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

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Annexes

SECTION A. General description of the project

A.1. Title of the project:

Revamping of sintering and blast-furnace production at OJSC «Alchevsk Iron and Steel Works»

Sectoral scope: 9 (metallurgy).

Project Design Document Version 4
14/04/2011

A.2. Description of the project:

OJSC "Alchevsk Iron and Steel Works" (AISW) is one of the largest integrated iron and steel plants in Ukraine. It is located in the city of Alchevsk in Lugansk Oblast, Eastern Ukraine. It is part of the Industrial Union of Donbass (IUD), an industrial group that is a major shareholder in a number of metallurgical enterprises in Ukraine as well as in Poland and Hungary.

AISW produces agglomerate, pig iron, steel, rolled products. Commodity part of the plants products includes plate steel, construction section bar, square and round billets and continuously cast slabs[1].

While one of the more modern integrated steel works in Ukraine, AISW 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 the 1950s and 1960s. The plant has high energy intensity, causing significant emissions into atmosphere of greenhouse and harmful gases as well as dust.

AISW 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, blooming mill, power plant and auxiliary facilities. Before the project implementation the sintering and blast furnace production at AISW was based on old production facilities such as sinter plant, blast furnace shop and local power plant.

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, in May 2003 both enterprise and IUD Corporation have 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 2.2 times[3]).

The proposed Joint Implementation project considers complex resource-saving effect based on introduction of new sinter plant and blast furnace #2, radical reconstruction of blast furnace #1 and gradual reconstruction of the remaining blast furnaces #3, 4 and 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 AISW pig iron production to reduce consumption of coke and other fuel and materials. Some of these measures involved improvements in preparation of

[1] http://uas.ukrsteel.org/node/144
[2] The prior consideration of the project is stated by the Protocol of technical Council of the plant dated 26th of May, 2003.
[3] http://www.isd.com.ua/business/modernization/

raw materials at Sinter Plant which mainly of technological character and also connected with introduction of the new Sinter Plant that would replace the existing one.

New Sinter Plant would be a state of art metallurgical equipment comprising engineering and design achievements with automatic solutions[4] and would lead to lower fuel consumption and emission levels during sintering process. The same effect will be reached after introduction of new BF#2, which would replace less efficient existing BF production, and radical reconstruction of BF#1.

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.

The implementation of JI project requires the total investment costs of US$ 2,2 billion as described further in this PDD (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 AISW 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 the IUD and AISW to realize the similar JI project based on precedent experience[5] [6].

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[4] http://www.industry.siemens.com/industrysolutions/metals-mining/en/metals/ironmaking/sinter_plant/Pages/home.aspx

[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 & Steel Works", http://ji.unfccc.int/UserManagement/FileStorage/279ANLJMEX8HG1KT653ODRIUQZFSPY

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)	OJSC “Alchevsk Iron and Steel Works” (AISW)	No
Japan	Sumitomo Corporation	No
Spain	Endesa Carbono, S.L.	No
The United Kingdom of Great Britain and Northern Ireland	CF Carbon Fund II	No
The Netherlands	Stichting Carbon Finance (SCF) - *on behalf of the Netherlands*	No
Spain	Stichting Carbon Finance (SCF) - *on behalf of Spain*	No
The Netherlands	Deutsche Bank AG, *London branch*	No

A.4. Technical description of the project:

A.4.1. Location of the project:

The project is located in the town Alchevsk in Ukraine, 48°28′0″N latitude and 38°48′0″E longitude.

A.4.1.1. Host Party(ies):

Ukraine

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

Lugansk Region

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

Alchevsk

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

Alchevsk is a town in Lugansk region subordinate and one of the biggest industrial centers of the Lugansk and Donbas regions. It is situated in the northwest of the Lugansk region, 45 kilometers from the city of Lugansk itself. Alchevsk was founded in 1896. It has a territory of 50 square kilometers and a population of 118 ths. people.

Figure 1. Location of proposed JI Project site, Alchevsk Iron and Steel Works.

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) technological improvements of blast furnaces operation; 2) reconstruction of BF shop with an introduction of the new blast furnace #2 that will displace pig iron production at the remaining blast furnaces #3, 4 as well as modernization of secondary power facilities at the site; 3) modernization of sintering process with an introduction of the new Sinter Plant.

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

Table 1. JI Project Implementation Schedule

Phase	*Measures*	*Invest-ments, mio. USD*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
1	**Technological improvements of the BFs operation**		■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Installation of pulverized coal injection (PCI) facility at BF # 1	71,63[7]					■	■	■							
	Installation of PCI facility at BF # 5						■	■	■							
	Installation of PCI facility at BF # 3, 4	19,37[7]					■	■	■	■	■	■	■	■	■	
	Installation of PCI facility at BF # 2	41,80[7]									■	■	■	■		
2	**Reconstruction of the BF shop**															
	Renewal and reconstruction of BF # 1	55,6[8]		■	■	■	■									
	Renewal and reconstruction of BF # 3	16,7[9]											■	■	■	
	Renewal and reconstruction of BF # 4	16,7[9]										■	■	■		
	Renewal and reconstruction of BF # 5	16,7[9]				■	■	■	■	■	■					
	Construction of the BF № 2	609,84[10]					■	■	■	■	■	■	■	■		
	Reconstruction of the oxygen unit № 4	18,9[8]			■											
	Installation of the oxygen unit № 7	196,49[11]					■									
	Installation of the oxygen unit № 8							■	■							
3	**Modernization of the sintering process**															
	Construction of a new sinter plant	1 091,40[12]					■	■	■	■	■	■	■	■	■	■
	Construction of new lime kilns	40, 7[13]			■	■	■	■	■	■						
	Total	2 195,83														

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.

[7] Feasibility study "Pulverized coal injection at BF № 1, 2, 3, 4, 5".
[8] The document "Chronology of construction works at AISW 2003-2009"
[9] The precise investment will be shown at later stage of feasibility study completion.
[10] Memorandum, project title "OJSC "Alchevsk Iron and Steel Works". Reconstruction of the BF shop with the construction of BF № 2".
[11] Memorandum, project title "OJSC "Alchevsk Iron and Steel Works". Air separation shop with the productivity of 120,0 ths. m³/h. of oxygen".
[12] Feasibility study "Introduction of a new sinter plant".
[13] Program of reconstruction and financing of AISW

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.

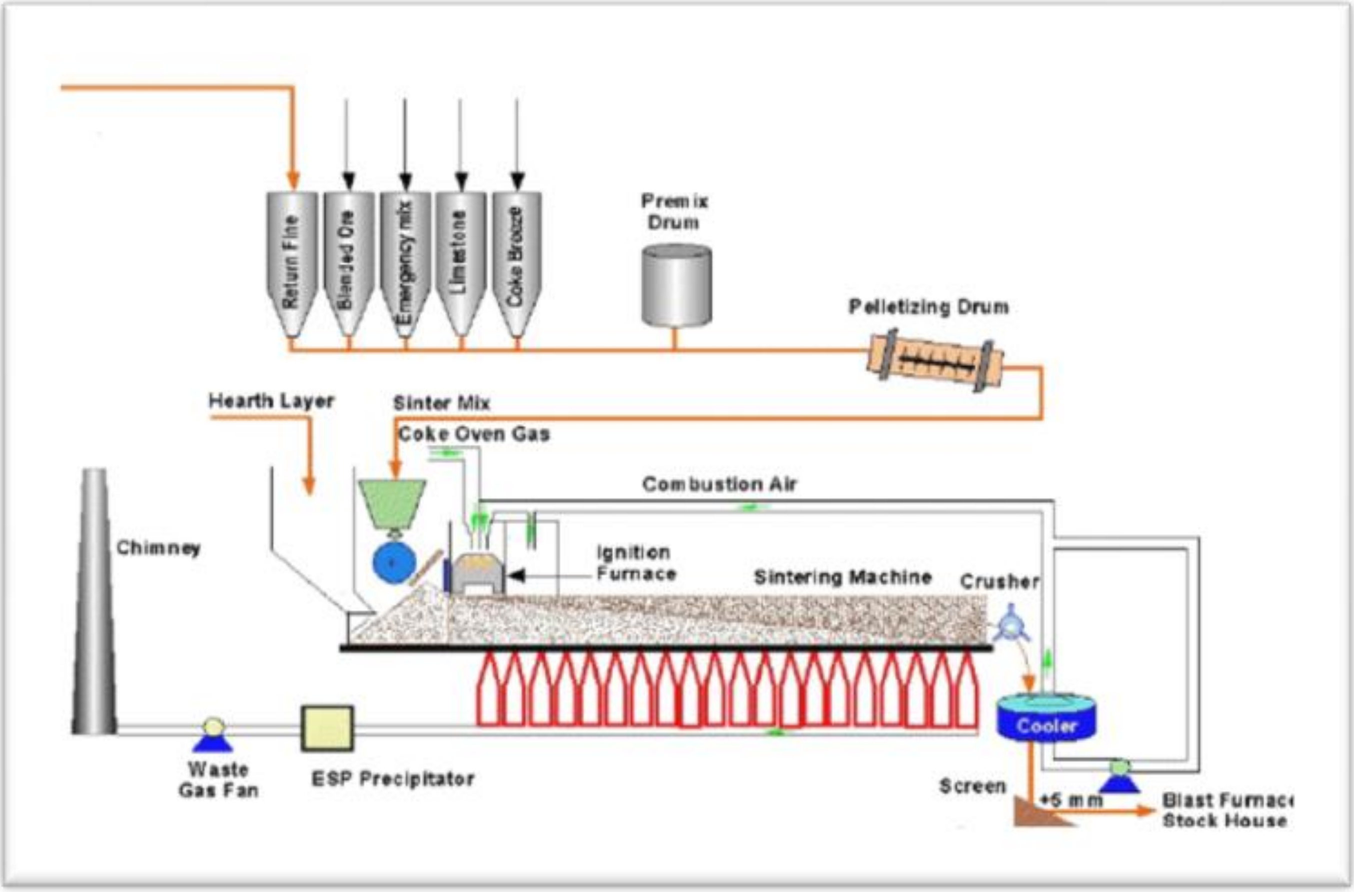

Figure 2. Principal process description of sintering production

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.

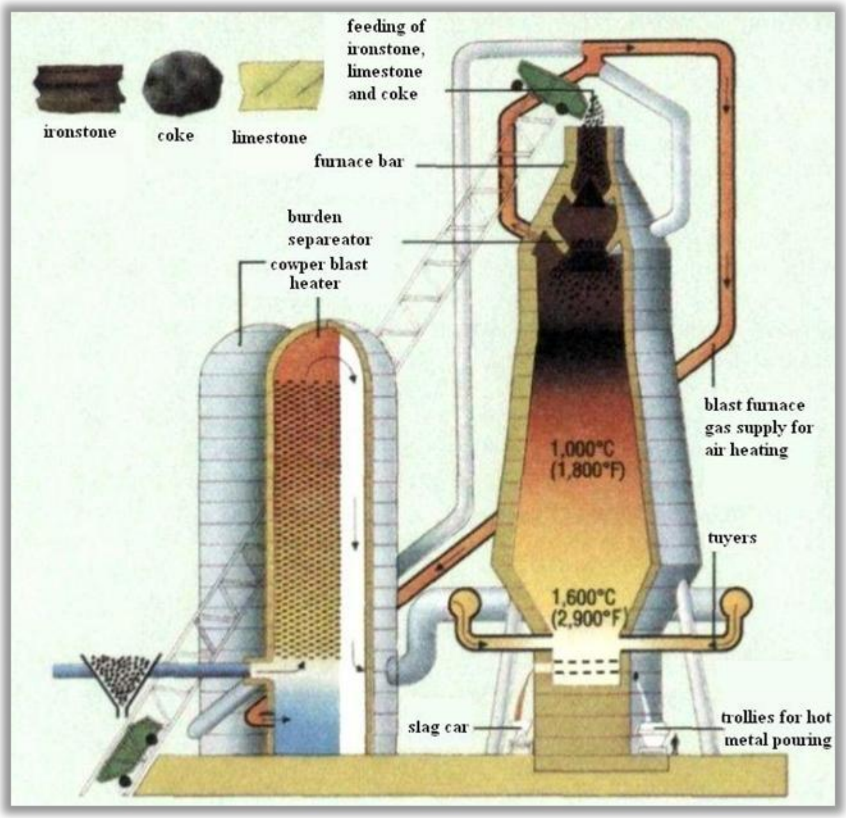

Figure 3. The general scheme of blast furnace process

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:

$3Fe_2O_3 + CO = CO_2 + 2Fe_3O_4$	Begins at 450 °C;
$Fe_3O_4 + CO = CO_2 + 3FeO$	Begins at 600 °C;
$FeO + CO = Fe + CO_2$ or	
$FeO + C = Fe + CO$	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 AISW is planned to be performed within certain time periods (see Table 2).

