseline setting and full additionality test can be found in section B of this PDD.

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

	Years
Period before 2008, for which emission reductions are estimated	4
Year	**Estimate of annual emission reductions in tonnes of CO2 equiv.**
Year 2004	611 417
Year 2005	905 408
Year 2006	1 756 040
Year 2007	1 445 621
Total estimated emission reductions before the crediting period (tonnes of CO_2 equivalent)	4 718 486
Annual average of estimated emission reductions before the crediting period (tonnes of CO2 equiv.)	1 179 621

Table A.8: Estimated amount of emission reductions before the commitment period

	Years
Length of the crediting period	5
Year	**Estimate of annual emission reductions in tonnes of CO2 equiv.**
Year 2008	1 014 047
Year 2009	698 544
Year 2010	811 238
Year 2011	1 014 047
Year 2012	1 014 047
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4 551 923
Annual average of estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	910 385

Table A.9: Estimated amount of emission reductions over the commitment period

	Years
Period after 2012, for which emission reductions are estimated	8
Year	**Estimate of annual emission reductions in tonnes of CO2 equiv.**
Year 2013	1 014 047
Year 2014	1 014 047
Year 2015	1 014 047
Year 2016	1 014 047
Year 2017	1 014 047
Year 2018	1 014 047
Year 2019	1 014 047
Year 2020	1 014 047
Year 2021	1 014 047
Year 2022	1 014 047
Total estimated emission reductions after the crediting period (tonnes of CO_2 equivalent)	10 140 470
Annual average of estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	1 014 047

Table A.10: Estimated amount of emission reductions after the commitment period

A.5. Project approval by the Parties involved:

The Project Idea Note was submitted for review to the National Environmental Investment Agency of Ukraine. A Letter of Endorsement # 1335/23/7 for the proposed project was issued on the 10 November 2009. After the determination report will be completed by AIE, the PDD and the Determination Report will be presented to the National Environmental Investment Agency of Ukraine to obtain a Letter of Approval from the Host Party. A Letter of Approval from the second Party will be obtained before first periodic verification.

SECTION B. Baseline

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

A baseline for the JI project has to be set in accordance with Appendix B to decision 9/CMP.1 (JI guidelines)[7], and with further guidance on baseline setting and monitoring developed by the Joint Implementation Supervisory Committee (JISC). In accordance with the Guidance on Criteria for Baseline Setting and Monitoring (version 2)[8] (hereinafter referred to as Guidance), the baseline for a JI project is the scenario that reasonably represents the anthropogenic emissions by sources or anthropogenic removals by sinks of GHGs that would occur in **the absence of the proposed project**. In accordance with the Paragraph 9 of the Guidance the project participants may select either: an approach for baseline setting and monitoring developed in accordance with appendix B of the JI guidelines (JI specific approach); or a methodology for baseline setting and monitoring approved by the Executive Board of the clean development mechanism (CDM), including methodologies for small-scale project activities, as appropriate, in accordance with paragraph 4(a) of decision 10/CMP.1, as well as methodologies for afforestation/reforestation project activities. Paragraph 11 of the Guidance allows project participants that select a JI specific approach to use selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools, as appropriate.

Description and justification of the baseline chosen is provided below in accordance with the "Guidelines for users of the Joint Implementation Project Design Document Form", version 04[9], using the following step-wise approach:

Step 1: Indication and description of the approach chosen regarding baseline setting

Project participants have chosen the following approach regarding baseline setting, defined in the Guidance (Paragraph 9):

a) An approach for baseline setting and monitoring developed in accordance with appendix B of the JI guidelines (JI specific approach).

The Guidance is applied to this project since the above indicated approach is selected, as mentioned in the Paragraph 12 of the Guidance. The detailed theoretical description of the baseline in a complete and transparent manner, as well as a justification in accordance with Paragraph 23 through 29 of the Guidance, should be provided by the project participants.

The baseline for this project shall be established in accordance with appendix B of the JI guidelines. Furthermore, the baseline shall be identified by listing and describing plausible future scenarios on the basis of conservative assumptions and selecting the most plausible one.

Key factors that affect the baseline are taken into account:

a) **Sectoral reform policies and legislation.** Direction of the main development of metallurgical industry is stated in two governmental policies:
   - Strategy of the Ukrainian metallurgical sector development for the period up to 2010[10];
   - Sectoral energy efficiency program of Ukraine for the period up to 2017[11];

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[7] http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=2

[8] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

[9] http://ji.unfccc.int/Ref/Documents/Guidelines.pdf

[10] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=385%2F95-%E2%F0

Both programs are not prescriptive or not legally binding but are rather recommending.

b) **Economic situation/growth and socio-demographic factors in the relevant sector as well as resulting predicted demand. Suppressed and/or increasing demand that will be met by the project can be considered in the baseline as appropriate (e.g. by assuming that the same level of service as in the project scenario would be offered in the baseline scenario)**. The main product of the BFW is a pig iron that is used internally at Azovstal for the steel production. It is assumed that the level of steel production and demand are not influenced by the project. The steel industry is a transparent market where standardized types of steel products exist. Within a certain region or country steel can be transported from the producer to the consumer without constrains**;**

c) **Availability of capital (including investment barriers).** Capital is available but high bank rate and high country investment risk make new equipment introduction in Ukraine unprofitable (see barrier analysis in section B.2);

d) **Local availability of technologies/techniques, skills and know-how and availability of the best available technologies/techniques in the future.** The only one technology that used in Ukraine for the pig iron production is Blast Furnace technology;

e) **Fuel prices and availability.** Electricity, natural gas and coke are widely used and available in Ukraine.

The baseline is established in a transparent manner with regard to the choice of approaches, assumptions, methodologies, parameters, data sources and key factors. Information is mostly taken from the international publicly available sources and is referenced. Uncertainties are taken into account and conservative assumptions are used. ERUs cannot be earned for decreases in activity levels outside the project activity or due to force majeure, as emission factors based on specific production are used (e.g. tCO2/t pig iron).

The baseline for this project will be the most plausible future scenario on the basis of conservative assumptions and key factors described above. The basic principle applied is that the demand for pig iron is not influenced by the project and is identical in the project and the baseline scenario.

Step 2. Application of the approach chosen

Plausible future scenarios will be identified in order to establish a baseline.

Sub step 2.1 Identifying and listing plausible future scenarios.

Scenario 1. Implementation of the proposed project's measures without JI incentives
This scenario is similar to the project activity, only in this case the project does not benefit from the possible development as a joint implementation project. In this scenario energy efficiency program will be fully implemented at BFW. Coke consumption will be reduced.

Scenario 2. Implementation of the proposed project without modernisation of the BFW
This scenario is a partial implementation of the scenario 1. Only operational and management measures of the energy efficiency program will be implemented. Those measures include the following components:

a) Increasing the iron content in the iron-ore materials;
b) Decreasing the silicon content in the pig iron;
c) Decreasing the BFs idle times;
d) Partial substitution of the limestone by lime.

[11] http://industry.kmu.gov.ua/control/uk/archive/docview?typeId=70489

Scenario 3. Implementation of the BFW modernisation only
This scenario is a partial implementation of the scenario 1. Only modernisations of BFs as a part of the energy efficiency program will be implemented. Those measures include the following components:

a) Modernisation of the BF6;
b) Modernisation of the BF3;
c) Reconstruction of the BF2.

Scenario 4. Consequent implementation of the proposed project's measures
This scenario is similar to the project activity, though in this case the project's measures will be introduced in sequential order, i.e. the next measure would be started only after previous measure is in place.

Scenario 5. Introduction of the PCI technology at BFW
In this scenario Pulverized Coal Injection (PCI) technology will be introduced at BFW of Azovstal. In order to realize this scenario the following subprojects should be implemented:

a) A new workshop for the coal milling and drying construction;
b) Pulverized coal transportation system construction;
c) Modernisation of the BFs;
d) Auxiliary infrastructure preparation.

Scenario 6. Continuation of existing situation
In this scenario BFW of Azovstal will continue producing pig iron at the level limited by project capacity of the existing at the moment BFs. Energy efficiency program will not be implemented and specific coke consumption will remain on the same level. Only regular maintenance will be performed in order to prolong lifetime of the BFs.

Sub step 2.2 Consistency with mandatory applicable laws and regulations.

All the proposed scenarios do not contradict existing laws and regulations.

Sub step 2.3 Barrier analysis

Scenario 1. Implementation of the proposed project's components without JI incentives
For the detailed barrier analysis of this scenario please refer to Section B.2.

Scenario 2. Implementation of the proposed project without modernisation of the BFW
An energy efficiency program directed at reducing the coke consumption considered as a proposed JI project is an integrated program. Therefore, a program could not be implemented at the BFW without the modernisation of the equipment due to the following reasons.

Increasing the iron content in the iron-ore materials.
BFW at Azovstal uses mainly a mix of sinter and pellets as iron-ore materials. Iron content of the sinter and pellets is about 51-53% and 63-64%, respectively. So the goal of this subproject could be reached by increase of pellets content.

One of the main characteristics of the charging into BFs materials is basicity that could be expressed as $\frac{CaO}{SiO_2}$ with the following values for the materials:

- Sinter – 1.8
- Pellets – 0.5-0.8

Oxides as a part of materials being melted in the BF create protective layer, called a skull, on the walls of BFs. It is very important to keep this skull intact. The skull is effective only when basicity of the charging materials is at the level of about 1.25. In case of pellets intensive usage basicity of the materials will be much lower than 1.25 and the skull will outwash from the wall leading to the high risk of damage of the brickwork and cooling system. To avoid the outwashing of the skull due to the high pellet content in the charging materials, basicity could be increased up to 1.25 by charging additional amount of lime/limestone. However, additional amounts of coke will be needed to process lime/limestone and the coke savings will be not achieved.

Decreasing the silicon content in the pig iron

In order to prolong the life of the BF and especially already depreciated brickwork of the hearth the temperature at the hearth should be kept at the high level (not less than 1450^0C). At this temperature part of coke is transferred into flaked graphite. This graphite seals up the interstice and breaks of damaged brickwork of the blast furnace hearth. In the same time, with a temperature of more than 1450^0C a reduction of the silicon is taking place as a result of the following heat-absorbing reaction:

$$SiO_2 + 2C = Si + 2CO – Q$$

So, in order to reduce coke consumption by decreasing silicon content, the hearth of the blast furnace should be modernized and kept in a proper condition.

Decreasing the BFs idle times

Idle times decreasing of the furnaces mainly depend on three factors:

- Overall technical condition of the BFs;
- Ability to control and monitor the technological process of pig iron production by automatic control systems;
- Well trained personnel.

So, idle times decreasing at BFW could be achieved only as a result of modernisations at BFW.

So, in order to implement operational and management measures within the framework of this scenario the BFs should be upgraded. Introduction of the proposed scenario without modernisations of the BFs would lead to equipment failures. So, this scenario faces strong technological barriers and looks not realistic.

Scenario 3. Implementation of the modernisation of the BFW only

As it was mentioned above, an energy efficiency program directed to the coke consumption reduction considered as a proposed JI project is an integrated program. The content of the proposed scenario developed with the purpose of a certain performance of the BFW achieved in combination with operational and management measures. If the operational component of the program is ignored the planned performance of the BFW (in terms of coke consumption) could not be achieved.

In addition, the implementation of the proposed scenario requires significant investment, thus facing an investment barrier. For more detailed information concerning investment barriers please refer to the section B.2.

That is why the proposed scenario, implemented in isolation from operational measures, is not realistic.

Scenario 4. Sequential implementation of the proposed project's measures

An energy efficiency program at Azovstal was developed in order to reduce specific coke consumption keeping the techno-economical performance indicators of the BFW on the certain level. Pig iron production is the complex multi-factor process. Introduction of any changes will lead to the disturbance of the normal BF's operation. That is why the proposed program has a **gradual** implementation schedule. The way of the introduction was developed based on the specific character of the pig iron production at Azovstal (such as content of the available raw materials, condition of the BFs, etc).

So, implementation of the program in sequential order would introduce the different disturbances in the BFs operations with underperformance of the BFs. As a result, coke consumption reduction will be not achieved. That is why the proposed scenario is not realistic.

<u>Scenario 5. Introduction of the PCI technology at BFW</u>
PCI technology, energy saving measure allowing reduction of the coke consumption, is widely used in the world. Azovstal considered introduction of the PCI by constructing:

a) The new workshop for the coal milling and drying construction;
b) Pulverized coal transportation system construction;
c) Modernisation of the BFs;
d) Auxiliary infrastructure preparation.

According to the feasibility study a PCI facility with the capacity 150 kg/t of pig iron for the BFW will cost about $90m USD. Financial indicator of the proposed scenario, such as payback period, is less than 3 years.

Nevertheless, this scenario faces a strong investment barrier. For more detailed information concerning investment barriers please refer to the section B.2.

In addition, there are additional technological risks for this scenario associated with the following issues:

1) New workshop for the coal milling and drying requires well trained personnel that is absent at Azovstal at the moment;
2) Failure and stoppage of the new workshop which could lead to an emergency/worst-case situations at all BFs of Azovstal;
3) Introduction of the PCI requires changing of the technological parameters at BFs and could lead to the disturbance of the normal operational mode of the BFW and to the underperformance as the result.

Taking into account risks and barriers mentioned above, this scenario looks unrealistic.

<u>Scenario 6. Continuation of existing situation.</u>
This scenario does not anticipate any activities (except for regular maintenance) and therefore does not face any barriers.

Step 2.4 General description of the baseline scenario
Azovstal produces pig iron using Blast Furnaces (BFs). Technology for the pig iron production is not likely to be substituted by other technologies (like direct reduction iron DRI) because of the following main reasons:

- BFW is a core workshop at Azovstal, so the substitution of the main technology means the construction of a new metallurgical plant.
- Azovstal is a part of the integrated holding with own raw materials recourses, which is suitable for the BF technology mainly.

BFW includes six BFs, the project capacity of each is shown in the table B.1 below. At the base period five from six BFs are operating. BF2 was stopped in 1998 because of raw materials shortages. The reconstruction started in 2003 and is to be finished in 2006.

Furnace	Payload volume, m^3	Project design capacity, t/a
BF1	1233	710 000
BF3	1800	1 100 000
BF4	2002	1 300 000
BF5	1513	1 000 000
BF6	1719	1 050 000
Total	**8267**	**5 160 000**

Table B.1. Project design parameters of the BFs

The comparison of tables A.2 and B.1 shows that after reconstruction of BF2 capacity of BFW will be increased from 5.16m tons of pig iron to 6.26m tons. According to the baseline scenario that has been justified in the Section B.2., the BFW will continue pig iron production at the levels shown in table B.1 without any significant modernisation and/or other measures directed to energy source savings, apart from certain circumstances such as regular maintenances. In the baseline scenario BFs will require regular maintenance to sustain the current performance in line with Table B.1.

According to the standards and norms, regular maintenance and overhauling of the main equipment of the BFW planning is to be performed within certain time periods shown below in Table B.2.

Type of maintenance	Period between maintenances, years	Maintenance duration, days
First category maintenance of the BF	14-16	36-40
Second category maintenance of the BF	3-5	15-20
Third category maintenance of the BF	1-2	2-5
First category maintenance of the hot stove	25	360
Second category maintenance of the hot stove	10	180
Third category maintenance of the hot stove	5	90

Table B.2. Maintenance timing

During maintenance the production of pig iron at a particular BF is stopped.

The emissions in the baseline scenario are calculated based on the specific factor, so ERUs will not be earned for the decrease in activity levels during maintenances.

Step 2.5. Description of the specific emission factor calculation approach in the baseline scenario

Pig iron production at the BFs requires a set of materials and fuel types to be charged into the furnace. All carbon content materials are taken into account. Moreover, four supporting workshops such as CHP1, CHP2, Oxygen workshop, and Coke plant are also taken into account. The schematic layout of the material flows between workshops is shown in Figure B.1 below.

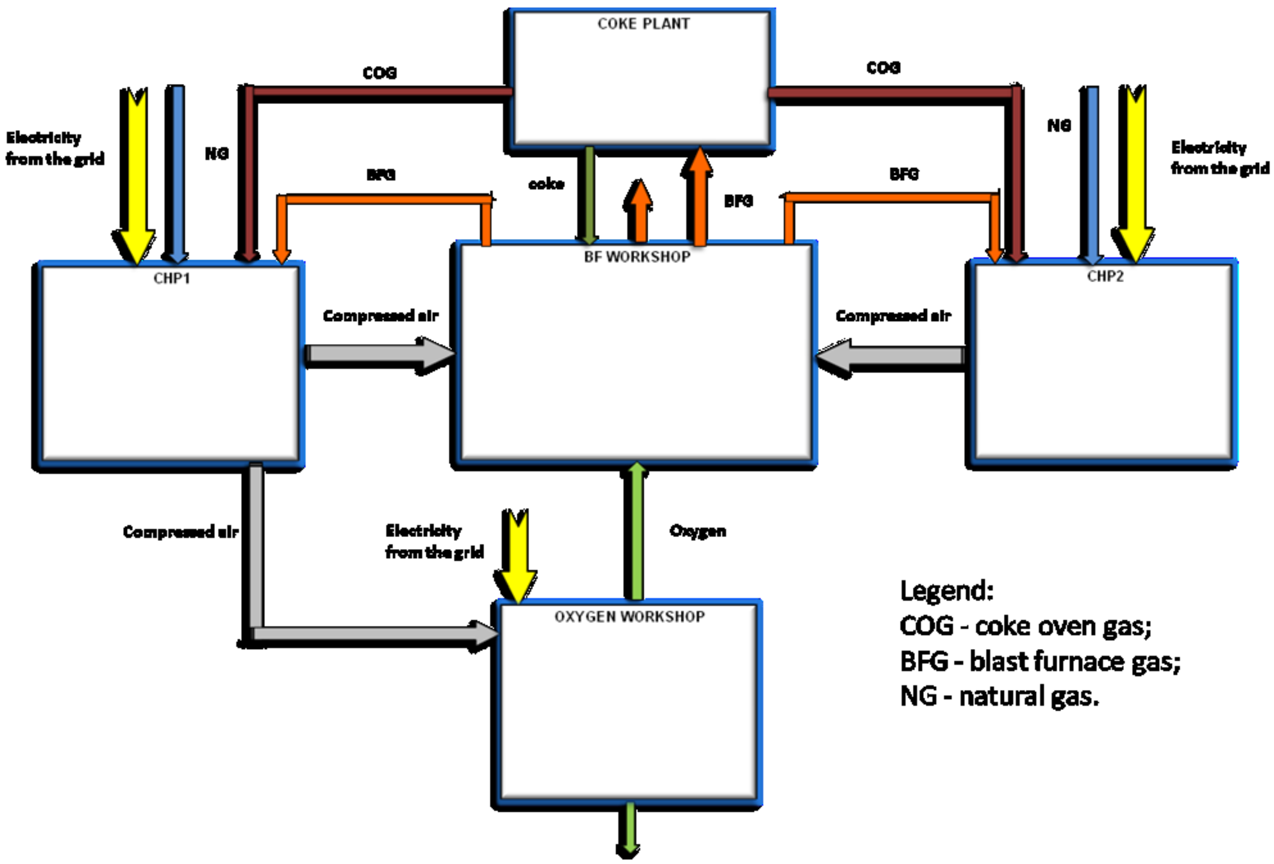

Figure B.1. Materials and fuel flows between workshops at Azovstal

The Coke plant belongs to Azovstal does not cover 100% of the coke demand of the BFW. To resolve uncertainty related to the different coke suppliers and adopting a conservative approach, the default factor for the IPCC calculations for coke production was chosen[12].

