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

## CONTENTS



**Annexes**

# SECTION A. General description of the project

## A.1. Title of the project:

«Reconstruction of the agglomerate and blast-furnace production at the JSC «Zaporizhstal».

Sectoral scope: 9 (metal production).
Project Design Document Version 2
14/04/2011

## A.2. Description of the project:

The project is realized on the territory of the metallurgical plant JSC "Zaporizhstal", which is located in the city of Zaporizhia in Zaporizhia region, southern-east part of Ukraine. JSC "Zaporizhstal" (Zaporizhstal) is the enterprise with the full metallurgical cycle, which produces hot rolled coils and cold rolled coils and also tinplate.

Zaporizhstal is the producer of agglomerate, pig iron, steel and rolled metal. Marketable products of the enterprise are hot–rolled and cold–rolled steel in sheets and in coils from 0.5 to 8.0 mm thick of carbon, low–alloy, alloy and stainless steels, cold roll–formed sections, hot–dipped tinplate, black plate, steel strip, ingot moulds and stools, granulated slag and broken slag, liquid gases, a wide range of metal, wooden and concrete articles (over 170 items)[1]. While one of the more modern integrated steel works in Ukraine, Zaporizhstal was fairly typical of the Ukrainian iron and steel sector up to 2003 in terms of the vintage of technologies. The facilities of the plant were mainly built in 1930s and 1940s. The plant has high energy intensity, causing significant emissions into the atmosphere of greenhouse and harmful gases as well as dust.

Zaporizhstal consists of the following main units: sintering shop, blast furnace (BF) shop, open-hearth furnace shop, converter shop, plate and rolling mill shops, slab-casting machines, power plant and auxiliary facilities.

Blast furnaces and sintering machines are operated at the Steel Mill for a long time and have not been changed technologically since their operation start. There were not any legal requirements to replace or reconstruct less effective blast furnaces in the country leaving a decision on their replacement at project owner's discretion.

The greater presence at the market could be achieved by use of old production technologies, virtually without additional investment. However, at 25th of December, 2002 the management team of the enterprise has decided to start development of the enterprise by technical revamping of sintering and blast-furnace production[2]. The main goal was not only to improve performance of the enterprise, but also to solve environmental problems of production process (according to the plan of revamping the amount of harmful emissions had to be reduced by more than 41%[3]).

The proposed Joint Implementation project considers complex resource-saving effect based on introduction of new sintering machine # 1, which will replace the old one under the same number, radical reconstruction of blast furnace #2, retirement from service of blast furnace # 1, gradual reconstruction of the remaining blast furnaces ## 4 and 5 and introduction of pulverized coal injection (PCI) system at all the BFs (## 2, 3, 4, 5) as well as technological improvements in the process of sintering and pig iron production.

Several project measures and activities have been and would be implemented in Zaporizhstal pig iron production to reduce consumption of coke and other fuel and materials. Some of these measures involved improvements in preparation of raw materials at Sinter Plant which mainly of technological character and also connected with introduction of the new sintering machine.

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[1] http://www.zaporizhstal.com/en/products/
[2] The prior consideration of the project is stated by the Protocol of technical Council of the plant dated 25h of December, 2002.
[3] http://www.zaporizhstal.com/about/ecology/

After implementation of these and other measures of technological character, this would lead to reduction of specific consumption of coke in the blast furnaces and better productivity of blast furnaces.

The sinter plant and blast furnace shop require production of so called secondary energy sources such as compressed air, steam, nitrogen, oxygen etc. These products are produced at the Steel Mill and a major part of them comes from the local power facilities. For a long time the modernization of the energy production has not been done because of absence of incentives into energy saving, uncertainty with market situation, difficulties with mobilizing the credit resources etc.

Without implementation of the proposed project activity Zaporizhstal would continue to operate the SP and BFs without introduction of new facilities, technical upgrade and improvement of sintering and BF production processes. The baseline scenario of the proposed project activity assumes continuation of the situation existing prior to the project, i.e., continuation of SP and BFs ## 1, 2, 3, 4 and 5 operation (in more detail baseline scenario is described in section B).

The implementation of JI project requires the total investment costs of 1876,8 mio. UAH or 170,9 mio. Euro[4] (investment costs of the project are further described in Section A.4.2, Table 1).

The possibility to use Kyoto mechanisms contributed to identification of ways to improve energy-efficiency and environment at the sintering and blast-furnace process. These mechanisms will allow Zaporizhstal to receive additional financing needed to expand the JI project boundaries and reduce the period of credit payment and thus enhance the attractiveness of the project.

For a long time a realization of such projects was restrained by the absence of proper methodologies and practice on assessment of greenhouse gas emissions into atmosphere, caused by technological processes to be used in iron and steel sector. Only recently first examples of positive developments of similar JI projects have been demonstrated. It has opened the opportunity for Zaporizhstal to realize the similar JI project based on precedent experience[5] [6] [7]

## A.3. Project participants:

| Party involved | Legal entity project participant (as applicable) | Please indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Ukraine (Host Party) | JSC “Zaporizhstal” | No |

[4] In accordance with the National Bank of Ukraine exchange rate as of the 01.04.2011 (10,98 UAH for 1 Euro).
[5] Reconstruction of the OJSC “Nizhiy Tagil Iron and Steel Works” Blast Furnaces №5 and №6, Russian Federation”, http://ji.unfccc.int/UserManagement/FileStorage/279ANLJMEX8HG1KT653ODRIUQZFSPY,
[6] “Energy Efficiency measures at the “Public Joint Stock Company Azovstal Iron & Steal Works”, http://ji.unfccc.int/UserManagement/FileStorage/279ANLJMEX8HG1KT653ODRIUQZFSPY
[7] JI project “Revamping of sintering and blast furnace production at OJSC “Alchevsk Iron and Steel Works”.

**A.4. Technical description of the project:**

**A.4.1. Location of the project:**

The project is located in the city of Zaporizhia in Ukraine.

**A.4.1.1. Host Party(ies):**

Ukraine

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

Zaporizhia region

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

Zaporizhia

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

Zaporizhia city is the administrative center of Zaporizhia region, situated on the banks of the Dnieper River. Zaporizhia has population of 776 000 people (as of 2010)[8]. Zaporizhia region is located in Southern-East part of Ukraine. The area of Zaporizhia region is 27,2 ths. km$^2$ (4,5% of the territory of Ukraine). Zaporizhia region is contiguous with Dnipropetrovs'k, Kherson, Donetsk regions, and in the South-East it is washed by Azov Sea.
The geographical coordinates of project site are 48°52′0″N latitude and 35°09′0″E longitude.


**Figure 1. Location of proposed JI Project site, JSC "Zaporizhstal".**

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8 http://www.zp.ukrstat.gov.ua/images/stories/Exp_dem_1377.pdf

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

Project activity contains three main components such as: 1) improvement of pig iron production process; 2) improvement of sintering process; 3) improvement of secondary energy resources production process.

The revamping of sintering and blast-furnace production at Zaporizhstal is assumed to be implemented as follows:

**Table 1. JI Project Implementation Schedule together with the financing plan**[9]

| *Phase* | *Measures* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* | *2010* | *2011* | *2012* | *2013* | *2014* | *2015* | *2016* | *Investments, mio. UAH* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | **Improvement of pig iron production process** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| | Radical reconstruction of BF # 2[10] | ■ | ■ | | | | | | | | | | | | | **345,057** |
| | Reconstruction of BF # 4 | | | | | | ■ | ■ | ■ | ■ | | | | | | **300** |
| | Reconstruction of BF # 5 | | | | | | | | | | | | | ■ | ■ | **300** |
| | Installation of PCI facility at BFs ## 2, 3, 4, 5 | | | | | ■ | ■ | ■ | ■ | | | | | | | **1001,39** |
| *2* | **Improvement of sintering process** | | | | | | | | | | | | | | | |
| | Installation of the new sintering machine # 1 | | | | | | | | | ■ | | | | | | **226,832** |
| | The commissioning of air aspiration equipment of tail part of sintering machines | | | ■ | ■ | ■ | | | | | | | | | | **112,398** |
| *3* | **Improvement of secondary energy resources production process** | | | | | | | | | | | | | | | |
| | The construction of the station for heating gas and combustion of air in blast furnace shop | ■ | ■ | | | | | | | | | | | | | Investment for this measure is included in reconstruction of BFs |
| | **Total** | | | | | | | | | | | | | | | **2285,68** |

In order to understand the character of project activity that involves technological improvements, it is needed to give a brief explanation about principal technological scheme of sintering process and blast furnace operation.

Carbon dioxide emissions in the sintering production processes are mainly achieved during: the process of burning solid fuel, which is part of the sintering charge; the process of burning natural gas, which is fed into burners for ignition of sintering charge; reaction of limestone decomposition, which is part of sintering charge, to calcium oxide and carbon dioxide. The principal scheme of sinter plant operation is described below.

[9] The exact dates of project implementation measures will be provided in monitoring reports.
[10] Reconstruction of BF # 2 foresee retirement from service of BF # 1.

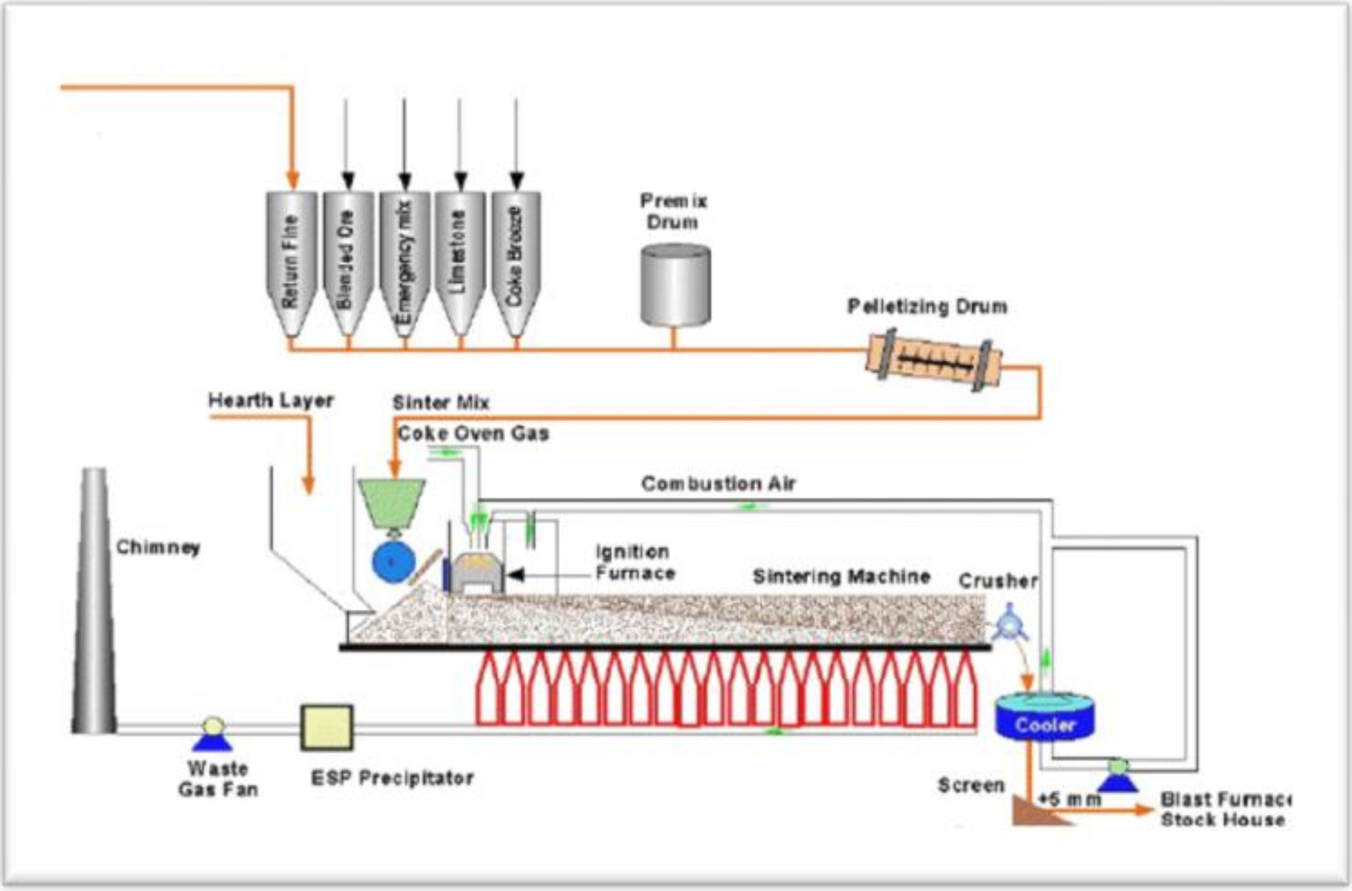


**Figure 2. Principal process description of sintering production**

By sintering, the pelletisation of fine-grained, smeltable ores, iron ore in particular, to compact lumps by heating nearly to the melting or softening point is understood. Melting tendencies at the grain boundaries lead to a caking of the material. Before the sintering, the various substances are first mixed and granulated. The iron ores are agglomerated on conveyor sinter installations, the conveyor belts consist of a large number of waggons. These waggons that have been linked up as an endless conveyor belt. The fine ore to be sintered is moistened and fed on to the circulating grid together with coke slack and additions such as limestone, quick lime, olivine or dolomite. Burners above a heat-resistant grate belt heat the material to the required temperature (1100-1200 °C). This causes the fuel in the mixture to be ignited. The carbon burns with the aid of the air sucked through the grid into the mixture, resulting in the flame front being moved through the sintering bed. The sintering processes are completed once the flame front has passed through the entire mixed layer and all fuel has been burnt.

Iron sintering plants are associated with the manufacture of pig iron. The sintering process is a pre-treatment step in the production of pig iron, where fine particles of iron ores and also secondary iron oxide wastes (collected dusts, mill scale), are agglomerated by combustion. Sintering involves the heating of fine iron ore with flux and coke fines or coal to produce a semi-molten mass that solidifies into porous pieces of sinter with the size and strength characteristics necessary for feeding into the blast furnace. Moistened feed is delivered as a layer onto a continuously moving grate or "strand." The surface is ignited with gas burners at the start of the strand, and air is drawn through the moving bed causing the fuel to burn. Strand velocity and gas flow are controlled to ensure that "burn through" (i.e. the point at which the burning fuel layer reaches the base of the strand) occurs just prior to the sinter being discharged. The solidified sinter is then broken into pieces in a crusher and is air-cooled. Product outside the required size range is screened out, oversize material is recrushed, and undersize material is recycled back to the process.

The flexibility of the sintering process permits conversion of a variety of materials, including iron ore fines, captured dusts, ore concentrates, and other iron-bearing materials of small particle size (e.g., mill scale) into a clinker-like agglomerate.

Agglomerate or ironstone is main feeding product of the blast furnaces.

The general scheme of blast furnace process is given below.

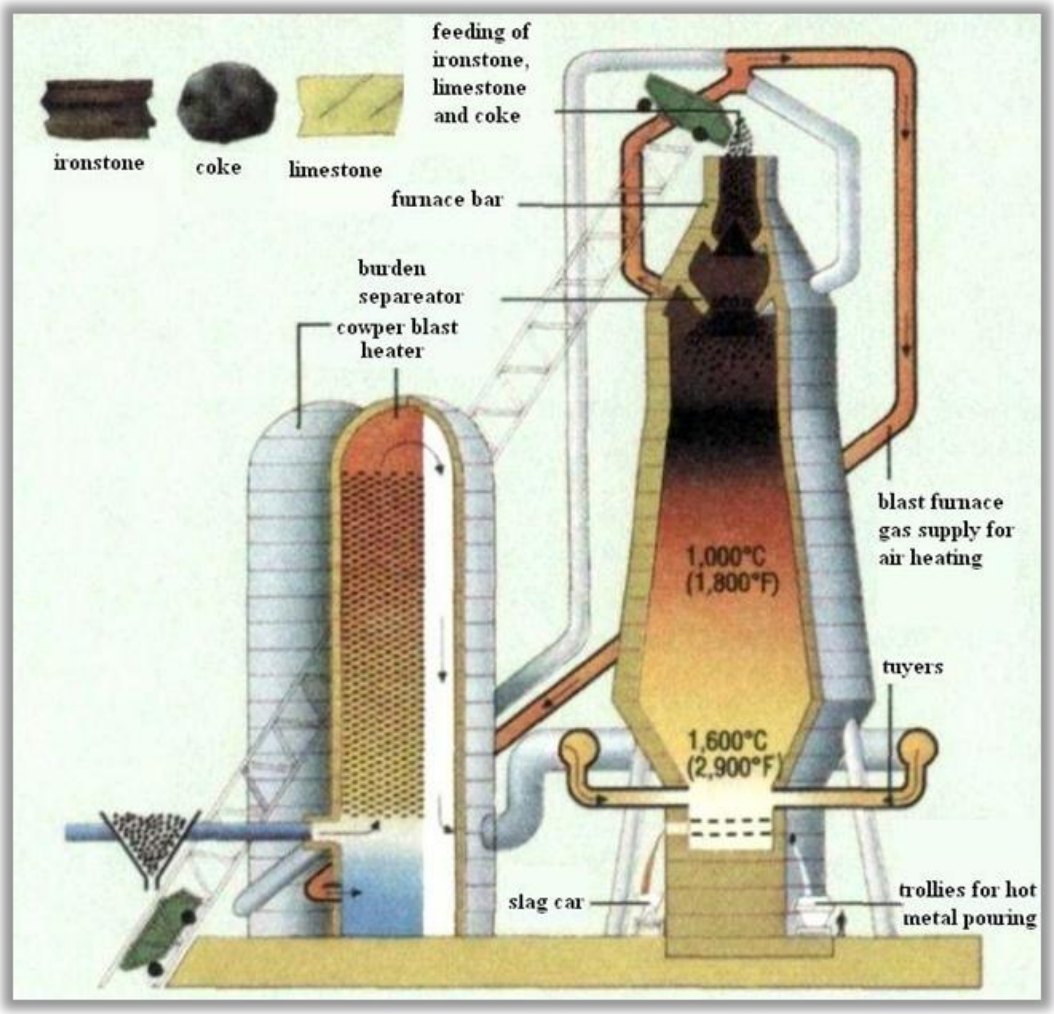


**Figure 3. The general scheme of blast furnace process**

The blast furnace is a counter flow kiln. A simplified schematic of the Blast Furnace is shown in Figure 3.

The iron making blast furnace itself is built in the form of a tall chimney-like structure lined with refractory brick. Coke, limestone flux, and iron ore (iron oxide) are charged into the top of the furnace in a precise filling order which helps control gas flow and the chemical reactions inside the furnace. Four "uptakes" allow the hot, dirty gas to exit the furnace dome, while "bleeder valves" protect the top of the furnace from sudden gas pressure surges. The "casthouse" at the bottom half of the furnace contains the bustle pipe, tuyeres and the equipment for casting the liquid iron and slag. Once a "taphole" is drilled through the refractory clay plug, liquid iron and slag flow down a trough through a "skimmer" opening, separating the iron and slag. Once the pig iron and slag has been tapped, the taphole is again plugged with refractory clay.

Pig iron is a product of the reduction of the iron bearing materials. The process of the iron reduction from pellets and agglomerate can be expressed by following chemical reactions:

1. $3Fe_2O_3 + CO = CO_2 + 2Fe_3O_4$ Begins at 450 °C;
2. $Fe_3O_4 + CO = CO_2 + 3FeO$ Begins at 600 °C;
3. $FeO + CO = Fe + CO_2$ or
4. $FeO + C = Fe + CO$ Begins at 700 °C.

Emissions that occur during the pig iron production mainly occur from coke combustion, natural gas combustion, limestone calcination as well as electricity consumption.

Below it is given a more detailed explanation of project activity.

**1. Technological improvements of the BFs operation**

According to the Ukrainian standards and norms, regular *maintenance and overhauling* of the main equipment of the blast furnace shop at Zaporizhstal is planned to be performed within certain time periods (see Table 2).

**Table 2. Maintenance timing. Source: "Maintenance and equipment repair"[11]**

| 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 | 4 - 5 | 15 - 20 |
| Third category maintenance of the BF | 1 - 2 | 2 - 5 |

The purpose of maintenance is to maintain the performance 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 technical improvements of the blast furnaces were planned.

Technological improvements in the context of this project are defined as measures that exceed those that would be normally included during regular maintenance. Therefore the project activity cannot be mixed activities for maintenance of the blast furnaces.

Technological improvements in the blast furnace shop mainly include the following measures:

**Improvement of blast furnace coke quality**

The strength and fraction of coke are ones of the main factors of the BFs productivity and pig iron quality. They also impact on coke consumption at the BF Shop. Zaporizhstal is planning to consume coke of better quality in particular dry quenching coke from coke dry quenching (CDQ) facilities in Ukraine and abroad. Better quality of coke has already being consumed at Zaporizhstal fragmentary starting from the project activity. Zaporizhstal is planning to rich a sustainable level for consumption of better quality of coke.

Currently coke at Zaporizhstal is supplied mainly by JSC "Zaporozhkoks" (near 80 % of coke supplying), PJSC "Yasynovsky Coking Plant" and CJSC "Gorlovsky Coking Plant. This would lead to better efficiency of BF operation. Better quality also covers ash and sulfur content as mentioned further in the Section A.4.3.

The measure is implemented since 2003 at different blast furnaces.

[11] The following document is available at JSC "Zaporizhstal".

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

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

$SiO_2 + 2C = Si + 2CO - Q$

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

In addition it needs to be stressed that a temperature of pig iron less than 1450 $^0$C could be achieved using well maintained equipment, otherwise BF could be frozen up to the solidification of the pig iron. Therefore, the modernization of the BFs is required in the reduction of the coke consumption.

This measure is gradually implemented during whole project activity time.

**Decreasing the BFs idle times and downtime**

Blast furnaces are in continuous operation, only interrupted for maintenance. Any idle time or downtime requires that the BFs are kept at a high temperature, which is achieved by burning coke. Therefore, any measures focused on decreasing idle times and downtime will reduce the coke consumption.

According to the plan, Zaporizhstal aimed to reduce idle time to as low as possible manageable level. However, this plan depends upon market conditions.

This measure is implemented since 2003.

**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.

The measure is gradually implemented in the period from 2003 to 2012.

**Improvement of the quality of agglomerate**

The strength of agglomerate to be produced at local sinter plant is generally leading to the same effects as other components in the list of technological improvements, however there is deficit of empirical justification of such an impact, partly it can be explained by table presented further in Section A.4.3. Nevertheless the positive impact of better strength of agglomerate can be witnessed by the BFs operators. Zaporizhstal plans to increase the quality of agglomerate gradually during the project time.

Measures related to improvement of the quality of agglomerate are further described in component 2 of the project activity.

**Replacement of coke by natural gas and coal**

Due to high consumption of coke in the BFs, Zaporizhstal planned to decrease its level gradually which included higher coal consumption for instance by PCI. This is considered to be more environmentally friendly measure that will lead to lower emissions with keeping C-balance at needed operational level.

PCI will be installed at BFs ## 2, 3, 4 and 5. The technology is supplied by Kuttner company[12] (Germany). Technological scheme of the PCI implies injection of fine coal into blast furnaces instead of coke and natural gas.

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[12] http://www.kuttnerllc.com/pci.php

The technology of injecting pulverized coal into a blast furnace as an auxiliary fuel allows to reduce the amount of coke consumed and therefore to reduce operating costs in the production of pig iron and then ultimately crude steel. The technology involves injecting very fine particles of coal at high rates into the chamber of the blast furnace as a fuel. Most modern furnaces are equipped with a coal grinding and coal injection system.

At the same time, even without PCI coke is replaced by coal and natural gas as it could be seen in calculations of emission reductions.