Table 2. Maintenance timing. Source: "Maintenance and equipment repair"[14]

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 improvement of coke quality, in particular, of its fraction content, hardness, abrasion, ash content, sulphur content etc., influence directly on reduction of coke consumption and increase of productivity of BFs, as it can be seen from the table 3, Section A.4.3.

Measures on improvement of BF coke quality are implemented at the plant since the second half of the year 2003, Starting from the year 2007 AISW consumes coke of dry quenching from CDQ facility of OJSC "Alchevskkoks". The experience of dry coke usage has showed its positive influence on energy intensity of pig iron process. However due to the calculations of dry coke impact on emissions of greenhouse gases in another JI project UA1000130[15], this part of project activity will be taken into account only in a way that would exclude possible double counting of the emission reductions, for instance in the cases that imply imports of dry coke or coke of better quality outside of the mentioned JI project boundary. In order to assure that no double counting is in place, the proposed JI emissions reductions will deduct the emissions reductions from the other JI project.

Currently coke at AISW is supplied exclusively by OJSC "Alchevskkoks". However, AISW is planning to receive coke of better quality also from other sources. This would lead to better efficiency of BF operation.

[14] The following document is available at AISW
[15] http://ji.unfccc.int/JIITLProject/DB/1D4N29Y8OQJEF2BPYY0WSRW4WWDWGT/details

The improvement of BF coke quality is not monitored directly within proposed project activity as utilization of coke of better quality leads to changes in specific rates of coke consumption and productivity of BFs, which are monitored according to the monitoring plan.

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.

The average silicon content in the pig iron before the project implementation was 1.04%, but after project activities implementation it decreased to 0.72%[16]. The decrease of silicon content in pig iron is caused by improvement of pig iron process and modernization of BFs.

This measure is gradually implemented in the period from 2nd half of the year 2003 to 2012.

Decrease of silicon content in pig iron is not monitored directly within the proposed project activity as it leads to changes in specific rates of coke consumption, other energy resources and BFs productivity, which are monitored according to the monitoring plan.

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

This measure is implemented since 2nd half of the year 2003.

The decrease of BFs idle times and downtime is not monitored directly within the proposed project activity as it leads to changes in specific rates of coke consumption and productivity of BFs, which are monitored according to the monitoring plan.

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 the 2nd half of the year 2003 to 2012.

The measure is not monitored directly within the proposed project activity as it leads to changes in specific rates of coke consumption and productivity of BFs, which are monitored according to the monitoring plan.

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[16] The data can be provided additionally upon request to AISW.

Improvement of the quality of agglomerate

From the beginning of the proposed project activity AISW has started implementation of measures on improvement of agglomerate quality by improvement of its production technology.

The quality 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. Nevertheless the positive impact of better strength of agglomerate can be witnessed by the BFs operators. AISW 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 3 of the project activity.

This measure is not monitored directly within the proposed project activity as it leads to changes in specific rates of coke consumption and productivity of BFs, which are monitored according to the monitoring plan.

Replacement of coke by natural gas and coal

Due to high consumption of coke in the BFs, AISW 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 #1, 2, 3, 4 and 5. The technology is supplied by Kuttner company[17] (Germany). Technological scheme of the PCI implies injection of fine coal into blast furnaces instead of coke and natural gas.

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.

The overall efficiency of PCI facilities is 170 t/h of pulverized coal. The total expected output of PCI is 1553 ths. t/year or 1322 ths. t/year if using coal K(HGI)=50.

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.

This measure is not monitored directly within the proposed project activity as it leads to changes in specific rates of fuel and energy resources consumption and productivity of BFs, which are monitored according to the monitoring plan.

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, Table 3).

The enrichment of BF blowing is not monitored directly within the proposed project activity as it leads to changes in specific rates of fuel and energy resources consumption and productivity of BFs, which are monitored according to the monitoring plan.

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

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 plan.

2. Reconstruction of the BF shop

Pig iron production at AISW 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 AISW involves rather high coke consumption rate. Before the project activity this level could reach 580 - 600 kg/t[18]. Therefore AIWS considered seriously how to decrease specific coke consumption rate to much lower levels often below 500 kg/t during project activity. Within project activity AISW has reached the average annual coke consumption 495 kg/t[19] during the 2nd half of the year 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 AISW is planned in the way that was described above according to the schedule.

The reconstruction of the BF Shop envisages such measures as:

a) introduction of the brickwork of the furnace’s stack and hearth made from composite refractory body (Si-SiC-Al_2O_3). This measure directed to the decreasing of the heat losses from the hearth, adjustment of the heat balance of the furnace and coke savings as a consequence. In addition introduction of the new brickwork’s materials will prolong lifetime of the furnace in compare with regular materials used in Ukraine;

b) 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;

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

Within project activity envisaged introduction of two oxygen units (#7 and #8) by Air Liquide[20] company (France) with total output 60,0 ths. nm³/h of oxygen each and reconstruction of the existing oxygen unit #4.

Oxygen unit #4 was reconstructed in 2005, oxygen unit #7 was introduced in 2008 and oxygen unit #8 in 2009. Introduction of new units and reconstruction of oxygen unit #4 allowed to reduce energy consumption in the blast furnace shop and also increase pig iron production productivity. AISW plans to increase the rates of oxygen injection into the blast furnaces during the project activity.

d) introduction of the automatic and control systems in order to control and manage:
- BFs;
- tuyere failure;
- gas flow;
- BF gas purification;

[18] As per 1998 – 2002. The data can be provided additionally upon request to AISW.
[19] The data can be provided additionally upon request to AISW.
[20] http://www.airliquide.com/

- temperature field on the charging materials;
- cooling system of the furnace's stack;
- heat load at heat exchangers at hearth;
- charging process.

Also within project activity envisaged introduction of new BF#2 of Danieli Corus with the following techical parameters:

- net volume – 4445 m^3;
- pig iron output – 3750 ths t/year;
- nominal BF operating time, day – 360;
- the share in iron ore part of the mine, %
  - of agglomerate – 10/50;
  - of pellets – 90/50;
- temperature of blowing, C° - 1250;
- slag volume, kg/t – 370;
- output of BF gas, m^3/t - 1510
  including for heating of stoves, m^3/t – 640;
- coke oven gas consumption for stove, m^3/t – 15.

Within the plan of revamping of the plant, BF#2 will further substitute BF#3 and #4. Introduction of BF#2 will lead to further reduction of coke consumption and also facilitate to injection of auxiliary fuels such as pulverized coal as replacement of metallurgical coke. New BF #2 will satisfy even strictest environmental and safety requirements. More detailed information regarding the blast furnace is given at the web site of supplier[21].

The BF shop of AISW currently consists of four BFs with net volume: BF#1 (modernized) – 3000 m^3, BF#3 – 1386 m^3, BF#4 – 1386 m^3, BF#5 – 1719 m^3.

It should be noted that legislation of Ukraine does not require an obligatory reconstruction of blast furnaces. Nevertheless AISW has realized already a radical reconstruction of BF#1 and already invested around 15 to 20% into new BF #2.

BF #1 at AISW is considered to be the most modern in Ukraine. The furnace is equipped with secondary dust suppression, which appears in the works at the site where ore is stored, in closed and open conveyors, cargo bins. Moreover dust capture facility is applied at the furnace with the aim to achieve the output performance of secondary purification system with dust emissions not more than 15 mg/m^3, 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. Emission reduction is achieved by using special devices installed with the system of disposal of harmful emissions. Overall dust emissions at the site of BF #1 should not exceed 50 mg/m^3.

Reconstructions of BFs #3, 4, 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. The impact of the reconstruction of the BF shop on specific rates of energy and fuel resources consumption, in particular coke, will be monitored by the parameters specifically determined in the monitoring plan.

3. Modernization of sintering process

Currently AISW uses a sinter plant which was built in 1959-1961 and is consisting of six sintering machines with sintering area of 89,6 m^2 and cooling zone of 84,0 m^2 each, facilities for receiving materials, its preparation and transportation. Designed capacity of sinter plant is 5400 ths t/year of cooled agglomerate.

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[21] http://www.danieli-corus.com/media/Stoves.pdf

The program of revamping of the plant envisages the introduction of new Siemens - VAI sinter plant with total output of 11,5 mio t/year of agglomerate, consisting of two sinter machines with the following technical characteristics each:
- width of the pallet - 4,5 m;
- speed of sinter machine - 0,5 ÷ 6,0 m / min;
- layer height – 600 mm;
- sintering area - 477 m^2.

After sintering machines, sector mills for hot agglomerate will be installed. Crushed to a size of 200 mm sinter fully loaded in the cooling ring. Cooling of hot sinter will be realized on a cooling ring (Simens -VAI) with the following technical specifications:
- average diameter - 35 m;
- width of the gutter - 4,6 m;
- height of material layer- 1500 mm;
- cooling surface - 431 m2;
- the temperature of the cooled sinter – less than 140 º C.
Each sinter machine will be equipped with a cooling ring.

With the introduction of new sinter plant of Siemens VAI the following benefits will be achieved[22]:

a. low electrical energy consumption even when the sinter machine is operated with high bed height;
b. low solid fuel and energy consumption because of the best fuel distribution;
c. stable high sinter quality;
d. lower coke consumption in blast furnaces because of better quality of agglomerate;
e. 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 switchboard incandescent lamps with modern LED;

[22] http://is.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/SinterSolutions_en.pdf

- 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;
- replacement of electric motors drive of vane with high speed electric motors (from 750 rpm to 1000 rpm). As a result, time of vane transfer will be decreased.

JI project maintenance will be in accordance with national requirements and AISW internal routines with technical support on the part of Siemens VAI, Danieli Corus, Kuttner and other technology suppliers.

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.

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

It should be noted that factors presented in the Table 2 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[23].

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

A.4.3.1. Estimated amount of emission reductions over the crediting period:[24]

In the proposed project activity the crediting period starts from the 1st of April 2004, after Ukraine's ratification the Kyoto protocol to the United Nations Framework convention on climate change.

	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	1 101 687
2005	1 631 070
2006	1 859 951
2007	1 890 486
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**6 483 194**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 620 798

[23] http://ukhin.org.ua/index.php?option=com_mtree&task=viewlink&link_id=456&Itemid=3
[24] Project emissions, baseline emissions together with 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 Accredited Independent Entity.