Electricity production at CHP1 and CHP2 covers auxiliary demand only, so electricity for the BFs and electro compressors is imported from the grid.

The heat consumption at BFW is excluded from the calculations because of the following reasons:

- Demand has been decreasing every year since 2001;
- Heat is supplied to the BFW from three different sources, with the different sources selected from time to time on a demand basis.

Hence, this exclusion is conservative.

The production of the pig iron at the existing BFW is in line with national policies. Fuels and raw materials are available.

Emissions of the GHG in the baseline scenario for the commitment period will be calculated by the following formulae:

[12] Volume 3, Chapter 4 "Metal Industry", table 4.1, p.4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

$$BE_y = P_y^{iron} \times EF_{iron} \qquad (B.1)$$

Where:

BE_y	Baseline emissions in the year y (tCO_2);
P_y^{iron}	Quantity of iron produced in the year y (t);
EF_{iron}	Baseline emission factor of iron production (tCO_2/t);

Baseline emission factor of pig iron production is calculated as a specific emission factor for raw materials and fuels which are the source of the CO_2 emissions during pig iron production and preparation phase:

$$EF_{iron} = (EF_{blast} \times P_{blast} + EF_{oxygen} \times P_{oxygen} + EF_{NG}^{IPCC} \times NCV_{NG} \times P_{NG} + EF_{elec} \times P_{elec} + \\ + EF_{coke}^{production} \times P_{coke} + C_{coke} \times P_{coke} \times 44/12 + EF_{\text{limestone}} \times P_{\text{limestone}} + EF_{\text{lime}}^{production} \times P_{\text{lime}} + \\ + EF_{pellet}^{IPCC} \times P_{pellet} + EF_{\text{sinter}}^{IPCC} \times P_{\text{sinter}}) / P_{iron} \qquad (B.2)$$

Where:

EF_{blast}	Specific emission factor for the blast production at CHP1 and CHP2 (see Formulae B.2-4)($tCO_2/1000m^3$);
P_{blast}	Amount of blast produced for the BFW in the base period ($1000m^3$);
EF_{oxygen}	Specific emission factor for the oxygen production at oxygen workshop (see Formulae B.5-6) ($tCO_2/1000m^3$);
P_{oxygen}	Amount of oxygen produced for the BFW in the base period ($1000m^3$);
EF_{NG}^{IPCC}	IPCC default emission factor for the natural gas combustion. Set as 0.0561 tCO_2/GJ[13];
NCV_{NG}	Net calorific value of the natural gas for the base period ($GJ/1000m^3$);
P_{NG}	Amount of natural gas combusted at the BFW during the base period ($1000m^3$);
EF_{elec}	Emission factor for the Ukrainian electrical grid. Set as 0,896 tCO_2/MWh[14];
P_{elec}	Amount of electricity consumed at BFW during the base period (MWh);
$EF_{coke}^{production}$	IPCC default emission factor for the coke production. Set as 0.56 tCO_2/t;
C_{coke}	IPCC carbon content of coke consumed at BFW during the baseline period. Set as 0.83 (t/t);
P_{coke}	Amount of coke consumed at BFW during the base period (t);
$EF_{\text{limestone}}$	Default emission factor for the limestone calcination. Carbon content is 0.12tC/t[15]. Set as 0.44 tCO_2/t;
$P_{\text{limestone}}$	Amount of limestone consumed at BFW during the base period (t);
$EF_{\text{lime}}^{production}$	IPCC default emission factor for the lime production. Set as 0.75 tCO_2/t[16];

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[13] Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

[14] For more details see Annex 2.

[15] Volume 3, Chapter 4 "Metal Industry", table 4.3, p.4.27 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

[16] Volume 3 Chapter 2 Mineral Industry emissions. Equation 2.8, p. 2.22 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf

P_{lime}	Amount of lime consumed at BFW during the base period (t);
EF_{pellet}^{IPCC}	IPCC default emission factor for the pellets production. Set as 0.03 tCO_2/t[17];
P_{pellet}	Amount of pellets consumed at BFW during the base period (t);
$EF_{\text{sinter}}^{IPCC}$	IPCC default emission factor for the sinter production. Set as 0.2 tCO_2/t[18];
P_{sinter}	Amount of sinter consumed at BFW during the base period (t);

Blast for the BFW is a product of CHP1 and CHP2. It is produced by turbo compressors, which are driven by steam turbines. Steam for the turbines is produced in the boilers by the combustion of three types of gases – natural gas, COG, and BFG. Electricity for the blast production is taken from their own generation capacities of the CHP1 and CHP2. Electricity is generated in a similar manner to that of the blast, by the combustion of three types of gases. BFG is not taken into account during emission factor calculation to avoid double counting. So, emission factor for the blast production is calculated as follows:

$$EF_{blast} = (P_{NG}^{CHP1} + P_{NG}^{CHP2}) \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP1} + P_{COG}^{CHP2}) \times NCV_{COG} \times EF_{COG}^{IPCC} + \\ + EF_{elec}^{CHP1} \times P_{elec}^{CHP1} + EF_{elec}^{CHP2} \times P_{elec}^{CHP2})/(P_{blast}^{CHP1} + P_{blast}^{CHP2}) \quad (B.3)$$

With

$$EF_{elec}^{CHP1} = (P_{NG}^{CHP1elec} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP1elec} \times NCV_{COG} \times EF_{COG}^{IPCC}) / P_{elec}^{CHP1} \quad (B.4)$$

And

$$EF_{elec}^{CHP2} = (P_{NG}^{CHP2elec} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP2elec} \times NCV_{COG} \times EF_{COG}^{IPCC}) / P_{elec}^{CHP2} \quad (B.5)$$

Where:

P_{NG}^{CHP1}	Amount of natural gas consumed at CHP1 for blast production ($1000m^3$);
P_{NG}^{CHP2}	Amount of natural gas consumed at CHP2 for blast production ($1000m^3$);
P_{COG}^{CHP1}	Amount of COG consumed at CHP1 for blast production ($1000m^3$);
P_{COG}^{CHP2}	Amount of COG consumed at CHP2 for blast production ($1000m^3$);
NCV_{COG}	Net calorific value of COG ($GJ/1000m^3$);
EF_{COG}^{IPCC}	IPCC default emission factor for the COG combustion. Set as 0.0444 tCO_2/GJ[19];
EF_{elec}^{CHP1}	Specific emission factor for the electricity production at CHP1 (tCO_2/MWh);
P_{elec}^{CHP1}	Amount of electricity consumed during blast production at CHP1 (MWh);
EF_{elec}^{CHP2}	Specific emission factor for the electricity production at CHP2 (tCO_2/MWh);
P_{elec}^{CHP2}	Amount of electricity consumed during blast production at CHP2 (MWh);
P_{blast}^{CHP1}	Amount of blast produced at CHP1 ($1000m^3$);

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17 Volume 3, Chapter 4 "Metal Industry", table 4.1, p.4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

18 Volume 3, Chapter 4 "Metal Industry", table 4.1, p.4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

19 Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

P_{blast}^{CHP2}	Amount of blast produced at CHP2 (1000m^3);
$P_{NG}^{CHP1elec}$	Amount of natural gas consumed at CHP1 for electricity production (1000m^3);
$P_{COG}^{CHP1elec}$	Amount of COG consumed at CHP1 for electricity production (1000m^3);
P_{elec}^{CHP1}	Amount of electricity produced at CHP1 (MWh);
$P_{NG}^{CHP2elec}$	Amount of natural gas consumed at CHP2 for electricity production (1000m^3);
$P_{COG}^{CHP2elec}$	Amount of COG consumed at CHP2 for electricity production (1000m^3);
P_{elec}^{CHP2}	Amount of electricity produced at CHP2 (MWh).

Oxygen at Azovstal is produced in the oxygen workshop from compressed air. Compressed air enters the oxygen workshop from three sources:

- Turbo compressors of CHP1;
- Electro compressors of CHP1;
- Electro compressors of oxygen workshop;

In addition some electricity is consumed by oxygen workshop by itself. So, specific emission factor for the oxygen production is calculated as follows:

$$EF_{oxygen} = ((P_{elec}^{CHP1compress} + P_{elec}^{OXcompress} + P_{elec}^{OX}) \times EF_{elec} + P_{air}^{CHP1} \times EF_{air}^{CHP1}) / P_{oxygen}^{workshop} \qquad (B.6)$$

With

$$EF_{air}^{CHP1} = (P_{NG}^{CHP1air} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP1air} \times NCV_{COG} \times EF_{COG}^{IPCC} + P_{elec}^{CHP1air} \times EF_{elec}^{CHP1}) / P_{air}^{CHP1} \qquad (B.7)$$

Where:

$P_{elec}^{CHP1compress}$	Amount of electricity consumed by electro compressors of CHP1 (MWh);
$P_{elec}^{OXcompress}$	Amount of electricity consumed by electro compressors of oxygen workshops (MWh);
P_{elec}^{OX}	Amount of electricity consumed by oxygen workshops (MWh);
P_{air}^{CHP1}	Amount of compressed air produced by turbo compressors of CHP1 (1000m^3);
EF_{air}^{CHP1}	Specific emission factor for the compressed air produced by turbo compressors of CHP1 (tCO_2/1000m^3);
$P_{oxygen}^{workshop}$	Amount of oxygen produced by oxygen workshop (1000m^3);
$P_{NG}^{CHP1air}$	Amount of natural gas consumed for the compressed air production by turbo compressors of CHP1 (1000m^3);
$P_{COG}^{CHP1air}$	Amount of COG consumed for the compressed air production by turbo compressors of CHP1 (1000m^3);
$P_{elec}^{CHP1air}$	Amount of electricity consumed for the compressed air production by turbo compressors of CHP1 (MWh);

Step 2.5 Application of the approach to the EF calculation

To calculate the baseline specific emission factor, an average value for every factor was calculated for the three years prior to the start of the project activities.

The performance of the BFW over the years 2001-2003 calculated based on the data for each BF is shown in the following table, B.3:

	Unit	2001	2002	2003
Pig iron production	t	3 788 692	3 840 986	4 395 196
Coke consumption[20]	t	2 328 720	2 310 296	2 548 271
Blast production for BFW	$1000m^3$	7 916 660	7 609 691	8 304 221
Oxygen production for BFW	$1000m^3$	415 526	465 147	615 279
NG consumption	$1000m^3$	341 504	352 160	513 173
Electricity consumption	MWh	41 470	29 610	38 346
Consumption of lime	t	0	0	171 191
Consumption of limestone	t	333 468	418 672	329 610
Sinter consumption	t	4 511 694	3 738 628	3 944 125
Pellet consumption	t	2 527 867	3 360 239	3 973 031
Pig iron carbon content	tC/t	0,042	0,042	0,042
Coke carbon content	tC/t	0,830	0,830	0,830

Table B.3. Main baseline material flows of the BFW. Source – Technical reports of BFW

The performance of the CHP1 over the years 2001-2003 is shown in the following table, B.4:

	Unit	2001	2002	2003
General factors				
NCV of NG	$ccal/m^3$	8 006	8 043	8 015
NCV of COG	$ccal/m^3$	3 951	4 001	4 038
Electricity production at CHP1				
Electricity produced	MWh	197 218	189 643	257 914
NG consumption	$1000m^3$	17 919	14 606	21 218
COG consumption	$1000m^3$	19 967	22 190	39 759
Blast production at CHP1				
Blast production by CHP1	$1000m^3$	4 130 575	3 878 539	4 016 173
NG consumption	$1000m^3$	39 858	27 386	28 101
COG consumption	$1000m^3$	44 414	41 606	52 657
Electricity consumed	MWh	32 261	33 274	32 436
Compressed air production	$1000m^3$	2 138 638	554 877	1 303 297
NG consumption	$1000m^3$	28 015	5 310	12 218
COG consumption	$1000m^3$	31 217	8 067	22 896
Electricity consumption	MWh	29 315	7 764	16 755
Compressed air production	$1000m^3$	1 061 803	2 364 029	2 271 744
Electricity consumption	MWh	140 040	244 959	246 270

Table B.4. Main baseline figures of the CHP1. Source – Technical reports of CHP1

The performance of the CHP2 the years 2001-2003 is shown in the following table, B.5:

	Unit	2001	2002	2003
General factors				
NCV of NG	$ccal/m^3$	8 006	8 043	8 015
NCV of COG	$ccal/m^3$	3 951	4 001	4 038
Electricity production at CHP2				
Electricity produced	MWh	75 791	160 058	147 814

[20] Coke consumption includes consumption of coke and coke nuts

	Unit	2001	2002	2003
NG consumption	$1000m^3$	2 871	10 835	5 219
COG consumption	$1000m^3$	20 112	44 671	38 821
Blast production at CHP2				
Blast production by CHP2	$1000m^3$	3 786 085	3 731 152	4 288 048
NG consumption	$1000m^3$	10 194	17 431	10 178
COG consumption	$1000m^3$	71 421	71 867	75 700
Electricity consumed	MWh	19 324	18 405	22 675

Table B.5. Main baseline figures of the CHP2. Source – Technical reports of CHP2

The performance of the oxygen workshop over the years 2001-2003 is shown in the following table, B.6:

	Unit	2001	2002	2003
Oxygen production	$1000m^3$	767 473	821 705	989 258
Compressed air production at electro compressors	$1000m^3$	1 428 623	1 818 323	2 016 100
Electricity consumption at electro compressors	MWh	153 256	190 276	208 992
Electricity consumption	MWh	118 455	117 380	127 307

Table B.6. Main baseline figures of the oxygen workshop. Source – Technical reports of oxygen workshop

Default factors shown in the table below, B.7:

Factor	Unit	Value
Natural gas combustion	tCO_2/GJ	0.0561
COG combustion	tCO_2/GJ	0.0444
Ukrainian electricity grid	tCO_2/MWh	0.896
Coke production	tCO_2/t	0.56
Lime production	tCO_2/t	0.75
Coke carbon content	t/t	0.83
Limestone calcinations	tCO_2/t	0.44
Sinter production	tCO_2/t	0.2
Pellets production	tCO_2/t	0.03
Conversion factor	kcal/MJ	238.846

Table B.7. Default emission and conversion factors

Applying formulas B.1-B.7 to the figures in the tables B.3-B.7 the following baseline emission factors are obtained, shown below in table B.8:

Emission Factor	Unit	Value
Electricity production at CHP1	tCO_2/MWh	0.251
Electricity production at CHP2	tCO_2/MWh	0.294
Blast production	$tCO_2/1000m^3$	0.023
Compressed air production at turbo compressors CHP1	$tCO_2/1000m^3$	0.036
Oxygen production	$tCO_2/1000m^3$	0.594

Table B.8. Specific baseline emission factors for auxiliary facilities

EF for the pig iron production is calculated for the each BF and for the BFW based on aggregated data. Results of the calculations of the overall EF for the BFW presents in the following table, B.9:

Facility	Unit	2001	2002	2003	Average
BFW	tCO_2/t	2.805	2.734	2.713	**2.749**

Table B.9. Specific baseline emission factors for the BFW

Outcome of Section B.1

According to the "Guidelines for Users of The Joint Implementation Project Design Document Form" (version 04 available at http://ji.unfccc.int/Ref/Docs.html) the baseline is established:

- based on a JI specific approach and using a multi-project emission factor for the Ukrainian electricity grid;
- with the calculation of the baseline specific emission factor for the pig iron production made in transparent manner with regard to the choice of approaches, assumptions, parameters, data sources and key factors;
- taking into account national policies and circumstances;
- in such a way that ERUs cannot be earned for decreases in activity level outside the project activity or due to force majeure;
- taking into account uncertainties and using conservative assumptions.

The key information and data used to establish baseline presents below in a tabular form.