**Oxygen enrichment of BF blowing**

Gradual oxygen enrichment of blast-furnace blowing is realised as part of project activity. This also has positive impact on coke consumption reduction and blast-furnace operation (see Section A.4.3).

**Other measures**

Improvement of technology of BF production is an endless process. If any additional measures would be implemented in order to improve technology of production this shall be indicated in monitoring plans.

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

**Table 3. Dependence of coke consumption. Source: "Soviet Union standard "Influence of technological factors on the specific consumption of coke and blast furnace performance"**

| Factor/measure | Unit | Coke consumption | BF productivity |
|---|---|---|---|
| Increasing of the iron content in the iron-bearing materials on every 1% within the limits: | | | |
| up to 50% | % | -1,4 | +2,4 |
| from 50%-55% | % | -1,2 | +2,0 |
| from 55-60% | % | -1,0 | +1,7 |
| Silicon content decreasing in pig iron on every 0,1% | % | -1,2 | +1,2 |
| Decreasing of the idle time on every 1% | % | -0,5 | +1,0 |
| Decreasing of the downtime on every 1% | % | -0,5 | +1,5 |
| Consumption decreasing on every 10kg/t of the pig iron of limestone | % | -0,5 | +0,5 |
| Increase of coke hardness ($M_{25}$) on every 1% | % | -0,6 | +0,6 |
| Reduction of coke abrasion ($M_{10}$) on every 1% | % | -2,8 | +2,8 |
| Reduction of coke faction content over 80mm, ($M_{80}$) on every 1% | % | -0,2 | +0,2 |
| Oxygen enrichment of BF blowing on every 1% | | | |
| up to 25% | % | +0,20 | +2,4 |
| from 25%-30% | % | +0,30 | +2,1 |
| from 30%-35% | % | +0,40 | +1,8 |
| from 35%-40% | % | +0,50 | +1,6 |
| Ash content decreasing in coke on every 1% | % | -1,3 | +1,3 |
| Sulphur content decreasing in coke on every 0,1% | % | -0,3 | +0,3 |

**2. Reconstruction of the BF shop**

Pig iron production at Zaporizhstal is one of the most energy intensive processes. Generally, based on world modern pig iron production experience, the specific coke consumption per 1 t of pig iron produced is at the level of 400 kg/t. However, the pig iron process at Zaporizhstal involves rather high coke consumption rate. Before the project activity this level could reach 550 - 560 kg/t[13]. Therefore Zaporizhstal considered seriously how to decrease specific coke consumption rate to much lower levels often below 500 kg/t during project activity. Within project activity Zaporizhstal has reached the average annual coke consumption 492 kg/t[14] during the period from 2003 to 2010 and it is expected to further decrease.

As mentioned above, 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.

Reconstruction of blast furnaces at the Zaporizhstal is planned in the way that was described above according to the schedule.
The reconstruction of the BF Shop envisages such measures as:

a) construction of coal drying and grinding units with introduction of a distribution system and facilities for injection of dust and pulverized coal into blast furnace tuyeres. PCI facility is made in accordance with the contract with “Kuttner” firm;

b) introduction of auxiliary equipment related to oxygen, nitrogen and air blowing production, dust aspiration and gas cleaning etc.

   Within project activity envisaged introduction of oxygen unit ASU-60 by Air Liquide[15] company (France) with total output 60,0 ths. nm³/h of oxygen. The unit was put into operation in 2007.

   Introduction of oxygen unit allows to ensure the production shops by oxygen with the clarity of 99,5 % (against 95-96 %), decrease the uncontrolled air emissions into the atmosphere and ensure the economy of electric power, heat energy and industrial water.
   Introduction of new unit also allowed to reduce energy consumption in the blast furnace shop and also increase pig iron production productivity. Zaporizhstal plans to increase the rates of oxygen injection into the blast furnaces during the project activity. At the same time, because of the fact, that influence of the reduction of energy consumption into the greenhouse gases emissions have already been taken into account in another JI project “Reconstruction of the Oxygen Compressor Plant at the JSC “Zaporizhstal”, # UA1000189[16], this part of the project will be taken into consideration only in a case of preclude of double accounting of emission reductions. To preclude double accounting, the amount of emission reductions that was received from another JI project will be deducted from this JI project.

c) introduction of the automatic and control systems in order to control and manage:
   - BFs;
   - tuyere failure;
   - gas flow;
   - BF gas purification;
   - temperature field on the charging materials;
   - cooling system of the furnace’s stack;
   - heat load at heat exchangers at hearth;
   - charging process.

The BF shop of Zaporizhstal currently consists of four BFs with net volume: BF#2 (modernized) – 1513 m³, BF#3 – 1513 m³, BF#4 – 1513 m³, BF#5 – 1513 m³. BF#1 was retired from service in 2005.

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[13] As per 1997 – 2002. The data can be provided additionally upon request to Zaporizhstal.
[14] The data can be provided additionally upon request to Zaporizhstal.
[15] http://www.airliquide.com/
[16] http://neia.gov.ua/nature/control/uk/doccatalog/list?currDir=116707

It should be noted that legislation of Ukraine does not require an obligatory reconstruction of blast furnaces. Nevertheless Zaporizhstal has realized already a radical reconstruction of BF#2 and already invested around 50 to 60% into reconstruction of BF #3. The reconstruction of BF #3 was made before the project implementation.

Reconstructions of BFs # 4 and 5 are also expected to be realized gradually. As a result the specific consumption rate for coke per tonne of pig iron will be reduced, as well as other carbon containing resources, and productivity of BFs will be increased, that would lead to GHG and other dangerous substances' emission reductions.

**3. Modernization of sintering process**

Currently Zaporizhstal uses a sinter plant which was built in 1951-1961 and is consisting of six sintering machines with sintering area of 62,5 m² and facilities for receiving materials, its preparation and transportation.

The works in the commissioning of air aspiration equipment of tail part sintering machine were concluded in 2008.

The new complex of nature saving equipment can treat up to 1,6 mio. $m^3$ per hour of dust air, that allows to reduce dust emissions into the atmosphere nearby 2,5 ths. tonnes per year. Detained in electrical filters dust goes back to the manufacture. Indicated measures considerably improved work conditions of workers.

The program of revamping of the plant envisages gradual replacement of all existing sintering machines with sintering area of 62,5 m² into new ones with sintering area of 75,0 m² with state-of-the-art gas purifying facility and screening through lattice vibration.

Carbon dioxide emissions in the sintering and blast-furnace production processes are mainly achieved during: the process of burning solid fuel, which is part of the sintering charge; the process of burning natural gas, which is fed into burners for ignition of sintering charge; reaction of limestone decomposition, which is part of sintering charge, to calcium oxide and carbon dioxide.

The main measure in modernization of sintering process the introduction of new sintering machine #1 with 75 sq. m sintering area, which will replace existing machine with 62,5 sq. m sintering area and building of new state-of-the-art gas purifying facility is planned to be realized in 2011. This measure envisages iron ore sinter production process modernization, and also its screening through lattice vibration.

New sintering machine will allow to increase sinter output by 163 thousand tonnes per year.

In order to reduce carbon emissions during sintering production a number of technological measures were developed (and will be implemented), which would allow:

- improve quality of sinter in terms of fine fraction content (reduction by 4,2%);
- to reduce maximum size of pieces to 120 mm;
- utilization of sintering and blast furnace slag for sinter preparation;
- to receive homogeneous sinter, which would consist of strong and well-renewable fraction of 8-35 mm (85%);
- to reduce fuel and energy consumption (electricity, gas, solid fuels);
- to reduce concentration of pollutants in emitted gases to the rate of 50 mg/m3, which will reduce dust emissions by 240 tons per year and sulfur dioxide emissions - by 206 tonnes per year.

Consumption of better quality sinter will allow to increase pig iron production by 27,0 thousand tonnes per year, reduce limestone consumption by 20,6 thousand tonnes per year, coke – by 25 thousand tonnes per year and at the same time reduce GHG emissions.

With the introduction of new sinter machine of Uralmach Machine-Building Corporation the following benefits will be achieved[17]:

- low electrical energy consumption even when the sinter machine is operated with high bed height;
- low solid fuel and energy consumption because of the best fuel distribution;
- stable high sinter quality;
- lower coke consumption in blast furnaces because of better quality of agglomerate;
- low quantity of off-gas and better utilization of cooling air etc.

In order to reduce carbon emissions during sintering production a number of technological measures and installations were implemented during the project activity from the year 2003 to 2010:

- improvements of solid fuel burning process, which is part of the sintering charge;
- increase of the level of steel waste utilization in sintering process;
- optimization of limestone decomposition reaction by means of introduction of components with low content of Si (SiO2) in the sinter charge that would lead to lower limestone consumption;
- improvement of natural gas burning process, which is supplied to burners for the ignition of sintering charge;
- improvements of chemical composition of sinter charge by means of adding the better quality of iron ore;
- initial treatment of sinter charge by superheated steam;
- introduction of new lime kilns that would replace less efficient old ones with significant saving of natural gas consumption;
- reduction of fine fraction content in agglomerate. To reduce consumption of coke and iron, one need to produce cooled and stabilized agglomerate with low fine fraction content as well as with better strength. Stabilization of agglomerate means its mechanical treatment, crushing, cooling and grating. Before project implementation the sinter plant produced a hot sintering mix (agglomerate), which contained 12-15% of fine fraction at the moment of feeding the mix into the blast furnace bin. The technology of production of agglomerate envisages that furnace charge raw mix is charged in the agglomeration machines (sintering machines) for fritting and breaking-in. The agglomerate was unloaded from the agglomeration machines and transported to the blast furnaces. During transportation the agglomerate naturally cooled and partly crushed, which increased the mass content of fine fraction (with diameter less than 5 mm). Further agglomerate together with coke and limestone were supplied to blast furnace shop. Before project implementation the specific coke consumption per tonne of pig iron was rather high and general efficiency of pig iron production was rather low;
- improvement of gas consumption and the “gas-air” ratio based on new current sensors. As a result, gas saving will be achieved because of accurate measurement and intensity of gas burning process;
- replacement of centralized electromechanical system of sinter machine startup by electronic system. As a result, a reliable startup of sinter machine after stop and exception of downtime will be achieved.

JI project maintenance will be in accordance with national requirements and Zaporizhstal internal routines with technical support on the part of Uralmach Machine-Building Corporation, Kuttner and other technology suppliers.

[17] http://www.uralmash.ru/eng/about.htm

**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 to reduce energy and materials, mainly coke, consumption during pig iron production. Coke consumption is associated with two sources of emissions of GHGs:

1. During coke production. IPCC set the value of the emission factor for the coke production at the level 0.56 t $CO_{2e}$/t of coke, and
2. Coke processing in the BF. The emission factor for coke processing is 3.1 t $CO_{2e}$/t, assuming that default IPCC factor is used.

It should be noted that factors presented in the Table 3 are indicative and are of an empirical nature. Nevertheless, we can see that the proposed measures will lead to the reduction of coke consumption that would not have occurred in the absence of the project. The impact of the above mentioned factors on the coke consumption and blast furnace production is also supported by scientific publications[18].

Emissions that occur during pig iron production at Zaporizhstal are calculated based on the specific emission factor (EF) for pig iron production in tonnes of $CO_2$ per 1 tonne of pig iron produced. The EF is a sum of emission components associated with different carbon-bearing material flows taking part in the BFs operations and preceding processes such as sintering and secondary energy production.

In the absence of the proposed project, the BF Shop and Sinter and Power Plants of Zaporizhstal will continue operations without implementing the set of measures described in Section A.4.2., so the structure of the EF for the pig iron production will be identical.

After the project's implementation the specific coke as well as other fuels and materials consumption per tonne of pig iron output will be reduced significantly.

Without project activity emission reductions of GHG would not be achieved as the plant would continue operation of old sinter plant and BFs without reconstruction and introduction of new facilities and technologies, as:

a. this scenario represents the usual (business-as-usual) operation for Zaporizhstal;
b. Ukrainian legislation does not require obligatory reconstruction of the facilities of the plant;
c. continuation of operation within baseline scenario does not require large investments for revamping of sinter and blast furnace production process.

The reason why emission reductions would not be achieved without project activity is described in more detail in Section B.1.

Total estimated emission reductions before the start of Kyoto protocol crediting period are 1 858 850 tonnes of $CO_{2e}$.

Total estimated emission reductions during Kyoto protocol crediting period are 1 738 152 tonnes of $CO_{2e}$.

Total estimated emission reductions during post-Kyoto period are 3 800 893 tonnes of $CO_{2e}$.

Total estimated emission reductions during the whole crediting period are 7 397 895 tonnes of $CO_{2e}$.

[18] http://ukhin.org.ua/index.php?option=com_mtree&task=viewlink&link_id=456&Itemid=3

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

Beginning of crediting period starts from 1st of April 2004.

| | 3 years and 9 months |
|---|---|
| Length of the crediting period | |
| Year | Estimate of annual emission reductions in tonnes of $CO_2$ equivalent |
| 01/04/2004 – 31/12/2004 | 275 098,2 |
| 2005 | 602 381,6 |
| 2006 | 606 374,5 |
| 2007 | 374 995,9 |
| Total estimated emission reductions over the crediting period [19] (tonnes of $CO_2$ equivalent) | **1 858 850** |
| Annual average of estimated emission reductions over the crediting period (tonnes of $CO_2$ equivalent) | 495 693,4 |

**First commitment period of Kyoto Protocol**

| | 5 years |
|---|---|
| Length of the crediting period | |
| Year | Estimate of annual emission reductions in tonnes of $CO_2$ equivalent |
| 2008 | 431 273,0 |
| 2009 | 245 475,8 |
| 2010 | 284 051,3 |
| 2011 | 349 431,6 |
| 2012 | 427 920,5 |
| Total estimated emission reductions over the crediting period [19] (tonnes of $CO_2$ equivalent) | **1 738 152** |
| Annual average of estimated emission reductions over the crediting period (tonnes of $CO_2$ equivalent) | 347 630,4 |

[19] Total project emissions, total baseline emissions together with total emission reductions (which are provided in this section) are rounded to the whole figure (1t) and are based on calculations which are demonstrated in attached excel file. This file is provided to the verifier.

**Period following first commitment period of Kyoto Protocol**

| | |
|---|---|
| | 8 Years |
| Length of the crediting period | |
| Year | Estimate of annual emission reductions in tonnes of $CO_2$ equivalent |
| 2013 | 475 111,6 |
| 2014 | 475 111,6 |
| 2015 | 475 111,6 |
| 2016 | 475 111,6 |
| 2017 | 475 111,6 |
| 2018 | 475 111,6 |
| 2019 | 475 111,6 |
| 2020 | 475 111,6 |
| Total estimated emission reductions over the crediting period [19] (tonnes of $CO_2$ equivalent) | **3 800 893** |
| Annual average of estimated emission reductions over the crediting period (tonnes of $CO_2$ equivalent) | 475 111,6 |

## A.5. Project approval by the Parties involved:

The project has already received Letter of Endorsement (LoE) from the Government of Ukraine #13442/11/10-07 of 14.12.2007 issued by the Ministry of Environmental Protection of Ukraine. The final version of the Project Design Document shall be submitted to the State Environmental Investment Agency of Ukraine along with a positive determination report for the Letter of Approval (LoA), which is usually expected within 30 days.

Letter of Approval was provided by the government of Swiss Confederation #J294-0485 of 27.04.2011– Federal department of the Environment, Transport, Energy and Communications (DETEC) and Federal office for the Environment, Climate division (FOEN).

## SECTION B. Baseline

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

The baseline for the proposed project is identified and justified following the Annex B to the JI Guidelines[20] and the JISC "*Guidance on Criteria for Baseline Setting and Monitoring"*[21]. No applicable approved CDM methodologies are available for this project; however, in 2010 the JI Project "Energy Efficiency measures at the "Public Joint Stock Company Azovstal Iron and Steel Works",_UA1000223[22] was registered as a JI project and the project "Revamping of sintering and blast-furnace production at OJSC «Alchevsk Iron and Steel Works" has already passed a positive determination by AIE. Both projects assume implementation of technological measures to improve the energy efficiency of blast furnace production as well as its modernization, moreover, the JI project at AISW covers all the components, which are envisaged by the proposed project activity. Both projects are similar to the proposed project activity; therefore their approach can be fully applied to the project in question. Besides, in terms of methodological approach, the proposed project to the relevant part is alike with the project registered at UNFCCC with reference number UA1000022[23], as it covers basically the same assets as in the proposed JI project- it refers to blast furnace shop and sintering machines as well as secondary energy production. It takes into account all emissions of GHGs related to the process of pig iron and sintering production. Therefore the approach is fully applicable for the proposed project.

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

The baseline scenario was chosen based on project-specific approach in accordance with paragraph 9(a) of the JISC *"Guidance on Criteria for Baseline Setting and Monitoring"24* and refers to the Zaporizhstal project-specific conditions and parameters as they are described in this PDD. Everything related to the anthropogenic emission assessment is sufficiently described and justified. According to the Article 20 of the Guidance a baseline should be established based on scenario that reasonably represents the anthropogenic emissions by sources or net anthropogenic removals by sinks of such emissions that would occur in the absence of the project.

The following two-step approach was used to identify and choose the baseline scenario for the project:

a) Identifying and listing alternatives to the project activity on the basis of conservative assumptions and taking into account uncertainties.

b) Identifying the most plausible alternatives considering relevant sectoral policies and circumstances, such as economic situation in the steel sector in Ukraine and other key factors that may affect the baseline. The baseline is identified by screening of the alternatives based on the technological and economic considerations for the project developer, as well as on the prevailing technologies and practices in Ukrainian steel industry at the time of the investment decision.

All alternatives have been listed and analyzed below. The alternatives have been identified based on national practice and reasonable assumptions with regard to the sectoral legislation and reform, economic situation in the country, availability of raw materials and fuel as well as technologies and logistics etc.

[20] Decision 9/CMP.1 Conference of the Parties serving as the Meeting of the Parties of the Kyoto protocol 30th of March 2006
[21] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
[22] http://ji.unfccc.int/JIITLProject/DB/SH8R5WAZQ92CWBIXEZPJMSGCVXT2KS/details
[23] http://ji.unfccc.int/JIITLProject/DB/V75OZ8TQOFTB325LEDMXE2628ZD548/details
[24] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

***Sub-step 1a) Identify alternatives to the project activity***

All the Ukrainian Steel Mills continue to run so called old blast furnaces and sinter plants that have mostly been installed during Soviet time more than 20 years ago. The type of blast furnaces and sinter plants basically remain unchanged since $19^{th}$ century.

At the time of investment decision, i.e., in 2002, Zaporizhstal had two technically feasible alternatives for its planned development strategy assuming *inter alia* increase of market share and expansion of production output as there were no other intermediary solutions:

Alternative # 1: Preservation of situation prior to the JI project activity: continuation of sinter plant and BFs #1, 2, 3, 4 and 5 operation;
Alternative # 2: Reconstruction of the agglomerate and blast-furnace production without carbon financing.

All alternatives would meet all relevant Ukrainian requirements as discussed in a detailed way below. These alternatives would also provide the same service level to the market.

***Step 1b) Identify the most plausible alternative***

The most plausible alternative scenarios among the possible ones were identified as followings:

The alternatives are explained and considered below with regard to estimate the baseline in relation to the Project.

*Alternative # 1: Preservation of situation prior to the JI project activity: continuation of sinter plant and BFs #1, 2, 3, 4 and 5 operations.*

Ukrainian iron and steel production facilities have inherited process equipment installed during the Soviet era. Iron and steel industry is today in need of a sector-wide reform. However innovative development of the nation's iron and steel industry is practically minimal. The reason is that such practical decisions made bumped against lack of reliable financial and institutional support[25]. These reasons have also hampered Zaporizhstal to initiate and realise modernisation of the Plant.

Therefore, production of pig iron and steel and expansion of market share based on existing process lines, without introduction of new facilities, would be business-as-usual (BAU) solution fully in line with international steelmaking practices at the time of investment decision, as well as with economy environment of Zaporizhstal and Ukraine in general. The benefits for the project owner include (i) insignificant capital expenditures due to planned repair and maintenance works, which is common practice at Zaporizhstal , (ii) profit in the short-term perspective amid crisis environment; (iii) no need to secure access to significant financing, mostly required to make up operating capital, due to absent investment requirements and known technology, (iv) no need for capital construction, (v) low technical risk due to historical experience, familiarity and confirmed capacity to build, operate the facilities, and to manage related risks, (vi) availability of trained staff, etc.

In fact, the planned pig iron output could have also been secured with existing older BFs, SP and secondary power generation facilities. At the moment of the investment decision, as well as currently, there were no regulatory or technical limitations for the operation of the older BFs and other steel facilities. Such limitations will continue to be absent at least until 2012 and even in longer term till 2022 – if there persist current Ukrainian economy conditions and intentions for its reform encouraging to hold back administrative barriers before commercial production activity carried out by private entities. However, in order to ensure conservativeness of the assumptions used for the identification of the baseline alternatives, six previous consecutive years before reconstruction start were have been chosen for establishing the baseline. The average data for the 6-year period should be enough to equal the

[25] http://www.nbuv.gov.ua/portal/Natural/VDU/Ekon/2008_1/VDU1-2008/181.pdf

impact of regular maintenance and working renewal of the steel facilities. Therefore the considered alternative does not face any barriers.

*Alternative # 2: Reconstruction of the agglomerate and blast-furnace production without carbon financing.*

The project activity includes reconstruction of all the BFs, SP and secondary power generation facilities at Zaporizhstal.

In 2002, when decision was made, there were, and there still are, no legal or regulatory requirements in Ukraine for the adoption of obligatory reconstruction or modernisation activities in steel making sector. The proposed project is in line with non-mandatory, general government policies, such as the Restructuring Program of the Iron and Steel Sector and with the long-term Energy Strategy for Ukraine (adopted in 2006)[26].

The project activity is itself an integrated energy efficient programme aimed at reduction of energy consumption per tonne of pig iron produced. This cannot be done without reconstruction and modernisation of equipment in the Blast Furnace Shop as well in the Sinter Plant and Power Plant that includes other secondary production facilities and therefore without a massive investment programme.

Against the backdrop of the poor economic situation of the Zaporizhstal[27], which proceeded the project implementation and moreover the aftermaths of financial crisis[28,29] whose effects influenced all Ukrainian economy sectors, a project requiring the total investment of 170 million Euro would be hard to accomplish, which is further described in Section B.2.

Therefore, considering financial, technical and other barriers, project scenario without the JI component was not the most attractive one, which prevented its further implementation.

The Alternative #1 is the most likely baseline scenario for a number of reasons, for instance the required quantity and quality of pig iron can be produced without costly and large-scale reconstruction as well as change of historical manufacturing practice and logistics. The above suggests that the Alternative # 1 would be the most plausible and credible alternative and it represents the baseline scenario for the proposed project activity. For the baseline scenario, the full amount of CO2 emissions related to this scenario is accounted for; its monitoring is performed as part of detailed monitoring of steelworks processes required for the Zaporizhstal technical purposes (please see more detail in Section D).

**Step 2. Application of the approach chosen**

The detailed analysis of the alternatives was given above. Alternative #2 presents the project scenario and in comparison with Alternative #1 that is the baseline required significantly more investments. Therefore continuation of existing practice with gradual planned maintenance and repair does not require additional massive investments as well as change of used process technology and is the most plausible and realistic one.

[26] OECD Special Meeting at High-level on Steel Issues, The Ukrainian Steel Industry, Paris, 11 January, 2005.

[27] Bussiness Plan of Zaporizhstal: “Analysis of financial and business combine in 1997 indicates that the financial condition of the enterprise is unsustainable. Working capital ($ 230.6 million) barely cover short-term debt ($ 207.6 million). The overall coverage ratio has declined over the year from 1.3 to 1.11 (regulation 1.5 - 2). Enterprise, mobilizing all of its current assets, will be able to repay short-term debt, indicating the ability to pay, but will not be able to continue productive activities. Low liquidity of the company, which has a tendency to decrease (from 0.035 to 0.006 for the year with a minimum ratio of 0.2 - 0.25) indicates that there was insufficient liquid assets to meet the urgent demands of creditors”.