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	1 936 298
2009	1 781 724
2010	1 256 751
2011	1 353 792
2012	1 353 792
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**7 682 357**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 536 471

Period following first commitment period of Kyoto Protocol[25]

	8 Years
Length of the crediting period	
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2013	1 427 637
2014	1 427 637
2015	1 427 637
2016	1 582 711
2017	1 582 711
2018	1 582 711
2019	1 582 711
2020	1 582 711
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**12 196 464**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 524 558

A.5. Project approval by the Parties involved:

The project has already received Letter of Endorsement (LoE) from the Government of Ukraine #1806/23/7 of 09.11.2010 issued by the National Environmental Investment Agency 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. The LoA of a foreign government is usually provided within 30 days along with a positive determination report. It is expected that LoA of a foreign government will be provided by the Government of Japan (The Liaison Committee for the Utilization of the Kyoto Mechanisms), by the Government of Spain (Ministerio de Medio Ambiente, Medio Rural y

[25] In case the period will be changed by UNFCCC or by the Government of Ukraine, it will be indicated in the monitoring reports.

Marino Oficina Española de Cambio Climático), by the Government of the Netherlands (Ministry of Economic Affairs) or by the Government of the United Kingdom of Great Britain and Northern Ireland (Department of Energy and Climate Change (DECC).

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[26] and the JISC "*Guidance on Criteria for Baseline Setting and Monitoring*". No applicable approved CDM methodologies are available for this project; however, JI Project "Energy Efficiency measures at the "Public Joint Stock Company Azovstal Iron and Steel Works"[27] has been submitted to the accredited independent entity (AIE) in 2010 and already passed a positive determination and received a letter of approval from the Government of Ukraine. It is assuming implementation of technological measures to improve the energy efficiency of blast furnace production as well as its modernisation. This may be treated as similar to the proposed project, therefore its approach can be fully applied to the project in question. Besides, in terms of methodological approach, the proposed project is fully identical to the relevant part of the project registered at UNFCCC with reference number UA1000022[28], 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. However, in the project UA1000022 the specific energy consumption by all assets that are also covered by the proposed project is the same in order to avoid double counting of the ERs.

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 and refers to the AISW 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.

Substep 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 19th century.

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[26] Decision 9/CMP.1 Conference of the Parties serving as the Meeting of the Parties of the Kyoto protocol 30th of March 2006

[27] http://ji.unfccc.int/JI_News/issues/issues/I_6O4WUKCQKHSADTWQV0BD8XZ3U0RLO6/viewnewsitem.html

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

At the time of investment decision, i. e. in 2003, AISW had three 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 No. 1: Preservation of the situation existing prior to the project:: continuation of sinter plant and BFs operation without reconstruction and introduction of new technology;
Alternative No. 2: Revamping of sinter plant and all the blast furnaces without carbon financing;
Alternative No. 3: Realisation of projects on the not blast-furnace iron-making plants at AISW.

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 No. 1: Preservation of the situation existing prior to the project:: continuation of sinter plant and BFs operation without reconstruction and introduction of new technology.

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[29]. These reasons have also hampered AISW 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, which envisaged insignificant investment due to maintenance and equipment repair which is within usual practice of the plant, 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 IUD and Ukraine in general. The benefits for the project owner include (i) insignificant capital expenditures due to maintenance and equipment repair, (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, five previous consecutive years before reconstruction start were have been chosen for establishing the baseline. The average data for the 5-year period should be enough to equal the impact of regular maintenance and working renewal of the steel facilities. Therefore the considered alternative does not face any barriers.

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

Alternative No. 2: Revamping of sinter plant and all the blast furnaces without carbon financing.

The project activity includes reconstruction of all the BFs, SP and secondary power generation facilities at the AISW as well as introduction of the new SP and BFs.

In 2003, 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)[30].

The project activity is itself an integrated energy efficient programme aimed at reduction of energy consumption per tonne of pig iron produced. This can not 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 AISW at the beginning of the project implementation and moreover the global crisis whose effects were particularly acute for the whole Ukrainian iron and steel sector, a project requiring the total investment of US$ 2 billion would be hard to accomplish, given its current status (see 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.

Alternative No. 3: Realisation of projects on the not blast-furnace iron-making plants at AISW.

In general there is an option to replace blast furnace production and therefore also influence on sintering production.

This option is related to the construction of industrial plants for production of reduced iron by Midrex or similar technology. However this option is not fully realistic for the AISW because the Steel Mill does not have its own access to iron ore resources and fully relies on market condition. The recent problems with iron ore supply have shown the extreme volatility of such a decision upon market conditions. Additionally such a decision could require a significant portion of investments estimated at around more than US$3 billion. In Ukraine so far no company has been able to overcome such investment barriers. The declared project activity by OJSC “Vorskla Steel” in a construction of Midrex-based furnaces has been suspended for an indefinite time. Moreover new technological decisions like not blast-furnace iron making require a replacement of the established logistical scheme which is additional risk for AISW. Therefore the switch to the new steelmaking technology based on Midrex technology can not be considered as baseline scenario due to a number of mentioned obstacles.

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 No. 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 CO_2 emissions related to this scenario is accounted for; its monitoring is performed as part of detailed monitoring of steelworks processes required for the AISW 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 #3 was the least feasible among all 3 alternatives because it required huge investments and complete change of logistical scheme. Alternative #2 presents the project scenario and in comparison with Alternative #1 that is the baseline required significantly more

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

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.

Consistency with mandatory applicable laws and regulations.

As it was also mentioned above the 2^{nd} half of the year 2003 was selected as the year when the investment decision was made. All the listed alternatives in the year 2003 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) 5 year base period from 1998 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;

d) AISW faced no difficulties with supply of raw materials such as ore and coal (as is the project period, especially from 2008).

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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{f,b}$[31] (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 AISW average data
Source of data	AISW average data IPCC 1996 Potentially measured by AISW laboratory or local fuel distributor
Parameter value (for indicative calculations/identification)	See Table 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 AISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[32] Net calorific value is anticipated at nearly 32,892 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,836 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
Quality assurance and control procedures	See Section D.2.
Note	

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 AISW
Parameter value (for indicative calculations/identification)	See Table 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.

[31] For more detailed information please see Annex 2.
[32] In case if the data regarding net calorific value for mentioned above fuels will be available at AISW 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	$EF_{e,b}$ (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 Table 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[33]. 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[34]. 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	

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

Key Variables/Parameters	$Q_{fio,b}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fio) used in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECIO_b$
Measuring unit	MWh
Description	Electricity consumed in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{ra,b}$[35]
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 IPCC 2006 Potentially measured by AISW laboratory
Parameter value (for indicative calculations/identification)	See Table 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). 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). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	This PDD uses default factors: For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne; For coal the anticipated factor is 2.5 tonnes CO_{2e}/tonne. 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

[35] 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{oi,b}$[36]
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 Table 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). 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 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite.

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

Key Variables/Parameters	$Q_{fbpn,b}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fbpn) used for balance of process needs
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECBPN_b$
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 AISW
Parameter value (for indicative calculations/identification)	See Table 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:

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 based on the latest version (version 05.2) of the Tool for the Demonstration and Assessment of Additionality approved by CDM Executive Council and accordingly may be fully applied to Joint Implementation Projects.

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

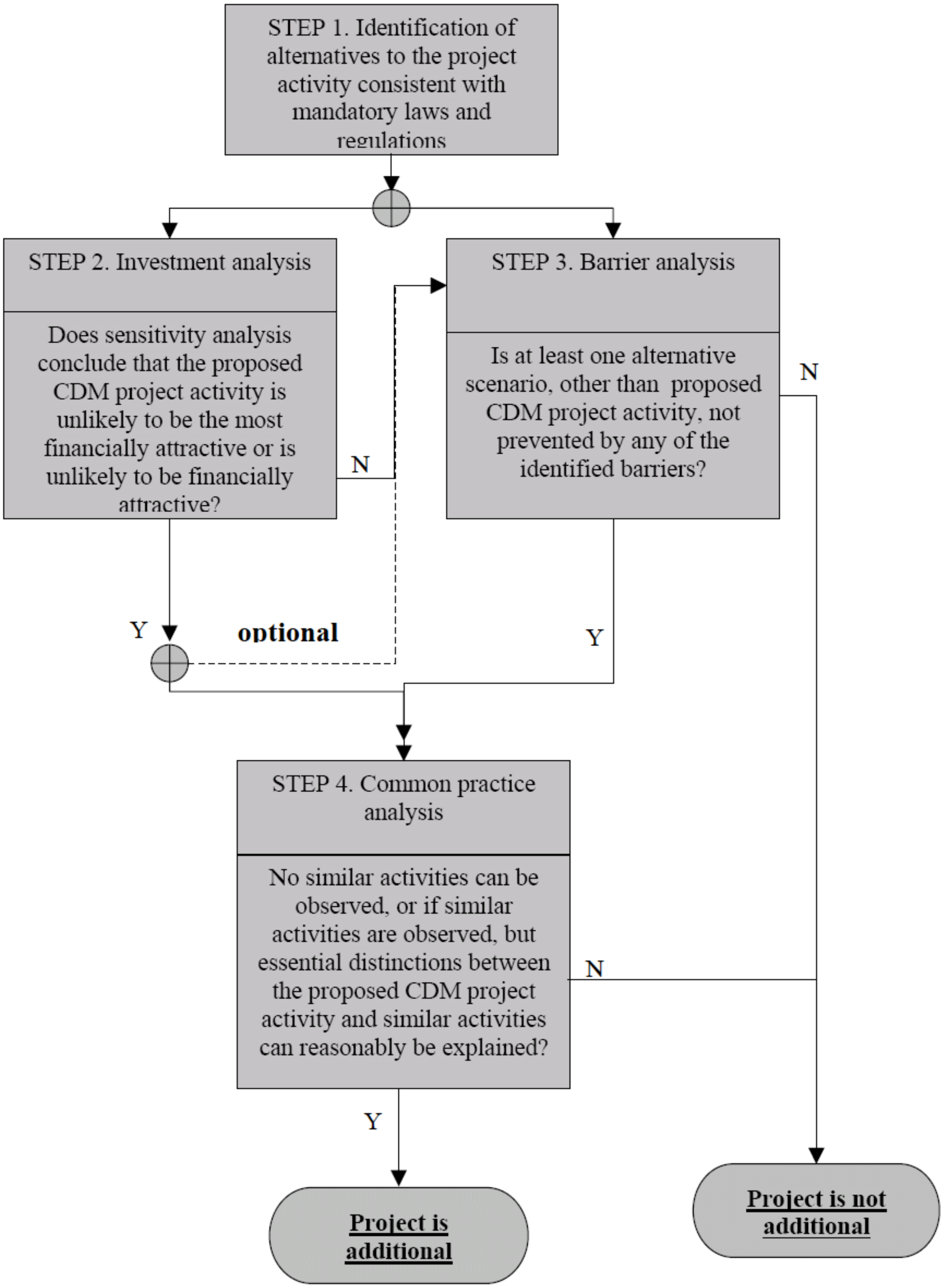

Figure 4. JI Project Additionality Scheme Defined in the Tool for the Demonstration and Assessment of Additionality (version 05.2)

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 No. 1: Preservation of the situation existing prior to the project: continuation of sinter plant and BFs operation without reconstruction and introduction of new technology;
Alternative No. 2: Revamping of sinter plant and all the blast furnaces without carbon financing;
Alternative No. 3: Realisation of projects on the not blast-furnace iron-making plants at AISW.

As it was mentioned in Section B.1 the alternative No.3 is not fully realistic for the AISW due to high capital expenditures and logistical risks, also the plant does not have its own access to iron ore resources, which makes this alternative the least credible one. Therefore, only alternatives No.1 and No.2 shall be selected to demonstrate additionality of the project.