Data/Parameter	P_{blast}
Data unit	1000m^3
Description	amount of blast produced for the BFW in the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical reports of CHP1 and CHP2
Value of data applied (for ex ante calculations/determinations)	2001 / 2002 / 2003 / average: 4 130 575 / 3 878 539 / 4 016 173 / 4 008 429 3 786 085 / 3 731 152 / 4 288 048 / 3 935 095
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	average
4 130 575	3 878 539	4 016 173	4 008 429
3 786 085	3 731 152	4 288 048	3 935 095

Data/Parameter	P_{oxygen}
Data unit	1000m^3
Description	amount of oxygen produced for the BFW in the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001 / 2002 / 2003 / **average**: 767 473 / 821 705 / 989 258 / **859 479**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003

2001	2002	2003	**average**
767 473	821 705	989 258	**859 479**

QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{NG}
Data unit	$1000m^3$
Description	Amount of natural gas combusted at the BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 341 504; 2002: 352 160; 2003: 513 173; **average: 402 279**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
341 504	352 160	513 173	**402 279**

Data/Parameter	P_{elec}
Data unit	MWh
Description	Amount of electricity consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 41 470; 2002: 29 610; 2003: 38 346; **average: 36 475**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
41 470	29 610	38 346	**36 475**

Data/Parameter	P_{coke}
Data unit	t
Description	Amount of coke consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 2 328 720; 2002: 2 310 296; 2003: 2 548 271; **average: 2 395 762**

2001	2002	2003	**average**
2 328 720	2 310 296	2 548 271	**2 395 762**

Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{limestone}$
Data unit	t
Description	Amount of limestone consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 332 980; 2002: 418 672; 2003: 329 610; **average: 360 421**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
332 980	418 672	329 610	**360 421**

Data/Parameter	P_{lime}
Data unit	t
Description	Amount of lime consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 0; 2002: 0; 2003: 171 191; **average: 57 064**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
0	0	171 191	**57 064**

Data/Parameter	P_{iron}
Data unit	t
Description	Amount of iron produced at BFW during the baseline period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW

Value of data applied (for ex ante calculations/determinations)	2001: 3 788 692; 2002: 3 840 986; 2003: 4 395 196; **average: 4 008 291**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{NG}^{CHP1}
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP1 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 39 858; 2002: 27 386; 2003: 28 101; **average**: 31 782
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{NG}^{CHP2}
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP2 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 10 194; 2002: 17 431; 2003: 10 178; **average**: 12 601
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{COG}^{CHP1}
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP1 for blast production
Time of	Fixed ex-ante during determination

determination/monitoring	
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 44 414; 2002: 41 606; 2003: 52 657; **average**: 46 226
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{COG}^{CHP2}
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP2 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 71 421; 2002: 71 867; 2003: 75 700; **average**: 72 996
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	EF_{elec}^{CHP1}
Data unit	MWh
Description	Amount of electricity consumed during blast production at CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 32 261; 2002: 33 274; 2003: 32 436; **average**: 32 657
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{elec}^{CHP2}

Data unit	MWh
Description	Amount of electricity consumed during blast production at CHP2
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 19 324; 2002: 18 405; 2003: 22 675; **average**: 20 135
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{NG}^{CHP\backslash elec}$
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP1 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 17 919; 2002: 14 606; 2003: 21 218; **average**: **17 914**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{COG}^{CHP\backslash elec}$
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP1 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 19 967; 2002: 22 190; 2003: 39 759; **average**: **27 305**
Justification of the choice of data or description of measurement methods and procedures (to be)	Average value for the period 2001-2003

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

Data/Parameter	P_{elec}^{CHP1}
Data unit	MWh
Description	Amount of electricity produced at CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 197 218; 2002: 189 643; 2003: 257 914; **average: 214 925**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
197 218	189 643	257 914	**214 925**

Data/Parameter	$P_{NG}^{CHP2elec}$
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP2 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 2 871; 2002: 10 835; 2003: 5 219; **average: 6 308**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
2 871	10 835	5 219	**6 308**

Data/Parameter	$P_{COG}^{CHP2elec}$
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP2 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 20 112; 2002: 44 671; 2003: 38 821; **average: 34 534**

2001	2002	2003	**average**
20 112	44 671	38 821	**34 534**

Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{elec}^{CHP2}
Data unit	MWh
Description	Amount of electricity produced at CHP2
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 75 791; 2002: 160 058; 2003: 147 814; **average: 127 887**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
75 791	160 058	147 814	**127 887**

Data/Parameter	$P_{elec}^{CHP1compress}$
Data unit	MWh
Description	Amount of electricity consumed by electro compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 140 040; 2002: 244 959; 2003: 246 270; **average: 210 423**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
140 040	244 959	246 270	**210 423**

Data/Parameter	$P_{elec}^{OXcompress}$
Data unit	MWh
Description	Amount of electricity consumed by electro compressors of oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination

Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 153 256; 2002: 190 276; 2003: 208 992; **average: 184 175**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{elec}^{OX}
Data unit	MWh
Description	Amount of electricity consumed by oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 118 455; 2002: 117 380; 2003: 127 307; **average: 121 047**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{air}^{CHP1}
Data unit	$1000m^3$
Description	Amount of compressed air produced by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 2 138 638; 2002: 554 877; 2003: 1 303 297; **average: 1 332 271**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{oxygen}^{workshop}$
Data unit	$1000m^3$

Description	Amount of oxygen produced by oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 767 473; 2002: 821 705; 2003: 989 258; **average: 859 479**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{NG}^{CHP1air}$
Data unit	1000m^3
Description	Amount of natural gas consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 28 015; 2002: 5 310; 2003: 12 218; **average: 15 181**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	$P_{COG}^{CHP1air}$
Data unit	1000m^3
Description	Amount of COG consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 31 217; 2002: 8 067; 2003: 22 896; **average: 20 727**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	

Any comment	

Data/Parameter	$P_{elec}^{CHP1air}$
Data unit	MWh
Description	Amount of electricity consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 29 315; 2002: 7 764; 2003: 16 755; **average: 17 945**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
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 following step-wise approach is used to demonstrate that the project provides reductions in emissions by sources that are additional to any that would otherwise occur:

Step 1. Indication and description of the approach applied
As suggested by Paragraph 2 (c) of the Annex 1 of the Guidance the most recent version of the "Tool for the demonstration and assessment of additionality" approved by the CDM Executive Board is used to demonstrate additionality. At the time of this document completion the most recent version of the "Tool for the demonstration and assessment of additionality" approved by the CDM Executive Board is version 05.2[21] and it is used to demonstrate additionality of the project activity.

Step 2. Application of the approach chosen
The following steps are taken as per "Tool for the demonstration and assessment of additionality" version 05.2

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity:
The identified alternatives are identical to the alternatives mentioned in section B.1.

Step 2. Investment analysis
Not applicable. Barrier analysis has been chosen for additionality proof.

Step 3. Barrier analysis

[21] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

Sub-step 3a. Identification of barriers that would prevent the proposed JI project activity
According to the tool list of the barriers may include**:**

- Investment barrier;
- Technological barrier;
- Lack of prevailing practice;
- Other barriers.

Investment barriers
Ukraine is considered to be a high risk country for doing business and investing in. Almost no private capital is available from domestic or international capital markets for mid to long term investments, and any capital that is available has high cost. The table below represents risks of doing business in Ukraine according to various international indexes and studies.

Indicators	2008	Note
Corruption index of Transparency International	134 position from 180	Index of corruption
Rating of business practices of The World Bank (The Doing Business)	139 position from 178	Rating of conduct of business (ease of company opening, licensing, staff employment, registration of ownership, receipt of credit, defence of interests of investors)
The IMD World Competitiveness Yearbook	54 position from 55	Research of competitiveness (state of economy, efficiency of government, business efficiency and state of infrastructure)
Index of Economic Freedom of Heritage Foundation	133 position from 157	Determination of degrees of freedom of economy (business, auction, financial, monetary, investment, financial, labour freedom, freedom from Government, from a corruption, protection of ownership rights)
Global Competitiveness Index of World Economic Forum	72 position from 134	Competitiveness (quality of institutes, infrastructure, macroeconomic stability, education, development of financial market, technological level, innovative potential)

Table B.10. International ratings of Ukraine[22]

The data above shows that both real and perceived risks of investing in Ukraine are in place and influence the availability of capital in Ukraine both in terms of size of the investments and in terms of capital costs. The comparison of commercial lending rates in Ukraine and in Eurozone for the loans over 5 years in EUR is presented in a figure below:

[22] State Agency of Ukraine for Investments and Innovations http://www.in.gov.ua/index.php?lang=en&get=225&id=1990

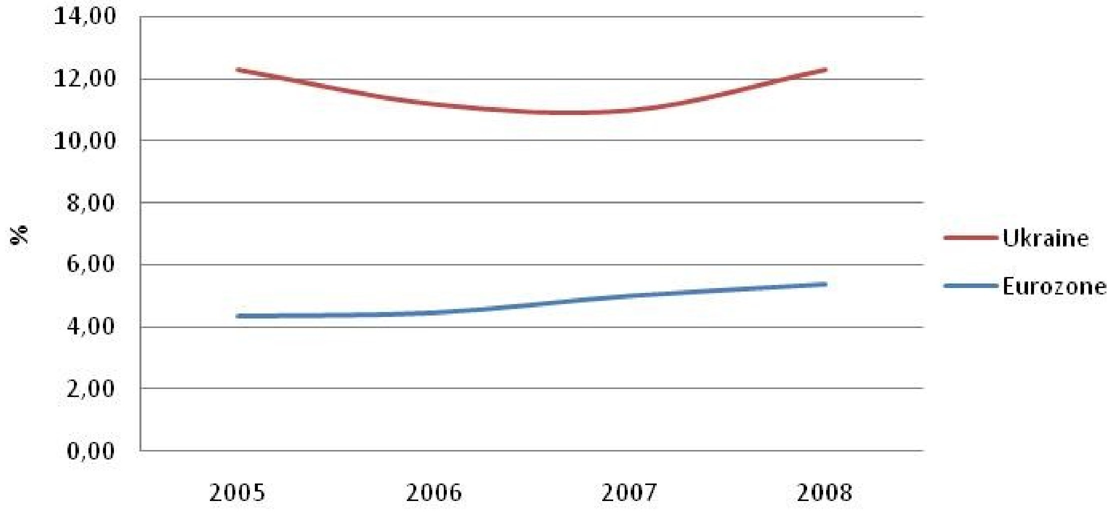

Figure B.2. Commercial lending rates, EUR, over 5 years[23]

Cost of debt financing in Ukraine is at least twice higher than in the Eurozone. The risks of investing into Ukraine are additionally confirmed by the country ratings provided by the Moody's international rating agency and the associated country risk premium. The table below compares country risk premiums for Russia and Ukraine:

Total Risk Premium, %	**2004**[24]	**2005**[25]	**2006**[26]
Russia	7.02	6.6	6.64
Ukraine	11.59	10.8	10.16

As it is demonstrated by this table, Russia, while offering a comparable set of investment opportunities, is a significantly less risky country for investing in than Ukraine. An assessment of investment process throughout metallurgical sectors shows that in 2000-2003 average investments in $ per 1 tonne of steel were $30 in US, $25 in EU, $15 in Russia and $7.8 in Ukraine[27]. In this sector in Ukraine financing is needed but is inadequate and most of the investments are covered by equity.

As stated at the OECD Roundtable on Enterprise Development and Investment Climate in Ukraine, the current legal basis is not only inadequate, but to a large extent sabotages the development of market economy in Ukraine. Voices in the western press can basically be summarized as follows: The reforms in the tax and legal systems have improved considerably with the adoption of the commercial Code, Civil Code and Customs Code on 1 January 2004 but still contain unsatisfactory elements and pose a risk for

[23] Data for Ukraine from National Bank of Ukraine http://www.bank.gov.ua/Statist/Electronic%20bulletin/data/4-Financial%20markets(4.1).xls

Data for Eurozone from European Central Bank http://sdw.ecb.europa.eu/browseSelection.do?DATASET=0&REF_AREA=308&BS_COUNT_SECTOR=2240&node=2018783

[24] Data from Aswath Damodaran, Ph.D., Stern School of Business NYU http://www.stern.nyu.edu/~adamodar/pc/archives/ctryprem04.xls

[25] Data from Aswath Damodaran, Ph.D., Stern School of Business NYU http://www.stern.nyu.edu/~adamodar/pc/archives/ctryprem05.xls

[26] Data from Aswath Damodaran, Ph.D., Stern School of Business NYU http://www.stern.nyu.edu/~adamodar/pc/archives/ctryprem06.xls

[27] Metallurgical Sector of Ukraine Investment Problems, Chentukov Y.I., Problems of foreign economic relations development and attraction of foreign investments: regional aspect., ISSN 1991-3524, Donetsk, 2007. p. 535-538

foreign investors[28]. Ukraine is considered to be heading in the right direction with significant reforms having been put into action but still has a long way to go to realize its full potential. Frequent and unpredictable changes in the legal system along with conflicting and inconsistent Civil and Commercial Codes do not allow a transparent and stable enforced legal business environment to be established. This is perceived as a great source of uncertainty by international companies, which makes future predictions of business goals and strategy risky.

The conclusion from the abovementioned is as follows: the investment climate of Ukraine is risky and unwelcoming, private capital is not available from domestic or international sources or is available at prohibitively high cost due to real and perceived risks of doing business in Ukraine, as shown by various sources. Alternative markets, such as Russia, offer similar profile of investment opportunities with lower risk and better business environment.

Taking this into account, Azovstal has to use its own financial resources in order to implement the JI project, directly from the cash flow. This reduces the working capital for Azovstal and deviates money from other necessary investments, such as PCI technology introduction, for example. As a result, the investment barrier is a strong barrier for this project.

Technological barriers.
The main technological barriers which prevent implementation of the project are described below.

1. **Decreasing the BFs idle times.** The idle time at BFW is planned to be decreased by introducing a few automatic control systems, such as:
   a) Tuyere failure;
   b) Natural gas flow distribution over the tuyeres;
   c) Temperature field over the surface of charging materials;
   d) Cooling of the furnace's stack;
   e) Heat load at heat exchangers at hearth;
   f) Charging process.

These technologies have never been used before at Azovstal and some of them are first of its kind in Ukraine. This fact leads to the high risk of control systems' malfunctions, resulting in the underperformance of the BFs.

2. **Increasing the iron content in the iron-ore materials.** The BFW at Azovstal uses mainly a mix of sinter and pellets as iron-ore materials. The iron content of the sinter and pellets is about 51-53% and 63-64%, respectively. Therefore, the goal of this subproject could be reached by increasing of pellets content.

One of the main characteristics of the charging into BFs materials is basicity that could be expressed as $\frac{CaO}{SiO_2}$ with the following values for the materials:

- Sinter – 1.8
- Pellets – 0.5-0.8

Oxides as a part of materials that are melted in the BF create a protective layer, called a skull, on the walls of BFs. The skull is only effective when the basicity of the charging materials is at the level of about 1.25. In case of pellets intensive usage basicity of the materials will be much lower than 1.25 and skull will outwash from the wall leading to the high risk of damage of the brickwork and decreasing lifetime of the BFs as a result. Decreasing of the lifetime of the BF and brickwork particularly, leads to a

[28] Foreign Direct Investment in Ukraine – Donbass, Philip Burris, Problems of foreign economic relations development and attraction of foreign investments: regional aspect., ISSN 1991-3524, Donetsk, 2007. p. 507-510

more frequent maintenance and lower performance of the BFW. It is hard to establish the correlation between increased iron content and frequency of the maintenance. Assumption that the period between maintenances will be 10% less means that BFW will have additionally 2.5 hours of maintenance every year (see Table B.2) or equivalent of 1000 tons of pig iron losses annually (see Table B.3).

3. **Decreasing the silicon content in the pig iron.** In order to reduce silicon content in the pig iron, temperature in the hearth of the BF should be decreased. On the other hand, high temperature (more than 1450^{0}C) helps to create the layer of the flaked graphite on the brickwork of the hearth. So, the proposed subproject's realisation will lead to a higher risk of the brickwork damage and decrease the lifetime of the BFs and a conservative estimated loss of about 1000 tons of pig iron annually.

Lack of prevailing practice
The project is the first of its kind. Although several components of this project have been implemented or tried elsewhere, it is the first time in Ukraine that such an integral approach has been implemented at one plant. Due to the complexity of this project (modernisations, different mixture of raw materials, lower silicon content, etc) this project faces a barrier due to prevailing practice.

Some of engineering solutions, such as ceramic package of the brickwork, control system of the gas flow are being used in Ukraine for the first time.

In addition it should be noted that in spite of the fact that Azovstal personnel is experienced in the maintenance, it would be challenge for them to introduce modernisations and use technologies that have never been used before. The planned modernisations which would be implemented during the regular maintenance also requires extra time and labour. According to the estimation of the Azovstal management, maintenance at:

- BF6 without modernisations could save about 60 days or 170 000 extra tones of pig iron;
- BF3 – 20 days or 57 000 extra tones of pig iron.

So, implementation of the proposed energy efficiency program would lead to the underperformance of the BFW and additional financial losses.

On top of this, new automatic and control systems that would be accessible after modernisations require adjustement of the technological process and could lead to the additional underperformance of the BFW.

Sub-step 3 b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except for the proposed project activity):
Identified barriers above do not prevent the implementation of at least one alternative to project activity, which is the alternative scenario 5.

Step 4: Common practice analysis
There are 44 BFs in Ukraine. About 40% of those already exceed their lifetime according to the standards and norms. In spite of this fact, those BFs are still in operation. Generally, the schedule of the maintenance of all categories of the Ukrainian BFs is systematically violated.

Average specific coke consumption at European BFs estimated[29] as from 280 up to 410 kg/t of pig iron depends on site. At the same time, for the Ukrainian BFs this indicator gives value about 500 kg/t at the time of the proposed project starting date. This significant difference could be explained mainly by technical condition of Ukrainian BFs and level of technologies used.

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[29] IPPC. Best Available Techniques Reference Document on the Production of Iron and Steel, p 183. ftp://ftp.jrc.es/pub/eippcb/doc/isp_bref_1201.pdf

The proportion of sinter and pellets in the charging materials depends on value of basicity (see Sub Step 3a "Technological barrier"). In order to prolong lifetime of the already obsolete Ukrainian BFs level of sinter and pellets are kept at the level 76% and 24% correspondingly without any trend to increase pellets consumption and iron content in the iron-ore materials.

Unlike the overall Ukrainian situation in pig iron production, Azovstal is planning to decrease coke consumption on the system base by:

- modernisations of BFs;
- increasing the iron content in the iron-ore materials by increasing usage of pellets;
- decreasing silicon content in the pig iron;
- other operational and management measures that lead to the decreasing of the idle times.

So, an energy efficiency program planned to be implemented at the BFW is an integrated program that has no predecessors in Ukraine and could not be considered as a common practice.

Conclusion

This JI project provides reduction in emissions that is additional to any that would otherwise occur.