[28] http://www.kneu.kiev.ua/journal/eng/article/2005_1_Kravchuk_eng.pdf,

[29] http://www.scribd.com/doc/12844695/The-Ukrainian-Weekly-199937

***Consistency with mandatory applicable laws and regulations.***

As it was also mentioned above the year 2002 was selected as the year when the investment decision was made. All the listed alternatives in the year 2002 were considered to be feasible and did not face any legislative barriers. Moreover even at the date of PDD preparation situation is still identical. Ukrainian legislation does not regulate $CO_{2e}$ emissions and does not demand reductions of such emissions.

Therefore, the most plausible scenario for the baseline is the Altenative #1. All the information concerning approach for calculation of emission reductions are given below.

*Conservative assumptions used for baseline emission calculations have been applied:*

a) 6 year base period from 1997 to 2002 has been chosen in order to nullify the impact of annual or periodic repair and maintenance of the equipment;

b) timing of baseline period coincides with gradual improvements at the global steel market. At the same time project line faces negative impact of world financial and economic crisis that makes specific energy consumption rate per tonne of pig iron to be more intensive than under normal operation;

c) in the baseline period natural gas was historically cheaper than in the project line that could cause its replacement on coal and coke with higher emission factor during the project activity. This impact was ignored that makes approach a very conservative.

In order to calculate the project emission reduction units the total pig iron production is accepted as equal to the project production.

**Key parameters**

No national policies and circumstances can significantly influence the baseline. Therefore, only some technical parameters have to be described.

As key parameters that can significantly influence emission reduction amount, the following parameters have to be considered:

**Key Information and Data Used for Baseline Case Identification**

| **Key Variables/Parameters** | $TPII_b$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Total pig iron output |
| Identification/monitoring frequency | Measured on regular basis (monthly) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is equal to the total pig iron output during the project activity |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $Q_{fpi,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ |
| Description | Quantity of fuel (fpi) used in making pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$. |

| | |
|---|---|
| **Key Variables/Parameters** | $EF_{f,b}$[30] (B-6, B-13, B-26) |
| Measuring unit | Tonnes $CO_{2e}$/1000 $m^3$ |
| Description | Emission factor for fuel consumption |
| Identification/monitoring frequency | Fixed value based on Zaporizhstal average data |
| Source of data | Zaporizhstal average data<br>IPCC 1996<br>National GHG inventory of Ukraine, 1990-2008<br>Potentially measured by Zaporizhstal laboratory or local fuel distributor |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with Zaporizhstal average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[31]<br>Net calorific value is anticipated at nearly 33,8685 TJ/1 000 000 $Nm^3$.<br>Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,89052 tonnes of $CO_{2e}$/1000 $Nm^3$ and is calculated based on mentioned above net calorific value.<br>Carbon emission factor for coke oven gas combustion is anticipated at the level of 0,79824 tonnes $CO_{2e}$/1000 $Nm^3$. The carbon content of coke oven gas is in accordance with "National GHG inventory of Ukraine, period 1990-2008", Table P2.7, page 264 (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php). Net calorific value for coke oven gas is based on Zaporizhstal average data.<br>Net calorific value for peat is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for peat is in accordance with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf) and anticipated at nearly 1,03 tonnes of $CO_{2e}$/tonne.<br>Net calorific value of residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf) and anticipated at nearly 3,1 tonnes $CO_{2e}$/tone.<br>Also please see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[30] For more detailed information please see Annex 2.

[31] In case if the data regarding net calorific value for mentioned above fuels will be available at Zaporizhstal for each of the specific monitoring periods, the carbon emission factors will be accordingly modified at the stage of monitoring report development.

| **Key Variables/Parameters** | $ECPI_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in producing pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for all sources of electricity consumption for primary and secondary production needs. |

| **Key Variables/Parameters** | $EF_{e,b}$ (B-9, B-16, B-29) |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/MWh |
| Description | Emission factor for electricity consumption |
| Identification/monitoring frequency | Regular tabulation (on monthly basis) |
| Source of data | Carbon emission factors verified by TÜV SÜD and carbon emission factors based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | Up to 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[32]. Starting from year 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[33]. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[32] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[33] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

| **Key Variables/Parameters** | $Q_{fio,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fio) used in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$ and peat is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECIO_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

| **Key Variables/Parameters** | $Q_{rapi,b}$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Quantity of each reducing agent (rapi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of reducing agents consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{ra,b}$[34] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each reducing agent |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996<br>IPCC 2006<br>Potentially measured by Zaporizhstal laboratory |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf).<br><br>For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | This PDD uses default factors:<br>For coke it is anticipated at 3.66 tonnes $CO_{2e}$/tonne;<br>For coal the anticipated factor is 2.5 tonnes $CO_{2e}$/tonne.<br>However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of coal. If information on actual carbon content or net calorific value is available, it would prevail over default factors |

[34] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{oipi,b}$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Quantity of each other input (oipi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of other inputs consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{oi,b}$[35] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each other input |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996; IPCC 2006 |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf).<br><br>For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Table 4.1 *Default $CO_{2e}$ emission factors for coke production and iron and steel production*, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf)<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | For limestone it is anticipated at 0.44 tonnes $CO_{2e}$/tonne of limestone.<br>For pellets it is anticipated at 0.03 tonnes $CO_{2e}$/tonne of pellets produced.<br>For lime it is anticipated at 0.75 tonnes $CO_{2e}$/tonne of lime. |

[35] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{fbpn,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fbpn) used for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$, coke oven gas is considered to be a fuel measured in 1000 $m^3$ and residual oil is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECBPN_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

**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 stepwise approach is used to demonstrate that the project provides reductions in emissions by sources that are additional to any that would occur otherwise:

**Step 1. Indication and description of the approach applied**

A JI specific approach is used, therefore one of the approaches, defined in paragraph 2 of the annex I to the "Guidance on criteria for baseline setting and monitoring"[36], to demonstrate additionality of the project shall be used. As suggested by paragraph 2 (c) of the annex I to the "Guidance on criteria for baseline setting and monitoring" the most recent version of the Tool for the Demonstration and Assessment of Additionality approved by CDM Executive Board (version 05.2[37]) is used to demonstrate the additionality of the project.

**Step 2. Application of the approach chosen**

This section includes analysis of project additionality and is intended to demonstrate that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of GHG emissions in comparison to the baseline. The analysis below is performed following steps of the latest version (version 05.2) of the Tool for the Demonstration and Assessment of Additionality[38] approved by CDM Executive Board, which accordingly may be fully applied to Joint Implementation Projects.

Fig. 4 below presents JI project additionality assessment flowchart based on the Tool for the Demonstration and Assessment of Additionality (version 05.2):

[36] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
[37] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf
[38] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

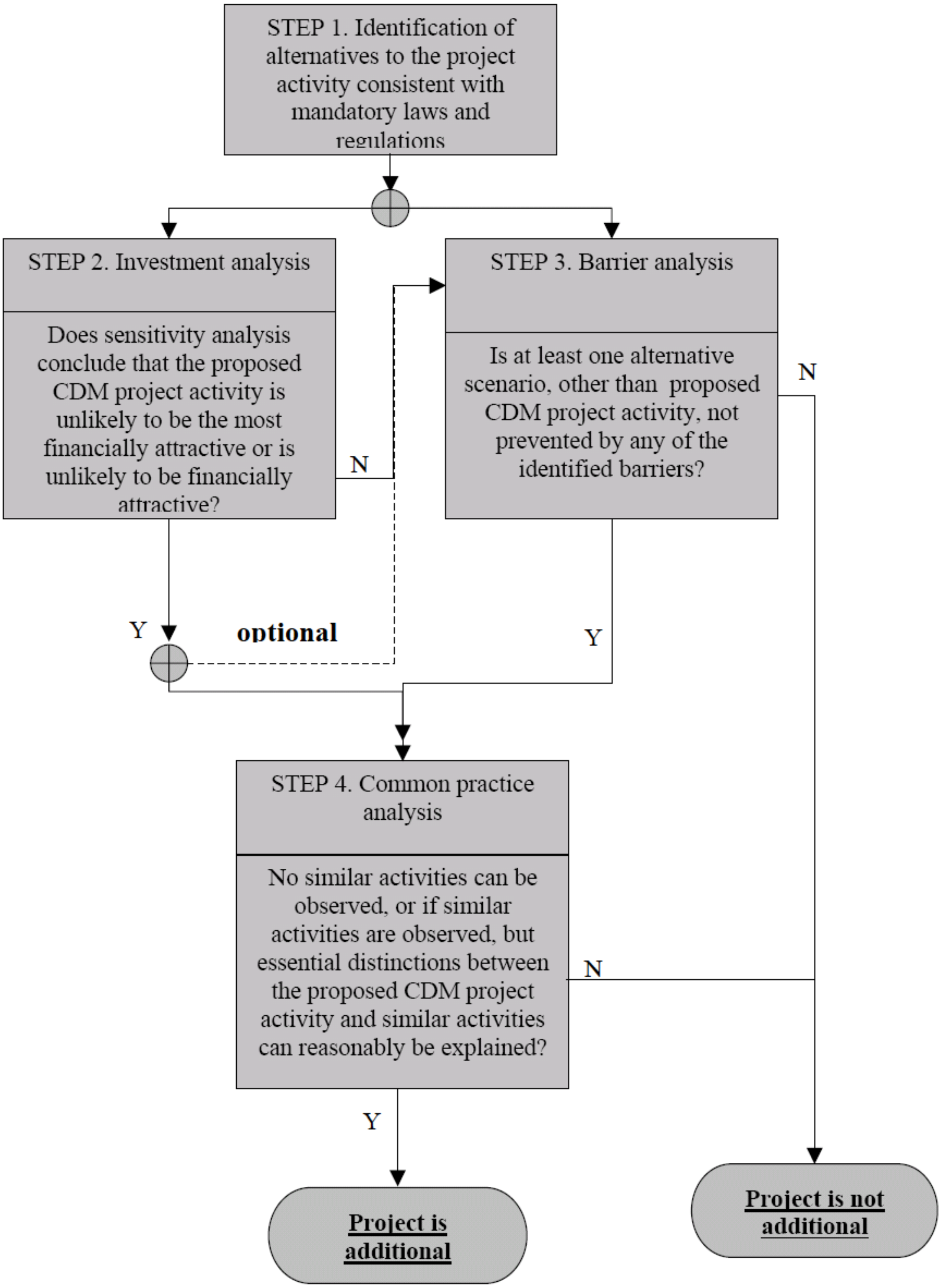


**Figure 4. JI Project Additionality Scheme Defined in the Tool for the Demonstration and Assessment of Additionality (version 05.2)**

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

***Sub-step 1a. Define alternatives to the project activity:***

In Section B.1 the following scenarios to the project activity were chosen:

Alternative # 1: Preservation of situation prior to the JI project activity: continuation of sinter plant and BFs #1, 2, 3, 4 and 5 operation;
Alternative #2: Reconstruction of the agglomerate and blast-furnace production without carbon financing.

**Outcome of Step 1a:** Realistic and credible alternative scenarios to the project activity were identified.

***Sub-step 1b. Consistency with mandatory laws and regulations:***

All the alternatives above comply with mandatory laws and regulations. Under the current national and/or sectoral policies and circumstances and regulations of the proposed project site, both alternatives above can be selected as credible and realistic alternatives.

National policy of Ukraine regarding the emissions of pollutants into atmosphere is determined by the Law of Ukraine *On Protection of Atmospheric Air* of 21 June 2001 No. 2556-III[39]. The Order of the Ministry for Environment of Ukraine dated 27.06.2006, No. 309 approves admissible level of emissions of polluting substances from stationary sources, both active and those being designed, developed, or retrofitted. Regulatory allowances for admissible level of emissions of polluting agents and their aggregates set limits on mass concentration of pollutants in point source emissions from stationary sources (in $mg/m^3$) and do not provide any specific requirements as to new technologies. Nonetheless, as specified above, most Ukrainian steel and pig iron making enterprises continue successfully to operate equipment installed back during the Soviet era.

The above Order of the Ministry for Environment of Ukraine does not ration GHG emissions from stationary sources. Such rationing will be introduced provided approval of a National GHG Emission Allowance Distribution Plan and a National GHG Emission Allowance Trading Scheme by the Ukrainian government, which seems unlikely either today or during the time horizon until 2020.

The above, as well as the current practice of pig iron productions operation in Ukraine uphold the consistency of the baseline scenario of the proposed Joint Implementation Project with the national requirements and practice.

The Tool for the Demonstration and Assessment of Additionality requires that the next step in the project additionality assessment process be Step 2, Investment Analysis, or Step 3, Barrier Analysis. Most appropriate way to prove additionality of the project was considered barrier analysis due to the presence of clearly defined barriers to the project implementation.

**Outcome of Step 1b:** The identified alternatives are realistic and credible alternative scenarios to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region and Ukraine.

**Step 3. Barrier analysis**

The step-by-step approach in this case means sequential description of existing barriers and explanation of the way in which they hamper the project activity, as well as of how application of the JI mechanism helps remove these barriers. Based on the requirements of the document referenced above, the process should culminate in the common practice analysis intended to confirm barrier analysis conclusions.
***Sub-step 3a. Identify barriers that would prevent the implementation of the proposed JI project activity:***

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[39] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=2707-12

Specific Barriers

The project has faced certain barriers of different nature. In accordance with paragraph 6 of the Annex 13 of Guidelines for objective demonstration and assessment of barriers40 (Version 01), the evidence of presence of the barrier can be based on barrier experience of other projects under similar circumstances. However the “Guidelines for objective demonstration and assessment of barriers” (Annex 13, version 01, page 2/5, Guideline 3) does not require that other JI projects should be the same technologically. For demonstrating additionality it is enough to show, based on reputed source, that already registered JI project is similar to the proposed one, in other words it realized in similar circumstances (in similar industries/sectors, in companies of similar size and ownership structure, in similar projects). Today the following project activities, similar to the proposed exist:

1) JI project at AISW «Revamping of sintering and blast-furnace production at OJSC «Alchevsk Iron and Steel Works». The mentioned project consists of the same components, i.e., same GHG mitigation measure, is almost technologically the same with the proposed project activity (the difference between the two projects is that at AISW project envisaged introduction of a new BF and SP, while it is not envisaged by the proposed project activity) and is implemented in the same country – Ukraine.
2) The registered JI project at PJSC “Azovstal Iron & Steel Works”, UA100022341. The project is realized in similar industry/sector and envisages activities (modernization and reconstruction of BF shop and technological improvements of BF’s operation) which are also envisaged by the proposed project activity.
3) JI project Introduction of Energy Efficiency Measures at OJSC “Enakievo Metallurgical Works”, UA100022442. The project envisages modernization of BF shop - reconstruction of BFs, introduction of PCI system and introduction of the new oxygen block. These measures are also envisaged by the proposed project activity; the mentioned project is of the same scale and is realized in Ukraine.

All project activities are realised under similar circumstances and within the same industry, same country moreover same GHG mitigation measures and similar technologies were applied.

The reference to the project at AISW was made by taking into account that it was already positively determined by **Bureau Veritas** company, which is considered to be the **reputed source**. This fact is in accordance with the “Guidelines for objective demonstration and assessment of barriers” (Annex 13, version 01, page 2/5, Guideline 3) which envisages demonstration of additionality in case if similar projects were approved by using **reputed sources** (IAE – Bureau Veritas): “Most investment projects face some type of barriers, but it is very difficult to evaluate whether a barrier actually prevents the investment from being done. The evidence of presence of the barrier for other project(s) under similar circumstances, using **reputed sources**, makes them much more objective and therefore **makes a strong argument that a project is additional**”.

Together with this, in accordance with the “Guidelines for objective demonstration and assessment of barriers” (Annex 13, version 01, page 2/5, Guideline 3) the technological barrier may be confirmed by showing evidence that the use of this technology in the considered sector is marginal (below 10%). At the time the investment decision, despite the fact that majority of Ukrainian steel plants required modernisation of their steel capacities with involvement of state of the art technologies, no positive experience was demonstrated by other steel mills due to the existing market barriers.

All mentioned above information proves that the project is additional.

[40] http://cdm.unfccc.int/EB/050/eb50_repan13.pdf
[41] http://ji.unfccc.int/JIITLProject/DB/SH8R5WAZQ92CWBIXEZPJMSGCVXT2KS/details
[42] http://ji.unfccc.int/JIITLProject/DB/FX1G65CCXNL6DMJKCKODRF3QL2Z3EF/details

Barriers due to Prevailing Practice and Technological Barriers

Due to the complexity of this project (modernizations, different mixture of raw materials, introduction of new facilities etc.) this project faces a barrier due to prevailing practice. In particular, for the first time in Ukraine such measures were initiated as control and improvement of cast iron production technology, full reconstruction of blast furnaces, including equipping them with modern means of treatment and control of hazardous emissions into the atmosphere.

It should be noted that the attractiveness of the project is crucially dependent on its ability to deliver the expected savings from fuel and material consumption. However at the same time quality of products should be secured and supplies of raw materials should not be undermined. This represents a very high risk in the project activity due to its innovate character and uncertainty regarding potential results and product quality.

There is a risk related to reduction of specific coke consumption. In relation to this a risk of discrepancy between actual and projected consumption of coke may occur. Even though reduction of coke can be observed, it occurred gradually over time. Coke consumption in BF is affected by numerous technological and economic factors, which are closely related to each other. Thus, there is a considerable probability that the projected activities may not bring about the expected reductions in coke consumption, or it may take a long time to achieve the estimated reductions. This raises uncertainty in project results, and may be interpreted as a barrier to project implementation.

Modernization of BFs and sinter plant could cause lower output and additional loses to JSC “Zaporizhstal”. However, it is difficult to estimate this. On top of this, new automatic and control systems that would be accessible after modernizations require adjusting of the technological process and could lead to the additional underperformance of the BFs and sinter plant.

The improvement of BFs operation is planned to be achieved by introduction of the list of activities described in Section A4.2. Some of the listed activities have never been realized before at the project site 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.

Know-how of technology and facilities providers under the project, to some extent, could have guaranteed that stuff of the enterprise would receive the appropriate qualification to work with the new iron and agglomerate production process, but at that time there weren’t fully trained professionals. The planned modernizations required extra time and labor.

In such event technological barriers would have additionally prevented implementation of Alternative 2.

This also proves that project is additional.

**Outcome of Sub-step 3a:** The identified barriers may prevent the Alternative #2 from implementation.

***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):***

**Barrier Analysis Conclusions:**

All mentioned barriers to some extent hamper the realisation of proposed project activity.

The above barriers would hinder project scenario implementation without additional revenue from Kyoto benefits and would in fact prevent any alternative scenario except baseline. There are also no alternative technologies to the existing situation that are affordable in the local situation. The down turned economy and very poor investment climate are very significant barrier to the implementation of more energy efficient technologies.

Thus the barriers identified above would hamper implementation of Alternative #2. At the same time these barriers would not constrain Alternative #1 (baseline) that could be realised based on the existing production cycle with practically no additional investments and on the basis of a well-known conventional technology.

**Step 4. Common Practice Analysis**

***Sub-step 4a. Analyze other activities similar to the proposed project activity:***

The proposed joint implementation project is not common practice. To-date, similar projects have been implemented at Azovstal (some measures related to technological improvements of BFs operation and reconstruction of BF shop components of the proposed JI project) and at Enakievo Metallurgical Works within the framework of one of the mechanisms provided by the Kyoto protocol to UNFCCC. Also, the same project is implemented at Industrial Union of Donbass enterprise within JI mechanisms: "Revamping of sintering and blast-furnace production at OJSC Alchevsk Iron and Steel Works" have received positive determination by AIE. Pursuant to the Tool for the Demonstration and Assessment of Additionality, a project registered under Kyoto mechanism is excluded from common practice analysis, which makes the proposed project the only one of its kind for Ukraine.

So, the program of revamping of sintering and blast-furnace production planned to be implemented at JSC "Zaporizhstal" is an integrated program that has no predecessors in Ukraine and could not be considered as a common practice.

Therefore, the overall conclusion is that the project activity meets all additionality criteria, which is best seen within Step 3.

***Sub-steps 4a and 4b are satisfied. The project activity is additional.***

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

The project boundary is determined in the way to cover all emissions of GHGs related to the project activity. With respect to organizational structure of Zaporizhstal, project boundary includes directly sinter plant and blast-furnace shop together with all auxiliary power facilities of the plant. Power grid, as well as emissions due to production and possibly transportation of raw materials, such as coke, iron pellets etc. are integrally connected with the project activity. Therefore they are included into project boundary, based on default emission factors given in calculations. Thus, all $CO_2$ emissions related to project and baseline scenarios have been taken into account.

The leakages occur due to JI projects: "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine" (UA1000189[43]) and other JI projects that are currently under development. In case if other projects that are causing energy efficiency effect on agglomerate and blast-furnace production at JSC "Zaporizhstal" will be registered under JI mechanisms, at the stage of monitoring report development the following emission reductions that are generated due to the specific project will be subtracted from the total volume of emission reductions generated by this project in the specific monitoring period.

$N_2O$ emissions from steelmaking process are unlikely to be significant; IPCC does not provide a methodology to calculate $N_2O$ emissions[44]. They will not typically change from baseline to project case. $CH_4$ emissions are related to sinter and coke production in this type of project and are very minor in comparison with $CO_{2e}$ emissions. Both types of emissions are excluded from the quantification of baseline and project emissions. The exclusion of $CH_4$ represents a conservative approach as more sinter and coke is consumed in absolute terms in the baseline in comparison with the project.

**Table 4. Sources of Emissions**

[43] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details

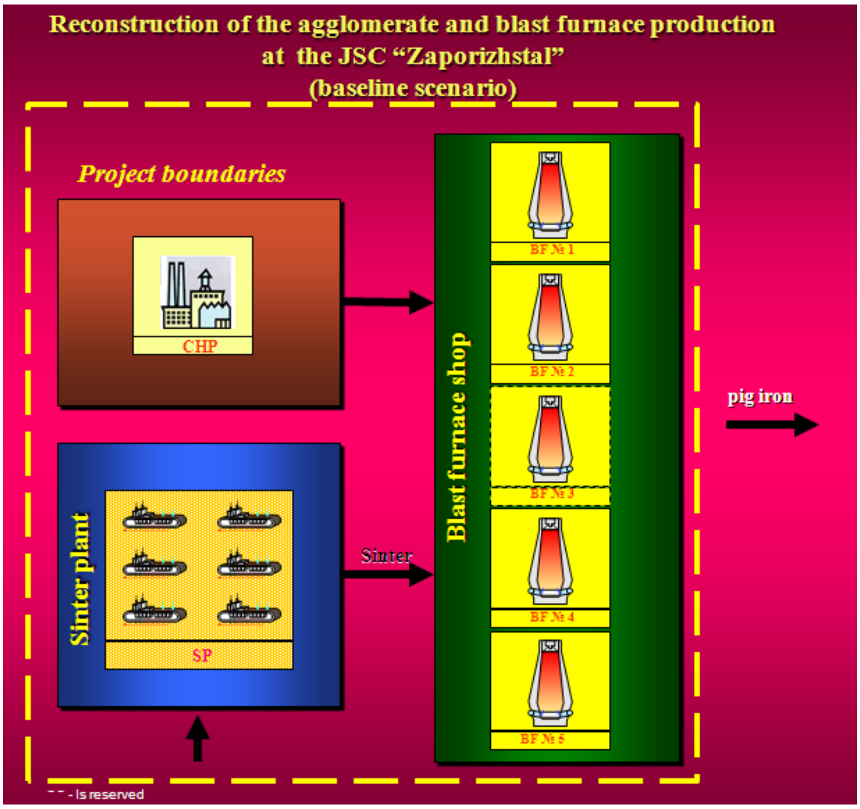
[44] IPCC, 2006, Guidelines for National Greenhouse Gas Inventories, Volume 3, Industrial Processes and Product Use.

| | Source | Gas | Inclusion/ Exclusion | Justification / Explanation |
|---|---|---|---|---|
| Baseline Scenario | Fuel used | $CO_2$ | Yes | Will be source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Electricity used | $CO_2$ | Yes | Will be source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Material flow as part of production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Coke production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Lime production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Pellets production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |

| | Source | Gas | Inclusion/ Exclusion | Justification / Explanation |
|---|---|---|---|---|
| Project Scenario | Fuel used | $CO_2$ | Yes | Will be source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Electricity used | $CO_2$ | Yes | Will be source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Material flow as part of production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Coke production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Lime production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | Pellets production process | $CO_2$ | Yes | Will be the main source of $CO_2$ emissions. |
| | | $CH_4$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |
| | | $N_2O$ | No | This amount is likely to be insignificant and will not typically change from baseline to project case. |

Fuels include Natural Gas and Blast Furnace Gas as well as Coke Oven Gas, Peat and Residual Oil. This fuel mix is specific to Zaporizhstal steel making process. Material inputs having impact on GHG emissions include agglomerate, coal, pulverized coal, small coke, coke, lime, limestone, dolomite, compressed air, oxygen, nitrogen and steam, as well as for process water supply.