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[40]. 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.

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.

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

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed JI project activity:

Investment Barriers

Below are described investment barriers that prevented the implementation of the proposed JI project activity:

1. Adverse financial situation of AISW

In 2003, when the investment decision was taken the project could not receive any financial grant support from any financial institution or national financing programs due to a number of reasons. Firstly, the capitalization of AISW was very low and general economic situation in Ukraine remained to be poor. Also AISW was in a difficult situation as the bankruptcy procedures had began towards the enterprise[41]. This means that a high priority for the enterprise was a satisfaction of creditors' demands rather than investment in technical revamping. In 2003, AISW had significant bill payable, meaning that at the beginning of the project realization AISW was in lack of working capital, therefore the enterprise was forced to use short-term borrowed funds[42], which under precedent conditions were dramatically rising in price. Moreover, only few banks were willing to provide the funding in smaller amounts due to bankruptcy proceedings that were raised against the enterprise.

At the same time in 2003 IUD Corporation, together with AISW achieved the closure of the bankruptcy case by decision of Economic Court of Lugansk region. Despite this, the court applied to the process of reorganization towards the enterprise[43]. This improved credit capacity of the enterprise; however, obtaining a credit was still virtually impossible.

Moreover, at the time the investment decision was made, AISW also needed financing for other measures related to modernization of the enterprise[44] (the modernization plan of the enterprise had become the largest in Ukraine[45] and involved a large number of investments, over $ 1 billion). As of 2003, Ukraine's domestic financial market was too weak to support a project of a similar level of magnitude. No Ukrainian bank was able to fund a like project on its own. The similar situation is typical for Ukraine even today. Therefore, investment partnerships were used as the common approach to investment projects financing at industrial ventures.

2. Backwardness of the Ukrainian Domestic Financial Market

As of 2003[46] and until now Ukraine is considered to be a high risk country for doing business and investing in. Almost no private capital is available from domestic or international capital markets for mid to long term investments, and any capital that is available has high cost.

Ukraine has relatively high price of credit resources which was[47] and is much higher than in other countries with full metallurgical cycle. At the time the investment decision was made interest rates were over 17,89% in hryvna-denominated loans[48] in part because of credit risk, and in part because of banks high operating costs[49], while in Europe interest rates were 2,21% in euro-denominated loans[50].

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[41] http://region.isd.com.ua/press/publications/?id=322
[42] http://www.smida.gov.ua/emitents/zvit_menu.php?kod=05441447&year=2003&forma=BUS_TEXT&zvit_type=vat194
[43] http://region.isd.com.ua/press/publications/?id=322
[44] http://ji.unfccc.int/JIITLProject/DB/V75OZ8TQOFTB325LEDMXE2628ZD548/details
[45] To date the modernization of AISW is considered to be the largest investment project in Ukraine since its independency.
[46] "The Investment Climate for Climate Investment: Joint Implementation in Transition Countries", Jan. 2003. This report ranks 13 European transition countries as to their investment climate and associated business risk of doing business in the countries. In this report, Ukraine is ranked as the last country in regards to investment climate and business risk.
[47] http://www.imf.org/external/pubs/ft/scr/2003/cr03340.pdf
[48] http://www.tradingeconomics.com/ukraine/lending-interest-rate-percent-wb-data.html
[49] http://www.imf.org/external/pubs/ft/scr/2003/cr03340.pdf
[50] http://www.euribor-rates.eu/euribor-2003.asp

In general in 2003 the enterprise sector of Ukraine was weak. Inadequate accounting standards in enterprises hindered the evaluation of creditworthiness. Corporate governance was acknowledged to be non-transparent and open to abuse. The overall framework for creditors' rights and insolvency in Ukraine has improved in recent years, but continues to be weak.

The current legal basis is not only inadequate, but to a large extent it sabotages the development of market economy in Ukraine. Frequent and unpredictable changes in the legal system along with conflicting and inconsistent Civil and Commercial Codes do not allow for a transparent and stable enforced legal business environment, especially when it comes to VAT returned etc. This is perceived as a great source of uncertainty by international companies, which make future predictions of business goals and strategy risky.

Furthermore, the impact of global economic crisis influenced significantly on possibility of AISW to continue and accomplish the project. During the years 2008-2009 AISW experienced net loss in amount of UAH 1 240,5 mln. and also had negative EBIT – UAH -455.9 mln[51]. Investment environment that developed by 2010 was and continue to be unstable and hampered the improvement of the Ukraine's investment ratings and the country's ability to attract enough direct foreign investments in its economy to be able to borrow from International Financial Institutions. AISW, as part of IUD, was unable to take new loans amid financial and economy hurdles, neither in the form of project finance nor as a way to make up its operating capital requirements. Furthermore, global crisis prevented IUD from achieving access to international capital markets (by way of Eurobonds issue). The situation caused inability of IUD to complete several initiated JI projects at other sites.

3. IUD Low Credit Rating

At the beginning of 2005, IUD management launched preparation of company financial accounts under International Financial Reporting Standards (IFRS)[52], typically required from companies seeking international funding. This gave the Corporation an opportunity to attract loans for profound modernisation much needed by Group's key enterprises, but as economy crisis unfolded, debt became unavailable; besides IUD's credit portfolio was so large it could not be expanded any further.

In 2007, Moody's rated IUD at "B1" (corporate) for its foreign and local currency liabilities[53]. The same year, the company was rated by Fitch Ratings at "B+" for long-term issuer default rating (IDR) and "B" for short-term IDR[54]. During 2008 Fitch Ratings has lowered long-term issuer default rating (IDR) of IUD Corporation from "B+" to "B," keeping the negative forecast[55]. "B" group of ratings means presence of certain credit risk, namely company's weakened ability to favor its financial liabilities and, as the result, likely default on its financial covenants. The downgrading of the long-term IDR was caused by a 50% reduction of the company revenue and EBITDA resulting from reduced output and price against the backdrop of the global economy decline and potential volatility of the demand and prices for steelmaking products[56].

In early 2009, IUD's ratings were dramatically downgraded. Namely, Fitch Ratings reduced its long-term IDR from "B" to "B–"[57]. At the same time Moody's revoked the IUD's "B1"corporate rating as, according to this agency's classifications, securities and issuers rated "B" are considered too risky for long-term investments[58]. However, the rating is known to have been revoked upon IUD's request for business reasons. It should be added that sovereign rating of Ukraine was downgraded by Fitch Ratings from "BB–" to "B+" during the same period. The short-term IDR was confirmed at "B". As mentioned above, "B" ratings suggest presence of certain credit risk against limited safety margin. On the other hand, high credit ratings increase value of private sector entities such as AISW[59].

[51] http://www.stockmarket.gov.ua/ua_UA/year_2010/showform/55/55289
[52] Ernst &Young, Special Auditor Report of Preliminary IFRS Consolidated Financial Accounts
[53] http://www.ukrrudprom.ua/news/5412457887545778.html
[54] http://www.fitchratings.ru/issuers/_sub/news/newsrelease/news.wbp?article-id=55881BA0-E58B-4EE9-95BC-D9420E948408
[55] http://delo.ua/biznes/kompanii/moody-otozvalo-rejting-isd-104649/
[56] http://www.cbonds.info/ua/rus/news/index.phtml/params/id/416644
[57] http://delo.ua/biznes/kompanii/fitch-ponizilo-i-otozvalo-isd-104261/
[58] http://delo.ua/biznes/kompanii/moody-otozvalo-rejting-isd-104649/
[59] http://delo.ua/biznes/ukraina/fitch-ponizilo-nacionalnyj-rejting-ukrainy-101002/

All these factors contributed to low credit attractiveness of the project in 2003 – 2010 and created major barriers before the efforts to raise long-term funding needed to complete the project.

Accordingly, under the circumstances the need to raise nearly US$ 3 billion[60] in debt was a significant barrier on the way of the project realisation (one of the largest private projects in Ukraine). Integration of the potential ERU revenue component was for the company the only opportunity to finalise the project. In this respect, this JI project can be considered financially additional since the JI project activity will bring in the investment portion needed to actually implement the project.

As of 2010 the project is uncompleted, only relatively small portion of investments has been mobilized, all mentioned above obstacles were preventing the accomplishment of the project.

<u>Technological Barriers</u>

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.

At the moment of the project decision was taken, other enterprises of Ukraine had never introduced such a wide-scale program of modernization. Actually IUD Corporation became the first in Ukraine to establish a program of modernization of this scale.

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. Also, only in rare cases, the introduction of dust suppression facilities was done. AISW has widely introduced such technologies.

For the first time in Ukraine project envisaged the introduction of new sintering machines, fully modernized blast furnace etc.

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.

In spite of the fact that AISW personnel are experienced in the maintenance, it would be challenge for them to introduce modernizations and use technologies never used before. The planned modernizations which would be implemented during the regular maintenance require extra time and labor. Modernization of BFs and sinter plant could cause lower output and additional loses to AISW. 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.

[60] Taking into account 1 bio. investments needed for other measures related to modernization of the plant.

There is also 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.

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:

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, a similar project but to incomparable lower scale has been implemented only at Azovstal (some measures related to technological improvements of BFs operation and reconstruction of BF shop components of the proposed JI project) within the framework of one of the mechanisms provided by the Kyoto protocol to UNFCCC. 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 AISW 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.

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, as it is required by the paragraph 14 of the Guidance on criteria for baseline setting and monitoring (version 02)[61]. With respect to organizational structure of AISW, project boundary includes directly sinter plant and blast-furnace shop together with all auxiliary power facilities of the plant. Power grid, natural gas supply network and material supplies such as coke are included to extended boundary of the project, as the proposed project activity is related with emissions which are caused by its manufacture and transportation. These emissions were taken into account in the project emission calculations with consideration of the default factors per tonne of output based on national sources or IPCC data of 1996 and 2006. Thus all CO_2 emissions related to project and baseline cases have been taken into account.

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

N_2O emissions from steelmaking process are unlikely to be significant; IPCC does not provide a methodology to calculate N_2O emissions[63]. 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

	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.