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

The project activities are limited physically by the BFW of the Azovstal. At the same time, there are few facilities attributable to the project where indirect emissions of the GHG are taking place, such as:

- CHP1 (production of the blast, electricity and compressed air for the oxygen workshop);
- CHP2 (production of the blast and electricity);
- Coke plants (production of coke);
- Lime kilns (production of lime);
- Ukrainian electricity grid (electricity production).

In accordance with "Guidance on criteria for baseline setting and monitoring" (available at http://ji.unfccc.int/Ref/Docs.html), all sources of emissions at the abovementioned facilities are either under control of project participants, or reasonably attributable to the project. Therefore, all of them are taken into account. In the table below an overview of all emission sources in the baseline and project scenarios process is given:

Source	Gas	Included/Excluded	Justification / Explanation
Natural gas combustion at BFW	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Coke consumption at BFW	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.

Source	Gas	Included/Excluded	Justification / Explanation
	N_2O	Excluded	Excluded for simplification. This is conservative.
Limestone calcination process in the BFW	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Blast production at CHP1 and CHP2	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Oxygen production for the BFW	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Lime production process	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Pellets production	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.
Sinter production	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.

Source	Gas	Included/Excluded	Justification / Explanation
Electricity production from fossil fuels and supplying through Ukrainian power grid	CO_2	Included	Included according to the "Guidance on criteria for baseline setting and monitoring"
	CH_4	Excluded	Excluded for simplification. This is conservative.
	N_2O	Excluded	Excluded for simplification. This is conservative.

Table B.11. Sources of emissions in the baseline and project scenarios

The following figure shows the project boundaries and sources of emissions grouped by facilities in the baseline and project scenarios.

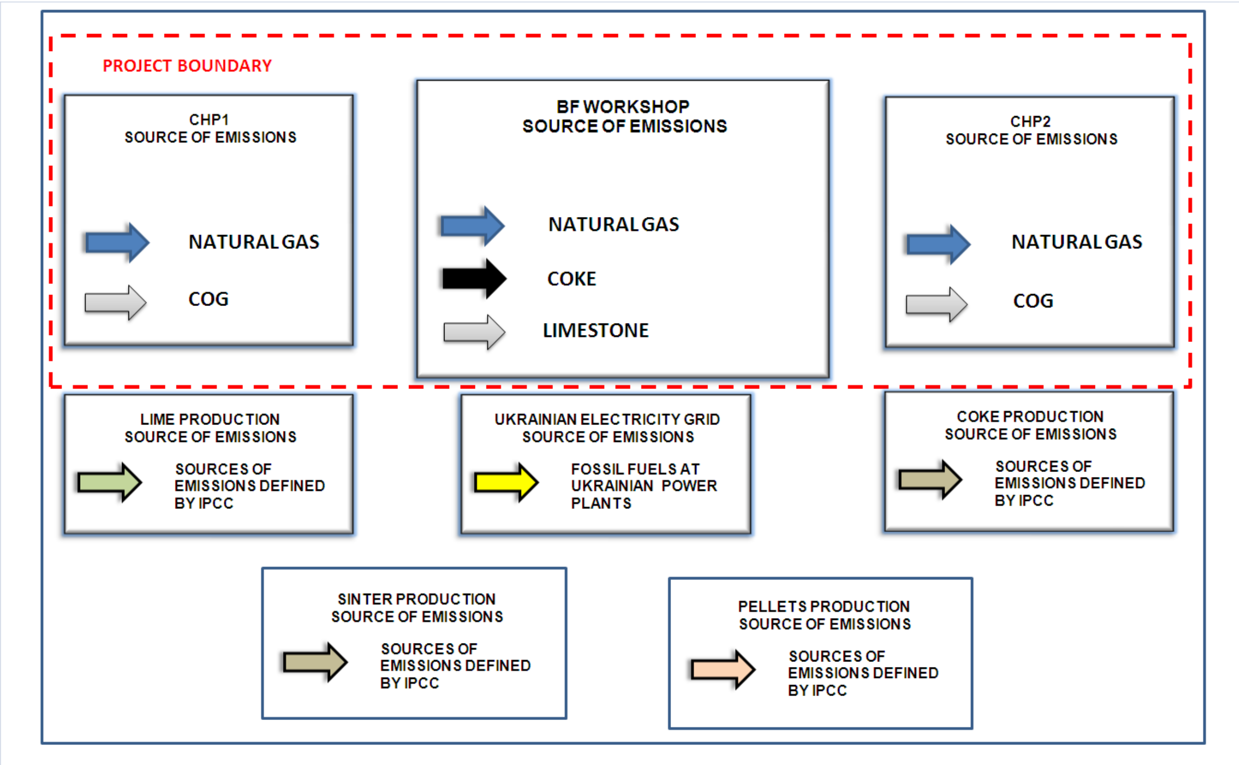

Figure B.3. Project boundary

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 completion of the baseline study: 14/06/2010
Name of person/entity determining the baseline:
Global Carbon B.V.
Oleg Bulany
For the contact details please refer to Annex 1.
Global Carbon B.V. is a Project Participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

06 February 2003.
This is the date when modernisation of the BF6 was started.

C.2. Expected operational lifetime of the project:

The lifetime of equipment is at least 30 years. Thus operational lifetime of the project will be 30 years or 360 months.

C.3. Length of the crediting period:

Start of crediting period: 01/01/2004.
Length of crediting period: 19 years or 228 months.

For the period up to 31 December 2007 Early Credits will be claimed to be transferred through Article 17 of the Kyoto Protocol (IET).

Emission reductions generated after the crediting period may be used in accordance with an appropriate mechanism under the UNFCCC.

SECTION D. Monitoring plan

According to the "Guidance on criteria for baseline setting and monitoring" the monitoring plan to the proposed project is established in accordance with the appendix B of the JI guidelines (both documents available at http://ji.unfccc.int/Ref/Docs.html).

D.1. Description of monitoring plan chosen:

In order to provide a detailed description of the monitoring plan chosen a step-wise approach is used:

Step 1. Indication and description of the approach chosen regarding monitoring
Option *(a)* provided by the Guidelines For The Users Of The Joint Implementation Project Design Document Form, Version 04[30] is used: JI specific approach is used in this project and therefore will be used for establishment of monitoring plan.

Step 2. Application of the approach chosen

Project emissions

To monitor project emissions the following material and fuels flows are included in the monitoring plan:

1. Coke;
   Coke is supplied to the plant from different coke plants. So, for the calculation of the emissions due to the coke production, an IPCC default value was chosen. The IPCC default value was calculated based on the data from EU's coke plants. It is *lower* than the Ukrainian standard due to better conditions of the EU's plants and stricter ecological standards. For the coke combustion the carbon content approach is based on the assumption that 100% of coke is combusted in the BF. Carbon content of the coke was taken as an IPCC default factor and set as 0.83t/t. This approach is deemed conservative and transparent. Amount of coke is weighted by specially dedicated scales.

[30] http://ji.unfccc.int/Ref/Documents/Guidelines.pdf

2. Oxygen;
   To calculate the emissions due to the oxygen usage at BFW the actual amount of oxygen used at BFW and specific emission factor is used. Oxygen used at BFW is added to the blast at CHP1 and CHP2. Every turbo compressor assigned for the blast production has metering equipment for the oxygen consumption. So, oxygen consumption will be directly monitored. The specific emission factor reflects all sources of the energy resources used for the oxygen production. It is fixed as an average value for the base period (2001-2003). For more detailed information see Section B.1. This is a conservative approach because it does not allow the indirect inclusion of any modernisation at Oxygen Workshop during the crediting period.

3. Natural gas;
   The emissions from the consumption of natural gas are calculated based on the consumed quantity, NCV, and IPCC default emission factor of the natural gas. Every BF has a natural gas meter.

4. Hot Blast;
   Hot Blast emissions are calculated based on produced quantity and specific emission factor. Similar to the specific emission factor for the oxygen production, it reflects all sources of the energy resources used for the blast production. It is fixed as an average value for the base period (2001-2003). For more detailed information please see Section B.1. This is conservative approach because it does not allow the indirect inclusion of any modernisation at CHP1 or CHP2 during the crediting period. Every turbo compressor dedicated for the blast production has metering equipment for the blast production.

5. Limestone;
   Emissions from the limestone calcinations are calculated based on a conservative assumption that the oxidation factor is 1. Raw materials (such as limestone, lime, sinter, pellets) have special scales for the weighting purpose.

6. Lime;
   For the lime involved in the pig iron production an IPCC default factor for the production is applied. Raw materials (such as limestone, lime, sinter, pellets) have special scales for the weighting purpose.

7. Sinter;
   For the sinter involved in the pig iron production an IPCC default factor for the production is applied. Raw materials (such as limestone, lime, sinter, pellets) have special scales for the weighting purpose.

8. Pellets;
   For the pellets involved in the pig iron production an IPCC default factor for the production is applied. Raw materials (such as limestone, lime, sinter, pellets) have special scales for the weighting purpose.

9. Melted iron.
   Amount melted iron is weighted by two scales.

10. Electricity.
    Electricity consumption at BFW calculation is based on the accounting chart.

Baseline emissions

For the BFW baseline emissions are calculated based on amount of the melted iron and fixed specific emission factor for one ton of iron production. The specific emission factor is calculated based on the same materials flow as in the project scenario. For more detailed information see Annex 2.

Data and parameters that are not monitored throughout the crediting period, but are determined only once (and thus remain fixed throughout the crediting period), and that are available already at the stage of determination regarding the PDD are provided in the table below:

Data / Parameter	*Data unit*	*Description*	*Data Source*	*Value*
EF_{blast}	$tCO_2/1000m^3$	Emission factor for the blast production	Technical reports of Azovstal	0.023
EF_{oxygen}	$tCO_2/1000m^3$	Emission factor for the oxygen production	Technical reports of Azovstal	0.594
EF_{iron}	tCO_2/t	Baseline emission factor of iron production	Technical reports of Azovstal	2.749
P_{blast}	$1000m^3$	Amount of blast produced for the BFW in the base period	Technical reports of Azovstal	7 943 524

P_{oxygen}	$1000m^3$	Amount of oxygen produced for the BFW in the base period	Technical reports of Azovstal	859 479
NCV_{NG}	$GJ/1000m^3$	Net calorific value of the natural gas for the base period	Donetskoblgas	33.494
P_{NG}	$1000m^3$	Amount of natural gas combusted at the BFW during the base period	Technical reports of Azovstal	402 279
P_{elec}	MWh	Amount of electricity consumed at BFW during the base period	Technical reports of Azovstal	36 475
P_{coke}	t	Amount of coke consumed at BFW during the base period	Technical reports of Azovstal	2 395 762
$P_{\mathrm{lim}estone}$	t	Amount of limestone consumed at BFW during the base period	Technical reports of Azovstal	360 421
$P_{\mathrm{lim}e}$	t	Amount of lime consumed at BFW during the base period	Technical reports of Azovstal	57 064
P_{pellet}	t	Amount of pellets consumed at BFW during the base period	Technical reports of Azovstal	3 287 046
P_{NG}^{CHP1}	$1000m^3$	Amount of natural gas consumed at CHP1 for blast production	Technical reports of Azovstal	31 782
P_{NG}^{CHP2}	$1000m^3$	Amount of natural gas consumed at CHP2 for blast production	Technical reports of Azovstal	12 601
P_{COG}^{CHP1}	$1000m^3$	Amount of COG consumed at CHP1 for blast production	Technical reports of Azovstal	46 226

P_{COG}^{CHP2}	$1000m^3$	Amount of COG consumed at CHP2 for blast production	Technical reports of Azovstal	72 996
NCV_{COG}	$GJ/1000m^3$	Net calorific value of COG	Technical reports of Azovstal	12.560
EF_{elec}^{CHP1}	tCO_2/MWh	Specific emission factor for the electricity production at CHP1	Technical reports of Azovstal	0.251
P_{elec}^{CHP1}	MWh	Amount of electricity consumed during blast production at CHP1	Technical reports of Azovstal	32 657
EF_{elec}^{CHP2}	tCO_2/MWh	Specific emission factor for the electricity production at CHP2	Technical reports of Azovstal	0.294
P_{elec}^{CHP2}	MWh	Amount of electricity consumed during blast production at CHP2	Technical reports of Azovstal	20 135
P_{blast}^{CHP1}	$1000m^3$	Amount of blast produced at CHP1	Technical reports of Azovstal	6 043 657
P_{blast}^{CHP2}	$1000m^3$	Amount of blast produced at CHP2	Technical reports of Azovstal	5 986 299
$P_{NG}^{CHP1elec}$	$1000m^3$	Amount of natural gas consumed at CHP1 for electricity production	Technical reports of Azovstal	17 914
$P_{COG}^{CHP1elec}$	$1000m^3$	Amount of COG consumed at CHP1 for electricity production	Technical reports of Azovstal	27 305
P_{elec}^{CHP1}	MWh	Amount of electricity produced at CHP1	Technical reports of Azovstal	214 925

$P_{NG}^{CHP2elec}$	$1000m^3$	Amount of natural gas consumed at CHP2 for electricity production	Technical reports of Azovstal	6 308
$P_{COG}^{CHP2elec}$	$1000m^3$	Amount of COG consumed at CHP2 for electricity production	Technical reports of Azovstal	34 534
P_{elec}^{CHP2}	MWh	Amount of electricity produced at CHP2	Technical reports of Azovstal	127 887
$P_{elec}^{CHP1compress}$	MWh	Amount of electricity consumed by electro compressors of CHP1	Technical reports of Azovstal	210 423
$P_{elec}^{OXcompress}$	MWh	Amount of electricity consumed by electro compressors of oxygen workshops	Technical reports of Azovstal	184 175
P_{elec}^{OX}	MWh	Amount of electricity consumed by oxygen workshops	Technical reports of Azovstal	121 047
P_{air}^{CHP1}	$1000m^3$	Amount of compressed air produced by turbo compressors of CHP1	Technical reports of Azovstal	1 332 271
EF_{air}^{CHP1}	$tCO_2/1000m^3$	Specific emission factor for the compressed air produced by turbo compressors of CHP1	Technical reports of Azovstal	0.036
$P_{oxygen}^{workshop}$	$1000m^3$	Amount of oxygen produced by oxygen workshop	Technical reports of Azovstal	859 479
$P_{NG}^{CHP1air}$	$1000m^3$	Amount of natural gas consumed for the compressed air production by turbo compressors of CHP1	Technical reports of Azovstal	15 181
$P_{COG}^{CHP1air}$	$1000m^3$	Amount of COG consumed for the compressed air production by turbo compressors of CHP1	Technical reports of Azovstal	20 727

$P_{elec}^{CHP1air}$	MWh	Amount of electricity consumed for the compressed air production by turbo compressors of CHP1	Technical reports of Azovstal	17 945

Leakages
Monitoring plan has been chosen for the proposed project taking into account assessable sources of emissions which occur out of the project boundaries and are associated with the production of the fuels and raw materials. The only source that is neglected is fugitive emissions from the distribution of the natural gas through the Ukrainian gas distribution system. The reasons are the following:

- Using the IPCC values for the CH_4 and CO_2 emissions due to natural gas transportation[31] in the most conservative way (i.e. maximum value with a maximum level of the uncertainty) the level of 2,000 tCO_2 equivalent[32] could be reached with a natural gas consumption at BFW on the level more than 7,600 mln. m^3.
- The average natural gas consumption at the BFW during the period of three years prior to the project implementation is about 400 mln. m^3 (see Table B.3).

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
P.1	P_y^{coke} - Quantity of coke proceeds in the iron production process at BFW	scales	t	m	daily	100%	Electronic and paper	

31 Volume 2 Energy, Chapter 4, table 4.2.5, page 4.57 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf

32 http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

P.2	$EF^{coke}_{production}$ - IPCC default emission factor for the coke production	IPCC	tCO_2/t	c	yearly	100%	Electronic and paper	Chapter 4, Table 4.1
P.3	C^{coke}_{y} - Carbon content in the coke. IPCC default carbon content	IPCC	t/t	c	yearly	100%	Electronic and paper	Chapter 4, Table 4.3
P.4	P^{NG}_{BFW} - Quantity of natural gas proceeds in the iron production process at BFW	meters	$1000m^3$	m	daily	100%	Electronic and paper	
P.5	NCV^{NG}_{y} - Net calorific value of the natural gas	Donetskoblgas	$MJ/1000m^3$	c	monthly	100%	Electronic and paper	
P.6	EF^{NG}_{IPCC} - IPCC default emission factor for the natural gas combustion	IPCC	tCO_2/MJ	c	yearly	100%	Electronic and paper	Chapter 2, Table 2.3
P.7	P^{blast}_{y} - Quantity of blast produced for the BFW	meters	$1000m^3$	m	daily	100%	Electronic and paper	
P.8	P^{oxygen}_{y} - Quantity of oxygen produced for the BFW	meters at CHP1 and CHP2	$1000m^3$	m	daily	100%	Electronic and paper	
P.9	$P^{limestone}_{y}$ - Amount of limestone consumed at BFW	scales	t	m	daily	100%	Electronic and paper	
P.10	$EF_{limestone}$ - Default emission factor for the limestone calcination process.	Fixed ex ante value	$tCO_2/t.$	c	yearly	100%	Electronic and paper	Set as $0.44tCO_2/t.$

P.11	P_y^{lime} - Amount of lime consumed at BFW	scales	t	m	daily	100%	Electronic and paper	
P.12	EF_{lime} - Default IPCC emission factor for the lime production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as 0.75tCO_2/t.
P.13	P_y^{sinter} - Amount of sinter consumed at BFW	scales	t	m	daily	100%	Electronic and paper	
P.14	EF_{sinter} - Default IPCC emission factor for the sinter production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as 0.2tCO_2/t.
P.15	P_y^{pellet} - Amount of lime consumed at BFW	scales	t	m	daily	100%	Electronic and paper	
P.16	EF_{pellet} - Default IPCC emission factor for the lime production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as 0.03tCO_2/t.
P.17	P_y^{elec} - Amount of electricity consumed at BFW	Technical reports of BFW	MWh	c	monthly	100%	Electronic and paper	
P.18	EF_{elec} - Emission factor of Ukrainian grid for reducing projects	See annex 2	tCO_2/MWh	c	fixed ex-ante	100%	Electronic and paper	Ukrainian grid EF = 0.896 tCO_2/MWh

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

Project emissions that take place during crediting period are calculated as the sum of emissions from raw materials and fuel that charge the BFs.