The following schematics provide a very simple overview of the project and the baseline and the main elements associated with emission reductions.



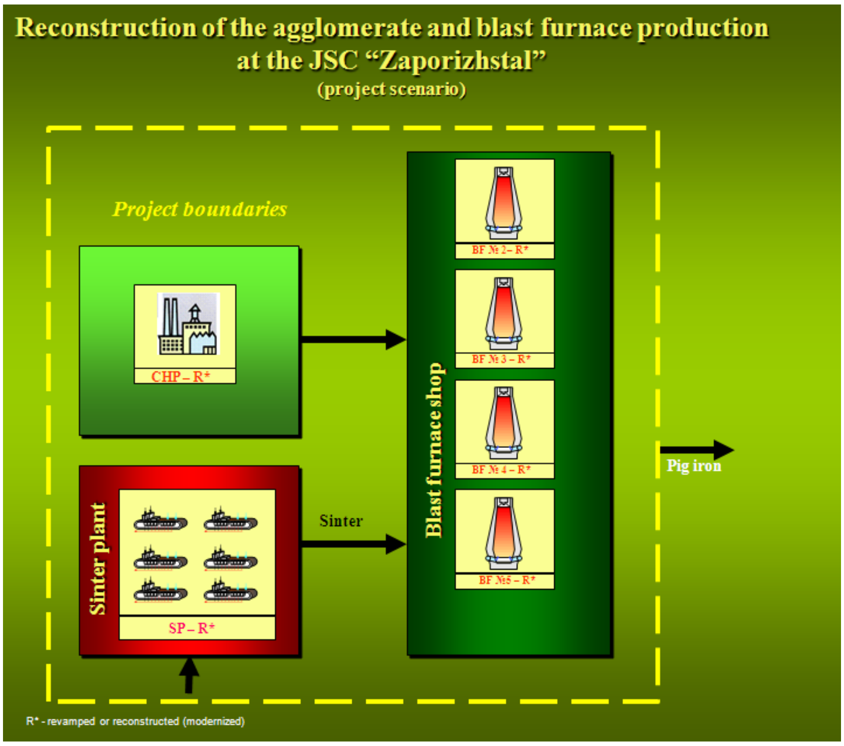




**Figure 5. Schemes of the project and the baseline and the main elements associated with emission reductions**

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

**Date of Completion of Baseline Identification and Monitoring Methodology Application**

The implementation of the above baseline identification and monitoring plan is completed on 30/03/2011.

**Name of person/entity responsible for baseline identification and monitoring methodology application to the project**

Tahir Musayev
Tel.: +38 044 490 69 67
Fax: +38 044 490 69 25
E-mail: t.musayev@gmail.com

## SECTION C. Duration of the project / crediting period

### C.1. Starting date of the project:

01/01/2003[45].

### C.2. Expected operational lifetime of the project:

The operational lifetime of the project is at least 20 years (240 months) for all installed equipment and according to the schedule of the project.

### C.3. Length of the crediting period:

Crediting period: 1st April 2004 – 31 December 2020.

Length of the crediting period: 16 years and 9 months or 201 months.

For the period from 1st April 2004 and up to 31 December 2007 Early Credits (AAU's) will be claimed to be transferred through Article 17 of the Kyoto Protocol.

Period before first commitment period: 1st April 2004 – 31st December 2007.

Length of period before first commitment period: 3 years and 9 months or 45 months.

First commitment period: 1st January 2008 – 31st December 2012.

Length of first commitment period: 5 years or 60 months.

Period following first commitment period: 1st January 2013 – 31st December 2020.

Length of period following first commitment period: 8 years or 96 months.

Emission reductions generated after the crediting period may be used in accordance with an appropriate mechanism under the UNFCCC. Also, In the event an agreement to prolong the Kyoto Protocol is achieved the crediting period may also be extended provided relevant approval.

[45] The starting date of the project is proved by the Protocol of technical Council of the plant dated 25th of December, 2002.

## SECTION D. Monitoring plan

### D.1. Description of monitoring plan chosen:

This Monitoring Plan is identical to the relevant part of Monitoring Plan used for the "Revamping and Modernisation of the Alchevsk Steel Mill" Joint Implementation Project, Project Registration Number UA 1000022[46]. This means the complete correlation between project and baseline scenarios of the proposed project and the said JI Project in Alchevsk.

The monitoring approach developed for this specific project is consistent with the assumptions and procedures adopted in the baseline approach (please see Section B.1). This monitoring approach mainly requires monitoring and measurement of variables and parameters (and, partially, the use of average and historical Zaporizhstals' data) necessary to quantify the baseline emissions and project emissions in a conservative and transparent way. In case if there will be no possibility to monitor some of the parameters the average data of Zaporizhstal will be used at the stage of monitoring report development.

1. The baseline technology with old blast furnaces and sinter plant reflects the common practice and has been successfully operated at JSC "Zaporizhstal" for an extended time period. This allows the project developer to use historical data on the production and materials efficiency and compare with actual data in order to calculate emission reductions of GHG's. Specifically, all facilities are having identical technological characters under the baseline scenario and the project scenario with only difference in their efficiency.

2. The historical period has been chosen with regard to cover project previous statistically and technologically reliable period of 6 years from 1997 and till the end of 2002. 6-year baseline period should neutralise the potential impact of facilities' maintenance and repair as a part of normal routine operation of the Steel Mill.

3. This Plant is an integrated modern steel mill. It has the project specific oversight and control and respects the high-level metering requirements, in accordance with national norms and regulations and based on Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department". In fact, monitoring under baseline and project cases is a routine activity whose quality was checked by certification companies on numerous occasions. This will ensure accurate data on both energy and material flows into the project boundary, but also the data required determining the $CO_{2e}$ impact of the materials in accordance with the Monitoring Plan.

4. In the baseline and project lines, Blast Furnace Gas is used as a fuel. Blast Furnace Gas is a by-product of the Blast Furnace process. Its main embedded energy and carbon reside in $CH_4$ and CO which typically make up about 50% of blast furnace gas. The carbon content of the blast furnace gas comes from the coke and to a lesser extent natural gas used in the process. All carbon entering the Blast Furnace, mostly as combusted coke or natural gas, is

[46] http://ji.unfccc.int/JIITLProject/DB/V75OZ8TQOFTB325LEDMXE2628ZD548/details

calculated already as $CO_{2e}$ emissions within the boundary including the carbon that ends up in blast furnace gas. Therefore, blast furnace gas is treated as a carbon free fuel for blast furnaces, sinter plant and auxiliary power facilities[47].

5. Carbon content of pig iron will not be taken into account in order to avoid double counting of emissions due to the fact that carbon will be counted as a sum of all carbon containing elements during pig iron production. It is assumed that carbon in pig iron will end up into atmosphere at later stages of its usage.

6. All parameters will be measured/monitored *ex-post* based on specific Monitoring Plan developed for this project. In case if data will not be available, IPCC default factors will be used. This monitoring approach reduces the risk of overestimation of the emission reductions given that no key parameters/factors of quantification would be based on uncertain assumptions.

7. Carbon emission factor for natural gas consumption is calculated based on fixed net calorific value (based on average data regarding net calorific value), default emission factor which is in accordance with IPCC 1996. To follow the conservative approach in this document, net calorific value is rather lower than actual net calorific value during next periods. However if AIE requests to use actual calorific value of natural gas, the relevant calculations will be done in monitoring reports based on Zaporizhstals' laboratory data.

8. Carbon emission factor for coke-oven gas (COG) consumption is identified based on carbon content of COG (in accordance with National Greenhouse Gas Inventory of Ukraine, period 1990-2008[48]) and average COG net calorific value which is based on average Zaporizhstals' data. Taking into account that usually COG that was consumed at Zaporizhstal had a net calorific value varying from 4000 – 4100 and also to follow the conservative approach, default COG net calorific value is identified at the level of 4020 kcal. However if AIE requests to use actual calorific value of coke oven gas, the relevant calculations will be done in monitoring reports based on Zaporizhstals' laboratory data.

9. This monitoring plan assumes accounting of all primary and secondary energy resources[49] consumed and to be consumed under the project and baseline cases. Since in the project and baseline scenario secondary energy will be consumed not only by major equipment but also for process support purposes, Zaporizhstal will monitor such secondary energy resources as blast-furnace blowing, chemically treated water and heat (steam) production, as well as compressed air, oxygen, nitrogen, water, and treated gas together with its transportation.

10. Step 2 "Balance of process needs" of chosen JI specific approach in PDD implies $CO_{2e}$ emissions from such units as: CHP (that produces blast-furnace blowing, heat and chemically treated water), Oxygen Compressor Shop (that produces oxygen, nitrogen and compressed air) together with Water Supply Shop and Gas shop. These facilities consume fuel-and energy resources to produce and to ensure supply of all secondary energy resources to the technological process. Double counting is avoided.

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[47] If an emission factor is applied to BFG, these emissions would be double counted.
[48] Table P2.7, p. 264 - http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php
[49] Secondary energy is mainly derived from electricity to be measured directly using relevant meters.

11. Leakages are generated due to JI projects such as: "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine" (UA1000189[50]) and other JI projects that are currently under development. In case if other projects that are causing energy efficiency effect on agglomerate and blast-furnace production at JSC "Zaporizhstal" will be registered under JI mechanisms, at the stage of monitoring report development the following emission reductions that are generated due to the specific project will be subtracted from the total volume of emission reductions generated by this project in the specific monitoring period.

12. Data monitored and required for determination will be stored at Zaporizhstal during the whole crediting period and also during two years after the last transfer of ERU's.

All material and energy flows within the project boundary are measured and will be quantified as per their $CO_{2e}$ impact using equations (1) – (25).

The monitoring plan meters, encompasses and monitors the energy and material flows into the project boundary and calculations are made as to the associated $CO_{2e}$ emissions from those flows using the same formulae as the baseline approach:

1. Quantification of all $CO_{2e}$ contributions of all the material flows in the project scenario
2. Quantification of $CO_{2e}$ contributions of all energy flows in the project/baseline scenarios
3. Quantification of the total annual production output in the project/baseline cases

Each material flow will be measured for impact on the tonnes of $CO_{2e}$ emissions per tonne of pig iron production. Electricity consumed will be measured and converted to $CO_{2e}$ emissions using grid data. Each fuel used within the project boundary will also be measured and its $CO_{2e}$ emissions impact derived from local emissions factors based on the carbon content (or IPCC default data) of the fuels and their production and delivery costs. This will provide a comprehensive picture of the emissions of $CO_{2e}$ from the project and from the baseline.

As the project is configured, part of Blast Furnace Gas is used as a fuel in the existing combined heat and power plant to generate secondary energy sources. The $CO_{2e}$ emissions from Blast Furnace Gas are already counted in the context of the total emissions of the pig iron production process so the Blast Furnace Gas is a zero emission fuel. Blast Furnace Gas is created as a by-product of the pig iron production process. The carbon content in the Blast Furnace Gas comes from the coke, coal and to a lesser extent natural gas used in the process and so is already counted as an emission in the calculation of the $CO_{2e}$ impact of pig iron.

[50] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details

As described in section B.3., to ensure that double counting does not occur and that emission reductions are accurately calculated, agglomerate will be considered a material input into the pig iron making process. The total emissions from the sinter plant/blast furnace process will be calculated by using two basic steps: pig iron production and balance of process needs. The total pig iron output from the Blast Furnace will also be monitored allowing the project developer to calculate the tonnes of $CO_{2e}$ emissions per tonne of pig iron produced. The baseline calculations will include the $CO_{2e}$ emissions per tonne of pig iron in the project year multiplied by the baseline production of pig iron calculated for the project year as $CO_{2e}$ emissions from project production.

It should be noted that baseline and monitoring approach allows changes of fuels and materials used in baseline and project scenarios. Therefore not all parameters listed are currently used in baseline and project cases for this specific project. Monitoring Plan therefore takes into account possible changes in the project design. Several parameters are the same in baseline and project cases as indicated in table D.2.

**Data Quality Management**

The monitoring of JI project indicators of at JSC “Zaporizhstal” will be realized on regular basis where the system of data collection on fuel and energy resources (FER) consumption is being used. The data needed for the monitoring of the project will be collected during the process of normal equipment use.

The production facilities of the plant are equipped with the measuring devices such as scales, meters and gas, water, steam, electricity consumption meters. The monitoring of the project forms an organic part of routine monitoring of manufacturing process. This allows receiving data regarding the project continuously.

Zaporizhstal uses the accredited system of quality regulation according to the requirements of the ISO 9001:2008 standard. The internal order regarding “Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant” and internal order regarding “Metrological department” were developed in accordance with national Ukrainian legislation and ISO 9001:2008. They secure required level of accuracy by using monitoring equipment and by the possibility to crosscheck the data adequacy.

Monitoring equipment meets the regulatory requirements of Ukraine regarding accuracy and measurement error. All the equipment used for monitoring purposes, are in line with national legislative requirements and standards and also with ISO 9001:2008 standards. The accuracy of devices is guaranteed by the manufacturers; the error is calculated and confirmed by device certificates. All monitoring equipment is covered by the detailed verification (calibration) plan. The verification process is under strict control. All measuring equipment is included in the verification schedule and verified with established periodicity. According to the schedule of verification, all devices are in satisfactory condition. The documented instructions to operate the facilities are stored at the working places. The list of monitoring equipment can be provided to the verifier upon request.

The monitoring procedures are quite comprehensible, because they had already been used at Zaporizhstal for measuring input and output production parameters, and also for receiving data on level of FER and raw-materials consumption. The most effective accessible methods are used for the error minimization.

Generally the error level is low for all parameters (less than 2%) that are subjected to the monitoring. Thus, the measurements uncertainty level corresponded with technologies, used in the production process, and is taken into the account when the data are taken from devices.

The procedures of receiving data for monitoring execution and responsibility for its realization at Zaporizhstal will be regulated by the internal normative documents of Zaporizhstal, by internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and by internal order regarding "Metrological department" in accordance with project documentation and monitoring plan.

The Metrological Specialist of Zaporizhstal is in charge for maintenance of the facilities and monitoring equipment as well as for their accuracy required by the internal standards of the plant: STP 7.6-01-03, STP 7.6-03-03, STP 7.6-04-03, STP 7.6-05-03, STP 7.6-06-03, STP 7.6-07-03, STP 7.6-08-03, STP 7.6-09-03 and STP 7.6-07-10. Such mentioned above documents can be provided to the verifier upon request. In case of defect, discovered in the monitoring equipment, the actions of the staff are determined by the internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and by internal order regarding "Metrological department". The measurements are conducted constantly in automatic regime.

Data are collected in printed documents and, partially, in the electronic database of Zaporizhstal. Also data are systematized in the documents of the daily, monthly and annually registration. All those documents are saved in the planning-economic department.

The measurement results are being used by the Chief power-engineering specialist department, by the following services and technical staff of the Steel Mill. They are reflected in the technological instructions of production processes regime and also in the internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and in the internal order regarding "Metrological department". The monitoring data reports and calculations are under the competence of the planning-economic department in accordance to the interior orders of the Steel Mill.

Responsibilities for monitoring are defined in Table 5, and training and maintenance is also discussed in Annex 3.

The project developer has additional documentation to support Monitoring Plan, e.g.:

- the Monitoring Database (including also *ex-ante* estimates of materials and fuels used) that will be regularly updated with actual data to compile and calculate the emission reductions monthly and annually, and
- detailed guidelines regulating the monitoring procedures and responsibilities (Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department").

Compliance audits for the above standards are performed on an annual basis. In addition, the Plant has a number of other certificates (relevant information may be provided upon request), which could be seen as another proof of project monitoring quality assurance.

**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 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

The table is left blank on purpose.

**Key Information and Data Used for Project Case Identification**

| **Key Variables/Parameters** | $TPII_p$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Total pig iron output |
| Identification/monitoring frequency | Measured on regular basis (monthly) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is equal to the total pig iron output during the project activity |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $Q_{fpi,p}$ |
|---|---|
| Measuring unit | 1000 $m^3$ |
| Description | Quantity of fuel (fpi) used in making pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$. |

| **Key Variables/Parameters** | $EF_{f,p}$[51] (P-6, P-13, P-26) |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/1000 $m^3$ |
| Description | Emission factor for fuel consumption |
| Identification/monitoring frequency | Fixed value based on Zaporizhstal average data |
| Source of data | Zaporizhstal average data<br>IPCC 1996<br>National GHG inventory of Ukraine, 1990-2008<br>Potentially measured by Zaporizhstal laboratory or local fuel distributor |
| Parameter value<br>(for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with Zaporizhstal average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[52]<br>Net calorific value is anticipated at nearly 33,8685 TJ/1 000 000 $Nm^3$.<br>Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,89052 tonnes of $CO_{2e}$/1000 $Nm^3$ and is calculated based on mentioned above net calorific value.<br>Carbon emission factor for coke oven gas combustion is anticipated at the level of 0,79824 tonnes $CO_{2e}$/1000 $Nm^3$. The carbon content of coke oven gas is in accordance with "National GHG inventory of Ukraine, period 1990-2008", Table P2.7, page 264 (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php). Net calorific value for coke oven gas is based on Zaporizhstal average data.<br>Net calorific value for peat is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for peat is in accordance with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf) and anticipated at nearly 1,03 tonnes of $CO_{2e}$/tonne.<br>Net calorific value of residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf) and anticipated at nearly 3,1 tonnes $CO_{2e}$/tone.<br>Also please see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[51] For more detailed information please see Annex 2.
[52] In case if the data regarding net calorific value for mentioned above fuels will be available at Zaporizhstal for each of the specific monitoring periods, the carbon emission factors will be accordingly modified at the stage of monitoring report development.

| **Key Variables/Parameters** | $ECPI_p$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in producing pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for all sources of electricity consumption for primary and secondary production needs. |

| **Key Variables/Parameters** | $EF_{e,p}$ (P-9, P-16, P-29) |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/MWh |
| Description | Emission factor for electricity consumption |
| Identification/monitoring frequency | Regular tabulation (on monthly basis) |
| Source of data | Carbon emission factors verified by TÜV SÜD and carbon emission factors based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | Up to 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[53]. Starting from year 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[54]. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[53] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[54] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

| **Key Variables/Parameters** | $Q_{fio,p}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fio) used in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$ and peat is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECIO_p$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

| **Key Variables/Parameters** | $Q_{rapi,p}$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Quantity of each reducing agent (rapi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of reducing agents consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{ra,p}$[55] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each reducing agent |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996<br>IPCC 2006<br>Potentially measured by Zaporizhstal laboratory |
| Parameter value<br>(for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf).<br><br>For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | This PDD uses default factors:<br>For coke it is anticipated at 3.66 tonnes $CO_{2e}$/tonne;<br>For coal the anticipated factor is 2.5 tonnes $CO_{2e}$/tonne.<br>However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of coal. If information on actual carbon content or net calorific value is available, it would prevail over default factors |

[55] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{oipi,p}$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Quantity of each other input (oipi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of other inputs consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{oi,p}$[56] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each other input |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996<br>IPCC 2006 |
| Parameter value<br>(for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for* $CO_2$, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf).<br><br>For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Table 4.1 *Default* $CO_{2e}$ *emission factors for coke production and iron and steel production*, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf).<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | For limestone it is anticipated at 0.44 tonnes $CO_{2e}$/tonne of limestone.<br>For pellets it is anticipated at 0.03 tonnes $CO_{2e}$/tonne of pellets produced.<br>For lime it is anticipated at 0.75 tonnes $CO_{2e}$/tonne of lime. |

[56] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{fbpn,p}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fbpn) used for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$, coke oven gas is considered to be a fuel measured in 1000 $m^3$ and residual oil is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECBPN_p$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 26-27 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the project scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

**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 will equal the total tonnes of $CO_{2e}$ from the Pig Iron Process and Sintering (Sinter production) added to the total tonnes of $CO_{2e}$ from the energy consumed for the balance of process needs. The data will be measured regularly. Equations capture the entire $CO_{2e}$ impact from all material and energy flows into the project. Therefore the approach is both transparent and justifiable. Monitoring approach captures also potential changes in project design.

$PE_i = TCPI_{p,i} + TCBPN_{p,i}$ (1),

where:
$TCPI_{p,i}$ = total embodied $CO_{2e}$ from Pig Iron production, t $CO_{2e}$ (project case)
$TCBPN_{p,i}$ = total $CO_{2e}$ in the balance of production processes, t $CO_{2e}$ (project case)

$_i$ = regular data registration interval

To calculate project emissions, equations 1-12 are applied.

The approach includes 2 clear steps determining the $CO_{2e}$ emissions from Pig Iron production (Step 1) and emissions from balance of process needs (Step 2) required estimate total $CO_{2e}$ emissions in the projectline scenario.

The equations capture the entire $CO_{2e}$ impacts of all material and energy flows into the projectline. Therefore the approach is both transparent and justifiable. All the changes, e.g. the potential energy efficiency measures will be directly reflected in the projectline emissions further supporting the conservativeness of the projectline approach.

**STEP 1. PIG IRON PRODUCTION**

$CO_{2e}$ due to the production of Pig Iron ($TCPI_{p,i}$) comes from three sources: fuel (natural gas), electricity and material inputs, such as coke, coal, limestone, lime, pellets etc.