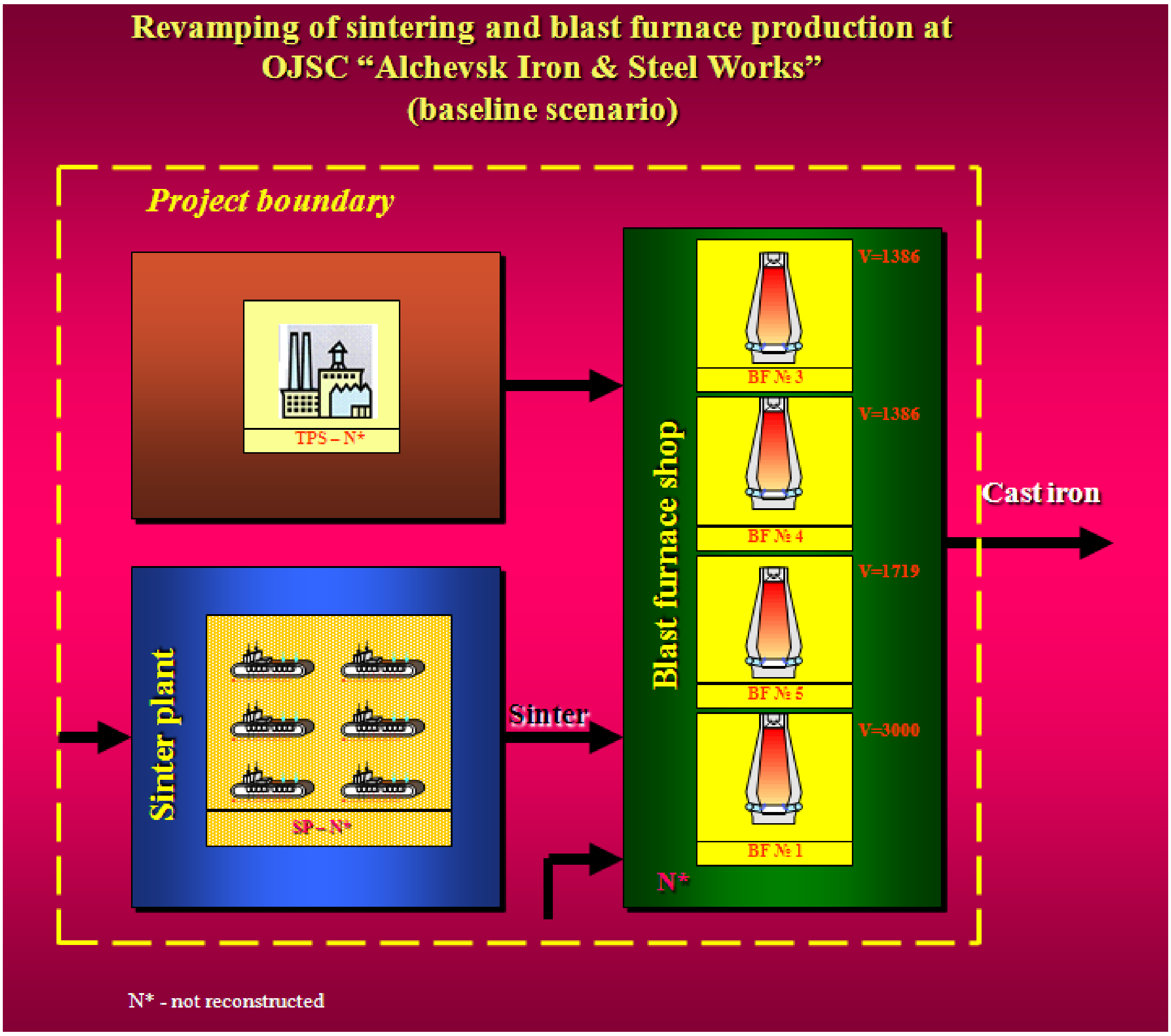
	Source	Gas	Inclusion/Exclusion	Justification / Explanation
Project Scenario	Fuels used	CO_2	Yes	CO_2 emissions will be reduced due to reduced use of fossil fuels (mainly coke).
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Electricity used	CO_2	Yes	No major change for total 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	CO_2	Yes	CO_2 emissions will be reduced due to

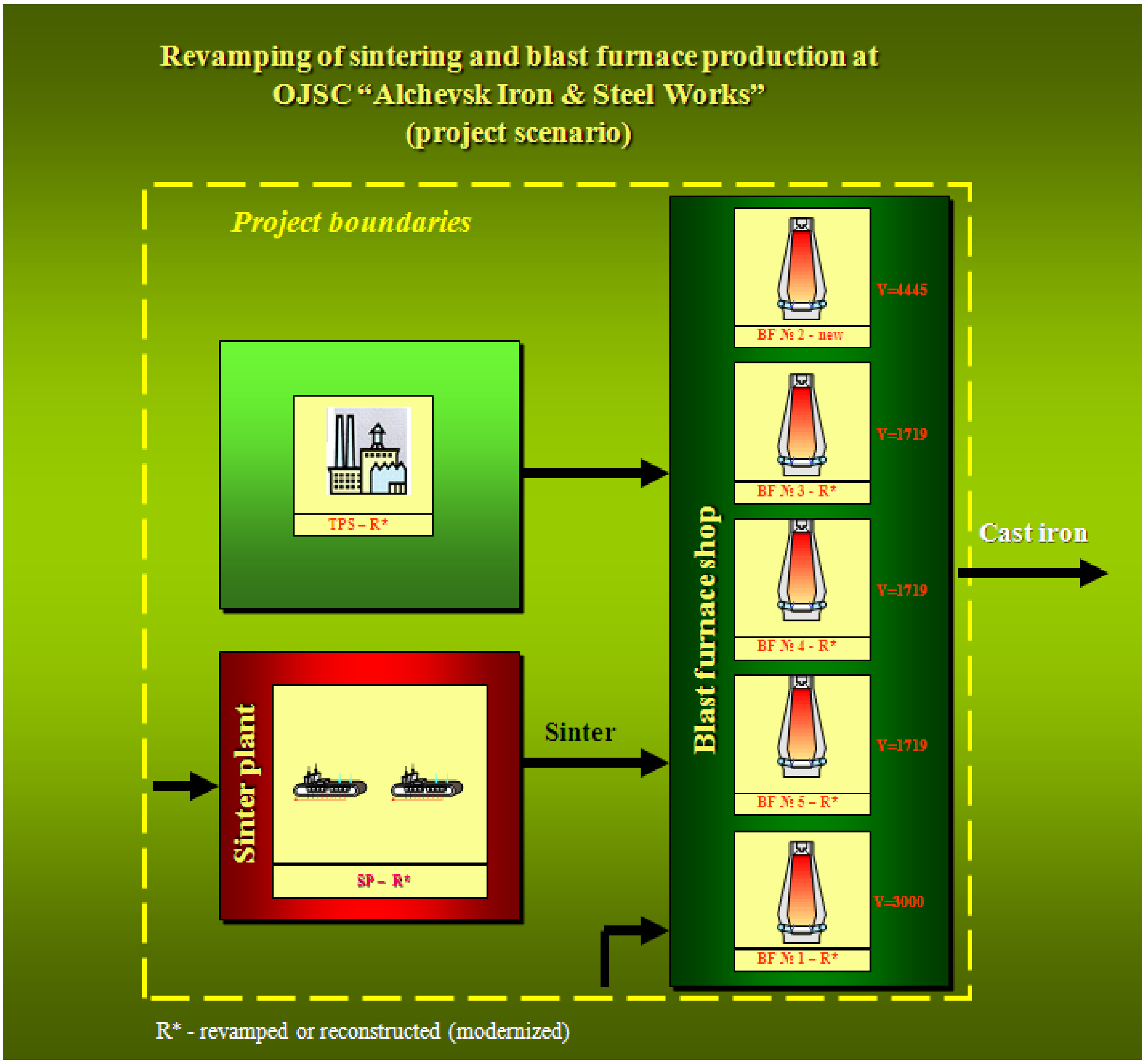
[63] IPCC 2006 "Guidelines for National Greenhouse Gas Inventories".

	part of production process			decreased use of coke
		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. This fuel mix is specific to AISW steel making process. Material inputs having impact on GHG emissions include agglomerate, coal, pulverised 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.





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 30/11/2010.

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

Mr. Vasyl Vovchak
Director
Institute for Environment and Energy Conservation, Limited
11 Kotovskogo street, Kiev 04060, Ukraine
Tel./fax: + 380 44 206 4940
vovchak@ipee.org.ua

Institute for Environment and Energy Conservation Company, Limited is a consultancy company with experience in application of the Emission Trading and Joint Implementation Mechanisms. The company is not a project participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01/07/2003[64].

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.

[64] The starting date of the project is proved by the Protocol of technical Council of the plant dated 26th of May, 2003.

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[65]. 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 requires monitoring and measurement of variables and parameters necessary to quantify the baseline emissions and project emissions in a conservative and transparent way.

1. The baseline technology with old blast furnaces and sinter plant reflects the common practice and has been successfully operated at AISW 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 5 years from 1998 and till the end of 2002. 5-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 AISW's *Guiding Metrological Instructions*. 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 to determine 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 calculated already

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

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[66].

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 historical data regarding net calorific value), default emission factor which is in accordance with IPCC 1996. To follow the conservative approach in this document, historical 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 AISW laboratory data.

8. This monitoring plan assumes accounting of all primary and secondary energy resources[67] consumed and to be consumed under the project and baseline cases. Since in the project and baseline scenario secondary energy resources will be consumed not only by major equipment but also for process support purposes, AISW will separately monitor such additional[68] secondary energy resources as blast-furnace blowing, chemically treated water and heat production, as well as compressed air, steam, oxygen, nitrogen, argon, water, air-free water and treated gas together with its transportation.

9. Step 2 “Balance of process needs” of chosen JI specific approach in PDD implies CO_{2e} emissions from such facilities as: CHP (that produces blast-furnace blowing, heat and chemically treated water), Oxygen Plant (that produces oxygen, nitrogen and argon), Compressed Air Shop that produces compressed air and other facilities that produce secondary heat power, air-free water, treated gas. These facilities consume fuel-and energy resources to ensure supply of all secondary energy resources to the technological process. Double counting is avoided.

10. Also for avoidance of double counting, the CO_{2e} emission reductions that are generated by the component three (3) of already registered JI project “Installation of a new waste heat recovery system at Alchevsk Coke Plant, Ukraine” (UA1000130[69]) will be attributed to the Leakages of GHG’s and which will be subtracted from the total volume of emission reductions associated with this project during the specific monitoring period.

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[66] If an emission factor is applied to BFG, these emissions would be double counted.
[67] Secondary energy is mainly derived from electricity to be measured directly using relevant meters.
[68] For avoidance of double counting additional energy resource consumption will be accounted net of consumption by major equipment.
[69] http://ji.unfccc.int/JIITLProject/DB/1D4N29Y8OQJEF2BPYY0WSRW4WWDWGT/details

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

Key Variables/Parameters	Data Sources
Electricity & Fuels Used	Measured
Emission Factors for Fuels and Electricity	Carbon emission factors for fuel consumption will be based on average historical data regarding net calorific value of fuel (Natural Gas) taking into account the calorific value remains practically stable with very low level of fluctuations. Such decision ensures applicability of JI specific approach. In case if it is required by verifier the actual calorific values of different fuels can be monitored and reflected in relevant monitoring reports. 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[70]. 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[71]. 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 report development. For more detailed information please also see Annex 2.
Pig iron Produced	Measured

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

Quantities of Materials Used	Measured.
Emission Factors of Materials Used	Factors will be calculated based on actual net calorific value and carbon content in accordance with governing principles for the National Greenhouse Gas Register (IPCC 1996)[72].

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

The material flows will include raw inputs of agglomerate, iron pellets as well as process inputs such as oxygen and compressed air (produced using electricity). 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. 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.

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.

[72] http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

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, e.g. oxygen is produced utilizing electricity, but Monitoring Plan takes into account the possible use of other fuels for oxygen production, depending on the market situation. 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 AISW 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.

AISW uses the accredited system of quality regulation according to the requirements of the ISO 9001:2008 standard. The Guiding Metrological Instructions were developed in accordance with 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, its calibration schedule has been verified by AIE's under the project UA1000022[73] and may be provided additionally upon request.

The monitoring procedures are quite comprehensible, because they had already been used at AISW 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.

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[73] http://ipee.org.ua/en/kyoto-protocol/projects/under-joint-implementation/69-tehnichne-pereozbrojennja-ta-modernizacija-vat-lamkr.html

The procedures of receiving data for monitoring execution and responsibility for its realization at AISW will be regulated by the normative documents of AISW and by the "Guiding Meteorological Instructions" in accordance with project documentation and monitoring plan.

The Chief Metrological Specialist of the OJSC "AISW" is in charge for maintenance of the facilities and monitoring equipment as well as for their accuracy required by Regulation PP 229-Э-056-863/02-2005 of "Metrological services of the metallurgical mills" and by "Guiding Metrological Instructions". In case of defect, discovered in the monitoring equipment, the actions of the staff are determined in Guiding Metrological Instructions. The measurements are conducted constantly in automatic regime.