Project emissions are calculated according to the following formulae:

$$PE_y = \sum_{y=}^{y=} (PE_y^{coke} + PE_y^{NG} + PE_y^{blast} + PE_y^{oxygen} + PE_y^{limestone} + PE_y^{lime} + PE_y^{sinter} + PE_y^{pellets} + PE_y^{elec}) \quad (1)$$

Where:

PE_y	The sum of project emissions from each month of the monitoring period (tCO_2);
PE_y^{coke}	Project emissions from coke using in the BFW in month y (tCO_2);
PE_y^{NG}	Project emissions from natural gas using in the BFW in month y (tCO_2);
PE_y^{blast}	Project emissions from hot blast using in the BFW in month y (tCO_2);
PE_y^{oxygen}	Project emissions from oxygen using in the BFW in month y (tCO_2);
$PE_y^{limestone}$	Project emissions from limestone oxidation using in the BFW in month y (tCO_2);
PE_y^{lime}	Project emissions form lime production in month y (tCO_2);
PE_y^{sinter}	Project emissions form sinter production in month y (tCO_2);
$PE_y^{pellets}$	Project emissions form pellets production in month y (tCO_2);
P_y^{elec}	Project emissions from electricity consumption in month y (tCO_2).

Emissions from the coke using in project scenario are calculated with using the formulae below:

$$PE_y^{coke} = P_y^{coke} \times EF_{production}^{coke} + 44/12 \times C_y^{coke}) \quad (2)$$

Where:

P_y^{coke}	Quantity of coke proceeds in the iron production process at BFW in the month y (t);
$EF_{production}^{coke}$	IPCC default emission factor for the coke production (Chapter 4, Table 4.1) (tCO_2/t);

C_y^{coke} Carbon content in the coke in the year y. IPCC default carbon content (Chapter 4, Table 4.3).

Emissions from the natural gas using in project scenario are calculated with using the formulae below:

$$PE_y^{NG} = P_{BFW}^{NG} \times NCV_y^{NG} \times EF_{IPCC}^{NG} \qquad (3)$$

Where:

P_{BFW}^{NG} Quantity of natural gas proceeds in the iron production process at BFW in the month y ($1000m^3$);

NCV_y^{NG} Net calorific value of the natural gas in the month y ($MJ/1000m^3$);

EF_{IPCC}^{NG} IPCC default emission factor for the natural gas combustion (Chapter 2, Table 2.3) (tCO_2/MJ);

Emissions from the hot blast using in project scenario are calculated with using the formulae below:

$$PE_y^{blast} = P_y^{blast} \times EF_{blast} \qquad (4)$$

Where:

P_y^{blast} Quantity of blast produced for the BFW in the month y ($1000m^3$);

EF_{blast} Emission factor for the blast production (for more detailed information see Section B.1) ($tCO_2/1000m^3$).

Emissions from the oxygen using in project scenario are calculated with using the formulae below:

$$PE_y^{oxygen} = P_y^{oxygen} \times EF_{oxygen} \qquad (5)$$

Where:

P_y^{oxygen} Quantity of oxygen produced for the BFW in the month y ($1000m^3$);

EF_{oxygen} Emission factor for the oxygen production (for more detailed information see Section B.1) ($tCO_2/1000m^3$).

Emissions from limestone calcinations process are calculated with using the formulae below:

$$PE_y^{limestone} = P_y^{limestone} \times EF_{limestone} \quad (6)$$

Where:

$P_y^{limestone}$ Amount of limestone consumed at BFW in the month y (t);

$EF_{limestone}$ Default emission factor for the limestone calcination process. Set as $0.44tCO_2/t$.

Emissions from lime production process are calculated with using the formulae below:

$$PE_y^{lime} = P_y^{lime} \times EF_{lime} \quad (7)$$

Where:

P_y^{lime} Amount of lime consumed at BFW in the month y (t);

EF_{lime} Default IPCC emission factor for the lime production. Set as $0.75tCO_2/t$.

Emissions from sinter production process are calculated with using the formulae below:

$$PE_y^{sinter} = P_y^{sinter} \times EF_{sinter} \quad (8)$$

Where:

P_y^{sinter} Amount of sinter consumed at BFW in the month y (t);

EF_{sinter} Default IPCC emission factor for the sinter production. Set as $0.2tCO_2/t$.

Emissions from pellets production process are calculated with using the formulae below:

$$PE_y^{pellet} = P_y^{pellet} \times EF_{pellet} \qquad (9)$$

Where:

P_y^{pellet}	Amount of pellets consumed at BFW in the month y (t);
EF_{pellet}	Default IPCC emission factor for the pellets production. Set as 0.03tCO_2/t.

Emissions from electricity consumption at BFW are calculated with using the formulae below:

$$PE_y^{elec} = P_y^{elec} \times EF_{elec} \qquad (10)$$

Where:

P_y^{elec}	Amount of electricity consumed at BFW in the month y (MWh);
EF_{elec}	Emission factor for the Ukrainian electrical grid. Set as 0,896 tCO_2/MWh[33].

[33] For more details see Annex 2.

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
B.1	P_y^{iron} - Quantity of iron produced	scales	t	m	daily	100%	Electronic and paper	
B.2	EF_{NG}^{IPCC} IPCC default emission factor for the natural gas combustion	IPCC	tCO_2/MJ	c	yearly	100%	Electronic and paper	Chapter 2, Table 2.3
B.3	EF_{elec} - Emission factor of Ukrainian grid for reducing projects	See annex 2	tCO_2/MWh	c	fixed ex-ante	100%	Electronic and paper	Ukrainian grid EF = 0.896 tCO_2/MWh
B.4	C_y^{coke} - Carbon content in the coke in the year y. IPCC default carbon content	IPCC	t/t	c	yearly	100%	Electronic and paper	Chapter 4, Table 4.3
B.5	$EF_{limestone}$ - Default emission factor for the limestone calcination process.	Fixed ex ante value	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as $0.44tCO_2/t$.
B.6	EF_{lime} - Default IPCC emission factor for the lime production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as $0.75tCO_2/t$.

B.7	EF_{pellet} - Default IPCC emission factor for the lime production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as $0.03tCO_2/t$.
B.8	EF_{sinter} - Default IPCC emission factor for the sinter production.	IPCC	tCO_2/t.	c	yearly	100%	Electronic and paper	Set as $0.2tCO_2/t$.

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

Baseline emissions are calculated according to the following formulae:

$$BE_y = \sum_{y=1} P_y^{iron} \times EF_{iron} \qquad (10)$$

Where:

BE_y The sum of baseline emissions from each month of the monitoring period (tCO_2);
P_y^{iron} Quantity of iron produced in the month y (t);
EF_{iron} Baseline emission factor of iron production (tCO_2/t);

Emission factor for the pig iron production is calculated as follows:

$$EF_{iron} = (EF_{blast} \times P_{blast} + EF_{oxygen} \times P_{oxygen} + EF_{NG}^{IPCC} \times NCV_{NG} \times P_{NG} + EF_{elec} \times P_{elec} + EF_{coke}^{production} \times P_{coke} + C_{coke} \times P_{coke} \times 44/12 + EF_{limestone} \times P_{limestone} + EF_{lime}^{production} \times P_{lime} + EF_{pellet}^{IPCC} \times P_{pellet} + EF_{sinter}^{IPCC} \times P_{sinter}) / P_{iron} \qquad (11)$$

Where:

EF_{blast}	Specific emission factor for the blast production at CHP1 and CHP2 ($tCO_2/1000m^3$);
P_{blast}	Amount of blast produced for the BFW in the base period ($1000m^3$);
EF_{oxygen}	Specific emission factor for the oxygen production at oxygen workshop for the base period ($tCO_2/1000m^3$);
P_{oxygen}	Amount of oxygen produced for the BFW in the base period ($1000m^3$);
EF_{NG}^{IPCC}	IPCC default emission factor for the natural gas combustion. Set as 0.0561 tCO_2/GJ[34];
NCV_{NG}	Net calorific value of the natural gas for the base period ($GJ/1000m^3$);
P_{NG}	Amount of natural gas combusted at the BFW during the base period ($1000m^3$);
EF_{elec}	Emission factor for the Ukrainian electrical grid. Set as 0,896 tCO_2/MWh[35];
P_{elec}	Amount of electricity consumed at BFW during the base period (MWh);
$EF_{coke}^{production}$	IPCC default emission factor for the coke production. Set as 0.56 tCO_2/t;
C_{coke}	IPCC carbon content of coke consumed at BFW during the baseline period. Set as 0.83 (t/t);
P_{coke}	Amount of coke consumed at BFW during the base period (t);
$EF_{limestone}$	Default emission factor for the limestone calcination. Carbon content is 0.12tC/t[36]. Set as 0.44 tCO_2/t;
$P_{limestone}$	Amount of limestone consumed at BFW during the base period (t);
$EF_{lime}^{production}$	IPCC default emission factor for the lime production. Set as 0.75 tCO_2/t[37];
P_{lime}	Amount of lime consumed at BFW during the base period (t);

34 Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

35 For more details see Annex 2.

36 Volume 3, Chapter 4 “Metal Industry”, table 4.3, p.4.27 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

37 Volume 3 Chapter 2 Mineral Industry emissions. Equation 2.8, p. 2.22 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf

EF_{pellet}^{IPCC}	IPCC default emission factor for the pellets production. Set as 0.03 tCO_2/t[38];
P_{pellet}	Amount of pellets consumed at BFW during the base period (t);
EF_{sinter}^{IPCC}	IPCC default emission factor for the sinter production. Set as 0.2 tCO_2/t[39];
P_{sinter}	Amount of sinter consumed at BFW during the base period (t);

Emission factor for the blast production is calculated as follows:

$$EF_{blast} = ((P_{NG}^{CHP1} + P_{NG}^{CHP2}) \times NCV_{NG} \times EF_{NG}^{IPCC} + (P_{COG}^{CHP1} + P_{COG}^{CHP2}) \times NCV_{COG} \times EF_{COG}^{IPCC} + EF_{elec}^{CHP1} \times P_{elec}^{CHP1} + EF_{elec}^{CHP2} \times P_{elec}^{CHP2}) / (P_{blast}^{CHP1} + P_{blast}^{CHP2}) \quad (12)$$

With

$$EF_{elec}^{CHP1} = (P_{NG}^{CHP1elec} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP1elec} \times NCV_{COG} \times EF_{COG}^{IPCC}) / P_{elec}^{CHP1} \quad (13)$$

And

$$EF_{elec}^{CHP2} = (P_{NG}^{CHP2elec} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP2elec} \times NCV_{COG} \times EF_{COG}^{IPCC}) / P_{elec}^{CHP2} \quad (14)$$

Where:

P_{NG}^{CHP1}	Amount of natural gas consumed at CHP1 for blast production ($1000m^3$);
P_{NG}^{CHP2}	Amount of natural gas consumed at CHP2 for blast production ($1000m^3$);
P_{COG}^{CHP1}	Amount of COG consumed at CHP1 for blast production ($1000m^3$);
P_{COG}^{CHP2}	Amount of COG consumed at CHP2 for blast production ($1000m^3$);

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[38] Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

[39] Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

NCV_{COG}	Net calorific value of COG (GJ/1000m^3);
EF_{COG}^{IPCC}	IPCC default emission factor for the COG combustion. Set as 0.0444 tCO_2/GJ[40];
EF_{elec}^{CHP1}	Specific emission factor for the electricity production at CHP1 (tCO_2/MWh);
P_{elec}^{CHP1}	Amount of electricity consumed during blast production at CHP1 (MWh);
EF_{elec}^{CHP2}	Specific emission factor for the electricity production at CHP2 (tCO_2/MWh);
P_{elec}^{CHP2}	Amount of electricity consumed during blast production at CHP2 (MWh);
P_{blast}^{CHP1}	Amount of blast produced at CHP1 (1000m^3);
P_{blast}^{CHP2}	Amount of blast produced at CHP2 (1000m^3);
$P_{NG}^{CHP1elec}$	Amount of natural gas consumed at CHP1 for electricity production (1000m^3);
$P_{COG}^{CHP1elec}$	Amount of COG consumed at CHP1 for electricity production (1000m^3);
P_{elec}^{CHP1}	Amount of electricity produced at CHP1 (MWh);
$P_{NG}^{CHP2elec}$	Amount of natural gas consumed at CHP2 for electricity production (1000m^3);
$P_{COG}^{CHP2elec}$	Amount of COG consumed at CHP2 for electricity production (1000m^3);
P_{elec}^{CHP2}	Amount of electricity produced at CHP2 (MWh).

Emission factor for the oxygen production is calculated as follows:

$$EF_{oxygen} = (P_{elec}^{CHP1compress} + P_{elec}^{OXcompress} + P_{elec}^{OX}) \times EF_{elec} + P_{air}^{CHP1} \times EF_{air}^{CHP1}) / P_{oxygen}^{workshop} \quad (15)$$

With

$$EF_{air}^{CHP1} = (P_{NG}^{CHP1air} \times NCV_{NG} \times EF_{NG}^{IPCC} + P_{COG}^{CHP1air} \times NCV_{COG} \times EF_{COG}^{IPCC} + + P_{elec}^{CHP1air} \times EF_{elec}^{CHP1}) / P_{air}^{CHP1} \quad (16)$$

Where:

[40] Volume 2 Energy. Chapter 1. Table 1.4, p. 1.24 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

$P_{elec}^{CHP1compress}$ Amount of electricity consumed by electro compressors of CHP1 (MWh);
$P_{elec}^{OXcompress}$ Amount of electricity consumed by electro compressors of oxygen workshops (MWh);
P_{elec}^{OX} Amount of electricity consumed by oxygen workshops (MWh);
P_{air}^{CHP1} Amount of compressed air produced by turbo compressors of CHP1 ($1000m^3$);
EF_{air}^{CHP1} Specific emission factor for the compressed air produced by turbo compressors of CHP1 ($tCO_2/1000m^3$);
$P_{oxygen}^{workshop}$ Amount of oxygen produced by oxygen workshop ($1000m^3$);
$P_{NG}^{CHP1air}$ Amount of natural gas consumed for the compressed air production by turbo compressors of CHP1 ($1000m^3$);
$P_{COG}^{CHP1air}$ Amount of COG consumed for the compressed air production by turbo compressors of CHP1 ($1000m^3$);
$P_{elec}^{CHP1air}$ Amount of electricity consumed for the compressed air production by turbo compressors of CHP1 (MWh);

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

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

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

Left blank on purpose

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):

Left blank on purpose

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

No leakages are identified for the proposed project.

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 annual emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \qquad (12)$$

where:

ER_y = Emissions reductions of the JI project (tCO_2);

BE_y = Baseline Emissions (tCO_2);
PE_y = Project Emissions (tCO_2);

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:

According to the Decree of Cabinet of Ministers #301 and order of the Ministry of the Environmental Protection #108[41], Azovstal gets the Approval for the emission of the contaminants into the atmosphere and monitoring the level of emissions in line with the regulations. All documents related to this activity are presented to the AIE during site visit.

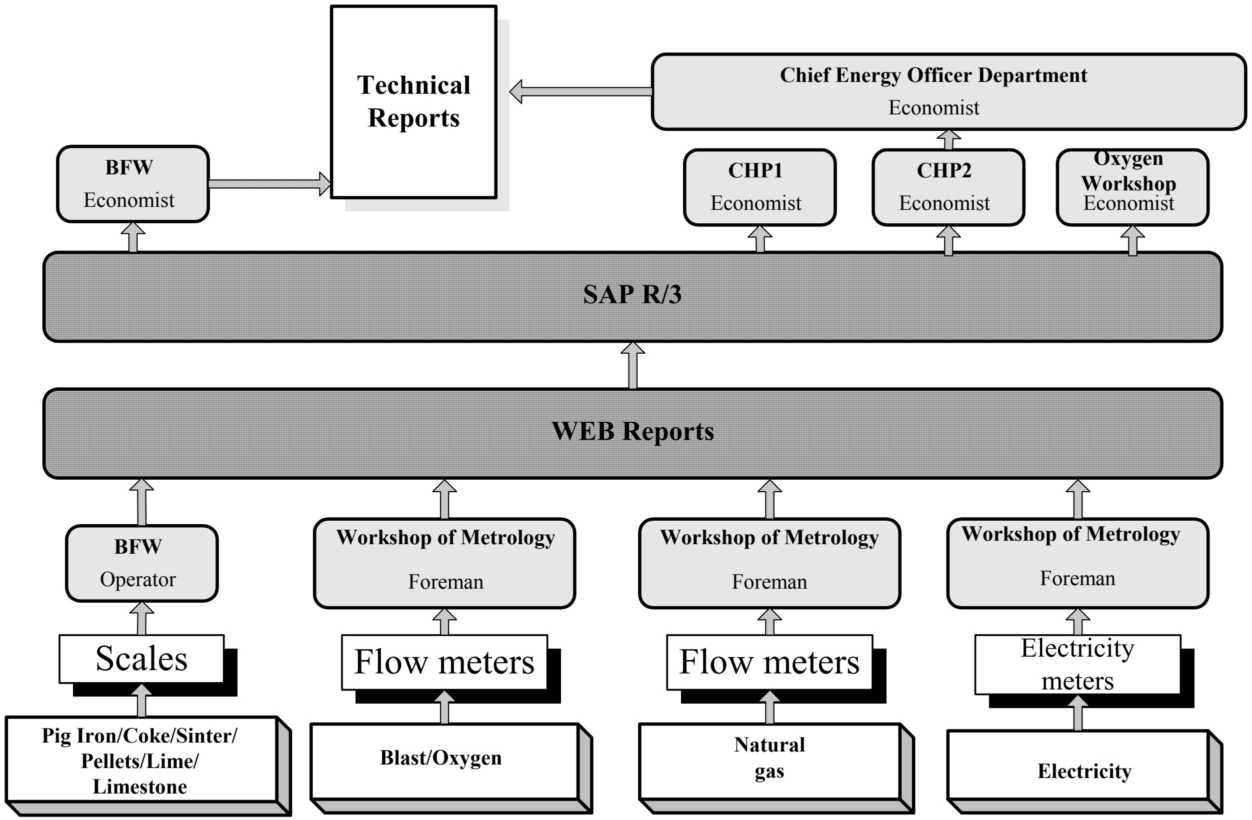
D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