$TCPI_{p,i} = (TCFCPI_{p,i} + TCEPI_{p,i} + TCIPI_{p,i})$ (2),

where:

$TCFCPI_{p,i}$ = total $CO_{2e}$ from fuel consumption in producing Pig Iron, t $CO_{2e}$
$TCEPI_{p,i}$ = total $CO_{2e}$ from electricity consumption in producing Pig Iron, t $CO_{2e}$
$TCIPI_{p,i}$ = total $CO_{2e}$ from Inputs into Pig Iron, t $CO_{2e}$

Total $CO_{2e}$ from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$) is the quantity of fuel multiplied by the emission factor of the fuel:

$$TCFCPI_{p,i} = \sum_{1}^{fpi} \left( Q_{fpi,p,i} \times EF_{f,p} \right) \quad (3),$$

where:
$fpi_{p,i}$ = fuel used in making pig iron
$Q_{p,i}$ = quantity of fuel fpi used (1000 $m^3$)
$EF_{f,p}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

Total $CO_{2e}$ from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$) is the quantity of electricity multiplied by the emission factor of electricity[57]:

$$TCEPI_{p,i} = ECPI_{p,i} \times EF_{e,p} \quad (4),$$

where:
$ECPI_{p,i}$ = electricity consumed in producing pig iron, MWh
$EF_{e,p}$ = emission factor for electricity, t $CO_{2e}$/MWh in the relevant period

$TCIPI_{p,i}$ – the total $CO_{2e}$ emissions from the material inputs into pig iron – include the $CO_{2e}$ from fuel and electricity used for Sinter production, the total $CO_{2e}$ from the reducing agents (coke, coal etc.), and the total $CO_{2e}$ from limestone, lime, pellets etc.

$$TCIPI_{p,i} = TCFIO_{p,i} + TCEIO_{p,i} + TCRAPI_{p,i} + TCOIPI_{p,i} \quad (5),$$

[57] In accordance with Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007 – (http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514) and with the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 – (http://www.neia.gov.ua/nature/doccatalog/document?id=126006).

where:
$TCFIO_{p,i}$ = total $CO_{2e}$ from fuel used for Sinter production, t $CO_{2e}$
$TCEIO_{p,i}$ = total $CO_{2e}$ from electricity consumption for Sinter production, t $CO_{2e}$
$TCRAPI_{p,i}$ = total $CO_{2e}$ from Reducing Agents, t $CO_{2e}$[58]
$TCOIPI_{p,i}$ = total $CO_{2e}$ from the other consumed inputs, t $CO_{2e}$[59]

Total $CO_{2e}$ from fuel (natural gas, peat[60]) used for Sinter production ($TCFIO_{p,i}$) is the quantity of fuel multiplied by the emission factor of this fuel:

$$TCFIO_{p,i} = \sum_{1}^{fio} \left( Q_{fio,p,i} \times EF_{f,p} \right) \quad (6),$$

where:
$fio_{p,i}$ = fuel used for Sinter production
$Q_{p,i}$ = quantity of fuel fio used (1000 $m^3$, tonnes)
$EF_{f,p}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel or tonnes of $CO_{2e}$ per tonne of fuel

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

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[58] For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

[59] For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for* $CO_2$, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Table 4.1 *Default* $CO_{2e}$ *emission factors for coke production and iron and steel production*, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf).

[60] Default emission factor is in accordance with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). Net calorific value is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).

Total $CO_{2e}$ from electricity consumption for Sinter production ($TCEIO_{p,i}$) is the quantity of electricity multiplied by the emission factor of electricity:

$$TCEIO_{p,i} = ECIO_{p,i} * EF_{e,p} \quad (7),$$

where:
$ECIO_{p,i}$ = electricity consumed for Sinter production, MWh
$EF_{e,p}$ = emissions factor for electricity, t $CO_{2e}$/MWh in the relevant period

Total $CO_{2e}$ from reducing agents in pig iron production $TCRAPI_{p,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAPI_{p,i} = \sum_{1}^{rapi} \left( Q_{rapi,p,i} \times EF_{ra,p} \right) \quad (8),$$

where:
$rapi_{p,i}$ = reducing agents used in pig iron production
$Q_{rapi,p,i}$ = quantity of each reducing agent rapi used (tonnes)
$EF_{ra,p}$ = emission factor for reducing agent, t $CO_{2e}$/tonne in the relevant period

The PDD is using default factors for coke (emission factor 3.66 t $CO_{2e}$/tonne, which includes the default factor for coke burning (3.1 t $CO_{2e}$/tonne) and the default factor for coke production (0.56 t $CO_{2e}$/tonne)), coal (default emission factor 2.5 t $CO_{2e}$/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on carbon content and the net calorific value of coke and coal are available, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations.

Total $CO_{2e}$ from the other inputs such as limestone, lime, pellets etc. in pig iron production $TCOIPI_{p,i}$ is the quantity of each other input multiplied by the emission factor for that input:

$$TCOIPI_{p,i} = \sum_{1}^{oipi} \left( Q_{oipi,p,i} \times EF_{oi,p} \right) \quad (9),$$

where:
$oipi_{p,i}$ = each other inputs used in pig iron production
$Q_{oipi,p,i}$ = quantity of each other input oipi used (tonnes)
$EF_{oi,p}$ = emission factor for the other inputs, t $CO_{2e}$/tonne in the relevant period

Default emission factor applied to limestone is 0.44 t $CO_{2e}$/tonne; emission factor applied to pellets is 0.030 t $CO_{2e}$/tone; emission factor applied to lime is 0.75 t $CO_{2e}$/tonne. Project developer may monitor impurities present in limestone and lime in the calculations. If other materials are to be used, their default factors will be applied.

**STEP 2. BALANCE OF PROCESS NEEDS**

Total tonnes of $CO_2$ related to the balance of process needs of the project, namely production of secondary energy at the CHP (that produces blast-furnace blowing, heat and chemically treated water), Oxygen Compressor Shop (that produces oxygen, nitrogen and compressed air) together with Water Supply Shop and Gas shop. The relevant parameters are calculated based on the amounts of fuel and electricity consumed by the said processes:

$TCBPN_{p,i}$ = total tonnes of $CO_2$ related to the balance of process needs, which is the sum of $CO_2$ emissions from fuel and electricity consumed:

$$TCBPN_{p,i} = TCFCBPN_{p,i} + TCEBPN_{p,i} \quad (10),$$

where:
$TCFCBPN_{p,i}$ = total $CO_{2e}$ from fuel (natural gas, coke oven gas and residual oil[61]) consumption for balance of process needs, t $CO_{2e}$:

$$TCFCBPN_{p,i} = \sum_{1}^{fbpn} Q_{fbpn,p,i} \times EF_{f,p} \quad (11),$$

where:
$fbpn_{p,i}$ = fuel used in producing secondary energy used for balance of process needs
$Q_{p,i}$ = quantity of fuel fbpn used (1000 $m^3$, tonnes)
$EF_{f,p}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel or tonnes of $CO_{2e}$ per tonne of fuel

[61] Default emission factor is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf). NCV is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

$TCEBPN_{p,i}$ = total $CO_{2e}$ from electricity consumption for balance of process needs, t $CO_{2e}$:

$$TCEBPN_{p,i} = ECBPN_{p,i} * EF_{e,p} \quad (12),$$

where:
$ECBPN_{p,i}$ = electricity used for production of secondary energy used for the balance of process needs (MWh)
$EF_{e,p}$ = emission factor for electricity, t $CO_{2e}$/MWh in the relevant period

**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 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

The table is left blank on purpose.

**Key Information and Data Used for Baseline Identification**

| **Key Variables/Parameters** | $TPII_b$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Total pig iron output |
| Identification/monitoring frequency | Measured on regular basis (monthly) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is equal to the total pig iron output during the project activity |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $Q_{fpi,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ |
| Description | Quantity of fuel (fpi) used in making pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$. |

| Key Variables/Parameters | $EF_{f,b}$[62] (B-6, B-13, B-26) |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/1000 $m^3$ |
| Description | Emission factor for fuel consumption |
| Identification/monitoring frequency | Fixed value based on Zaporizhstal average data |
| Source of data | Zaporizhstal average data<br>IPCC 1996<br>National GHG inventory of Ukraine, 1990-2008<br>Potentially measured by Zaporizhstal laboratory or local fuel distributor |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with Zaporizhstal average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[63]<br>Net calorific value is anticipated at nearly 33,8685 TJ/1 000 000 $Nm^3$.<br>Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,89052 tonnes of $CO_{2e}$/1000 $Nm^3$ and is calculated based on mentioned above net calorific value.<br>Carbon emission factor for coke oven gas combustion is anticipated at the level of 0,79824 tonnes $CO_{2e}$/1000 $Nm^3$. The carbon content of coke oven gas is in accordance with "National GHG inventory of Ukraine, period 1990-2008", Table P2.7, page 264 (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php). Net calorific value for coke oven gas is based on Zaporizhstal average data.<br>Net calorific value for peat is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for peat is in accordance with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf) and anticipated at nearly 1,03 tonnes of $CO_{2e}$/tonne.<br>Net calorific value of residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).<br>Carbon emission factor for residual oil is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf) and anticipated at nearly 3,1 tonnes $CO_{2e}$/tone.<br>Also please see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[62] For more detailed information please see Annex 2.
[63] In case if the data regarding net calorific value for mentioned above fuels will be available at Zaporizhstal for each of the specific monitoring periods, the carbon emission factors will be accordingly modified at the stage of monitoring report development.

| **Key Variables/Parameters** | $ECPI_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in producing pig iron |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for all sources of electricity consumption for primary and secondary production needs. |

| Key Variables/Parameters | $EF_{e,b}$ (B-9, B-16, B-29) |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/MWh |
| Description | Emission factor for electricity consumption |
| Identification/monitoring frequency | Regular tabulation (on monthly basis) |
| Source of data | Carbon emission factors verified by TÜV SÜD and carbon emission factors based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | Up to 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[64]. Starting from year 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[65]. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

[64] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[65] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

| **Key Variables/Parameters** | $Q_{fio,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fio) used in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$ and peat is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECIO_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed in sintering process |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

| | |
|---|---|
| **Key Variables/Parameters** | $Q_{rapi,b}$ |
| Measuring unit | Tonnes |
| Description | Quantity of each reducing agent (rapi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of reducing agents consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{ra,b}$ [66] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each reducing agent |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996<br>IPCC 2006<br>Potentially measured by Zaporizhstal laboratory |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf).<br><br>For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | This PDD uses default factors:<br>For coke it is anticipated at 3.66 tonnes $CO_{2e}$/tonne;<br>For coal the anticipated factor is 2.5 tonnes $CO_{2e}$/tonne.<br>However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of coal. If information on actual carbon content or net calorific value is available, it would prevail over default factors |

[66] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{oipi,b}$ |
|---|---|
| Measuring unit | Tonnes |
| Description | Quantity of each other input (oipi) in Pig Iron Production |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on volume of other inputs consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | |

| **Key Variables/Parameters** | $EF_{oi,b}$[67] |
|---|---|
| Measuring unit | Tonnes $CO_{2e}$/Tonnes |
| Description | Emission factor of each other input |
| Identification/monitoring frequency | Fixed and monitored values |
| Source of data | IPCC 1996<br>IPCC 2006 |
| Parameter value<br>(for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf).<br><br>For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Table 4.1 *Default $CO_{2e}$ emission factors for coke production and iron and steel production*, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf).<br>Also see Annex 2 |
| Quality assurance and control procedures | See Section D.2. |
| Note | For limestone it is anticipated at 0.44 tonnes $CO_{2e}$/tonne of limestone.<br>For pellets it is anticipated at 0.03 tonnes $CO_{2e}$/tonne of pellets produced.<br>For lime it is anticipated at 0.75 tonnes $CO_{2e}$/tonne of lime. |

[67] For more detailed information please see Annex 2.

| **Key Variables/Parameters** | $Q_{fbpn,b}$ |
|---|---|
| Measuring unit | 1000 $m^3$ and tonnes |
| Description | Quantity of each fuel (fbpn) used for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on quantity of fuel consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | For this project natural gas is considered to be a fuel measured in 1000 $m^3$, coke oven gas is considered to be a fuel measured in 1000 $m^3$ and residual oil is considered to be a fuel measured in tonnes (t). |

| **Key Variables/Parameters** | $ECBPN_b$ |
|---|---|
| Measuring unit | MWh |
| Description | Electricity consumed for balance of process needs |
| Identification/monitoring frequency | Continuous with regular tabulation (monthly basis) |
| Source of data | Recorded by Zaporizhstal |
| Parameter value (for indicative calculations/identification) | See Tables 28-30 |
| Justification of parameter choice or description of measurement methods and procedure | This parameter is based on amount of electricity consumption in the baseline scenario. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Accounts for sources of electricity consumption for primary and secondary production needs. |

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

$BE_i = TCPTPIP_b \times TPII_{p,i}$ (13),

where:
$TCPTPIP_b$ – total $CO_{2e}$ emissions per 1 tonne of pig iron produced, t $CO_{2e}$
$TPII_{p,i}$ = total pig iron production during the particular project period, tonnes

$_i$ = regular data registration interval
$_p$ = project case
$_b$ = baseline

$TCPTPIP_b$ – total $CO_{2e}$ emissions per 1 tonne of pig iron produced in the baseline scenario (historical data of Zaporizhstal operation regarding pig iron production during the period of 1997 – 2002) – includes total embodied $CO_{2e}$ from Pig Iron production and total $CO_{2e}$ in the balance of production processes, which are divided by total volume of pig iron production in the baseline scenario (historical pig iron production at Zaporizhstal during the period of 1997 – 2002).

$TCPTPIP_b = (TCPI_{b,i} + TCBPN_{b,i}) / TPII_{b,i}$ (14),

where:
$TCPI_{b,i}$ = total embodied $CO_{2e}$ from Pig Iron production, t $CO_{2e}$
$TCBPN_{b,i}$ = total $CO_{2e}$ in the balance of production processes, t $CO_{2e}$
$TPII_{b,i}$ = total pig iron production during the baseline period, tonnes

The approach includes 2 clear steps determining the $CO_{2e}$ emissions from Pig Iron production (Step 1) and emissions from balance of process needs (Step 2) required estimate total $CO_{2e}$ emissions per 1 tonne of pig iron produced in the baseline scenario.

The equations capture the entire $CO_{2e}$ impacts of all material and energy flows into the baseline. Therefore the approach is both transparent and justifiable. All the changes, e.g. the potential energy efficiency measures will be directly reflected in the baseline emissions further supporting the conservativeness of the baseline approach.

To calculate baseline emissions, equations 13-25 are applied.

**STEP 1. PIG IRON PRODUCTION**

$CO_{2e}$ due to the production of Pig Iron ($TCPI_{b,i}$) comes from three sources: fuel (natural gas), electricity and material inputs, such as coke, coal, limestone, lime, pellets etc.

$$TCPI_{b,i} = (TCFCPI_{b,i} + TCEPI_{b,i} + TCIPI_{b,i}) \quad (15),$$

where:

$TCFCPI_{b,i}$ = total $CO_{2e}$ from fuel consumption in producing Pig Iron, t $CO_{2e}$
$TCEPI_{b,i}$ = total $CO_{2e}$ from electricity consumption in producing Pig Iron, t $CO_{2e}$
$TCIPI_{b,i}$ = total $CO_{2e}$ from Inputs into Pig Iron, t $CO_{2e}$

Total $CO_{2e}$ from fuel consumption in producing Pig Iron ($TCFCPI_{b,i}$) is the quantity of fuel multiplied by the emission factor of the fuel:

$$TCFCPI_{b,i} = \sum_{1}^{fpi} \left(Q_{fpi,b,i} \times EF_{f,b}\right) \quad (16),$$

where:
$fpi_{b,i}$ = fuel used in making pig iron
$Q_{b,i}$ = quantity of fuel fpi used (1000 $m^3$)
$EF_{f,b}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

Total $CO_{2e}$ from electricity consumption in producing Pig Iron ($TCEPI_{b,i}$) is the quantity of electricity multiplied by the emission factor of electricity[68]:

[68] In accordance with Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007 – (http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514) and with the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 – (http://www.neia.gov.ua/nature/doccatalog/document?id=126006).

$TCEPI_{b,i} = ECPI_{b,i} \times EF_{e,b}$ (17),

where:
$ECPI_{b,i}$ = electricity consumed in producing pig iron, MWh
$EF_{e,b}$ = emission factor for electricity, t $CO_{2e}$/MWh in the relevant period

$TCIPI_{b,i}$ – the total $CO_{2e}$ emissions from the material inputs into pig iron – include the $CO_{2e}$ from fuel and electricity used for Sinter production, the total $CO_{2e}$ from the reducing agents (coke, coal etc.), and the total $CO_{2e}$ from limestone, lime, pellets etc.

$TCIPI_{b,i} = TCFIO_{b,i} + TCEIO_{b,i} + TCRAPI_{b,i} + TCOIPI_{b,i}$ (18),

where:
$TCFIO_{b,i}$ = total $CO_{2e}$ from fuel used for Sinter production, t $CO_{2e}$
$TCEIO_{b,i}$ = total $CO_{2e}$ from electricity consumption for Sinter production, t $CO_{2e}$
$TCRAPI_{b,i}$ = total $CO_{2e}$ from Reducing Agents, t $CO_{2e}$[69]
$TCOIPI_{b,i}$ = total $CO_{2e}$ from the other consumed inputs, t $CO_{2e}$[70]

Total $CO_{2e}$ from fuel (natural gas, peat[71]) used for Sinter production ($TCFIO_{b,i}$) is the quantity of fuel multiplied by the emission factor of this fuel:

$$TCFIO_{b,i} = \sum_{1}^{fio} \left( FIO_{fio,b,i} \times EF_{f,b} \right)$$ (19),

[69] For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).
[70] For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Section 3.2.1.2 *Choice of Emission Factors*, Equation 2.8, page 2.22 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).
[71] Default emission factor is in accordance with Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). Net calorific value is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).

where:
$fio_{b,i}$ = fuel used for Sinter production
$Q_{b,i}$ = quantity of fuel fio used (1000 $m^3$, tonnes)
$EF_{f,b}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel or tonnes of $CO_{2e}$ per tonne of fuel

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

Total $CO_{2e}$ from electricity consumption for Sinter production ($TCEIO_{b,i}$) is the quantity of electricity multiplied by the emission factor of electricity:

$$TCEIO_{b,i} = ECIO_{b,i} * EF_{e,b} \quad (20),$$

where:
$ECIO_{b,i}$ = electricity consumed for Sinter production, MWh
$EF_{e,b}$ = emissions factor for electricity, t $CO_{2e}$/MWh in the relevant period

Total $CO_{2e}$ from reducing agents in pig iron production $TCRAPI_{b,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAPI_{b,i} = \sum_{1}^{rapi} \left( Q_{rapi,b,i} \times EF_{ra,b} \right) \quad (21),$$

where:
$rapi_{b,i}$ = reducing agents used in pig iron production
$Q_{rapi,b,i}$ = quantity of each reducing agent rapi used (tonnes)
$EF_{ra,b}$ = emission factor for reducing agent, t $CO_{2e}$/tonne in the relevant period

The PDD is using default factors for coke (emission factor 3.66 t $CO_{2e}$/tonne, which includes the default factor for coke burning (3.1 t $CO_{2e}$/tonne) and the default factor for coke production (0.56 t $CO_{2e}$/tonne)), coal (default emission factor 2.5 t $CO_{2e}$/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on carbon content and the net calorific value of coke and coal are available, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations.

Total $CO_{2e}$ from the other inputs such as limestone, lime, pellets etc. in pig iron production $TCOIPI_{b,i}$ is the quantity of each other input multiplied by the emission factor for that input:

$$TCOIPI_{b,i} = \sum_{1}^{oipi} \left( Q_{oipi,b,i} \times EF_{oi,b} \right) \quad (22),$$

where:
$oipi_{b,i}$ = each other inputs used in pig iron production
$Q_{oipi,b,i}$ = quantity of each other input oipi used (tonnes)
$EF_{oi,b}$ = emission factor for the other inputs, t $CO_{2e}$/tonne in the relevant period

Default emission factor applied to limestone is 0.44 t $CO_{2e}$/tonne; emission factor applied to pellets is 0.030 t $CO_{2e}$/tone; emission factor applied to lime is 0.75 t $CO_{2e}$/tonne. Project developer may monitor impurities present in limestone and lime in the calculations. If other materials are to be used, their default factors will be applied.

**STEP 2. BALANCE OF PROCESS NEEDS**

Total tonnes of $CO_2$ related to the balance of process needs of the project, namely production of secondary energy at the CHP (that produces blast-furnace blowing, heat and chemically treated water), Oxygen Compressor Shop (that produces oxygen, nitrogen and compressed air) together with Water Supply Shop and Gas shop. The relevant parameters are calculated based on the amounts of fuel and electricity consumed by the said processes:

$TCBPN_{b,i}$ = total tonnes of $CO_2$ related to the balance of process needs, which is the sum of $CO_2$ emissions from fuel and electricity consumed:

$$TCBPN_{b,i} = TCFCBPN_{b,i} + TCEBPN_{b,i} \quad (23),$$

where:

$TCFCBPN_{b,i}$ = total $CO_{2e}$ from fuel (natural gas, coke oven gas and residual oil[72]) consumption for balance of process needs, t $CO_{2e}$:

$$TCFCBPN_{b,i} = \sum_{1}^{fbpn} Q_{fbpn,b,i} \times EF_{f,b} \quad (24),$$

where:
$fbpn_{b,i}$ = fuel used in producing secondary energy used for balance of process needs
$Q_{b,i}$ = quantity of fuel fbpn used (1000 $m^3$, tonnes)
$EF_{f,b}$ = tonnes of $CO_{2e}$ per 1000 $m^3$ of fuel or tonnes of $CO_{2e}$ per tonne of fuel

Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

$TCEBPN_{b,i}$ = total $CO_{2e}$ from electricity consumption for balance of process needs, t $CO_{2e}$:

$$TCEBPN_{b,i} = ECBPN_{b,i} * EF_{e,b} \quad (25),$$

where:
$ECBPN_{b,i}$ = electricity used for production of secondary energy used for the balance of process needs (MWh)
$EF_{e,b}$ = emission factor for electricity, t $CO_{2e}$/MWh in the relevant period

[72] Default emission factor is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf). NCV is in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).

**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 |
| | | | | | | | | |

Not applicable.

**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):**

Not applicable.

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

| **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 |
| | | | | | | | | |

The table is left blank on purpose.

| **Key Variables/Parameters** | $LE_i$ |
|---|---|
| Measuring unit | t $CO_{2e}$ |
| Description | The parameter is measured in tones of $CO_{2e}$ (leakages of GHG emissions) based on the total volume of $CO_{2e}$ emission reductions that are generated due to the energy efficiency measures at sintering and blast-furnace production by already registered JI project “Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine” (UA1000189[73]) and others JI projects that are currently under development. |
| Identification/monitoring frequency | Regular on monthly basis |
| Source of data | Emission reductions estimations which are provided in the PDD or in the periodic monitoring reports. |
| Parameter value<br>(for indicative calculations/identification) | Leakages will be taken into account at the stage of monitoring report development in case if double counting between mentioned above registered JI projects would be observed.<br>Also see section E. |
| Justification of parameter choice or description of measurement methods and procedure | The parameter will be identified as a volume of leakages of GHG in the specific period that will be added to the total amount of project emissions generated during the specific period. More detailed approach that is used to calculate leakages of GHG may be presented at the stage of monitoring report development. |
| Quality assurance and control procedures | See Section D.2. |
| Note | Leakages of GHG |

[73] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details

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

Leakages are generated due to JI projects such as: "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine" (UA1000189[74]) and other JI projects that are currently under development. In case if other projects that are causing energy efficiency effect on agglomerate and blast-furnace production at JSC "Zaporizhstal" will be registered under JI mechanisms, at the stage of monitoring report development the following emission reductions that are generated due to the specific project will be subtracted from the total volume of emission reductions generated by this project in the specific monitoring period.

$$LE_i = LE_1 + LE_2 \quad (26),$$

where:
$LE_1$ = leakages from the JI project "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine" (UA1000189[75])
$LE_2$ = leakages from the JI project „Energy efficiency increase in steelmaking and sinter plants JSC „Zaporizhstal", Ukraine" (under development)

$$LE_1 = (Q_1/Q_2)*ERs_{\text{Oxygen Compressor Plant}} \quad (27),$$

where:
$Q_1$ = quantity of oxygen used fort he needs of blast furnace production, $m^3$
$Q_2$ = total volume of oxygen produced at the Oxygen Compressor Plant[76], $m^3$
$ERs_{\text{Oxygen Compressor Plant}}$ = anticipated emission reductions after implementation of the JI project "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal"[77], t $CO_{2e}$

[74] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details
[75] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details

[76] This data is provided by JSC "Zaporizhstal"

[77] This date is taken from the PDD of the JI project "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", http://www.neia.gov.ua/nature/doccatalog/document?id=121370

$LE_2 = ER_{SINTERPLANT} = BE_{SINTERPLANT} - PE_{SINTERPLANT}$ (28),

$ER_{SINTERPLANT}$,- anticipated $CO_2$ emission reductions, $tCO_2$ **on the Sinter plant** after implementation of the JI project „Energy efficiency increase in steelmaking and sinter plants JSC „Zaporizhstal", t $CO_{2e}$
$BE_{SINTERPLANT}$,- $CO_2$ baseline emissions, $tCO_2$ **on the Sinter plant**
$PE_{SINTERPLANT}$,- $CO_2$ project emissions, $tCO_2$ **on the Sinter plant**[78]

There should be no other leakages except the mentioned ones. The emissions from installing the new equipment will not be significant. The emissions from transport of materials will not be significantly higher for the baseline; however this will not be taken into account to secure conservativeness of the analysis.