Data are collected in the electronic database of OJSC "AISW" and in printed documents. 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 "Guiding Metrological Instructions" revised versions. The monitoring data reports and calculations are under the competence of the Chief power-engineering specialist assistant 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;
- the Investment Plan giving a schedule of construction activities, and
- detailed guidelines regulating the monitoring procedures and responsibilities (AISW's *Guiding Metrological Instructions*)

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

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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{f,p}$[83] (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 AISW average data
Source of data	AISW average data IPCC 1996 Potentially measured by AISW laboratory or local fuel distributor
Parameter value (for indicative calculations/identification)	See Table 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 AISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[84] Net calorific value is anticipated at nearly 32,892 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,836 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
Quality assurance and control procedures	See Section D.2.
Note	

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

[84] In case if the data regarding net calorific value for mentioned above fuels will be available at AISW 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 Table 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[85]. 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[86]. 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	

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

Key Variables/Parameters	$Q_{fio,p}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fio) used in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECIO_p$
Measuring unit	MWh
Description	Electricity consumed in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{ra,p}$[87]
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 IPCC 2006 Potentially measured by AISW laboratory
Parameter value (for indicative calculations/identification)	See Table 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). 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). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	This PDD uses default factors: For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne; For coal the anticipated factor is 2.5 tonnes CO_{2e}/tonne. 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

[87] 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{oi,p}$[88]
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 Table 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). 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 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite.

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

Key Variables/Parameters	$Q_{fbpn,p}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fbpn) used for balance of process needs
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECBPN_p$
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 AISW
Parameter value (for indicative calculations/identification)	See Table 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, dolomite, 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:

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

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 to prepare iron ore, the total CO_{2e} from the reducing agents (coke, coal etc.) and the total CO_{2e} from limestone, dolomite, pellets etc.

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

where:
$TCFIO_{p,i}$ = total CO_{2e} from fuel used to prepare iron ore, t CO_{2e}

$TCEIO_{p,i}$ = total CO_{2e} from electricity consumption in preparing iron ore, t CO_{2e}
$TCRAPI_{p,i}$ = total CO_{2e} from reducing agents, t CO_{2e}[92]
$TCOIPI_{p,i}$ = total CO_{2e} from the other consumed inputs, t CO_{2e}[93]

Total CO_{2e} from fuel 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)
$EF_{f,p}$ = 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 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
$EF_{e,p}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

[92] 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).
[93] 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, 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).

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:
$rapi_{p,i}$ = number of reducing agents 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, dolomite, 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:
$oipi_{p,i}$ = number of the other inputs 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

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, chemically treated water and heat), as well as processes to produce compressed air, steam, oxygen, nitrogen, argon[94], water, air-free water and treated gas together with its transportation. 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 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)
$EF_{f,p}$ = 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.

$TCEBPN_{p,i}$ = 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)

[94] Argon is a by-product of Oxygen production therefore will not be double counted.

$EF_{e,p}$ = 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

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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{f,b}$[98] (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 AISW average data
Source of data	AISW average data IPCC 1996 Potentially measured by AISW laboratory or local fuel distributor
Parameter value (for indicative calculations/identification)	See Table 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 AISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[99] Net calorific value is anticipated at nearly 32,892 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,836 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
Quality assurance and control procedures	See Section D.2.
Note	

[98] For more detailed information please see Annex 2.
[99] In case if the data regarding net calorific value for mentioned above fuels will be available at AISW 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 Table 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[100]. 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[101]. 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	

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

Key Variables/Parameters	$Q_{fio,b}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fio) used in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECIO_b$
Measuring unit	MWh
Description	Electricity consumed in sintering process
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{ra,b}$[102]
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 IPCC 2006 Potentially measured by AISW laboratory
Parameter value (for indicative calculations/identification)	See Table 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). 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). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	This PDD uses default factors: For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne; For coal the anticipated factor is 2.5 tonnes CO_{2e}/tonne. 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

[102] 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 AISW
Parameter value (for indicative calculations/identification)	See Table 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	$EF_{oi,b}$[103]
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 Table 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). 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 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
Quality assurance and control procedures	See Section D.2.
Note	For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite.

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

Key Variables/Parameters	$Q_{fbpn,b}$
Measuring unit	1000 m^3
Description	Quantity of fuel (fbpn) used for balance of process needs
Identification/monitoring frequency	Continuous with regular tabulation (monthly basis)
Source of data	Recorded by AISW
Parameter value (for indicative calculations/identification)	See Table 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	$ECBPN_b$
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 AISW
Parameter value (for indicative calculations/identification)	See Table 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 AISW operation regarding pig iron production during the period of 1998 – 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 AISW during the period of 1998 – 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, dolomite, pellets, etc.

$TCPI_{b,i} = (TCFCPI_{b,i} + TCEPI_{b,i} + TCIPI_{b,i})$ (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:

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

$TCEPI_{b,i} = ECPI_{b,i} \times EF_{e,b}$ (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 to prepare iron ore, the total CO_{2e} from the reducing agents (coke, coal etc.) and the total CO_{2e} from limestone, dolomite, pellets etc.

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

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}[107]
$TCOIPI_{b,i}$ = total CO_{2e} from the other consumed inputs, t CO_{2e}[108]

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

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

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

[107] 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).

[108] 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, 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).

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:

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

where:
$ECIO_{b,i}$ = electricity consumed for Sinter production, MWh
$EF_{e,b}$ = emission 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:

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

where:
$rapi_{b,i}$ = number of reducing agents 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, dolomite, 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:
$oipi_{b,i}$ = number of the other inputs 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

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, chemically treated water and heat), as well as processes to produce compressed air, steam, oxygen, nitrogen, argon[109], water, air-free water and treated gas together with its transportation. 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 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)
$EF_{f,b}$ = tonnes of CO_{2e} per 1000 m^3 of fuel

[109] Argon is a by-product of Oxygen production therefore will not be double counted.

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}:

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

where:
$ECBPN_{b,i}$ = 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. 1.2. 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

Key Variables/Parameters	LE_i
Measuring unit	tCO_{2e}
Description	Total volume of CO_2 emission reductions that are generated due to component three (3) of the JI project "Installation of a new waste heat recovery system at Alchevsk Coke Plant, Ukraine" (UA1000130)
Identification/monitoring frequency	Continuous data recording frequency
Source of data	Monitoring report for the specific monitoring period (for the period during 2007-2009) Emission reductions estimations which are provided in the PDD for the JI project UA1000130 (for the period 2010-2020)[113]
Parameter value (for indicative calculations/identification)	2007 – 27 814, 2008 – 90 241, 2009 – 137 547, 2010-2020 – 123 104 (annually)
Justification of parameter choice or description of measurement methods and procedure	This parameter is based on CO_2 emission reductions that are generated due to component three (3) of the JI project "Installation of a new waste heat recovery system at Alchevsk Coke Plant, Ukraine" (UA1000130)
Quality assurance and control procedures	See Section D.2.
Note	Leakages of GHG's

[113] During the monitoring process leakages will always be equal to the actual volume of generated emission reductions (by the component 3) during the specific monitoring period.

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

Taking into account that the project boundary of the JI project "Installation of a new waste heat recovery system at Alchevsk Coke Plant, Ukraine" (UA1000130[115] - registered under Track 1) includes blast-furnaces of AISW with respect to particular volumes of consumed dry blast-furnace coke, the CO_{2e} emission reductions that are generated due to component three (3)[116] of mentioned above JI project will be attributed to the leakages of GHG's and which will be subtracted from the total volume of emission reductions associated with this project during the specific monitoring period.

Leakages are generated starting from the 1st of October 2007 when the CDQ facility was launched and the first volumes of dry blast-furnace coke were consumed at the blast-furnaces of AISW. Leakages during the period of 2007 – 2009 are equal to emission reductions (generated by the component 3), which where already verified by IAE. All leakages generated starting from the 1st of January 2010 are equal to emission reductions estimations which are provided in the PDD for a mentioned above JI project. During the monitoring process leakages will always be equal to the actual volume of generated emission reductions (by the component 3) during the specific monitoring period.

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):

$$ER_i = BE_i - (PE_i + LE_i) \quad (26),$$

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

[115] http://ji.unfccc.int/JIITLProject/DB/1D4N29Y8OQJEF2BPYY0WSRW4WWDWGT/details
[116] Component three consists in reduction of coke input per unit of pig iron production at the blast furnaces of Alchevsk Iron and Steel Works (AISW) as the result of high-quality coke production at the CDQ facility.

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[119] has been implemented and certified at AISW. 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.

Within AISW's structure there is a special environmental department (SED) 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 AISW. 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 AISW's *Guiding Metrological Instructions*, as well as national standards.
P-5	Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,p}$)	Low, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
P-6, 13, 26	Emission factor of each fuel in Pig Iron Production (fpi_p) $EF_{fpi,p}$	Low	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. 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.

[119] www.amk.lg.ua , директорія "Сертифікати"

P-8	Electricity Consumed in producing Pig Iron ($ECPI_p$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.
P-9, 16, 29	Emissions Factor for Electricity Consumption in Pig Iron Production ($EFECPI_p$)	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[120]. 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[121]. 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, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
P-15	Electricity Consumed in Sintering ($ECIO_p$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.
P-18	Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p,i}$)	Medium, ±500kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.

[120] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[121] 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. 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 ($Q_{oipi,p,i}$)	Low, 0,5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's Guiding Metrological Instructions, 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.
P-25	Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p}$)	Low, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
P-28	Electricity Consumed for balance of process needs ($ECBPN_p$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.
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 AISW's *Guiding Metrological Instructions*, as well as national standards.

B-5	Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi,b}$)	Low, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
B-6, 13, 26	Emission factor of each fuel in Pig Iron Production (fpi_b) $EF_{fpi,b}$	Low	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. 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.
B-8	Electricity Consumed in producing Pig Iron ($ECPI_b$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.
B-9, 16, 29	Emissions Factor for Electricity Consumption in Pig Iron Production ($EFECPI_b$)	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[122]. 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[123]. 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, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
B-15	Electricity Consumed in Sintering ($ECIO_b$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.
B-18	Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b,i}$)	Medium, ±500kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.

[122] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
[123] 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. 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 ($Q_{oipi,b,i}$)	Low, 0,5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's Guiding Metrological Instructions, 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.
B-25	Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b}$)	Low, 1,8%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards.
B-28	Electricity Consumed for balance of process needs ($ECBPN_b$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with AISW's *Guiding Metrological Instructions*, as well as national standards. Detailed monitoring device listing is available.

	Leakages of GHG's (LE_i)	Low	Leakages are generated starting from the 1st of October 2007 when the CDQ facility was launched and the first volumes of dry blast-furnace coke were consumed at the blast-furnaces of AISW. Leakages during the period of 2007 – 2009 are equal to emission reductions (generated by the component 3), which where already verified by IAE. All leakages generated starting from the 1st of January 2010 are equal to emission reductions estimations which are provided in the PDD for a mentioned above JI project. During the monitoring process leakages will always be equal to the actual volume of generated emission reductions (by the component 3) during 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.

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 AISW 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 Department.

The monitoring plan will be implemented by different specialists of the AISW under supervision of Chief Energy Specialist and managed by Director General of the Plant. All main production shops and specialists of the plant will be involved into the preparation of monitoring report under coordination of Chief Energy Specialist.