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.
P.1	*Low*	The scales used for the coke weighting calibrated once a month
P.2	*Low*	This is fixed ex ante data
P.3	*Low*	This is fixed ex ante data
P.4	*Low*	Natural gas meters calibrated once a year
P.5	*Low*	NCV of natural gas provided by the third party (Donetskoblgas)
P.6	*Low*	This is fixed ex ante data
P.7	*Low*	Meters used for the blast accounting calibrated once per year
P.8	*Low*	Meters used for the oxygen accounting calibrated once per year
P.9	*Low*	The scales used for the sinter/pellets/lime/limestone weighting calibrated once a month
P.10	*Low*	This is fixed ex ante data
P.11	*Low*	The scales used for the sinter/pellets/lime/limestone weighting calibrated once a month
P.12	*Low*	This is fixed ex ante data
P.13	*Low*	The scales used for the sinter/pellets/lime/limestone weighting calibrated once a month
P.14	*Low*	This is fixed ex ante data
P.15	*Low*	The scales used for the sinter/pellets/lime/limestone weighting calibrated once a month
P.16	*Low*	This is fixed ex ante data

[41] http://www.menr.gov.ua/cgi-bin/go?node=ZAK%20povitrja

P.17	*Low*	Electricity meters calibrated once per four/six years depends on type of the meter
P.18	*Low*	This is fixed ex ante data
B.1	*Low*	The scales used for the pig iron weighting calibrated twice a month
B.2	*Low*	This is fixed ex ante data
B.3	*Low*	This is fixed ex-ante value.
B.4	*Low*	This is fixed ex ante data
B.5	*Low*	This is fixed ex ante data
B.6	*Low*	This is fixed ex ante data
B.7	*Low*	This is fixed ex ante data
B.8	*Low*	This is fixed ex ante data

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



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

Name of person/entity determining the monitoring plan:
Global Carbon B.V.
Oleg Bulany

For the contact details please refer to Annex 1.
Global Carbon B.V. is a Project Participant.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

		2004	2005	2006	2007	Total
Project emissions from coke	[tCO_2/yr]	9 552 127	9 628 527	9 670 688	9 940 881	**38 792 223**
Project emissions from NG	[tCO_2/yr]	1 077 034	1 154 401	999 521	1 067 751	**4 298 708**
Project emissions from limestone	[tCO_2/yr]	208 072	221 687	199 543	107 538	**736 840**
Project emissions from lime	[tCO_2/yr]	95 681	79 358	54 425	189 851	**419 314**
Project emissions from blast production	[tCO_2/yr]	210 495	208 523	227 555	240 704	**887 277**
Project emissions from oxygen production	[tCO_2/yr]	395 861	392 682	345 831	364 254	**1 498 628**
Project emissions from electricity	[tCO_2/yr]	37 845	41 016	42 332	32 972	**154 166**
Project emissions from pellets production	[tCO_2/yr]	119 535	126 185	198 096	170 673	**614 490**
Project emissions from sinter production	[tCO_2/yr]	876 303	834 356	425 514	624 599	**2 760 771**
Project emissions before the crediting period	**[tCO_2/yr]**	**12 572 954**	**12 686 734**	**12 163 505**	**12 739 224**	**50 162 417**

Table E.1. Estimated project emissions before the commitment period

		2008	2009	2010	2011	2012	Total
Project emissions from coke	[tCO_2/yr]	9 090 616	8 736 062	7 272 493	9 090 616	9 090 616	**43 280 404**
Project emissions from NG	[tCO_2/yr]	849 359	449 348	679 487	849 359	849 359	**3 676 914**
Project emissions from limestone	[tCO_2/yr]	30 228	52 202	24 182	30 228	30 228	**167 068**
Project emissions from lime	[tCO_2/yr]	245 519	185 247	196 416	245 519	245 519	**1 118 221**
Project emissions from blast production	[tCO_2/yr]	227 184	201 155	181 747	227 184	227 184	**1 064 453**
Project emissions from oxygen production	[tCO_2/yr]	309 514	186 926	247 611	309 514	309 514	**1 363 079**
Project emissions from electricity	[tCO_2/yr]	32 146	36 176	25 717	32 146	32 146	**158 331**
Project emissions from pellets production	[tCO_2/yr]	126 501	145 242	101 201	126 501	126 501	**625 945**
Project emissions from sinter production	[tCO_2/yr]	749 688	353 767	599 750	749 688	749 688	**3 202 581**
Project emissions during the crediting period	**[tCO_2/yr]**	11 660 755	10 346 126	9 328 604	11 660 755	11 660 755	**54 656 994**

Table E.2. Estimated project emissions during the commitment period

		2013-2022	Total
Project emissions from coke	[tCO_2/yr]	90 906 163	**90 906 163**
Project emissions from NG	[tCO_2/yr]	8 493 593	**8 493 593**

		2013-2022	Total
Project emissions from limestone	[tCO_2/yr]	302 277	**302 277**
Project emissions from lime	[tCO_2/yr]	2 455 195	**2 455 195**
Project emissions from blast production	[tCO_2/yr]	2 271 835	**2 271 835**
Project emissions from oxygen production	[tCO_2/yr]	3 095 139	**3 095 139**
Project emissions from electricity	[tCO_2/yr]	321 460	**321 460**
Project emissions from pellets production	[tCO_2/yr]	1 265 008	**1 265 008**
Project emissions from sinter production	[tCO_2/yr]	7 496 878	**7 496 878**
Project emissions after the crediting period	**[tCO_2/yr]**	116 607 547	**116 607 547**

Table E.3. Estimated project emissions after the commitment period

E.2. Estimated leakage:

		2004	2005	2006	2007	Total
Leakage associated with a coke	[tCO_2/yr]	0	0	0	0	0
Leakage associated with NG	[tCO_2/yr]	0	0	0	0	0
Leakage associated with limestone	[tCO_2/yr]	0	0	0	0	0
Leakage associated with lime	[tCO_2/yr]	0	0	0	0	0
Leakage associated with blast	[tCO_2/yr]	0	0	0	0	0
Leakage associated with oxygen	[tCO_2/yr]	0	0	0	0	0
Leakage associated with electricity	[tCO_2/yr]	0	0	0	0	0
Leakage associated with pellets	[tCO_2/yr]	0	0	0	0	0
Leakage associated with sinter	[tCO_2/yr]	0	0	0	0	0
Leakage before the crediting period	**[tCO_2/yr]**	0	0	0	0	**0**

Table E.4. Estimated leakage before the commitment period

		2008	2009	2010	2011	2012	Total
Leakage associated with a coke	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with NG	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with limestone	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with lime	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with blast	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with oxygen	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with electricity	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with pellets	[tCO_2/yr]	0	0	0	0	0	0
Leakage associated with sinter	[tCO_2/yr]	0	0	0	0	0	0

		2008	2009	2010	2011	2012	Total
Leakage during the crediting period	**[tCO_2/yr]**	0	0	0	0	0	**0**

Table E.5. Estimated leakage during the commitment period

		2013-2020	Total
Leakage associated with a coke	[tCO_2/yr]	0	0
Leakage associated with NG	[tCO_2/yr]	0	0
Leakage associated with limestone	[tCO_2/yr]	0	0
Leakage associated with lime	[tCO_2/yr]	0	0
Leakage associated with blast	[tCO_2/yr]	0	0
Leakage associated with oxygen	[tCO_2/yr]	0	0
Leakage associated with electricity	[tCO_2/yr]	0	0
Leakage associated with pellets	[tCO_2/yr]	0	0
Leakage associated with sinter	[tCO_2/yr]	0	0
Leakage after the crediting period	**[tCO_2/yr]**	0	**0**

Table E.6. Estimated leakage after the commitment period

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

		2004	2005	2006	2007	Total
Project emissions from coke	[tCO_2/yr]	9 552 127	9 628 527	9 670 688	9 940 881	**38 792 223**
Project emissions from NG	[tCO_2/yr]	1 077 034	1 154 401	999 521	1 067 751	**4 298 708**
Project emissions from limestone	[tCO_2/yr]	208 072	221 687	199 543	107 538	**736 840**
Project emissions from lime	[tCO_2/yr]	95 681	79 358	54 425	189 851	**419 314**
Project emissions from blast production	[tCO_2/yr]	210 495	208 523	227 555	240 704	**887 277**
Project emissions from oxygen production	[tCO_2/yr]	395 861	392 682	345 831	364 254	**1 498 628**
Project emissions from electricity	[tCO_2/yr]	37 845	41 016	42 332	32 972	**154 166**
Project emissions from pellets production	[tCO_2/yr]	119 535	126 185	198 096	170 673	**614 490**
Project emissions from sinter production	[tCO_2/yr]	876 303	834 356	425 514	624 599	**2 760 771**
Project emissions before the crediting period	**[tCO_2/yr]**	**12 572 954**	**12 686 734**	**12 163 505**	**12 739 224**	**50 162 417**

Table E.7. Estimated total project emissions before the commitment period

		2008	2009	2010	2011	2012	Total
Project emissions from coke	[tCO_2/yr]	9 090 616	8 736 062	7 272 493	9 090 616	9 090 616	**43 280 404**
Project emissions from NG	[tCO_2/yr]	849 359	449 348	679 487	849 359	849 359	**3 676 914**
Project emissions	[tCO_2/yr]	30 228	52 202	24 182	30 228	30 228	**167 068**

		2008	2009	2010	2011	2012	Total
from limestone							
Project emissions from lime	[tCO_2/yr]	245 519	185 247	196 416	245 519	245 519	**1 118 221**
Project emissions from blast production	[tCO_2/yr]	227 184	201 155	181 747	227 184	227 184	**1 064 453**
Project emissions from oxygen production	[tCO_2/yr]	309 514	186 926	247 611	309 514	309 514	**1 363 079**
Project emissions from electricity	[tCO_2/yr]	32 146	36 176	25 717	32 146	32 146	**158 331**
Project emissions from pellets production	[tCO_2/yr]	126 501	145 242	101 201	126 501	126 501	**625 945**
Project emissions from sinter production	[tCO_2/yr]	749 688	353 767	599 750	749 688	749 688	**3 202 581**
Project emissions during the crediting period	**[tCO_2/yr]**	11 660 755	10 346 126	9 328 604	11 660 755	11 660 755	**54 656 994**

Table E.8. Estimated total project emissions during the commitment period

		2013-2022	Total
Project emissions from coke	[tCO_2/yr]	90 906 163	**90 906 163**
Project emissions from NG	[tCO_2/yr]	8 493 593	**8 493 593**
Project emissions from limestone	[tCO_2/yr]	302 277	**302 277**
Project emissions from lime	[tCO_2/yr]	2 455 195	**2 455 195**
Project emissions from blast production	[tCO_2/yr]	2 271 835	**2 271 835**
Project emissions from oxygen production	[tCO_2/yr]	3 095 139	**3 095 139**
Project emissions from electricity	[tCO_2/yr]	321 460	**321 460**
Project emissions from pellets production	[tCO_2/yr]	1 265 008	**1 265 008**
Project emissions from sinter production	[tCO_2/yr]	7 496 878	**7 496 878**
Project emissions after the crediting period	**[tCO_2/yr]**	116 607 547	**116 607 547**

Table E.9. Estimated total project emissions after the commitment period

E.4. Estimated baseline emissions:

		2004	2005	2006	2007	Total
Baseline emissions from coke	[tCO_2/yr]	10 329 360	10 648 831	10 905 337	11 113 186	**42 996 714**
Baseline emissions from NG	[tCO_2/yr]	906 868	934 916	957 436	975 684	**3 774 904**
Baseline emissions from limestone	[tCO_2/yr]	189 753	195 621	200 333	204 152	**789 859**
Baseline emissions from lime	[tCO_2/yr]	51 209	52 793	54 064	55 095	**213 161**
Baseline emissions from blast production	[tCO_2/yr]	222 934	229 829	235 365	239 851	**927 980**
Baseline emissions from oxygen production	[tCO_2/yr]	354 412	365 373	374 174	381 306	**1 475 265**
Baseline emissions from electricity	[tCO_2/yr]	39 105	40 314	41 285	42 072	**162 776**

		2004	2005	2006	2007	Total
Baseline emissions from pellets production	[tCO_2/yr]	117 992	121 641	124 571	126 946	**491 150**
Baseline emissions from sinter production	[tCO_2/yr]	972 738	1 002 824	1 026 979	1 046 553	**4 049 095**
Baseline emissions before the crediting period	**[tCO_2/yr]**	13 184 370	13 592 143	13 919 546	14 184 845	**54 880 903**

Table E.10. Estimated baseline emissions before the commitment period

		2008	2009	2010	2011	2012	Total
Baseline emissions from coke	[tCO_2/yr]	9 930 136	8 653 002	7 944 109	9 930 136	9 930 136	**46 387 518**
Baseline emissions from NG	[tCO_2/yr]	871 818	759 692	697 454	871 818	871 818	**4 072 600**
Baseline emissions from limestone	[tCO_2/yr]	182 419	158 957	145 935	182 419	182 419	**852 149**
Baseline emissions from lime	[tCO_2/yr]	49 230	42 898	39 384	49 230	49 230	**229 971**
Baseline emissions from blast production	[tCO_2/yr]	214 318	186 754	171 454	214 318	214 318	**1 001 162**
Baseline emissions from oxygen production	[tCO_2/yr]	340 714	296 894	272 571	340 714	340 714	**1 591 607**
Baseline emissions from electricity	[tCO_2/yr]	37 593	32 758	30 075	37 593	37 593	**175 613**
Baseline emissions from pellets production	[tCO_2/yr]	113 432	98 843	90 745	113 432	113 432	**529 883**
Baseline emissions from sinter production	[tCO_2/yr]	935 143	814 872	748 114	935 143	935 143	**4 368 414**
Baseline emissions during the crediting period	**[tCO_2/yr]**	12 674 802	11 044 671	10 139 841	12 674 802	12 674 802	**59 208 917**

Table E.11. Estimated baseline emissions during the commitment period

		2013-2022	Total
Baseline emissions from coke	[tCO_2/yr]	99 301 358	**99 301 358**
Baseline emissions from NG	[tCO_2/yr]	8 718 180	**8 718 180**
Baseline emissions from limestone	[tCO_2/yr]	1 824 187	**1 824 187**
Baseline emissions from lime	[tCO_2/yr]	492 298	**492 298**
Baseline emissions from blast production	[tCO_2/yr]	2 143 179	**2 143 179**
Baseline emissions from oxygen production	[tCO_2/yr]	3 407 140	**3 407 140**
Baseline emissions from electricity	[tCO_2/yr]	375 933	**375 933**
Baseline emissions from pellets production	[tCO_2/yr]	1 134 316	**1 134 316**
Baseline emissions from sinter production	[tCO_2/yr]	9 351 427	**9 351 427**
Baseline emissions after the crediting period	**[tCO_2/yr]**	**126 748 017**	**126 748 017**

Table E.12. Estimated baseline emissions after the commitment period

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

		2004	2005	2006	2007	Total
Emission reductions from coke	[tCO_2/yr]	777 233	1 020 304	1 234 649	1 172 305	**4 204 491**
Emission reductions from NG	[tCO_2/yr]	-170 166	-219 485	-42 086	-92 067	**-523 804**
Emission reductions from limestone	[tCO_2/yr]	-18 320	-26 066	791	96 613	**53 019**
Emission reductions from lime	[tCO_2/yr]	-44 472	-26 565	-360	-134 756	**-206 153**
Emission reductions from blast production	[tCO_2/yr]	12 439	21 307	7 810	-853	**40 702**
Emission reductions from oxygen production	[tCO_2/yr]	-41 449	-27 308	28 343	17 051	**-23 363**
Emission reductions from electricity	[tCO_2/yr]	1 259	-702	-1 047	9 100	**8 610**
Emission reductions from pellets production	[tCO_2/yr]	-1 543	-4 544	-73 525	-43 728	**-123 340**
Emission reductions from sinter production	[tCO_2/yr]	96 436	168 468	601 466	421 954	**1 288 324**
Emission reductions before the crediting period	**[tCO_2/yr]**	**611 417**	**905 408**	**1 756 040**	**1 445 621**	**4 718 486**

Table E.13. Estimated emission reductions before the commitment period

		2008	2009	2010	2011	2012	Total
Emission reductions from coke	[tCO_2/yr]	839 520	-83 060	671 616	839 520	839 520	**3 107 114**
Emission reductions from NG	[tCO_2/yr]	22 459	310 344	17 967	22 459	22 459	**395 687**
Emission reductions from limestone	[tCO_2/yr]	152 191	106 755	121 753	152 191	152 191	**685 081**
Emission reductions from lime	[tCO_2/yr]	-196 290	-142 349	-157 032	-196 290	-196 290	**-888 249**
Emission reductions from blast production	[tCO_2/yr]	-12 866	-14 401	-10 293	-12 866	-12 866	**-63 291**
Emission reductions from oxygen production	[tCO_2/yr]	31 200	109 968	24 960	31 200	31 200	**228 528**
Emission reductions from electricity	[tCO_2/yr]	5 447	-3 418	4 358	5 447	5 447	**17 282**
Emission reductions from pellets production	[tCO_2/yr]	-13 069	-46 399	-10 455	-13 069	-13 069	**-96 062**
Emission reductions from sinter production	[tCO_2/yr]	185 455	461 105	148 364	185 455	185 455	**1 165 834**
Emission reductions during the crediting period	**[tCO_2/yr]**	**1 014 047**	**698 544**	**811 238**	**1 014 047**	**1 014 047**	**4 551 923**