**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):**

$ER_i = BE_i – (PE_i + LE_i)$ (29),

where:
$ER_i$ = Emission Reductions
$BE_i$ = Baseline Emissions
$PE_i$ = Project Emissions
$LE_i$ = Leakages of GHG's
$_i$ = regular data registration interval

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

The environmental management standard ISO 14001:2004[79] has been implemented and certified at Zaporizhstal. The standard determines the procedures related to collection and archiving of data on environmental impacts within activity of the plant and, accordingly, the proposed project activity.

[78] This data is taken from the PDD of the JI project "Energy efficiency increase in steelmaking and sinter plants JSC Zaporizhstal"
[79] http://www.zaporizhstal.com/off-line/about/certification/7_big.jpg

Within Zaporizhstal structure there is a environmental department (ED) which is in charge of the monitoring for various kinds of environmental impacts within the plant activity, data collection, analysis and archiving, which is a routine activity of Zaporizhstal. It shall be noted that the project activity does not lead to aggravation of environmental situation, but rather opposite - reduces load on environment.

Overall environmental influence is under manageable control and fully in compliance with national and local regulations.

The monitoring frequency is in accordance with approved graphs of analytical and departmental control.

| **D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:** | | | |
|---|---|---|---|
| Data *(Indicate table and ID number)* | Data variable | Uncertainty level of data (high/medium/low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
| P-3 | Total Pig Iron Output ($TPII_p$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| P-5 | Quantity of each fuel ($fpi_p$) used in making Pig Iron ($Q_{fpi,p}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| P-6, 13, 26 | Emission factor of each fuel $EF_{f,p}$ | Low | Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13, "National GHG inventory of Ukraine, period 1990-2008", Table P2.7, page 264, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 Emission Factors, Table 1.2, page 18, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23.<br>Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor may be modified by taking into account actual net calorific value of fuel. |
| P-8 | Electricity Consumed in producing Pig Iron ($ECPI_p$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |

| | | | |
|---|---|---|---|
| P-9, 16, 29 | Emissions Factor for Electricity Consumption $EF_{f,p}$ | Low | Up to 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[80]. Starting from year 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[81]. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2. |
| P-12 | Quantity of each fuel ($fio_p$) used in Sintering ($Q_{fio,p}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| P-15 | Electricity Consumed in Sintering ($ECIO_p$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| P-18 | Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |

[80] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[81] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

| | | | |
|---|---|---|---|
| P-19 | Emission factor of each reducing agent, $EF_{ra,p}$ | Low | For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26. For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25.<br>The PDD is using default factors for coke (emission factor 3.66 t $CO_{2e}$/tonne, which includes the default factor for coke burning (3.1 t $CO_{2e}$/tonne) and the default factor for coke production (0.56 t $CO_{2e}$/tonne)), coal (default emission factor 2.5 t $CO_{2e}$/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on calorific value of coke and coal are available, such as carbon content and the net calorific value of coke and coal, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations. |
| P-21 | Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| P-22 | Emission factor of each other input, $EF_{oi,p}$ | Low | For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10. For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25. and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 |
| P-25 | Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |

| | | | |
|---|---|---|---|
| P-28 | Electricity Consumed for balance of process needs ($ECBPN_p$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-3 | Total Pig Iron Output ($TPII_b$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-5 | Quantity of each fuel ($fpi_b$) used in making Pig Iron ($Q_{fpi,b}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-6, 13, 26 | Emission factor of each fuel $EF_{f,b}$ | Low | Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13, "National GHG inventory of Ukraine, period 1990-2008", Table P2.7, page 264, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 Emission Factors, Table 1.2, page 18, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23.<br>Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor may be modified by taking into account actual net calorific value of fuel. |

| | | | |
|---|---|---|---|
| B-8 | Electricity Consumed in producing Pig Iron ($ECPI_b$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-9, 16, 29 | Emissions Factor for Electricity Consumption $EF_{f,b}$ | Low | Up to 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[82]. Starting from year 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[83]. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2. |
| B-12 | Quantity of each fuel ($fio_b$) used in Sintering ($Q_{fio,b}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-15 | Electricity Consumed in Sintering ($ECIO_b$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-18 | Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |

[82] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[83] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

| | | | |
|---|---|---|---|
| B-19 | Emission factor of each reducing agent, $EF_{ra,b}$ | Low | For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26. For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25.<br>The PDD is using default factors for coke (emission factor 3.66 t $CO_{2e}$/tonne, which includes the default factor for coke burning (3.1 t $CO_{2e}$/tonne) and the default factor for coke production (0.56 t $CO_{2e}$/tonne)), coal (default emission factor 2.5 t $CO_{2e}$/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on calorific value of coke and coal are available, such as carbon content and the net calorific value of coke and coal, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations. |
| B-21 | Quantity of each other input ($oipi_b$) in Pig Iron Production ($Q_{oipi,b}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| B-22 | Emission factor of each other input, $EF_{oi,b}$ | Low | For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10. For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25. and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22 |
| B-25 | Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b}$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |

| | | | |
|---|---|---|---|
| B-28 | Electricity Consumed for balance of process needs ($ECBPN_b$) | Low | Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with Zaporizhstal's internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department", as well as national standards. |
| | Leakages of GHG's ($LE_i$) | Low | Leakages are generated due to JI projects such as: "Installation Reconstruction of the Oxygen Compressor Plant at the JSC "Zaporizhstal", Ukraine" (UA1000189[84]) and other JI projects that are currently under development. In case if other projects that are causing energy efficiency effect on agglomerate and blast-furnace production at JSC "Zaporizhstal" will be registered under JI mechanisms, at the stage of monitoring report development the following emission reductions that are generated due to the specific project will be subtracted from the total volume of emission reductions generated by this project in the specific monitoring period. |

Uncertainties of measurement results are limited in chosen approach. Monitoring/measuring methodologies and QA/QC procedures are basically the same for the baseline and project scenarios leading to similar uncertainties (pls. see the Section D.2 for details). In fact, the main source of emission reductions is reduced use of materials. The monitoring/measurement procedures are exactly the same both for the baseline and project production line as far the use of pig iron is concerned and errors have similar implications in both cases.

[84] http://ji.unfccc.int/JIITLProject/DB/DHPBSAFIRHMN55DS7FFABELK8NAVMP/details

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

The data required to monitor JI project is routinely collected within the normal operations of the JSC "Zaporizhstal" therefore JI monitoring is integral part of routine monitoring. Data is compiled in (i) day-to-day records, (ii) quarterly records, and (iii) annual records. All records are finally stored in Planning and Economic Department.

The monitoring plan will be implemented by different specialists of the JSC "Zaporizhstal" under supervision of planning and economic department and by the technical director of the Plant. All main production shops and specialists of the plant will be involved into the preparation of monitoring report under coordination of the planning and economic department.

**Table 5. Specialists Responsible for Monitoring**

| Responsibility | Specialist Responsible | Data Variable | |
|---|---|---|---|
| | | Baseline | Project |
| Overall Project Responsibility | Technical Director – A.Putnoki | | |
| Overall Responsibility for Monitoring report | Chief of labarotary for environmental protection – I.Holina | B-6, B-9, B-13, B-16, B-17, B-18, B-22, B-25 | P-6, P-9, P-13, P-16, P-17, P-18, P-22, P-25 |
| Data for Blast Furnaces | Deputy Chief of the Blast-Furnace Shop – P.Shevchenko | B-3, B-5, B-8, B-17, B-18 | P-3, P-5, P-8, P-17, P-18 |
| Data for Sinter Plant | Deputy Chief of the Sinter Plant – P.Sidelnikov | B-12, B-15, B-17, B-18 | P-12, P-15, P-17, P-18 |
| Data for balance of process needs | Deputy Chief of Chief energy specialist department - V.Yarysh | B-21, B-24 | P-21, P-24 |

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

Tahir Musayev
Tel.: +38 044 490 69 67
Fax: +38 044 490 69 25
E-mail: t.musayev@gmail.com

## SECTION E. Estimation of greenhouse gas emission reductions

### E.1. Estimated project emissions:

**Table 6. Estimated project emissions (before the start of Kyoto protocol crediting period)**

| Project emissions (PE) | | 01/04/2004-31/12/2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 6 413 999,7 | 8 915 483,3 | 8 868 785,4 | 9 192 878,1 |
| Balance of process needs | t $CO_{2e}$/a | 260 182,3 | 259 461,8 | 286 743,9 | 266 370,8 |
| Totally | t $CO_{2e}$/a | 6 674 182,1 | 9 174 945,2 | 9 155 529,3 | 9 459 249,0 |
| Totally, 01/04/2004 - 2007[85] | t $CO_{2e}$ | 34 463 906 | | | |

**Table 7. Estimated project emissions (during Kyoto protocol crediting period)**

| Project emissions (PE) | | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 8 417 168,4 | 7 087 382,6 | 7 135 189,1 | 8 562 226,9 | 10 274 672,3 |
| Balance of process needs | t $CO_{2e}$/a | 194 443,8 | 170 656,1 | 228 407,1 | 274 088,5 | 328 906,2 |
| Totally | t $CO_{2e}$/a | 8 611 612,2 | 7 258 038,6 | 7 363 596,2 | 8 836 315,4 | 10 603 578,5 |
| Totally, 2008-2012[85] | t $CO_{2e}$ | 42 673 141 | | | | |

**Table 8. Estimated project emissions (during post-Kyoto period)**

| Project emissions (PE) | | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 11 302 139,5 | 11 302 139,5 | 11 302 139,5 | 11 302 139,5 | 11 302 139,5 |
| Balance of process needs | t $CO_{2e}$/a | 361 796,8 | 361 796,8 | 361 796,8 | 361 796,8 | 361 796,8 |
| Totally | t $CO_{2e}$/a | 11 663 936,3 | 11 663 936,3 | 11 663 936,3 | 11 663 936,3 | 11 663 936,3 |
| Totally, 2013-2017 | t $CO_{2e}$ | 58 319 681,6 | | | | |
| Project emissions (PE) | | 2018 | 2019 | 2020 | | |
| Pig Iron | t $CO_{2e}$/a | 11 302 139,5 | 11 302 139,5 | 11 302 139,5 | | |
| Balance of process needs | t $CO_{2e}$/a | 361 796,8 | 361 796,8 | 361 796,8 | | |
| Totally | t $CO_{2e}$/a | 11 663 936,3 | 11 663 936,3 | 11 663 936,3 | | |
| Totally, 2018-2020 | t $CO_{2e}$ | 34 991 809,0 | | | | |
| Totally, 2013-2020[85] | t $CO_{2e}$ | 93 311 491 | | | | |

### E.2. Estimated leakage:

| Leakages (LE) | | 2006 | 2007 |
|---|---|---|---|
| Totally | t $CO_{2e}$/a | 2 002,0 | 7 356,0 |
| Totally, 2006-2007[85] | t $CO_{2e}$ | 9 358 | |

| Leakages (LE) | | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 25 232,9 | 40 636,1 | 43 665,0 | 43 828,0 | 43 991,0 |
| Totally, 2008-2012[85] | t $CO_{2e}$ | 197 353 | | | | |

| Leakages (LE) | | 2013-2020 |
|---|---|---|
| Totally | t $CO_{2e}$/a | 43 991 |

[85] Total project emissions, total baseline emissions together with total emission reductions (which are provided in this section) are rounded to the whole figure (1t) and are based on calculations which are demonstrated in attached excel file. This file is provided to the verifier.

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

| Project emissions (PE) | | 01/04/2004-31/12/2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 6 674 182,1 | 9 174 945,2 | 9 157 531,3 | 9 466 605,0 |
| Totally, 01/04/2004 - 2007 | t $CO_{2e}$ | 34 473 264 | | | |

| Project emissions (PE) | | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 8 636 845,2 | 7 298 674,8 | 7 407 261,2 | 8 880 143,4 | 10 647 569,5 |
| Totally, 2008-2012 | t $CO_{2e}$ | 42 870 494 | | | | |

| Project emissions (PE) | | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 11 707 927,3 | 11 707 927,3 | 11 707 927,3 | 11 707 927,3 | 11 707 927,3 |
| Totally, 2013-2017 | t $CO_{2e}$ | 58 539 637 | | | | |
| Project emissions (PE) | | 2018 | | 2020 | | |
| Totally | t $CO_{2e}$/a | 11 707 927,3 | 11 707 927,3 | 11 707 927,3 | | |
| Totally, 2018-2020 | t $CO_{2e}$ | 35 123 782,0 | | | | |
| Totally, 2013-2020 | t $CO_{2e}$ | 93 663 419 | | | | |

## E.4. Estimated baseline emissions:

### Table 9. Estimated baseline emissions (before the start of Kyoto protocol crediting period)

| Baseline emissions (BE) | | 01/04/2004-31/12/2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 6 693 733,1 | 9 417 783,2 | 9 404 855,8 | 9 479 693,8 |
| Balance of process needs | t $CO_{2e}$/a | 255 547,2 | 359 543,5 | 359 050,0 | 361 907,1 |
| Totally | t $CO_{2e}$/a | 6 949 280,3 | 9 777 326,7 | 9 763 905,8 | 9 841 600,9 |
| Totally, 01/04/2004 - 2007 | t $CO_{2e}$ | 36 332 114 | | | |

### Table 10. Estimated baseline emissions (during Kyoto protocol crediting period)

| Baseline emissions (BE) | | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 8 734 654,5 | 7 266 728,0 | 7 376 422,0 | 8 851 706,4 | 10 622 047,6 |
| Balance of process needs | t $CO_{2e}$/a | 333 463,7 | 277 422,5 | 314 890,5 | 377 868,6 | 453 442,3 |
| Totally | t $CO_{2e}$/a | 9 068 118,2 | 7 544 150,6 | 7 691 312,5 | 9 229 575,0 | 11 075 490,0 |
| Totally, 2008-2012 | t $CO_{2e}$ | 44 608 646 | | | | |

### Table 11. Estimated baseline emissions (during post-Kyoto period)

| Baseline emissions (BE) | | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Pig Iron | t $CO_{2e}$/a | 11 684 252,4 | 11 684 252,4 | 11 684 252,4 | 11 684 252,4 | 11 684 252,4 |
| Balance of process needs | t $CO_{2e}$/a | 498 786,5 | 498 786,5 | 498 786,5 | 498 786,5 | 498 786,5 |
| Totally | t $CO_{2e}$/a | 12 183 039,0 | 12 183 039,0 | 12 183 039,0 | 12 183 039,0 | 12 183 039,0 |
| Totally, 2013-2017 | t $CO_{2e}$ | 60 915 194,8 | | | | |
| Baseline emissions (BE) | | 2018 | 2019 | 2020 | | |
| Pig Iron | t $CO_{2e}$/a | 11 684 252,4 | 11 684 252,4 | 11 684 252,4 | | |
| Balance of process needs | t $CO_{2e}$/a | 498 786,5 | 498 786,5 | 498 786,5 | | |
| Totally | t $CO_{2e}$/a | 12 183 039,0 | 12 183 039,0 | 12 183 039,0 | | |
| Totally, 2018-2020 | t $CO_{2e}$ | 36 549 116,9 | | | | |
| Totally, 2013-2020 | t $CO_{2e}$ | 97 464 312 | | | | |

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

### Table 12. Emission reductions estimations (before the start of Kyoto protocol crediting period)

| Emission reductions (ER) | | 01/04/2004-31/12/2004[86] | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 275 098,2 | 602 381,6 | 606 374,5 | 374 995,9 |
| Totally, 01/04/2004 – 2007[85] | t $CO_{2e}$ | 1 858 850 | | | |

### Table 13. Emission reductions estimations (during Kyoto protocol crediting period)

| Emission reductions (ER) | | 2008 | 2009 | 2010 | 2011[87] | 2012 |
|---|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 431 273,0 | 245 475,8 | 284 051,3 | 349 431,6 | 427 920,5 |
| Totally, 2008-2012[85] | t $CO_{2e}$ | 1 738 152 | | | | |

### Table 14. Emission reductions estimations (during post-Kyoto period)

| Emission reductions (ER) | | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Totally | t $CO_{2e}$/a | 475 111,6 | 475 111,6 | 475 111,6 | 475 111,6 | 475 111,6 |
| Totally, 2013-2017 | t $CO_{2e}$ | 2 375 558,2 | | | | |
| Emission reductions (ER) | | 2018 | 2019 | 2020 | | |
| Totally | t $CO_{2e}$/a | 475 111,6 | 475 111,6 | 475 111,6 | | |
| Totally, 2018-2020 | t $CO_{2e}$ | 1 425 334,9 | | | | |
| Totally, 2013-2020[85] | t $CO_{2e}$ | 3 800 893 | | | | |

[86] Emission reductions that are generated during the period of 01/04/2004-31/12/2004 are based on pig iron production during year 2004. Basically, volumes of fuel and energy resources consumption together with the volume pig iron output was decreased by 25% in order to estimate emission reductions generated during the period of 01/04/2004-31/12/2004 in PDD. At the stage of monitoring report development emission reductions for the period of 01/04/2004-31/12/2004 will be recalculated based on actual pig iron production data during the corresponding period.

[87] Annual emission reductions for the period starting from 2011 and till 2020 are calculated based on specific fuel and energy resources consumption that was observed during year 2010 and expected annual pig iron output in 2011 - 3 315 496 Tonnes of pig iron, in 2012 – 3 978 595 Tonnes of pig iron and during 2013-2020 – 4 376 454 Tonnes of pig iron annually.

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

| Year | Estimated project emissions (tones of $CO_{2e}$) | Estimated leakage (tones of $CO_{2e}$) | Estimated baseline emissions (tones of $CO_{2e}$) | Estimated emission reductions (tones of $CO_{2e}$) |
|---|---|---|---|---|
| **Before the start of Kyoto protocol crediting period** | | | | |
| **Year 2004 (01/04/2004-31/12/2004)** | **6 674 182,1** | **0,0** | **6 949 280,3** | **275 098,2** |
| **Year 2005** | **9 174 945,2** | **0,0** | **9 777 326,7** | **602 381,6** |
| **Year 2006** | **9 155 529,3** | **2 002,0** | **9 763 905,8** | **606 374,5** |
| **Year 2007** | **9 459 249,0** | **7 356,0** | **9 841 600,9** | **374 995,9** |
| **Total (tones of $CO_{2e}$)[85]** | **34 463 906** | **9 358** | **36 332 114** | **1 858 850** |
| **During Kyoto protocol crediting period** | | | | |
| **Year 2008** | **8 611 612,2** | **25 232,9** | **9 068 118,2** | **431 273,0** |
| **Year 2009** | **7 258 038,6** | **40 636,1** | **7 544 150,6** | **245 475,8** |
| **Year 2010** | **7 363 596,2** | **43 665,0** | **7 691 312,5** | **284 051,3** |
| **Year 2011** | **8 836 315,4** | **43 828,0** | **9 229 575,0** | **349 431,6** |
| **Year 2012** | **10 603 578,5** | **43 991,0** | **11 075 490,0** | **427 920,5** |
| **Total (tones of $CO_{2e}$)[85]** | **42 673 141** | **197 353** | **44 608 646** | **1 738 152** |
| **During post-Kyoto period** | | | | |
| **Year 2013** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2014** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2015** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2016** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2017** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2018** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2019** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Year 2020** | **11 663 936,3** | **43 991,0** | **12 183 039,0** | **475 111,6** |
| **Total (tones of $CO_{2e}$)[85]** | **93 311 491** | **351 928** | **97 464 312** | **3 800 893** |

## 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:

As it was mentioned in the chapter A.4.2 project activity contains three main components such as: 1) technological improvements of blast furnace operation; 2) reconstruction of BF # 2 and further reconstruction of BFs # 4 and # 5 as well as modernization of secondary power facilities at the site; 3) reconstruction of sintering process with replacement of existing sintering machines with 62,5 sq.m sintering area for new modern sintering machines with 75 sq.m sintering area with state-of-the-art gas purifying facility and screening through lattice vibration.

In terms of potential environmental impact, the project activities can be divided into two further groups. The first one does not require a preparation of an environmental impact assessment (EIA). The activities of the first group are of technological character that involves specific improvements in pig iron and sintering technological processes. The second group requires EIAs and contains activities related to introduction of new steel facilities or the reconstructions of old ones. According to the Ukrainian legislation EIAs are developed as a part of mandatory feasibility studies (FSs).

The project is realized in accordance with the project implementation schedule which is showed above at the page 6 of this document. Because of the reason that some project activities should be completed in the next few years, EIAs for such measures will be developed parallel to the realization of the project activities.

As for today, FSs have been completed together with EIAs for such activities as: reconstruction of BF #2; installation of PCI facilities at BFs # 2, 3, 4, 5 and aspiration system of the tail parts of sintering machines. In 2011introduction of new sintering machine #1 with 75 sq. m sintering area, which will replace existing machine with 62,5 sq. m sintering area and building of new state-of-the-art gas purifying facility are planned to be realized. This measure envisages iron ore sinter production process modernization, and also its screening through lattice vibration. In 2007 the commissioning of air aspiration equipment of tail part sintering machine at the sinter plant was completed.

New complex of environmental protection equipment can process up to 1,6 million m3 of polluted air per hour that leads to dust emission reductions at the rate nearly 2,5 thousand tonnes per year. Dust held in electrical filter is reverted to the production. The introduced measures have improved work conditions for employees of the plant. A number of studies have been prepared as a part of official FS for a new sinter plant. However, EIA has not been completed yet because FS is at its final stage of completion and expected to be formulized in 2012. EIA for such measures as reconstruction of BF # 4, # 5 will be developed during the process of preparation of FS of the BFs reconstruction. EIAs together with FSs that are not developed till this time will be developed during 2011-2014 years.