Table 5. Specialists Responsible for Monitoring

Responsibility	Specialist Responsible	Data Variable	
		Baseline	Project
Overall Project Responsibility	Chief Engineer		
Overall Responsibility for Monitoring report	Chief Energy Specialist	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 Engineer for blast-furnace production and staff	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 Head of Sinter Shop and staff	B-12, B-15, B-17, B-18	P-12, P-15, P-17, P-18

Data for balance of process needs	Chief of CHP, Deputy Chief Energy Specialist and staff	B-21, B-24	P-21, P-24

All data will be collected into electronic database of AISW. The appropriate data for GHG monitoring will be fed into the Monitoring Database. All the documents will be translated into Ukrainian by initial verification stage. Institute for Environment and Energy Conservation will also supervise the implementation of the Monitoring Plan for the Project at regular intervals. See Annex 3 for additional information.

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

Mr Vasyl Vovchak, Director, Institute for Environment and Energy Conservation
11 Kotovskogo street, Kiev, 04060 Ukraine
+ 380 44 206 49 40
vovchak@ipee.org.ua

Institute for Environment and Energy Conservation Company Limited is not a project Participant.

SECTION E. Estimation of greenhouse gas emission reductions[131]

E.1. Estimated project emissions:

Detailed calculation is provided in Tables 26 and 27.

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	5 747 845	7 587 500	7 506 439	8 564 185
Balance of process needs	t CO_{2e}/a	59 639	84 411	64 247	77 180
Totally	t CO_{2e}/a	5 807 484	7 671 911	7 570 686	8 641 364
Totally, 01/04/2004 – 31/12/2007	t CO_{2e}	29 691 446			

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

Project emissions (PE)		2008	2009	2010	2011	2012
Pig Iron	t CO_{2e}/a	9 908 972	8 321 682	9 036 567	9 672 084	9 672 084
Balance of process needs	t CO_{2e}/a	80 915	57 297	97 294	104 136	104 136
Totally	t CO_{2e}/a	9 989 887	8 378 979	9 133 861	9 776 220	9 776 220
Totally, 2008-2012	t CO_{2e}	47 055 167				

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

Project emissions (PE)		2013	2014	2015	2016	2017
Pig Iron	t CO_{2e}/a	10 155 688	10 155 688	10 155 688	10 155 688	11 171 257
Balance of process needs	t CO_{2e}/a	109 343	109 343	109 343	109 343	120 277
Totally	t CO_{2e}/a	10 265 031	10 265 031	10 265 031	10 265 031	11 291 534
Totally, 2013-2017	t CO_{2e}	53 378 162				
Project emissions (PE)		2018	2019	2020		
Pig Iron	t CO_{2e}/a	11 171 257	11 171 257	11 171 257		
Balance of process needs	t CO_{2e}/a	120 277	120 277	120 277		
Totally	t CO_{2e}/a	11 291 534	11 291 534	11 291 534		
Totally, 2018-2020	t CO_{2e}	33 874 603				
Totally, 2013-2020	t CO_{2e}	87 252 764				

E.2. Estimated leakage:

Leakages (LE)		2007
Totally	t CO_{2e}	27 814

Leakages (LE)		2008	2009	2010	2011	2012
Totally	t CO_{2e}/a	90 241	137 547	123 104	123 104	123 104
Totally, 2008-2012	t CO_{2e}	597 100				

Leakages (LE)		2013-2020
Totally	t CO_{2e}/a	123 104

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

Project emissions (PE)	01/04/2004 –	2005	2006	2007

[131] Project emissions, baseline emissions together with 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.

		31/12/2004			
Totally	**t CO_{2e}/a**	**5 807 484**	**7 671 911**	**7 570 686**	**8 669 178**
Totally, 01/04/2004 – 31/12/2007	**t CO_{2e}**	**29 719 260**			

Project emissions (PE)		**2008**	**2009**	**2010**	**2011**	**2012**
Totally	**t CO_{2e}/a**	**10 080 128**	**8 516 526**	**9 256 965**	**9 899 324**	**9 899 324**
Totally, 2008-2012	**t CO_{2e}**	**47 652 267**				

Project emissions (PE)		**2013**	**2014**	**2015**	**2016**	**2017**
Totally	**t CO_{2e}/a**	**10 388 135**	**10 388 135**	**10 388 135**	**11 414 638**	**11 414 638**
Totally, 2013-2017	**t CO_{2e}**	**53 993 682**				
Project emissions (PE)		**2018**	**2019**	**2020**		
Totally	**t CO_{2e}/a**	**11 414 638**	**11 414 638**	**11 414 638**		
Totally, 2018-2020	**t CO_{2e}**	**34 243 915**				
Totally, 2013-2020	**t CO_{2e}**	**88 237 596**				

E.4. Estimated baseline emissions:

Detailed calculation is provided in Tables 28 - 30.

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**	**6 591 571**	**8 875 341**	**8 997 129**	**10 074 257**
Balance of process needs	**t CO_{2e}/a**	**317 601**	**427 640**	**433 508**	**485 407**
Totally	**t CO_{2e}/a**	**6 909 172**	**9 302 981**	**9 430 637**	**10 559 664**
Totally, 01/04/2004 – 31/12/2007	**t CO_{2e}**	**36 202 454**			

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

Baseline emissions (BE)		**2008**	**2009**	**2010**	**2011**	**2012**
Pig Iron	**t CO_{2e}/a**	**11 464 055**	**9 824 860**	**10 022 860**	**10 727 740**	**10 727 740**
Balance of process needs	**t CO_{2e}/a**	**552 371**	**473 390**	**490 856**	**525 376**	**525 376**
Totally	**t CO_{2e}/a**	**12 016 426**	**10 298 250**	**10 513 716**	**11 253 116**	**11 253 116**
Totally, 2008-2012	**t CO_{2e}**	**55 334 624**				

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

Baseline emissions (BE)		**2013**	**2014**	**2015**	**2016**	**2017**
Pig Iron	**t CO_{2e}/a**	**11 264 127**	**11 264 127**	**11 264 127**	**12 390 539**	**12 390 539**
Balance of process needs	**t CO_{2e}/a**	**551 645**	**551 645**	**551 645**	**606 810**	**606 810**
Totally	**t CO_{2e}/a**	**11 815 772**	**11 815 772**	**11 815 772**	**12 997 349**	**12 997 349**
Totally, 2013-2017	**t CO_{2e}**	**61 442 014**				
Baseline emissions (BE)		**2018**	**2019**	**2020**		
Pig Iron	**t CO_{2e}/a**	**12 390 539**	**12 390 539**	**12 390 539**		
Balance of process needs	**t CO_{2e}/a**	**606 810**	**606 810**	**606 810**		
Totally	**t CO_{2e}/a**	**12 997 349**	**12 997 349**	**12 997 349**		
Totally, 2018-2020	**t CO_{2e}**	**38 992 047**				
Totally, 2013-2020	**t CO_{2e}**	**100 434 061**				

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**	**2005**	**2006**	**2007**

		– 31/12/2004			
Totally	**t CO_{2e}/a**	**1 101 687**	**1 631 070**	**1 859 951**	**1 890 486**
Totally, 01/04/2004 – 31/12/2007	**t CO_{2e}**	**6 483 194**			

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

Emission reductions (ER)		**2008**	**2009**	**2010**	**2011**	**2012**
Totally	**t CO_{2e}/a**	**1 936 298**	**1 781 724**	**1 256 751**	**1 353 792**	**1 353 792**
Totally, 2008-2012	**t CO_{2e}**	**7 682 357**				

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

Emission reductions (ER)		**2013**	**2014**	**2015**	**2016**	**2017**
Totally	**t CO_{2e}/a**	**1 427 637**	**1 427 637**	**1 427 637**	**1 582 711**	**1 582 711**
Totally, 2013-2017	**t CO_{2e}**	**7 448 332**				
Emission reductions (ER)		**2018**	**2019**	**2020**		
Totally	**t CO_{2e}/a**	**1 582 711**	**1 582 711**	**1 582 711**		
Totally, 2018-2020	**t CO_{2e}**	**4 748 133**				
Totally, 2013-2020	**t CO_{2e}**	**12 196 464**				

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

Year	**Estimated project emissions (Tonnes CO_{2e})**	**Estimated leakage (Tonnes CO_{2e})**	**Estimated baseline emissions (Tonnes CO_{2e})**	**Estimated emission reductions (Tonnes CO_{2e})**
Before the start of Kyoto protocol crediting period				
01/04/2004 – 31/12/2004	**5 807 484**	**0**	**6 909 172**	**1 101 687**
2005	**7 671 911**	**0**	**9 302 981**	**1 631 070**
2006	**7 570 686**	**0**	**9 430 637**	**1 859 951**
2007	**8 641 364**	**27 814**	**10 559 664**	**1 890 486**
Average annual amount, Tonnes of CO_{2e} per year	**7 422 861**	**6 954**	**9 050 613**	**1 620 798**
Totally (Tonnes CO_{2e})	**29 691 446**	**27 814**	**36 202 454**	**6 483 194**
During Kyoto protocol crediting period				
2008	**9 989 887**	**90 241**	**12 016 426**	**1 936 298**
2009	**8 378 979**	**137 547**	**10 298 250**	**1 781 724**
2010	**9 133 861**	**123 104**	**10 513 716**	**1 256 751**
2011	**9 776 220**	**123 104**	**11 253 116**	**1 353 792**
2012	**9 776 220**	**123 104**	**11 253 116**	**1 353 792**
Average annual amount, Tonnes of CO_{2e} per year	**9 411 033**	**119 420**	**11 066 925**	**1 536 471**
Totally (Tonnes CO_{2e})	**47 055 167**	**597 100**	**55 334 624**	**7 682 357**
During post-Kyoto period				

2013	**10 265 031**	**123 104**	**11 815 772**	**1 427 637**
2014	**10 265 031**	**123 104**	**11 815 772**	**1 427 637**
2015	**10 265 031**	**123 104**	**11 815 772**	**1 427 637**
2016	**11 291 534**	**123 104**	**12 997 349**	**1 582 711**
2017	**11 291 534**	**123 104**	**12 997 349**	**1 582 711**
2018	**11 291 534**	**123 104**	**12 997 349**	**1 582 711**
2019	**11 291 534**	**123 104**	**12 997 349**	**1 582 711**
2020	**11 291 534**	**123 104**	**12 997 349**	**1 582 711**
Average annual amount, Tonnes of CO_{2e} per year	**10 906 596**	**123 104**	**12 554 258**	**1 524 558**
Totally (Tonnes CO_{2e})	**87 252 764**	**984 832**	**100 434 061**	**12 196 464**

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 shop with an introduction of the new blast furnace #2 that will displace pig iron production at the remaining blast furnaces #3, 4 as well as modernization of secondary power facilities at the site; 3) modernization of sintering process with an introduction of the new sinter plant.

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 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: introduction of BF # 2; installation of the oxygen units # 7 and # 8; installation of PCI facilities at BFs # 1, 2, 3, 4, 5 and reconstruction of BF # 1.

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 # 3, # 4, # 5 will be developed during the process of preparation of FS of BF reconstruction. EIAs together with FSs that are not developed till this time will be developed during 2011-2012 years.