Table E.14. Estimated emission reductions during the commitment period

		2013-2022	Total
Emission reductions from coke	[tCO_2/yr]	8 395 195	**8 395 195**
Emission reductions from NG	[tCO_2/yr]	224 587	**224 587**
Emission reductions from limestone	[tCO_2/yr]	1 521 910	**1 521 910**
Emission reductions from lime	[tCO_2/yr]	-1 962 897	**-1 962 897**
Emission reductions from blast production	[tCO_2/yr]	-128 657	**-128 657**
Emission reductions from oxygen	[tCO_2/yr]	312 001	**312 001**

production			
Emission reductions from electricity	[tCO_2/yr]	54 474	**54 474**
Emission reductions from pellets production	[tCO_2/yr]	-130 692	**-130 692**
Emission reductions from sinter production	[tCO_2/yr]	1 854 549	**1 854 549**
Emission reductions after the crediting period	**[tCO_2/yr]**	10 140 470	**10 140 470**

Table E.15. Estimated emission reductions after the commitment period

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

YEAR	Estimated project emissions (tonnes CO_2 Equivalent)	Estimated leakage (tonnes CO2 Equivalent)	Estimated baseline Emissions (tonnes CO_2 Equivalent)	Estimated emissions reductions (tonnes CO_2 Equivalent)
2004	12 572 954	0	13 184 370	611 417
2005	12 686 734	0	13 592 143	905 408
2006	12 163 505	0	13 919 546	1 756 040
2007	12 739 224	0	14 184 845	1 445 621
Total (tonnes CO_2 Equivalent)	**50 162 417**	**0**	**54 880 903**	**4 718 486**

Table E.16. Estimated balance of emissions under the proposed project before the commitment period

YEAR	Estimated project emissions (tonnes CO_2 Equivalent)	Estimated leakage (tonnes CO2 Equivalent)	Estimated baseline Emissions (tonnes CO_2 Equivalent)	Estimated emissions reductions (tonnes CO_2 Equivalent)
2008	11 660 755	0	12 674 802	1 014 047
2009	10 346 126	0	11 044 671	698 544
2010	9 328 604	0	10 139 841	811 238
2011	11 660 755	0	12 674 802	1 014 047
2012	11 660 755	0	12 674 802	1 014 047
Total (tonnes CO_2 Equivalent)	**54 656 994**	**0**	**59 208 917**	**4 551 923**

Table E.17. Estimated balance of emissions under the proposed project over the commitment period

YEAR	Estimated project emissions (tonnes CO_2 Equivalent)	Estimated leakage (tonnes CO2 Equivalent)	Estimated baseline Emissions (tonnes CO_2 Equivalent)	Estimated emissions reductions (tonnes CO_2 Equivalent)
2013	11 660 755	0	12 674 802	1 014 047
2014	11 660 755	0	12 674 802	1 014 047
2015	11 660 755	0	12 674 802	1 014 047
2016	11 660 755	0	12 674 802	1 014 047
2017	11 660 755	0	12 674 802	1 014 047
2018	11 660 755	0	12 674 802	1 014 047
2019	11 660 755	0	12 674 802	1 014 047
2020	11 660 755	0	12 674 802	1 014 047
2021	11 660 755	0	12 674 802	1 014 047
2022	11 660 755	0	12 674 802	1 014 047
Total (tonnes CO_2 Equivalent)	**116 607 547**	**0**	**126 748 017**	**10 140 470**

Table E.18. Estimated balance of emissions under the proposed project after the commitment period

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:

Within the framework of the proposed JI project not all of the components should be proceed through the Environmental Impact Assessment (EIA). Reconstruction of the BF2 have been assessed according to the Ukrainian legislation as a part of the project design documents and approved by local authority. EIA is the part of the Ukrainian project planning and permitting procedures. Implementation regulations for EIA are included in the Ukrainian State Construction Standard DBN A.2.2.-1-2003[42] (Title: "Structure and Contents of the Environmental Impact Assessment Report (EIR) for Designing and Construction of Production Facilities, Buildings and Structures").

Transboundary impacts are not observed. There are no impacts that manifest within the area of any other country and that are caused by a proposed project activity which wholly physically originates within the area of Ukraine.

Analysis of this document shows that in addition to the obligatory scope of works the following facilities will be implemented at BF2:

a) suction cleaning of the cast house's emissions;
b) gas-treating of the charging unit's emissions;
c) automatic control system of the BFG combustion at cowpers.

Suction cleaning of the cast house's emissions. Facility includes:

[42] *State Construction Standard DBN A.2.2.-1-2003 :"Structure and Contents of the Environmental Impact Assessment Report (EIR) for Designing and Construction of Production Facilities, Buildings and Structures"* State Committee Of Ukraine On Construction And Architecture, 2004

- electrostatic scrubber;
- control system;
- dust collection and transportation system;

As a result of the introduction of the facility, dust concentration in the air will be less than 50 mg/m^3. Emissions of dust into atmosphere will be reduced by 3,000 t annually.

Gas-treating of the charging unit's emissions. The plan is to direct the gas into the gas pipeline instead of direct emission into atmosphere. The gas introduced to into the pipeline will be treated. As a result of the introduction of the facility, emissions of suspension particles and CO will be reduced annually by 300t and 1,000t correspondingly.

Automatic control system of the BFG combustion at cowpers. The plan is that the flue gases from the cowpers will be under continuous control. System will keep the level of the CO on the certain level by BFG combustion regulation. As a result of the introduction of the facility, emissions of CO will be reduced annually by 10t.

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 proposed JI project is directed to the GHG emissions reduction by reducing coke consumption during the pig iron production. Due to the fact that overall production will be kept on the same level, main environmental impact will be observed at coke plants. As it was mentioned above, coke is supplied from different plants to Azovstal, so effect could be conservatively estimated based on the data from European IPPC Bureau[43]. According to the Bureau survey, emissions from coke production are:
Dust - 50.5 g/t of coke;
SO_x – 80.2 g/t of coke;
NO_x – 683.5 g/t of coke;
CO – 386.3 g/t of coke.

Due to the fact that average pig iron production at BFW is 4.5mln tons and the goal of the proposed project is to reduce specific coke consumption by 70 kg per ton of pig iron, reduction of hazardous pollutions into the atmosphere could be estimated as:
Dust –16.8 tons annually;
SO_x – 26.7 tons annually;
NO_x – 227.6 tons annually;
CO – 128.6 tons annually.

SECTION G. Stakeholders' comments

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

No stakeholder consultation process for the JI projects is required by the Host Party. Stakeholder comments will be collected during the time of this PDD publication in the internet during the determination procedure.

[43] [43] IPPC. Best Available Techniques Reference Document on the Production of Iron and Steel, p 122. ftp://ftp.jrc.es/pub/eippcb/doc/isp_bref_1201.pdf

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

According to the "Guidelines for Users of The Joint Implementation Project Design Document Form" (version 04 available at http://ji.unfccc.int/Ref/Docs.html) Annex 2 contains a summary of the key elements in tabular form.

Data/Parameter	P_{blast}
Data unit	$1000m^3$
Description	amount of blast produced for the BFW in the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical reports of CHP1 and CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 4 130 575 / 3 786 085; 2002: 3 878 539 / 3 731 152; 2003: 4 016 173 / 4 288 048; average: 4 008 429 / 3 935 095
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	average
4 130 575	3 878 539	4 016 173	4 008 429
3 786 085	3 731 152	4 288 048	3 935 095

Data/Parameter	P_{oxygen}
Data unit	$1000m^3$
Description	amount of oxygen produced for the BFW in the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 767 473; 2002: 821 705; 2003: 989 258; **average: 859 479**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
767 473	821 705	989 258	**859 479**

Data/Parameter	P_{NG}
Data unit	$1000m^3$
Description	Amount of natural gas combusted at the BFW during the base period
Time of	Fixed ex-ante during determination

<table>
<tr><td>determination/monitoring</td><td></td></tr>
<tr><td>Source of data (to be) used</td><td>Technical report of BFW</td></tr>
<tr><td>Value of data applied
(for ex ante calculations/determinations)</td><td><table><tr><td>2001</td><td>2002</td><td>2003</td><td>average</td></tr><tr><td>341 504</td><td>352 160</td><td>513 173</td><td>402 279</td></tr></table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures (to be) applied</td><td>Average value for the period 2001-2003</td></tr>
<tr><td>QA/QC procedures (to be) applied</td><td></td></tr>
<tr><td>Any comment</td><td></td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>P_{elec}</td></tr>
<tr><td>Data unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Amount of electricity consumed at BFW during the base period</td></tr>
<tr><td>Time of determination/monitoring</td><td>Fixed ex-ante during determination</td></tr>
<tr><td>Source of data (to be) used</td><td>Technical report of BFW</td></tr>
<tr><td>Value of data applied
(for ex ante calculations/determinations)</td><td><table><tr><td>2001</td><td>2002</td><td>2003</td><td>average</td></tr><tr><td>41 470</td><td>29 610</td><td>38 346</td><td>36 475</td></tr></table></td></tr>
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<table>
<tr><td>Data/Parameter</td><td>P_{coke}</td></tr>
<tr><td>Data unit</td><td>t</td></tr>
<tr><td>Description</td><td>Amount of coke consumed at BFW during the base period</td></tr>
<tr><td>Time of determination/monitoring</td><td>Fixed ex-ante during determination</td></tr>
<tr><td>Source of data (to be) used</td><td>Technical report of BFW</td></tr>
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(for ex ante calculations/determinations)</td><td><table><tr><td>2001</td><td>2002</td><td>2003</td><td>average</td></tr><tr><td>2 221 224</td><td>2 310 296</td><td>2 548 271</td><td>2 359 930</td></tr></table></td></tr>
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<tr><td>QA/QC procedures (to be) applied</td><td></td></tr>
<tr><td>Any comment</td><td></td></tr>
</table>

Data/Parameter	$P_{limestone}$
Data unit	t
Description	Amount of limestone consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 332 980; 2002: 418 672; 2003: 329 610; **average: 360 421**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
332 980	418 672	329 610	**360 421**

Data/Parameter	P_{lime}
Data unit	t
Description	Amount of lime consumed at BFW during the base period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 0; 2002: 0; 2003: 171 191; **average: 57 064**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
0	0	171 191	**57 064**

Data/Parameter	P_{iron}
Data unit	t
Description	Amount of iron produced at BFW during the baseline period
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of BFW
Value of data applied (for ex ante calculations/determinations)	2001: 3 788 692; 2002: 3 840 986; 2003: 4 395 196; **average: 4 008 291**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be)	

2001	2002	2003	**average**
3 788 692	3 840 986	4 395 196	**4 008 291**

applied	
Any comment	

Data/Parameter	P_{NG}^{CHP1}
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP1 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 39 858; 2002: 27 386; 2003: 28 101; **average**: 31 782
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{NG}^{CHP2}
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP2 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 10 194; 2002: 17 431; 2003: 10 178; **average**: 12 601
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{COG}^{CHP1}
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP1 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 44 414; 2002: 41 606; 2003: 52 657; **average**: 46 226
Justification of the choice of data or description of measurement methods and procedures (to be)	Average value for the period 2001-2003

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

Data/Parameter	P_{COG}^{CHP2}
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP2 for blast production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 71 421; 2002: 71 867; 2003: 75 700; **average**: 72 996
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	EF_{elec}^{CHP1}
Data unit	MWh
Description	Amount of electricity consumed during blast production at CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 32 261; 2002: 33 274; 2003: 32 436; **average**: 32 657
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{elec}^{CHP2}
Data unit	MWh
Description	Amount of electricity consumed during blast production at CHP2
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante	2001; 2002; 2003; **average**

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<table>
<tr><td>Data/Parameter</td><td>$P_{NG}^{CHP1elec}$</td></tr>
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<tr><td>Description</td><td>Amount of natural gas consumed at CHP1 for electricity production</td></tr>
<tr><td>Time of determination/monitoring</td><td>Fixed ex-ante during determination</td></tr>
<tr><td>Source of data (to be) used</td><td>Technical report of CHP1</td></tr>
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<tr><td>Data/Parameter</td><td>$P_{COG}^{CHP1elec}$</td></tr>
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<tr><td>Time of determination/monitoring</td><td>Fixed ex-ante during determination</td></tr>
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<tr><td>Value of data applied (for ex ante calculations/determinations)</td><td><table><tr><td>2001</td><td>2002</td><td>2003</td><td>average</td></tr><tr><td>19 967</td><td>22 190</td><td>39 759</td><td>27 305</td></tr></table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures (to be) applied</td><td>Average value for the period 2001-2003</td></tr>
<tr><td>QA/QC procedures (to be) applied</td><td></td></tr>
<tr><td>Any comment</td><td></td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>P_{elec}^{CHP1}</td></tr>
<tr><td>Data unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Amount of electricity produced at CHP1</td></tr>
</table>

Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 197 218; 2002: 189 643; 2003: 257 914; **average: 214 925**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
197 218	189 643	257 914	**214 925**

Data/Parameter	$P_{NG}^{CHP2elec}$
Data unit	$1000m^3$
Description	Amount of natural gas consumed at CHP2 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 2 871; 2002: 10 835; 2003: 5 219; **average: 6 308**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
2 871	10 835	5 219	**6 308**

Data/Parameter	$P_{COG}^{CHP2elec}$
Data unit	$1000m^3$
Description	Amount of COG consumed at CHP2 for electricity production
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 20 112; 2002: 44 671; 2003: 38 821; **average: 34 534**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
20 112	44 671	38 821	**34 534**

Data/Parameter	P_{elec}^{CHP2}
Data unit	MWh
Description	Amount of electricity produced at CHP2
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP2
Value of data applied (for ex ante calculations/determinations)	2001: 75 791; 2002: 160 058; 2003: 147 814; **average: 127 887**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
75 791	160 058	147 814	**127 887**

Data/Parameter	$P_{elec}^{CHP1compress}$
Data unit	MWh
Description	Amount of electricity consumed by electro compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 140 040; 2002: 244 959; 2003: 246 270; **average: 210 423**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
140 040	244 959	246 270	**210 423**

Data/Parameter	$P_{elec}^{OXcompress}$
Data unit	MWh
Description	Amount of electricity consumed by electro compressors of oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 153 256; 2002: 190 276; 2003: 208 992; **average: 184 175**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003

2001	2002	2003	**average**
153 256	190 276	208 992	**184 175**

QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	P_{elec}^{OX}
Data unit	MWh
Description	Amount of electricity consumed by oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 118 455; 2002: 117 380; 2003: 127 307; **average: 121 047**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
118 455	117 380	127 307	**121 047**

Data/Parameter	P_{air}^{CHP1}
Data unit	$1000m^3$
Description	Amount of compressed air produced by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 2 138 638; 2002: 554 877; 2003: 1 303 297; **average: 1 332 271**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
2 138 638	554 877	1 303 297	**1 332 271**

Data/Parameter	$P_{oxygen}^{workshop}$
Data unit	$1000m^3$
Description	Amount of oxygen produced by oxygen workshop
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of oxygen workshop
Value of data applied (for ex ante calculations/determinations)	2001: 767 473; 2002: 821 705; 2003: 989 258; **average: 859 479**
Justification of the choice of data	Average value for the period 2001-2003

2001	2002	2003	**average**
767 473	821 705	989 258	**859 479**

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

Data/Parameter	$P_{NG}^{CHP1air}$
Data unit	$1000m^3$
Description	Amount of natural gas consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 28 015; 2002: 5 310; 2003: 12 218; **average: 15 181**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
28 015	5 310	12 218	**15 181**

Data/Parameter	$P_{COG}^{CHP1air}$
Data unit	$1000m^3$
Description	Amount of COG consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination
Source of data (to be) used	Technical report of CHP1
Value of data applied (for ex ante calculations/determinations)	2001: 31 217; 2002: 8 067; 2003: 22 896; **average: 20 727**
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Average value for the period 2001-2003
QA/QC procedures (to be) applied	
Any comment	

2001	2002	2003	**average**
31 217	8 067	22 896	**20 727**

Data/Parameter	$P_{elec}^{CHP1air}$
Data unit	MWh
Description	Amount of electricity consumed for the compressed air production by turbo compressors of CHP1
Time of determination/monitoring	Fixed ex-ante during determination

<table>
<tr><td>Source of data (to be) used</td><td>Technical report of CHP1</td></tr>
<tr><td>Value of data applied
(for ex ante calculations/determinations)</td><td><table><tr><td>2001</td><td>2002</td><td>2003</td><td>average</td></tr><tr><td>29 315</td><td>7 764</td><td>16 755</td><td>17 945</td></tr></table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures (to be) applied</td><td>Average value for the period 2001-2003</td></tr>
<tr><td>QA/QC procedures (to be) applied</td><td></td></tr>
<tr><td>Any comment</td><td></td></tr>
</table>

Standardized emission factors for the Ukrainian electricity grid

Introduction

Many Joint Implementation (JI) projects have an impact on the CO_2 emissions of the regional or national electricity grid. Given the fact that in most Economies in Transition (IET) an integrated electricity grid exists, a standardized baseline can be used to estimate the amount of CO_2 emission reductions on the national grid in case of:

a) Additional electricity production and supply to the grid as a result of a JI project (=producing projects);
b) Reduction of electricity consumption due to the JI project resulting in less electricity generation in the grid (= reducing projects);
c) Efficient on-site electricity generation with on-site consumption. Such a JI project can either be a), b), or a combination of both (e.g. on-site cogeneration with partial on-site consumption and partial delivery to the grid).

So far most JI projects in EIT, including Ukraine, have used the standardized Emission Factors (EFs) of the ERUPT programme. In the ERUPT programme for each EIT a baseline for producing projects and reducing projects was developed. The ERUPT approach is generic and does not take into account specific local circumstances. Therefore in recent years new standardized baselines were developed for countries like Romania, Bulgaria, and Estonia. In Ukraine a similar need exist to develop a new standardized electricity baseline to take the specific circumstances of Ukraine into account. The following baseline study establishes a new electricity grid baseline for Ukraine for both producing JI projects and reducing JI projects.

This new baseline has been based on the following guidance and approaches:

- The "Guidance on criteria for baseline setting and monitoring" for JI projects, issued by the Joint Implementation Supervisory Committee[44];
- The "Operational Guidelines for the Project Design Document", further referred to as ERUPT approach or baseline [45];
- The approved CDM methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" [46];
- Specific circumstances for Ukraine as described below.