**Table 15. Developed EIAs together with FSs for the project**

| № | Project activities | Developer | Independent approvals |
|---|---|---|---|
| 1 | 2 | 4 | 5 |
| 1 | "Reconstruction of the BF № 2" (2000 y.):<br>-explanatory note DT 336456 (volume 1)<br>-EIA DT 336456 (volume2)<br>-general cost estimate and object cost estimate DT 336456 (volume 3)<br>-business plan DT 336456 (volume 4)<br>-collection of equipment specifications DT 338184 | **Ukrainian State Steelworks Design Institute UKRDIPROMEZ Dnipropetrovsk** | Positive resolutions of Complex state expert appraisal:<br>-complex resolution from C.S.Ukrinvestekspertisa #73 dated from 29.12.03;<br>-resolution from Ministry of health of Ukraine # 36 dated from 01.12.03;<br>-energy efficiency inspection # 01-B-18-27.10-193 dated from 12.11.01;<br>- Dergnaglyadohoronprazi 01-B # 0304591216277 dated from 26.11.01;<br>- Ministry for ecology and natural resources of Ukraine # 12312/22-5 dated from 26.12.2003;<br>-Ministry of Internal Affairs of Ukraine # 12/6/1449 dated from 29.05.01 |
| 2 | FS "Installation of PCI facilities at BFs № 2-5" (2007 y.):<br>-techno-economic part DT 336487 (volume 1)<br>- EIA DT – 336487 (volume2);<br>-PPV 075010-PZ-1 (volume 3);<br>-electrical part 02153. FS (volume4) | **Ukrainian State Steelworks Design Institute UKRDIPROMEZ Dnipropetrovsk** | Positive resolutions of Complex state expert appraisal:<br>-complex resolution of Ukrderghbudekspertisa № 37/282 dated from 30.10.2008;<br>-positive resolution of state environmental appraisal from Ministry for ecology and natural resources of Ukraine # 9155/2/10-08 dated from 15.07.2008;<br>- resolution of sanitary well-being from Ministry of health of Ukraine # 05.03.02–07/9087 dated from 20.02.2008;<br>- expert resolution of State energy efficiency inspection #08-B-10-1024-27.35-0620 dated from 29.02.08;<br>-expert resolution from Main Directorate of Ministry of Emergence Situations of Ukraine in Zaporizhska oblast on issues of monitoring and prevention activities # 04/1-4/6031 dated from 08.10.08;<br>-expert opinion on labor safety #23.01.04-0078.08 dated from 13.02.08. |
| 3 | FS "Reconstruction of oxygen and compressor shop of Zaporizhstal JSC" (2005 y.):<br>-explanatory note DT 346135 (volume 1)<br>-general cost estimate and object cost estimate DT-346135 (volume 2)<br>-EIA DT – 346135 (volume 3)<br>-complex expertise information DT 346135 (volume 4) | **Ukrainian State Industrial Design Institute GIPROPROM** | Positive resolutions of Complex state expert appraisal:<br>-resolution of complex state expertise of "Oblderginvestekspertiza" # 140 dated from 05.09.05;<br>-expert resolution from Main Directorate of Ministry of Emergence Situations of Ukraine in Zaporizhska oblast # 11/1-4/3236 dated from 09/06/05;<br>-resolution of Zaporizhska miskSES # 284 dated from 26.06.05;<br>-expert resolution of |

| | | | |
|---|---|---|---|
| | | | Dergnaglyadohoronprazi in Zaporizhzhya #23.01.04-0489.05 dated from 01.08.05;<br>-resolution of State environmental expertise # 244/05 dated from 15.07.2005;<br>-expert resolution on energy conservation of territorial administration # 5-B-10-1024-42.11-0816 dated from 23.06.05 |
| 4 | "Reconstruction of the sintering machine #1 with introduction technological gas purification" (2010 y.):<br>-explanatory note DT 348030 (volume 1)<br>-drawings DT 348030 (volume 2)<br>-EIA DT – 348030 (volume 3)<br>-collection of specifications DT-348030 (volume 4) | **Ukrainian State Steelworks Design Institute UKRDIPROMEZ Dnipropetrovsk** | In the process of receiving approval and conclusions. |

Note: All mentioned documents can be submitted to the verifier upon its request.

All formal EIAs were undertaken in accordance with the applicable legislation and regulations of Ukraine. These include: the Laws of Ukraine "*On Protection of Environment"*, "*On Environmental Due Diligence"*, "*On Protection of Atmospheric Air"*, "*On Wastes"*, "*On Ensuring Sanitary and Epidemic Welfare of the Population"*, "*On Local Councils of People's Deputies"* and "*On Local Governance in Ukraine"*, as well as in line with effective versions of Water Code, Land Code, Forest Code, and Ukraine's State Code of Civil Practice DBN A.2.2-1-2003 etc.

EIAs were developed by Ukrainian State Steelworks Design Institute (Ukrdipromez). The documents provide assessment of impact of the project activity on various components of natural, social, and man-made environment.

The project has transboundary impact on the environment. Reduction and control over the emissions of hazardous substances is provided by the Protocols to the UN Convention on Long-range Transboundary Air Pollution, which Ukraine has ratified:
- The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, done at Helsinki, Finland, on 8 July 1985, entered into force as of September 2nd, 1987.
- The 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, done at Sofia, Bulgaria, on 31 October 1988, entered into force as of February 14th, 1991.

**Table 15-1. Estimation of transboundary emissions**

| № | Name | Quantity (+/-), tonnes per year |
|---|---|---|
| **1** | **Blast Furnace # 2** | |
| | dust | -3065,4 |
| | nitrogen dioxide | -45,9 |
| | sulfur dioxide | -543,0 |
| | carbon oxide | -4537,3 |
| | benzapyrene | 0,0 |
| | **Total reduction, tonnes per year** | **-8191,6** |
| **2** | **Tail part sintering machine** | |
| | dust | -2 500,0 |
| | **Total reduction, tonnes per year** | **-2 500,0** |
| **3** | **Sintering machine** | |
| | dust | -240,0 |
| | sulfur dioxide | -206,0 |
| | **Total reduction, tonnes per year** | **-446,0** |
| **4** | **Pulverized coal** | |
| | emissions | 100,7 |
| | **Total surplus, tonnes per year** | **100,7** |
| | **Total reduction, tonnes per year** | **-11 037,0** |

According to the EIA project activity will lead to the reduction of hazardous substances by 11 036 tonnes per year, therefore project activity is in compliance with obligations taken by Ukraine.

**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:**

As mentioned in section F1, EIA was realized by the government of Ukraine as the project Host Country and provides opinion on positive or neutral environmental impact of the project activity.

Hard copies of the said documents in Russian and Ukrainian could be available upon relevant request from Zaporizhstal.

It should be noted also that, as provided by the Ukrainian law, no positive opinion regarding environmental impact of any planned project activity could be issued unless comments of the public (if any) are taken into account.

The management of Zaporizhstal has developed, realized and certificated Integrated Management System of quality, environmental protection and labour appropriate to the international standards ISO 9001, ISO 14001, OHSAS 18001 and ILO-OSH 2001, which is in operation from September of 2008.

*Below it is given a brief summary of major environmental impacts of different parts of project activity.*

**Reconstruction of BF # 2**

BF #2 demonstrates positive economy effect, i.e., lower consumption of raw materials and energy resources which are required for achieving production targets in terms of pig iron production and its quality. At the same time well engineering equipment would minimise production downtime and allow lower-cost materials to be used as well as maximise the blast furnace campaign. The furnace refractories fully meet ISO standards and secure long lifetime.

Among others the following main environmental benefits that will be achieved after radical reconstruction of the BF #2:

- better energy efficiency of pig iron production;
- excellent emission control;
- low CO, SO and NOx emissions by using high efficiency burners;
- highly efficient gas cleaning with an introduction of state of art gas cleaning system allowing fulfilment of strictest environmental emission limitations such as dust content of less than 50 $mg/m^3$ etc;
- higher level of waste utilisation by better quality of waste that can be used in other industries;
- secured reliability of blast furnace operation controlled by innovated automatic system;
- efficient dust separation and high dust recycling;
- dust emissions after the cleaning by sack filters less than 20 $mg/m^3$.

**Construction of PCI facilities for BFs #2-5**

Construction of PCI facilities impacts on environment as follows:

- leads to better productivity of blast furnace operation;
- improves stability of blast furnace operation;
- avoids expensive and energy intensive coking production and leads to potential shut down of old environmentally unsound coke plants;
- reduces the output of an existing coke batteries, which could improve the quality of the coke produced by using extra process room due to lower production rates;
- has high reliability of operation;
- enables higher blast temperatures and lower moisture additions that effect in lower total fuel consumption etc[77].

**Technical revamping of oxygen units**

The modernization of BF production requires the technical revamping of oxygen production. The technical revamping of oxygen production leads to the next benefits:

- expanding the use of clean technologies to minimize the pollutants emissions;
- developing new oxy-combustion solutions to drastically reduce $CO_{2e}$ and pollutant emissions;
- improving of the thermal yield and heat transfer, reducing of fuel consumption;
- significant greenhouse gases (GHG) emissions reduction as carbon dioxide ($CO_{2e}$), $C_nH_m$ and volatile organic compounds (VOC);
- nitrogen oxide ($NO_x$) reduction by up to 90%;
- minimizing of emergency situations;
- permissible level of noise (39,0 dBA), that is envisaged by plantation of trees etc[77].

**Reconstruction of sintering production with replacement of existing sintering machines**

<u>Reconstruction leads to:</u>

- stable high sinter quality;
- low quantity of off-gas;
- increased productivity;
- high productivity with difficult charge materials;
- low coke consumption;
- lower energy consumption;

- possibility to recycle more than 50 t/h of contaminated ferrous materials to the sinter plant;
- significant savings in environmental costs for post-treatment and disposal with conventional solutions;
- conforming to all environmental guidelines, even stricter in the future;
- low hazardous emissions such as:
  - dust: <50 mg/Nm³;
  - SOx: <400 ppm/Nm³;
  - dioxin: <0.1 ng/Nm³;
  - NOx: <200 ppm/Nm³;

**Reconstruction of blast furnaces # 4 and 5**

Modernized BF # 3 is equipped with a new high-efficient automated control system in connection with cold repairs and installation of emission controls for secondary emissions, which primary occur during the tapping process. BF # 3 is characterized by the lowest dust emissions (not more than 15 mg/m³, and coefficients of emission of dust into the atmosphere outside the system should be between 5-15 g of dust per tone of pig iron) due to introduction of aspiration system for skip pit, bin trestle, receiving hopper of charging device etc.

In general after reconstruction BFs # 4 and # 5 will have the same parameters as BF #3.

## SECTION G. Stakeholders' comments

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

Law of Ukraine on environmental expertise defines the procedure of participation of citizens and public organizations in the public environmental expertise.

Public has been informed about the planned economic activities with the goal to identify public attitudes and take opinion in account during environmental impact assessment process.

Public was informed about the project, especially about the following information:

- project name, goals and site;
- legal name and address of project owner and its representative;
- approximate dates of EIAs procedures;

No negative comments from the public were received within the deadlines indicated in these publications. Public hearings have not been organized, because the project site lies within the Zaporizhstal territory and public did not express any interest in the planned activities.

All information on stakeholders' comments is included in the EIAs as a part of FSs completed in accordance with Ukrainian statutory requirements.

Annex 1

## CONTACT INFORMATION ON PROJECT PARTICIPANTS

| | |
|---|---|
| Organisation: | JSC "Zaporizhstal" |
| Street/P.O.Box: | Yuzhnoye shosse |
| Building: | 72 |
| City: | Zaporizhzhya |
| State/Region: | Zaporizhzhya region |
| Postal code: | 69008 |
| Country: | Ukraine |
| Phone: | +38(061)218-33-01, +38(061)218-34-14 |
| Fax: | +38(061)213-18-58 |
| E-mail: | zstal@zaporizhstal.com |
| URL: | http://www.zaporizhstal.com/ |
| Represented by: | |
| Title: | Deputy Technical Director |
| Salutation: | Mr. |
| Last name: | Lykov |
| Middle name: | Abramovich |
| First name: | Alexandr |
| Department: | Head power engineer department |
| Phone (direct): | +38 061 218 33 30 |
| Fax (direct): | +38 061 218 33 30 |
| Mobile: | |
| Personal e-mail: | Lykov@zaporizhstal.com |

Annex 2

## BASELINE INFORMATION

The baseline will be calculated for each project year using specific energy and materials consumption per tonne of pig iron production during historical period and the actual production in the given project year to determine the baseline emissions.

In this case, the most plausible baseline technology for pig iron production is represented by major steelmaking equipment such as old blast furnaces and sinter plant. These allow most of baseline parameters to be measured by the same approaches as the projectline.

The baseline tonnes $CO_{2e}$ emissions per tonne of pig iron output will be measured using the historical efficiency parameters, as well as calculated based on the historical and estimated values. These will be used to calculate the baseline for each project year to adjust to the amount of pig iron actually produced by the project line. In order to develop data in the baseline case that is comparable to the emissions data derived in the project case, the baseline $CO_{2e}$ emissions per output figure will include both the material flows and energy flows into project. The material flows will include major raw inputs of coke, coal, peat, residual oil, limestone, lime, pellets etc. as well as process inputs such as steam, oxygen and compressed air, water, nitrogen etc. Each material flow will be measured for its per unit impact on the tonnes of $CO_{2e}$ emissions per tonne of pig iron output.

**Table 16. Emission Factors for Inputs and Reducing Agents** (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26[88] and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for $CO_2$*, page 2.10[89])

**Table 16**
**Emission Factors for $CO_2$ from Inputs and Reducing Agents Consumption**
**Tonnes of $CO_2$ / Tone of material or reducing agent)**

| Reducing Agent | Emission Factor |
|---|---|
| Coal Coke | 3.1 |
| Coal | 2.5 |
| Limestone | 0.44 |

**Table 17. Emission Factors for Inputs and Reducing Agents Production and Transportation** (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Table 4.1 *Default $CO_{2e}$ emission factors for coke production and iron and steel production*, page 4.25[90] and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 2 Mineral Industries Emissions, Equation 2.8 *Default emission factor for lime production*, page 2.22[91]).

**Table 17**
**$CO_2$ Emission Factors for Inputs and Reducing Agents Production and Transportation (Tonnes of $CO_2$ / Tone of material or reducing agent)**

[88] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf
[89] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf
[90] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf
[91] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_2_Ch2_Mineral_Industry.pdf

| Reducing Agent | Emission Factor |
|---|---|
| Coal Coke | 0.56 |
| Pellets | 0.03 |
| Lime | 0.75 |

**Table 18. Emission Factors for Fuels** (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13[92], "National GHG inventory of Ukraine, period 1990-2008"[1], Table P2.7, page 264[93], 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18[94], 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4, page 23[95]

| | TJ/ 1,000,000 $m^3$ | t $CO_{2e}$/TJ | Oxidising Factor | t $CO_{2e}/m^3$ | t $CO_{2e}$/1 000 $m^3$ |
|---|---|---|---|---|---|
| NG | 33.8685 | 56.1 | 0.995 | 0.00189052 | 1.89052 |
| COG | 16.831 | 47.667 | 0.995 | 0.00079824 | 0.79824 |

| | t $CO_{2e}$/tonne |
|---|---|
| Peat | 1.03 |
| Residual oil | 3.1 |

**<u>Baseline Emission Factor for Ukrainian Electricity Grid</u>**

As soon as any other developed baseline emission factor of the Ukrainian electricity system will be approved, the project developer will make appropriate modifications of emission reduction calculations at the stage of monitoring repot development.

Before year 2010 the carbon emission factor for electricity consumption is based on Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007[96].

The baseline emission factor of the Ukrainian electricity system can be summarized as indicated in Table 19 for both components of power delivery to the grid and conservation of power consumption in Zaporizhstal. The approach and assumptions employed are broadly similar to those stipulated in the approved consolidated CDM methodology, ACM0002, taking account of *Guidance on criteria for baseline setting and monitoring for JI projects* issued by JISC, *Operational Guidelines for the Project Design Document, ERUPT* issued by the Ministry of Economic Affairs of the Netherlands, and also country specific circumstances of Ukraine. The estimation of baseline emission factor is assessed by TÜV SÜD for its validity. The scheme of the estimation is represented below.

**Table 19. Baseline carbon emission factors for JI projects for Ukrainian grid. Source: Standardized emission factors for the Ukrainian electricity grid, Annex 2 of Ukraine – Assessment of new calculation of CEF, assessed by TÜV SÜD, 2007**

| | | |
|---|---|---|
| Baseline carbon emission factor for generation | [$tCO_{2e}$/MWh] | 0.807 |

[92] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf
[93] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php
[94] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
[95] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
[96] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

| | | |
|---|---|---|
| Baseline carbon emission factor electricity consumption | [$tCO_{2e}$/MWh] | 0.896 |

Consolidated baseline methodology, ACM0002, takes combination of the Operating Margin, OM, and the Build Margin, BM, to estimate the emission in absence of the CDM project activity. OM accounts for the reduction in power generation plants that provide the electricity to the grid while BM accounts the potential delay in construction of future addition of power plants in the grid.

For OM calculation, it is therefore necessary to identify the group of power plants operating "on margin" that could most likely reduce their output when additional power is delivered to the grid. On the other hand, strict application of BM calculation specified in ACM0002 is not realistic and lead to distorted picture of the Ukrainian grid since most recent capacity addition to be identified is nuclear plants. Therefore, the Operating Margin only will be used to develop the baseline emission factor.

Following assumptions to calculate emission factor of Ukrainian grid are employed,

1) the grid must be constituted of all power plants servicing the grid,
2) there is no significant electricity import to the grid,
3) electricity export is not accounted and not excluding from the calculations.

All of above are in compliance with ACM0002.

The following four options are provided for calculation of OM in ACM0002,

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

Though "Dispatch Data Analysis" (c) is the first methodological choice as per ACM0002, this option is not applicable because of the data availability.[97] "Simple adjusted OM" (b) is not applicable either for the same reason. The "Average OM" (d) would not present a realistic picture since nuclear power plants always work as the base load and constitute up to 48% of overall electricity generation during past five years as indicated in Tables 20, and 21, respectively.

**Table 20. Electricity demand and generation in Ukraine as of March 2005**[98]

| | | Minimum demand (03:00) | Peak demand (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 import/export (MW) | | -1,177 | -1,228 |

[97] Source: State Committee of Statistics of Ukraine. *Fuel and Energy resources of Ukraine 2001-2003*, Kiev, 2004.

[98] *Ukraine – Assessment of new calculation of CEF*, 2007 – http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

**Table 21. Share of power generation by source in the annual power generation**[99]

| Year | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|
| Nuclear plant generation | 44.23 | 45.08 | 45.32 | 47.99 | 47.92 |
| Thermal power generation | 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 generation | 7.04 | 5.58 | 5.15 | 6.47 | 6.65 |

In Ukraine the low-cost must-run power plants are nuclear power plants and their contribution to the total electricity generation is below 59%. Therefore, the “Simple OM” is only applicable option for the Ukrainian grid.

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j,y}}{\sum_{j} GEN_{j,y}} \qquad (A.1),$$

where:
$F_{i,j,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by power plant source *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 $CO_{2e}$ emission coefficient of fuel *i* ($tCO_{2e}$ /mass or volume unit of the fuel), taking into account the carbon content of the fuels used by power sources *j* and the oxidation percent of the fuel in year(s) ‘*y’*, and
$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j* in year(s) ‘*y’*.

$$COEF_i = NCV_i \cdot EF_{CO_2,i} \cdot OXID_i \qquad (A.2),$$

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;
$EF_{CO2e,i}$ is the $CO_{2e}$ emission factor per unit of energy of the fuel *i* ($tCO_{2e}$ /TJ).

Individual data for power generation and fuel properties was obtained from the individual power plants.[100]

The local NCV values of individual power plants for natural gas and coal were used. For heavy oil, the IPCC[101] default NCV was used. Local $CO_2$ emission factors for all types of fuels were taken for the purpose of the calculations and Ukrainian oxidation factors were used.

The Simple OM is applicable to the JI project that delivers additional amount of electricity to the grid, “generation JI project”. However, the project that reduces on-site consumption of electricity, referred to as “reducing project”, reduces losses in the grid. Losses in the Ukrainian grid are classified as technical losses and non-technical losses that include no-payment and other losses of unknown reasons. For the

[99] *Overview of data on electric power plants in Ukraine 2001-2005*, Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.
[100] *Overview of data on electric power plants in Ukraine 2001-2005*, Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.
[101] Revised 1996 IPCC guidelines for national greenhouse gas inventories.

purpose to determine emission factor of the Ukrainian grid for "reducing project", only technical losses were considered. Statistical data on the losses are indicated in Table 22.

**Table 22. Grid losses in Ukraine**

| 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 |

Though technical losses decrease over years and are expected to reach 22% in 2012, technical losses of ten (10) percent are applied for the period during 2006 through 2012 as a conservative assumption.

As conclusions, emission factors for "generation JI projects" and "reducing JI projects" in Ukraine are summarized as follows,

$$EF_{grid,produced,y} = EF_{OM,y} \qquad \text{(A.3)}$$

and

$$EF_{grid,reduced,y} = \frac{EF_{gid,produced,y}}{1 - loss_{grid}} \qquad \text{(A.4),}$$

where:
$EF_{grid,produced,y}$ is the emission factor for JI projects supplying additional electricity to the grid ($tCO_{2e}$ /MWh);
$EF_{grid,reduced,y}$ is the emission factor for JI projects reducing electricity consumption from the grid ($tCO_{2e}$ /MWh);
$EF_{OM,y}$ is the simple OM of the Ukrainian grid ($tCO_{2e}$/MWh);
$Loss_{grid}$ is the technical losses in the grid (%).

Basic data employed for the assessment of carbon emission factor of the Ukrainian grid are summarized in Table 23.

**Table 23. Key data for OM factor calculation of the Ukrainian grid.**

| | Generation (MWh) | $CO_{2e}$ emissions ($tCO_{2e}$) | Technical losses (%) | for producing project, $EF_{grid,produced}$ ($tCO_{2e}$/MWh) | for reducing project, $EF_{grid,reduced}$ ($tCO_{2e}$/MWh) |
|---|---|---|---|---|---|
| 2003 | 98,214,112 | 80,846 | 14.2 | | |
| 2004 | 94,330,765 | 74,518 | 13.4 | | |
| 2005 | 96,526,887 | 78,203 | 13.1 | | |
| **total** | **289,071,764** | **233,567** | **10** | **0.807** | **0.896** |

The results of the calculation are summarized as indicated in Table 24.

**Table 24 Emission factors for the Ukrainian grid**

| Type of JI project | parameter | EF ($tCO_{2e}$/MWh) |
|---|---|---|
| Producing projects | $EF_{grid,produced,y}$ | 0.807 |
| Reducing projects | $EF_{grid,reduced,y}$ | 0.896 |

On March 28, 2011 the Order of the National Environmental Investment Agency of Ukraine (NEIA) № 43[102] regarding approval of specific indicators of carbon dioxide emissions for the year 2010 was issued.

Starting from year 2010 the $CO_2$ emission factor for electricity consumption from the grid is in accordance with mentioned above decree issued by NEIA[103] for the 1$^{st}$ – class electricity consumers and is equal to 1,093 $kgCO_2$/kWh. The use of the emission factor for the1$^{st}$-class electricity consumers is justified by the resolution of National Electricity Regulatory Commission of Ukraine № 1052 of 13 August 1998[104], according to the resolution the 1$^{st}$ – class electricity consumers are the consumers, who:

1) receive electricity from electricity supplier at the point of sale of electricity with the degree of voltage 27.5 kV and above;
2) connected to the power rails of power plants (except hydroelectric, which produce electricity periodically), as well as to power rails of substations of the electricity grid with voltage of 220 kV and above, regardless voltage level at the point of sale of electricity by the power supplier to consumer;
3) is the industrial enterprise with average monthly rate of electricity consumption - 150 million kWh and above for the technological needs of production, regardless of the voltage level at the point of sale of electricity by the power supplier to consumer.

Based on the information stated above, Zaporizhstal refers to the 1$^{st}$ – class electricity consumers, which can be proven by additional documents that can be provided to the verifier upon request.

[102] http://www.neia.gov.ua/nature/doccatalog/document?id=126006
[103] http://www.neia.gov.ua/nature/doccatalog/document?id=126006
[104] http://energetik.org.ua/node/90

Annex 3

## MONITORING PLAN

Detailed description of the monitoring plan please see in Section D.
In table 25 key parameters for monitoring methods for the project scenario are provided.