ERUPT

The ERUPT baseline was based on the following main principles:

- Based mainly on indirect data sources for electricity grids (i.e. IEA/OECD reports);
- Inclusion of grid losses for reducing JI projects;
- An assumption that all fossil fuel power plants are operating on the margin and in the period of 2000-2030 all fossil fuel power plants will gradually switch to natural gas.

The weak point of this approach is the fact that the date sources are not specific. For example, the Net Calorific Value (NCV) of coals was not determined on installation level but was taken from IPCC default values. Furthermore the IEA data included electricity data until 2002 only. ERUPT assumes that Ukraine would switch all its fossil-fuel plant from coal to natural gas. In Ukraine such an assumption is unrealistic as the tendency is currently in the opposite direction.

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[44] Guidance on criteria for baseline setting and monitoring, version 01, Joint Implementation Supervisory Committee, ji.unfccc.int

[45] Operational Guidelines for Project Design Documents of Joint Implementation Projects. Ministry of Economic Affairs of the Netherlands, May 2004

[46] Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 06, 19 May 2006, cdm.unfccc.int

ACM0002

The ACM0002 methodology was developed in the context of CDM projects. The methodology takes a combination of the Operating Margin (OM) and the Build Margin (BM) to estimate the emissions in absence of the CDM project activity. To calculate the OM four different methodologies can be used. The BM in the methodology assumes that recent built power plants are indicative for future additions to the grid in the baseline scenario and as a result of the CDM project activity construction of new power plants is avoided. This approach is valid in electricity grids in which the installed generating capacity is increasing, which is mostly the case in developing countries. However, the Ukrainian grid has a significant overcapacity and many power plants are either operating below capacity or have been moth-balled.

Nuclear is providing the base load in Ukraine

In Ukraine nuclear power plants are providing the base load of the electricity in Ukraine. To reduce the dependence on imported fuel the nuclear power plants are running at maximum capacity where possible. In the past five years nuclear power plants provide almost 50% of the total electricity:

Year	2001	2002	2003	2004	2005
Share of AES	44%	45%	45%	48%	48%

Table 11: Share of nuclear power plant in the annual electricity generation

All other power stations are operating on the margin. This includes hydro power plants which is show in the table below.

	Minimum; 03:00	Maximum; 19:00
Consumption, MW	21,287	27,126
Generation, MW	22,464	28,354
Thermal power plants	*10,049*	*13,506*
Hydro power plants	*527*	*3,971*
Nuclear power plants	*11,888*	*10,877*
Balance imports/export, MW	-1,177	-1,228

Table 12: Electricity demand in Ukraine on 31 March 2005[47]

Development of the Ukrainian electricity sector

The National Energy Strategy[48] sets the approach for the overall energy complex of Ukraine and the electricity sector in particular. The main priority of Ukraine is to reduce the dependence of imported fossil fuels. The strategy sets the following priorities[49]:

- increased use of local coal as a fuel;
- construction of the new nuclear power plants;
- energy efficiency and energy saving.

Due to the sharp increase of imported natural gas prices a gradual switch from natural gas to coal at the power plants is planned in the nearest future. Ukraine possesses a large overcapacity of the fossil-powered plants of which many are mothballed. These moth-balled plants might be connected to the grid in case of growing demand.

[47] Ukrenergo, http://www.ukrenergo.energy.gov.ua/ukrenergo/control/uk/publish/article?art_id=39047&cat_id=35061

[48] http://mpe.kmu.gov.ua/fuel/control/uk/doccatalog/list?currDir=50505

[49] Energy Strategy of Ukraine for the Period until 2030, section 16.1, page 127.

In the table below the installed capacity and load factor is given in Ukraine. As one can see the average load factor of thermal power plant is very low.

	Installed capacity (GW)	Average load factor, %
Thermal power plants	33.6	28.0
Hydro power plants	4.8	81.4
Nuclear power plants	13.8	26.0
Total	**52.2**	**39.0**

Table 13: Installed capacity in Ukraine in 2004[50]

According to IEA's estimations, about 25% of thermal units might not be able to operate (though there is no official statistics). This means that still at least 45% of the installed thermal power capacity could be utilized, but is currently not used. In accordance with the IEA report the 'current capacity will be sufficient to meet the demand in the next decade'[51].

In the table below the peak load of the years 2001- 2005 are given which is approximately 50% of the installed capacity.

	2001	2002	2003	2004	2005
Peak load (GW)	28.3	29.3	26.4	27.9	28.7

Table 14: Peak load in Ukraine in 2001 - 2005[52]

New nuclear power plants will take significant time to be constructed will not get on-line before the end of the second commitment period in 2012. There is no nuclear reactor construction site at such an advanced stage remaining in Ukraine, it is unlikely that Ukraine will have enough resources to commission any new nuclear units in the foreseeable future (before 2012)[53].

Latest nuclear additions (since 1991):
- Zaporizhzhya NPP unit 6, capacity 1 GW, commissioned in 1995;
- Rivne NPP unit 4, capacity 1 GW, commissioned in 2004;
- Khmelnitsky NPP unit 2, capacity 1 GW, commissioned in 2004.

Nuclear power plants under planning or at early stage of construction:
- South Ukraine NPP one additional unit, capacity 1 GW;
- Khmelnitsky NPP two additional units, capacity 1 GW each.

Approach chosen
In the selected approach of the new Ukrainian baseline the BM is not a valid parameter. Strictly applying BM in accordance with ACM0002 would result in a BM of zero as the latest additions to the Ukrainian grid were nuclear power plants. Therefore applying BM taking past additions to the Ukrainian grid would result in an unrealistic and distorted picture of the emission factor of the Ukrainian grid. Therefore the Operating Margin only will be used to develop the baseline in Ukraine.

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[50] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 272, table 8.1

[51] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 269

[52] Ministry of Energy, letter dated 11 January 2007

[53] http://www.xaec.org.ua/index-ua.html

The following assumptions from ACM0002 will be applied:
1) The grid must constitute of all the power plants connected to the grid. This assumption has been met as all power plants have been considered;
2) There should be no significant electricity imports. This assumption has been met in Ukraine as Ukraine is a net exporting country as shown in the table below;
3) Electricity exports are not accounted separately and are not excluded from the calculations.

	2001	2002	2003
Electricity produced, GWh	175,109	179,195	187,595
Exports, GWh	5,196	8,576	12,175
Imports, GWh	2,137	5,461	7,235

Table 15: Imports and exports balance in Ukraine[54]

ACM0002 offers several choices for calculating the OM. Dispatch data analysis cannot be applied, since the grid data is not available[55]. Simple adjusted OM approach is not applicable for the same reason. The average OM calculation would not present a realistic picture and distort the results, since nuclear power plants always work in the base load due to the technical limitations (and therefore cannot be displaced) and constitute up to 48% of the overall electricity generation during the past 5 years.

Therefore, the simple OM approach is used to calculate the grid emission factor. In Ukraine the low-cost must-run power plants are nuclear power stations. Their total contribution to the electricity production is below 50% of the total electricity production. The remaining power plants, all being the fossil-fuel plants and hydro power plants, are used to calculate the Simple OM.

%	2001	2002	2003	2004	2005
Nuclear power plants	44.23	45.08	45.32	47.99	47.92
Thermal power plants	38.81	38.32	37.24	32.50	33.22
Combined heat and power	9.92	11.02	12.28	13.04	12.21
Hydro power plants	7.04	5.58	5.15	6.47	6.65

Table 16: Share of power plants in the annual electricity generation of Ukraine[56]

[54] Source: State Committee of Statistics of Ukraine. Fuel and energy resources of Ukraine 2001-2003. Kyiv, 2004

[55] Ministry of Energy, letter dated 11 January 2007

[56] “Overview of data on electrical power plants in Ukraine 2001 - 2005“, Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

The simple OM is calculated using the following formula:

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum GEN_{j,y}} \quad \textit{(Equation 1)}$$

Where:
$F_{i,j,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y* (2001-2005);
j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid;
$COEF_{i,j,y}$ is the CO2 emission coefficient of fuel *I* (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources *j* and the percent oxidation of the fuel in year(s) *y*;
$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j*.

The CO2 emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \quad \textit{(Equation 2)}$$

Where:
NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel *i*;
$OXID_i$ is the oxidation factor of the fuel;
$EF_{CO2,i}$ is the CO2 emission factor per unit of energy of the fuel *i*.

Individual data for power generation and fuel properties was obtained from the individual power plants[57]. The majority of the electricity (up to 95%) is generated centrally and therefore the data is comprehensive[58].

The Net Calorific Value (NCV) of fossil fuel can change considerably, in particular when using coal. Therefore the local NCV values of individual power plants for natural gas and coal were used. For heavy fuel oil, the IPCC[59] default NCV was used. Local CO_2 emission factors for all types of fuels were taken for the purposes of the calculations and Ukrainian oxidation factors were used. In the case of small-scale power plants some data regarding the fuel NCV is missing in the reports. For the purpose of simplicity, the NCV of similar fuel from a power plant from the same region of Ukraine was used.

Reducing JI projects
The Simple OM is applicable for additional electricity production delivered to the grid as a result of the project (producing JI projects). However, reducing JI projects also reduce grid losses. For example a JI

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[57] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[58] The data for small units (usually categorized in the Ukrainian statistics as 'CHPs and others') is scattered and was not always available. As it was rather unrealistic to collect the comprehensive data from each small-scale power plant, an average CO2 emission factor was calculated for the small-scale plants that provided the data. For the purpose of simplicity it was considered that all the electricity generated by the small power plants has the same average emission factor obtained.

[59] IPCC 1996. Revised guidelines for national greenhouse gas inventories.

project reduces on-site electricity *consumption* with 100,000 MWh and the losses in the grid are 10%. This means that the actual reduction in electricity *production* is 111,111 MWh. Therefore a reduction of these grid losses should be taken into account for reducing JI projects to calculate the actual emission reductions.

The losses in the Ukrainian grid are given in the table below and are based on the data obtained directly from the Ukrainian power plants through the Ministry of Energy.

Year	Technical losses %	Non-technical losses %	Total %
2001	14,2	7	21,2
2002	14,6	6,5	21,1
2003	14,2	5,4	19,6
2004	13,4	3,2	16,6
2005	13,1	1,6	14,7

Table 17: Grid losses in Ukraine[60]

As one can see grid losses are divided into technical losses and non-technical losses. For the purpose of estimating the EF only technical losses[61] are taken into account. As can been seen in the table the technical grid losses are decreasing. The average decrease of grid losses in this period was 0.275% per annum. Extrapolating these decreasing losses to 2012 results in technical grid losses of 12% by 2012. However, in order to be conservative the grid losses *over the full period 2006-2012* have been taken as 10%.

Further considerations

The "Guidance on criteria for baseline setting and monitoring" for JI projects requires baselines to be conservative. The following measures have been taken to adhere to this guidance and to be conservative:

- The grid emission factor is actually expected to grow due to the current tendency to switch from gas to coal;
- Hydro power plants have been included in the OM. This is conservative;
- With the growing electricity demand, out-dated mothballed fossil fired power plants are likely to come on-line as existing nuclear power plants are working on full load and new nuclear power plants are unlikely to come on-line before 2012. The emission factor of those moth-balled power plants is higher as all of them are coal of heavy fuel oil fired[62];
- The technical grid losses in Ukraine are high, though decreasing. With the current pace the grid losses in Ukraine will be around 12% in 2012. To be conservative the losses have been taken 10%;
- The emissions of methane and nitrous oxide have not taken into consideration, which is in line with ACM0002. This is conservative.

Conclusion

An average CO_2 emission factor was calculated based on the years 2003-2005. The proposed baseline factors is based on the average constituting a fixed emission factor of the Ukrainian grid for the period of 2006-2012. Both baseline factors are calculated using the formulae below:

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[60] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[61] Ukrainian electricity statistics gives two types of losses – the so-called 'technical' and 'non-technical'. 'Non-technical' losses describe the non-payments and other losses of unknown origin.

[62] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

$$EF_{grid,produced,y} = EF_{OM,y} \quad \textit{(Equation 3)}$$

and

$$EF_{grid,reduced,y} = \frac{EF_{grid,produced,y}}{1 - loss_{grid}} \quad \textit{(Equation 4)}$$

Where:

$EF_{grid,produced,y}$ is the emission factor for JI projects supplying additional electricity to the grid (tCO2/MWh);

$EF_{grid,reduced,y}$ is the emission factor for JI projects reducing electricity consumptionfrom the grid (tCO2/MWh)factor of the fuel;

$EF_{OM,y}$ is the simple OM of the Ukrainian grid (tCO2/MWh);

$loss_{grid}$ is the technical losses in the grid (%).

The following result was obtained:

Type of project	Parameter	EF (tCO2/MWh)
JI project producing electricity	$EF_{grid,produced,y}$	0.807
JI projects reducing electricity	$EF_{grid,reduced,y}$	0.896

Table 18: Emission Factors for the Ukrainian grid 2006 - 2012

Monitoring

This baseline requires the monitoring of the following parameters:

- Electricity produced by the project and delivered to the grid in year y (in MWh);
- Electricity consumption reduced by the project in year (in MWh);
- Electricity produced by the project and consumed on-site in year y (in MWh);

The baseline emissions are calculated as follows:

$$BE_y = EF_{grid,produced,y} x EL_{produced,y} + EF_{grid,reduced,y} x \left(EL_{reduced,y} + EL_{consumed,y}\right) \quad \textit{(Equation 5)}$$

Where:

BE_y are the baseline emissions in year y (tCO2);

$EF_{grid,produced,y}$ is the emission factor of producing projects (tCO2/MWh);

$EL_{produced,y}$ is electricity produced and delivered to the grid by the project in year y (MWh);

$EF_{grid,reduced,y}$ is the emission factor of reducing projects (tCO2/MWh);

$EL_{produced,y}$ is electricity consumption reduced by the project in year y(MWh);

$EL_{consumed,y}$ is electricity produced by the project and consumed on-site in year y (MWh).

This baseline can be used as ex-ante (fixed for the period 2006 – 2012) or ex-post. In case an ex-post baseline is chosen the data of the Ukrainian grid have to be obtained of the year in which the emission reductions are being claimed. Monitoring will have to be done in accordance with the monitoring plan of ACM0002 with the following exceptions:

- the Monitoring Plan should also include monitoring of the grid losses in year y;
- power plants at which JI projects take place should be excluded. Such a JI project should have been approved by Ukraine and have been determined by an Accredited Independent Entity.

Acknowledgements
The development of this new baseline has been made possible by funding of the EBRD and the Netherlands' Ministry of Economic Affairs. The authors would further like to thank the Ukrainian Ministry of Energy for supplying the data and the Ministry of Environmental Protection for their support.
This baseline study can be used freely in case of proper reference.

Global Carbon B.V.
Version 5, 2 February 2007

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Ukraine - Assessment of new calculation of CEF

Introduction

Many Joint Implementation (JI) projects have an impact on the CO_2 emissions of the regional or national electricity grid. Given the fact that in most Economies in Transition an integrated electricity grid exists, a standardized baseline should be used to estimate the amount of CO_2 emission reductions on the national grid.

The Ukraine is one of the major JI host countries where many grid related projects have been developed or will be implemented. In order to enhance the project development and reliability in emission reductions from the Ukraine a standardized and common agreed grid factor expressing the carbondioxid density per kWh is crucial.

Objective

Global Carbon B.V. is one of the pioneers developing JI projects in Ukraine who has developed a baseline approach for determining the Ukrainian grid factor. The approach is implied from the approved CDM methodology ACM0002.

The team of Carbon Management Service (CMS) of TÜV SÜD Industrie Service GmbH with its accredited certification body "Climate and Energy" has been ordered to verify the developed approach and the calculated grid factor.

Once an approach is agreed it should be used for calculating the grid by using current available data served from the Ukraine Ministry for Fuel and Energy. Such annual grid factor shall be used as a binding grid factor for JI projects developed in the Ukraine.

Scope

The baseline approach to which this confirmation is referring is attached. The confirmation includes the inherent approach if the algorithms are developed reasonable and from a technical point of view correct. Furthermore the verified the

Date: 17.08.2007

Our reference:
IS-USC-MUC/

This document consists of
4 Pages
Page 1 of 4

The test results refer exclusively to the units under test.

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Industrie Service

origin of the data. The team consists of:

- Werner Betzenbichler (Head of the certification Body "Climate and Energy"),
- Thomas Kleiser (Head of division JI/CDM, GHG-Auditor and Project Manager)
- Markus Knödlseder (GHG-Auditor and Project Manager)

Mr. Kleiser and Betzenbichler assessed the baseline approach and agreed with Global Carbon on the conclusive approach. Mr. Kleiser and Mr. Knödlseder assessed the calculation model whereas Mr. Knödlseder interviewed also Mr. Nikolay Andreevich Borisov, Deputy Director for Strategic Development in Ministry of Fuel and Energy (+380 (44) 2349312 // bo-risov@mintop.energy.gov.ua) who explained the process of data gathering in the Ukraine. He also confirmed that GlobalCarbon B.V. uses the served data.

Conclusion

The conclusive assessment does not include potential uncertainties that might be occurred in the data gathering process of the ministry. Considering that we confirm that applied data served by Ministry of Fuel and Energy are reliable and correctly used.

Based on submitted calculation method, developed baseline study (see attachment), applied data and written confirmation from Ministry of Fuel and Energy (see attached documents) the team of Carbon Management Service of TÜV SÜD Industrie Service GmbH with its accredited certification body "Climate and Energy" confirms further that developed approach is eligible to determine the Ukrainian electricity grid factor as a standard value for JI project in the Ukraine.

The team recommends updating the calculation annually depending on point of time when national consolidated data are available.

Munich,17/08/2007	Munich, 17/08/2007
Markus Knödlseder	Werner Betzenbichler
GHG-Auditor and Project Manager	Head of the certification Body "Climate and Energy" and Carbon Management Service

Annex 3

MONITORING PLAN

For the monitoring plan please refer to section D of this PDD.