**Table 25. Outline for monitoring methods for the project scenario**

| | | |
|---|---|---|
| **Pig Iron** | | |
| **P-3** | Volume of pig iron output, tonnes | scales |
| **P-5, P-12** | Fuel consumption for pig iron production, (1000 $m^3$ and tonnes) | flow meter |
| **P-8, P-15** | Electricity consumption for pig iron production, MWh | supply meter |
| **P-18, P-21** | Materials consumption for pig iron production, tonnes | scales |
| **Balance of process needs** | | |
| **P-25** | Fuel consumption for balance of process needs, (1000 $m^3$ and tonnes) | flow meter |
| **P-28** | Electricity consumption for balance of process needs, MWh | supply meter |

All devices used will be in line with applicable Ukrainian standards, internal order regarding "Organization and procedure of metrological supervision conduction to ensure the unity of measurements at the Plant" and internal order regarding "Metrological department"

In Tables 26 and 27 detailed estimations of project emissions before and during Kyoto protocol crediting period are provided.

**Table 26. Detailed Project emissions estimations (before the start of Kyoto protocol crediting period)**

| ID number | Data variable | Units | 01/04/2004 - 31/12/2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **P-1** | **Total $CO_2$ in the project scenario ($PE_i$)** | **Tonnes $CO_2$** | **6 674 182** | **9 174 945** | **9 155 529** | **9 459 249** |
| **P-2** | **Total $CO_2$ from Pig Iron ($TCPI_{p,i}$)** | **Tonnes $CO_2$** | **6 414 000** | **8 915 483** | **8 868 785** | **9 192 878** |
| **P-3** | **Total Pig Iron Output ($TPII_{p,i}$)** | **Tonnes** | 2 516 477 | 3 540 571 | 3 535 711 | 3 563 846 |
| **P-4** | **Total $CO_2$ from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$)** | **Tonnes $CO_2$** | **613 130** | **674 271** | **666 722** | **671 772** |
| **P-5** | **Quantity of each fuel ($fpi_p$) used in making Pig Iron ($Q_{fpi,p,i}$)** | **1000 $m^3$** | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 324 318 | 356 659 | 352 666 | 355 337 |
| **P-6** | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$** | | | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 | 1,891 | 1,891 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **P-7** | **Total $CO_2$ from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$)** | **Tonnes $CO_2$** | **22 183** | **42 227** | **36 849** | **35 831** |
| **P-8** | **Electricity Consumed in producing Pig Iron ($ECPI_{p,i}$)** | **MWh** | 24 758 | 47 128 | 41 126 | 39 990 |
| **P-9** | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 0,896 | 0,896 |
| **P-10** | **Total $CO_2$ from Inputs into Pig Iron ($TCIPI_{p,i}$)** | **Tonnes $CO_2$** | **5 778 687** | **8 198 986** | **8 165 214** | **8 485 275** |
| **P-11** | **Total $CO_2$ from fuel used to prepare Iron Ore ($TCFIO_{p,i}$)** | **Tonnes $CO_2$** | **56 300** | **80 811** | **85 217** | **88 261** |
| **P-12** | **Quantity of each fuel ($fio_p$) used in Sintering ($Q_{fio,p,i}$)** | **1000 $m^3$ or Tonnes** | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 20 794 | 28 453 | 24 896 | 23 818 |
| | **Peat** | **Tonnes** | 16 493 | 26 232 | 37 040 | 41 973 |
| **P-13** | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000$m^3$** | 1,891 | 1,891 | 1,891 | 1,891 |
| | **Peat** | **Tonnes $CO_2$/Tonne** | 1,03 | 1,03 | 1,03 | 1,03 |
| **P-14** | **Total $CO_2$ from electricity consumption in preparing iron ore ($TCEIO_{p,i}$)** | **Tonnes $CO_2$** | **75 550** | **105 660** | **105 243** | **106 841** |
| **P-15** | **Electricity Consumed in Sintering ($ECIO_{p,i}$)** | **MWh** | 84 320 | 117 924 | 117 458 | 119 243 |
| **P-16** | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 0,896 | 0,896 |
| **P-17** | **Total $CO_{2e}$ from Reducing Agents in Pig Iron Production ($TCRAPI_{p,i}$)** | **Tonnes $CO_2$** | **5 198 472** | **7 374 709** | **7 323 903** | **7 636 185** |
| **P-18** | **Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p,i}$)** | **Tonnes** | | | | |
| | **Reducing agent (coke)** | **Tonnes** | 1 364 504 | 1 930 491 | 1 910 641 | 2 002 234 |
| | **Reducing agent (coal)** | **Tonnes** | 81 754 | 123 645 | 132 382 | 123 203 |
| **P-19** | **Emission factor of each reducing agent, $EF_{ra,p}$** | **Tonnes $CO_{2e}$/Tonne** | | | | |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 3,66 | 3,66 | 3,66 | 3,66 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 2,5 | 2,5 | 2,5 | 2,5 |
| **P-20** | **Total $CO_{2e}$ from other inputs ($TCOIPI_{p,i}$)** | **Tonnes $CO_2$** | **448 364** | **637 806** | **650 852** | **653 988** |
| **P-21** | **Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p,i}$)** | **Tonnes** | | | | |
| | **Limestone** | **Tonnes** | 826 625 | 1 166 864 | 1 189 994 | 1 218 759 |
| | **Lime** | **Tonnes** | 89 186 | 135 253 | 142 374 | 131 547 |
| | **Pellets** | **Tonnes** | 591 989 | 764 879 | 682 451 | 635 808 |
| **P-22** | **Emission factor of each other input, $EF_{oi,p}$** | **Tonnes $CO_{2e}$/Tonne** | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,44 | 0,44 | 0,44 | 0,44 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,75 | 0,75 | 0,75 | 0,75 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,03 | 0,03 | 0,03 | 0,03 |
| **P-23** | **Total tones of $CO_2$ related to the balance of process need of energy required for the project activity ($TCBPN_{p,i}$)** | **Tonnes $CO_2$** | **260 182** | **259 462** | **286 744** | **266 371** |
| **P-24** | **Total $CO_2$ from fuel consumption for balance of process needs of project activity ($TCFCBPN_{p,i}$)** | **Tonnes $CO_2$** | **50 632** | **96 765** | **93 495** | **74 009** |
| **P-25** | **Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p,i}$)** | **1000 $m^3$ or Tonnes** | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 14 575 | 23 253 | 25 011 | 18 477 |
| | **Coke Oven gas (COG)** | **1000 $m^3$** | 23 704 | 58 267 | 53 846 | 47 321 |
| | **Residual oil** | **Tonnes** | 1 340 | 2 030 | 1 042 | 421 |
| **P-26** | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 | 1,891 | 1,891 |
| | **Coke Oven gas (COG)** | **Tonnes $CO_2$/1000 $m^3$** | 0,79824 | 0,79824 | 0,79824 | 0,79824 |
| | **Residual oil** | **Tonnes $CO_2$/Tonne** | 3,1 | 3,1 | 3,1 | 3,1 |
| **P-27** | **Total $CO_2$ from electricity consumption for balance of process needs of project activity ($TCEBPN_{p,i}$)** | **Tonnes $CO_2$** | **209 551** | **162 697** | **193 248** | **192 362** |
| **P-28** | **Electricity Consumed for balance of process needs ($ECBPN_{p,i}$)** | **MWh** | 233 874 | 181 581 | 215 679 | 214 690 |
| **P-29** | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 0,896 | 0,896 |

**Table 27. Detailed Project emissions estimations (during Kyoto protocol crediting period)**

| ID number | Data variable | Units | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| P-1 | **Total $CO_2$ in the project scenario ($PE_i$)** | **Tonnes $CO_2$** | **8 611 612** | **7 258 039** | **7 363 596** | **8 836 315** | **10 603 578** |
| P-2 | **Total $CO_2$ from Pig Iron ($TCPI_{p,i}$)** | **Tonnes $CO_2$** | **8 417 168** | **7 087 383** | **7 135 189** | **8 562 227** | **10 274 672** |
| P-3 | **Total Pig Iron Output ($TPII_{p,i}$)** | **Tonnes** | 3 283 752 | 2 731 892 | 2 762 913 | 3 315 496 | 3 978 595 |
| P-4 | **Total $CO_2$ from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$)** | **Tonnes $CO_2$** | **594 661** | **447 252** | **538 530** | **646 236** | **775 483** |
| P-5 | **Quantity of each fuel ($fpi_p$) used in making Pig Iron ($Q_{fpi,p,i}$)** | **1000 $m^3$** | | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 314 549 | 236 576 | 284 858 | 341 830 | 410 196 |
| P-6 | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$** | | | | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 | 1,891 | 1,891 | 1,891 |
| P-7 | **Total $CO_2$ from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$)** | **Tonnes $CO_2$** | **14 191** | **9 812** | **12 691** | **15 229** | **18 275** |
| P-8 | **Electricity Consumed in producing Pig Iron ($ECPI_{p,i}$)** | **MWh** | 15 838 | 10 951 | 11 611 | 13 933 | 16 720 |
| P-9 | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 1,093 | 1,093 | 1,093 |
| P-10 | **Total $CO_2$ from Inputs into Pig Iron ($TCIPI_{p,i}$)** | **Tonnes $CO_2$** | **7 808 316** | **6 630 319** | **6 583 969** | **7 900 762** | **9 480 915** |
| P-11 | **Total $CO_2$ from fuel used to prepare Iron Ore ($TCFIO_{p,i}$)** | **Tonnes $CO_2$** | **79 318** | **63 912** | **60 165** | **72 198** | **86 638** |
| P-12 | **Quantity of each fuel ($fio_p$) used in Sintering ($Q_{fio,p,i}$)** | **1000 $m^3$ or Tonnes** | | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 21 028 | 17 816 | 17 983 | 21 580 | 25 895 |
| | **Peat** | **Tonnes** | 38 412 | 29 350 | 25 406 | 30 487 | 36 585 |
| P-13 | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | | | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000$m^3$** | 1,891 | 1,891 | 1,891 | 1,891 | 1,891 |
| | **Peat** | **Tonnes $CO_2$/Tonne** | 1,03 | 1,03 | 1,03 | 1,03 | 1,03 |
| P-14 | **Total $CO_2$ from electricity consumption in preparing iron ore ($TCEIO_{p,i}$)** | **Tonnes $CO_2$** | **96 676** | **83 933** | **107 781** | **129 337** | **155 204** |
| P-15 | **Electricity Consumed in Sintering ($ECIO_{p,i}$)** | **MWh** | 107 898 | 93 676 | 98 610 | 118 332 | 141 999 |
| P-16 | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 1,093 | 1,093 | 1,093 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **P-17** | **Total $CO_{2e}$ from Reducing Agents in Pig Iron Production ($TCRAPI_{p,i}$)** | **Tonnes $CO_2$** | **7 008 735** | **5 961 812** | **5 888 766** | **7 066 520** | **8 479 823** |
| **P-18** | **Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p,i}$)** | **Tonnes** | | | | | |
| | **Reducing agent (coke)** | **Tonnes** | 1 840 260 | 1 563 054 | 1 545 794 | 1 854 953 | 2 225 943 |
| | **Reducing agent (coal)** | **Tonnes** | 109 353 | 96 414 | 92 464 | 110 957 | 133 148 |
| **P-19** | **Emission factor of each reducing agent, $EF_{ra,p}$** | **Tonnes $CO_{2e}$/Tonne** | | | | | |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 3,66 | 3,66 | 3,66 | 3,66 | 3,66 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| **P-20** | **Total $CO_{2e}$ from other inputs ($TCOIPI_{p,i}$)** | **Tonnes $CO_2$** | **623 587** | **520 661** | **527 256** | **632 707** | **759 249** |
| **P-21** | **Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p,i}$)** | **Tonnes** | | | | | |
| | **Limestone** | **Tonnes** | 1 214 302 | 1 090 108 | 1 135 659 | 1 362 791 | 1 635 349 |
| | **Lime** | **Tonnes** | 110 219 | 51 284 | 34 131 | 40 957 | 49 149 |
| | **Pellets** | **Tonnes** | 220 993 | 85 021 | 65 593 | 78 712 | 94 454 |
| **P-22** | **Emission factor of each other input, $EF_{oi,p}$** | **Tonnes $CO_{2e}$/Tonne** | | | | | |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,44 | 0,44 | 0,44 | 0,44 | 0,44 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |
| **P-23** | **Total tones of $CO_2$ related to the balance of process need of energy required for the project activity ($TCBPN_{p,i}$)** | **Tonnes $CO_2$** | **194 444** | **170 656** | **228 407** | **274 088** | **328 906** |
| **P-24** | **Total $CO_2$ from fuel consumption for balance of process needs of project activity ($TCFCBPN_{p,i}$)** | **Tonnes $CO_2$** | **87 379** | **72 532** | **67 239** | **80 687** | **96 825** |
| **P-25** | **Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p,i}$)** | **1000 $m^3$ or Tonnes** | | | | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 31 118 | 26 558 | 27 845 | 33 414 | 40 096 |
| | **Coke Oven gas (COG)** | **1000 $m^3$** | 32 606 | 19 460 | 17 598 | 21 117 | 25 341 |
| | **Residual oil** | **Tonnes** | 814 | 2 191 | 178 | 213 | 256 |
| **P-26** | **Emission factor of each fuel $EF_{f,p}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 | 1,891 | 1,891 | 1,891 |
| | **Coke Oven gas (COG)** | **Tonnes $CO_2$/1000 $m^3$** | 0,79824 | 0,79824 | 0,79824 | 0,79824 | 0,79824 |
| | **Residual oil** | **Tonnes $CO_2$/Tonne** | 3,1 | 3,1 | 3,1 | 3,1 | 3,1 |
| **P-27** | **Total $CO_2$ from electricity consumption for balance of process needs of project activity ($TCEBPN_{p,i}$)** | **Tonnes $CO_2$** | **107 064** | **98 124** | **161 168** | **193 401** | **232 082** |
| **P-28** | **Electricity Consumed for balance of process needs ($ECBPN_{p,i}$)** | **MWh** | 119 492 | 109 513 | 147 454 | 176 945 | 212 334 |
| **P-29** | **Emissions Factor for Electricity Consumption $EF_{f,p}$** | **Tonnes $CO_2$/MWh** | 0,896 | 0,896 | 1,093 | 1,093 | 1,093 |

In tables 28 - 30 detailed estimations of baseline emissions before and during Kyoto protocol crediting period are provided.

**Table 28. Detailed information regarding identification of Baseline emissions estimations subject to variable emission factor for electricity consumption[105]**

| ID number | Data variable | Units | 01/01/1997 – 31/12/2002 | |
|---|---|---|---|---|
| | | | **01/04/2004-31/12/2009** | **01/01/2010-31/12/2020** |
| **B-1** | **Total $CO_2$ in the baseline scenario ($BE_i$)** | **Tonnes $CO_2$** | **46 104 773** | **46 476 382** |
| **B-2** | **Total $CO_2$ from Pig Iron ($TCPI_{b,i}$)** | **Tonnes $CO_2$** | **44 409 353** | **44 573 589** |
| **B-3** | **Total Pig Iron Output ($TPII_{b,i}$)** | **Tonnes** | 16 695 486 | 16 695 486 |
| **B-4** | **Total $CO_2$ from fuel consumption in producing Pig Iron ($TCFCPI_{b,i}$)** | **Tonnes $CO_2$** | **3 517 307** | **3 517 307** |
| **B-5** | **Quantity of each fuel ($fpi_b$) used in making Pig Iron ($Q_{fpi,b,i}$)** | **1000 $m^3$** | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 1 860 497 | 1 860 497 |
| **B-6** | **Emission factor of each fuel $EF_{f,b}$** | **Tonnes $CO_2$/1000 $m^3$** | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 |
| **B-7** | **Total $CO_2$ from electricity consumption in producing Pig Iron ($TCEPI_{b,i}$)** | **Tonnes $CO_2$** | **129 389** | **157 837** |
| **B-8** | **Electricity Consumed in producing Pig Iron ($ECPI_{b,i}$)** | **MWh** | 144 407 | 144 407 |
| **B-9** | **Emissions Factor for Electricity Consumption $EF_{f,b}$** | **Tonnes $CO_2$/MWh** | 0,896 | 1,093 |
| **B-10** | **Total $CO_2$ from Inputs into Pig Iron ($TCIPI_{b,i}$)** | **Tonnes $CO_2$** | **40 762 657** | **40 898 445** |

[105] The table is required for identification of baseline emissions, which are based on historical data (1997 - 2002) for further identification of baseline $CO_2$ emissions per 1 ton of pig iron produced during the project activity.

| | | | | |
|---|---|---|---|---|
| **B-11** | **Total $CO_2$ from fuel used to prepare Iron Ore ($TCFIO_{b,i}$)** | **Tonnes $CO_2$** | **299 025** | **299 025** |
| **B-12** | **Quantity of each fuel ($fio_b$) used in Sintering ($Q_{fio,b,i}$)** | **1000 $m^3$ or Tonnes** | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 152 066 | 152 066 |
| | **Peat** | **Tonnes** | 11 206 | 11 206 |
| **B-13** | **Emission factor of each fuel $EF_{f,b}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000$m^3$** | 1,891 | 1,891 |
| | **Peat** | **Tonnes $CO_2$/Tonne** | 1,03 | 1,03 |
| **B-14** | **Total $CO_2$ from electricity consumption in preparing iron ore ($TCEIO_{b,i}$)** | **Tonnes $CO_2$** | **617 595** | **753 383** |
| **B-15** | **Electricity Consumed in Sintering ($ECIO_{b,i}$)** | **MWh** | 689 280 | 689 280 |
| **B-16** | **Emissions Factor for Electricity Consumption $EF_{f,b}$** | **Tonnes $CO_2$/MWh** | 0,896 | 1,093 |
| **B-17** | **Total $CO_{2e}$ from Reducing Agents in Pig Iron Production ($TCRAPI_{b,i}$)** | **Tonnes $CO_2$** | **36 889 823** | **36 889 823** |
| **B-18** | **Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b,i}$)** | **Tonnes** | | |
| | **Reducing agent (coke)** | **Tonnes** | 9 502 535 | 9 502 535 |
| | **Reducing agent (coal)** | **Tonnes** | 844 217 | 844 217 |
| **B-19** | **Emission factor of each reducing agent, $EF_{ra,b}$** | **Tonnes $CO_{2e}$/Tonne** | | |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 3,66 | 3,66 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 2,5 | 2,5 |
| **B-20** | **Total $CO_{2e}$ from other inputs ($TCOIPI_{b,i}$)** | **Tonnes $CO_2$** | **2 956 214** | **2 956 214** |
| **B-21** | **Quantity of each other input ($oipi_b$) in Pig Iron Production ($Q_{oipi,b,i}$)** | **Tonnes** | | |
| | **Limestone** | **Tonnes** | 5 690 761 | 5 690 761 |
| | **Lime** | **Tonnes** | 554 643 | 554 643 |
| | **Pellets** | **Tonnes** | 1 209 915 | 1 209 915 |
| **B-22** | **Emission factor of each other input, $EF_{oi,b}$** | **Tonnes $CO_{2e}$/Tonne** | | |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,440 | 0,440 |
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,75 | 0,75 |

| | | | | |
|---|---|---|---|---|
| | **Default emission factor** | **Tonnes $CO_2$/Tonne** | 0,03 | 0,03 |
| **B-23** | **Total tones of $CO_2$ related to the balance of process need of energy required for the project activity ($TCBPN_{b,i}$)** | **Tonnes $CO_2$** | **1 695 420** | **1 902 792** |
| **B-24** | **Total $CO_2$ from fuel consumption for balance of process needs of project activity ($TCFCBPN_{b,i}$)** | **Tonnes $CO_2$** | **752 243** | **752 243** |
| **B-25** | **Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b,i}$)** | **1000 $m^3$ or Tonnes** | | |
| | **Natural gas (NG)** | **1000 $m^3$** | 177 877 | 177 877 |
| | **Coke Oven gas (COG)** | **1000 $m^3$** | 504 013 | 504 013 |
| | **Residual oil** | **Tonnes** | 4 400 | 4 400 |
| **B-26** | **Emission factor of each fuel $EF_{f,b}$** | **Tonnes $CO_2$/1000 $m^3$ or Tonnes CO2/Tonne** | | |
| | **Natural gas (NG)** | **Tonnes $CO_2$/1000 $m^3$** | 1,891 | 1,891 |
| | **Coke Oven gas (COG)** | **Tonnes $CO_2$/1000 $m^3$** | 0,79824 | 0,79824 |
| | **Residual oil** | **Tonnes $CO_2$/Tonne** | 3,1 | 3,1 |
| **B-27** | **Total $CO_2$ from electricity consumption for balance of process needs of project activity ($TCEBPN_{b,i}$)** | **Tonnes $CO_2$** | **943 177** | **1 150 550** |
| **B-28** | **Electricity Consumed for balance of process needs ($ECBPN_{b,i}$)** | **MWh** | 1 052 653 | 1 052 653 |
| **B-29** | **Emissions Factor for Electricity Consumption $EF_{f,b}$** | **Tonnes $CO_2$/MWh** | 0,896 | 1,093 |

**Table 29. Detailed Baseline emissions estimations (before the start of Kyoto protocol crediting period)**

| ID number | Data variable | Units | 01/04/2004 - 31/12/2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| B-2 | Total $CO_2$ from Pig Iron ($TCPI_{b,i}$) | Tonnes $CO_2$ | **44 409 353** | **44 409 353** | **44 409 353** | **44 409 353** |
| B-23 | Total tones of $CO_2$ related to the balance of process need of energy required for the project activity ($TCBPN_{b,i}$) | Tonnes $CO_2$ | **1 695 420** | **1 695 420** | **1 695 420** | **1 695 420** |
| B-3 | Total Pig Iron Output ($TPII_{b,i}$) | Tonnes | 16 695 486 | 16 695 486 | 16 695 486 | 16 695 486 |
| B-30 | Total $CO_2$ per 1 tonne of Pig Iron produced ($TCPTPIP_b$) | Tonnes $CO_2$/1 t. of Pig Iron Produced | **2,762** | **2,762** | **2,762** | **2,762** |
| P-3 | Total Pig Iron Output ($TPII_{p,i}$) | Tonnes | 2 516 477 | 3 540 571 | 3 535 711 | 3 563 846 |
| B-1 | Total $CO_2$ in the project scenario ($BE_i$) | Tonnes $CO_2$ | **6 949 280** | **9 777 327** | **9 763 906** | **9 841 601** |

**Table 30. Detailed Project emissions estimations (during Kyoto protocol crediting period)**

| ID number | Data variable | Units | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| B-2 | Total $CO_2$ from Pig Iron ($TCPI_{b,i}$) | Tonnes $CO_2$ | **44 409 353** | **44 409 353** | **44 573 589** | **44 573 589** | **44 573 589** |
| B-23 | Total tones of $CO_2$ related to the balance of process need of energy required for the project activity ($TCBPN_{b,i}$) | Tonnes $CO_2$ | **1 695 420** | **1 695 420** | **1 902 792** | **1 902 792** | **1 902 792** |
| B-3 | Total Pig Iron Output ($TPII_{b,i}$) | Tonnes | 16 695 486 | 16 695 486 | 16 695 486 | 16 695 486 | 16 695 486 |
| B-30 | Total $CO_2$ per 1 tonne of Pig Iron produced ($TCPTPIP_b$) | Tonnes $CO_2$/1 t. of Pig Iron Produced | **2,762** | **2,762** | **2,784** | **2,784** | **2,784** |
| P-3 | Total Pig Iron Output ($TPII_{p,i}$) | Tonnes | 3 283 752 | 2 731 892 | 2 762 913 | 3 315 496 | 3 978 595 |
| B-1 | Total $CO_2$ in the project scenario ($BE_i$) | Tonnes $CO_2$ | **9 068 118** | **7 544 151** | **7 691 312** | **9 229 575** | **11 075 490** |

**Table 31. Abbreviations[106]**

| | |
|---|---|
| BFG | Blast Furnace gas |
| COG | Coke Oven gas |
| NG | Natural gas |
| N/A | Not applicable |
| ERU | Emission reduction unit |
| ER | Emission reductions |
| CHP | Combined heat and power |

[106] For details of data variable please see tables D.1.1.1. and D.1.1.3.