Table 15. Developed EIAs together with FSs for the project

№	Project activities	Developer	Independent approvals
1	2	4	5

1	FS "Blast-furnace shop reconstruction with the introduction of the blast-furnace № 2" (BF 2) 23433 (2007 y.) EIA 90-PZ (2007 y.)	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental protection and secondary resources utilization for metallurgy and machine-building "Energostal" OJSC "Ukrainian scientific center of technical ecology" of Luhansk subsidiary of OJSC "UkrNTEC".	Positive resolutions of Complex state expert appraisal dated from 17.09.2010 # 38/349, State environmental appraisal dated from 17.06.2008 # 654, Ministry of health dated from 08.08.2008 # 05.03.02-07/50597.
2	FS "Installation of PCI facilities at BFs № 1, 2, 3, 4, 5 (phases (1, 2, 3))" 23554 (2008) EIA 23554-PZ (2008)	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental protection and secondary resources utilization for metallurgy and machine-building "Energostal" OJSC "Ukrainian scientific center of technical ecology" of Luhansk subsidiary of OJSC "UkrNTEC".	Positive conclusions of Complex state expert appraisal dated from 02.07.2009 # 74/109, State environmental appraisal dated from 01.07.2009 # 15/1-05.02.09-0038, Ministry of health dated from 10.12.2008 # 05.03.02-07/79823.
3	FS of technical revamping of oxygen production of AISW 23272 (2005) EIA 23272-ZA (2005)	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental protection and secondary resources utilization for metallurgy and machine-building "Energostal".	Positive conclusions of complex State expert appraisal dated from 24.10.2006 # 112, State environmental appraisal dated from 20.07.2006 # 382, Ministry of health 21.09.2006 # 05.03.02-07/4480
4	FS "Introduction of the new sinter plant" 23524-PZ/TM-114459 (2008)	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental protection and secondary resources utilization for metallurgy and machine-building "Energostal".	Independent approvals are under application.
5	Project design "Reconstruction of BF # 1" 23228 (2005) EIA 118-PZ (2005)	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental protection and secondary resources utilization for metallurgy and machine-building "Energostal" OJSC "Ukrainian scientific center of technical ecology" of Luhansk subsidiary of OJSC "UkrNTEC".	Project design is not required any environmental approvals.
6	Modernization of lime shop as a part of FS "Converter shop, corrected FS" 23218	Ukrainian State Scientific and Engineering Center for technology and equipment, metals working, environmental	Positive conclusions of complex State expert appraisal dated from 29.05.2007 # 80/113a

	(2007) EIA 23218-ZA (2007)	protection and secondary resources utilization for metallurgy and machine-building “Energostal” OJSC “Ukrainian scientific center of technical ecology” of Luhansk subsidiary of OJSC “UkrNTEC”.	

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.

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 AISW.

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 AISW intends to develop and realize, and also to certificate the system of environmental management of the enterprise appropriate to the international standard ISO 14001:2004 requests by the end of 2010 year or beginning of 2011.

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

Introduction of a new BF # 2

BF #2 with the capacity of 4445 cubic meters will be the largest steel furnace in Ukraine. Therefore it will demonstrate positive character of the economy of scale requiring lower consumption of raw materials to be used while melting the pig iron production and quality targets. 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 are expected to be achieved after introduction of the new 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 5 mg/nm³ etc;
- higher level of waste utilisation by better quality of waste that can be used in other industries;
- lower water consumption (2,5 times) and better options for cleaning of recirculated water;
- 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/m³
- dust emissions after the cleaning by electric air filters less than 30 mg/m³ etc[133].

Installation of PCI facilities at BFs

PCI effects on the 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 production

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].

Introduction of a new sinter plant

<u>The introduction of a new sinter plant by Siemens VAI leads to:</u>
- stable high sinter quality;
- low quantity of off-gas;
- increased productivity;
- high productivity with difficult charge materials;
- low coke consumption;
- less wear;
- lower energy consumption;

[133] More detailed information can be obtained from relevant EIA.

- less space requirement compared to conventional sinter plants;
- reduction of the off gas quantity up to 50 %. This significantly lowers not only environmental pollution but power consumption as well;
- possibility to recycle more than 50 t/h of contaminated ferrous materials to the sinter plant;
- up to 70 % reduction of noxious components and organics in the waste gas;
- 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: <10 mg/Nm³;
  - sox: <50 ppm/Nm³;
  - dioxin: <0.1 ng/Nm³;
  - NOx: <50 ppm/Nm³;
  - NOx content can be reduced to <50 ppm/Nm³;
  - significant decrease of emissions from current 300-400 pig particulate/Nm³ to at least 50 mg participate/Nm³.

Modernization of blast furnace # 1

BF # 1 is equipped with a new efficient control system in connection with cold repairs and installation of emission controls for secondary emissions, which primary occur during the tapping process. BF # 1 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 BF # 1 is one of the most modern blast furnaces in Ukraine and therefore one of the most environmentally friendly among the others.

Modernization of lime shop

Before modernization lime shop at AISW was the third largest emitter of particulates reaching 600-700 mg/Nm³. The modernization foresees an introduction of two new lime kilns, each with particulate emissions below 30 mg/Nm³. Besides the new lime kilns require significantly lower volumes of gas consumption. The modernization of lime shop will have positive environmental impact.

Generally the project activity would also lead to:

- lower water consumption and wastewater discharge;
- better waste utilization and management;
- preservation of current land foot print;
- decrease impact on ground and surface water capacity;
- lower numbers of potential accidences;
- general improvement of health and safety management system;
- better manageable options regarding operational aspects.

The modernization of project measures will have a positive environmental impact. The general environmental impact opinion via the procedure endorsed by the Ukrainian government is that the project will have a positive environmental impact and its foreseeable emergency negative impacts will be insignificant and easily repaired.

It may generally be stated that the project activity is in line with the EU best available technology principle. Project activity will cause no harmful transboundary impacts.

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;
- deadline and formats of submission of public comments;
- when and where EIA documents can be retrieved.

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 AISW 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

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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, limestone, dolomite etc. as well as process inputs such as steam, oxygen and compressed air 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[134] 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[135])

Table 16
Emission Factors for CO_2 from Inputs and Reducing Agents Consumption (tonnes CO_2 / tonne of material or reducing agent)

Reducing Agent	Emission Factor
Coal Coke	3.1
Coal	2.5
Limestone	0.44
Dolomite	0.477

Table 17. Emission Factors for Inputs and Reducing Agents Production (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)

Table 17
CO_2 Emission Factors for Inputs and Reducing Agents Production (tonnes CO_2 / tonne of material or reducing agent)

Reducing Agent	Emission Factor
Coal Coke	0.56
Pellets	0.03

[134] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf
[135] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf

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[136])

	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	32.892	15.3	0.995	0.001836	1.836

Baseline Emission Factor for Ukrainian Electricity Grid

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[137].

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 AISW. 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
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,

136 http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf
137 http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

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.[138] "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[139]

		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

Table 21. Share of power generation by source in the annual power generation[140]

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.

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

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

138 Source: State Committee of Statistics of Ukraine. *Fuel and Energy resources of Ukraine 2001-2003*, Kiev, 2004.
139 *Ukraine – Assessment of new calculation of CEF*, 2007 – http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514
140 *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.

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;
$EF_{CO2e\cdot i}$ 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.[141]

The local NCV values of individual power plants for natural gas and coal were used. For heavy oil, the IPCC[142] 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 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,

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

and

[141] *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.
[142] Revised 1996 IPCC guidelines for national greenhouse gas inventories.

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

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

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[143].

In accordance with mentioned above decree issued by NEIA for the 1st – class electricity consumers and is equal to 1,093 $kgCO_2$/kWh. The use of the emission factor for the1st-class electricity consumers is justified by the resolution of National Electricity Regulatory Commission of Ukraine № 1052 of 13 August 1998[144], according to the resolution the 1st – 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.

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

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

Annex 3

MONITORING PLAN

The monitoring procedures within the project boundaries are straightforward in term of what AISW already does to collect energy consumption data and measure inputs and outputs. See Chapter D for details. The monitoring procedure will center on the collection of baseline data from blast furnaces, sinter plant and other auxiliary facilities and annual project year data from the JI project boundary including:

- The types and amounts of different fuels used at various stages of the process.
- The amount and source of electricity consumed at various points of the process.
- Carbon emission factors for electricity consumption in Ukraine, approved by AIE or national authorized body.
- The quantities of material inputs entering into the project in order to produce pig iron.
- The electricity and fuels used to produce the material inputs into the process.
- CO_{2e} emissions released during the preparation of inputs.
- Other carbon emission factors.
- Quantity of output.

The approach accounts emission reductions due to decrease of specific fuel and energy resources consumption as the result of the project activity.

The approach envisages monitoring of the total pig iron production, a fuel and energy resource consumption at the plant during the project activity.

Specifically, the project developer gathers information on fuel consumption, electricity consumption and the CO_{2e} impact of the material inputs into the project boundary pig iron making process. This data will be used to determine in the baseline emissions for each year using historical data of measured the CO_{2e} emissions per tonne of pig iron output. This is then multiplied by the actual pig iron product output each project year in the JI project steel making line to get the baseline CO_{2e} emissions. This is then compared to the total CO_{2e} produced in the actual project year. The difference is the emission reductions for that year.

It is expected that in the baseline case electricity comes exclusively from the grid and natural gas is received from the national gas transportation system.

Such parameters as carbon emission factors for coke, coal, natural gas consumption are identified as default values in the PDD. In case if the data regarding carbon content or/and the net calorific value for each of the mentioned above fuel and energy resources will be available at AISW for each of the specific monitoring periods, the carbon emission factors will be accordingly modified.

Data Quality Management

Given the complexity of the basic data requirements for the project and the added complication resulting from the ongoing construction schedule of various parts of the process line, the project developer will take the following steps to ensure data quality.

- Each new meter installed will be calibrated according to manufacturer's specifications and frequency, national requirements and AISW's Guiding Metrological Instructions.
- All new meters will be installed and calibrated before flows requiring monitoring commence

- All old meters that are used in new functions or are subject to some physical disruption in their use due to construction will be recalibrated according to manufacturer's specifications before measuring any flow.

Three set of instructions at the AISW regulate the monitoring procedures and responsibilities. They are called Guiding Metrological Instructions (Russian abbreviation is РМИ):

1) "Metrological product quality assurance" (РМИ-I-19.0.1-07)
2) "Metrological expertise of documentation" (РМИ-I-19.0.2-07)
3) "Management of measurement technique" (РМИ-I-19.1.1-07)

According to national legislative requirements the instructions should be revised every 3 years. The procedures for calibration of all monitoring equipment are described in the following Instructions:

1) "Metrological product quality assurance" (РМИ I.19.0.1-07)
2) "Management of measurement technique" (РМИ I.19.1.1-07)

The instructions have been developed in accordance with ISO 9001 requirements. They secure required accuracy of all the measurements done using monitoring equipment.

The Chief Metrological Specialist of the AISW is in charge for maintenance of the monitoring equipment and installations as well as for their accuracy required by paragraphs 2.1.1, 3.1.1, 7.1 of the Regulation ПП 229-Э-056-863/02-2005 "On metrological services of the iron works" and p. 6.3 Guiding Metrological Instructions I.19.0.1-05. In case of defect discovered in the monitoring equipment the actions of the personnel are determined by Guiding Metrological Instructions I.19.0.1-07 (paragraph 5.4.4).

The measurement of the parameters included into the monitoring plan of the project is envisaged by the provisions of the Guiding Metrological Instructions I.19.1.1-07 (paragraph 5.3.2).

The measurements are conducted on continuous basis and automatically according with the Guiding Metrological Instructions (РМИ) I.19.1.1-07 (paragraph 5.4).

Data is collected into electronic database of AISW as well as in paper format. Data is further compiled in (i) day-to-day records, (ii) quarterly records, and (iii) annual records. All records are finally stored in Planning Department.

The results of the measurements are being used by relevant services and technical personnel of the iron works. They will be reflected in the technological instructions for the regimes of conducting the technological processes and in the revision of Guiding Metrological Instructions I.19.1.1-07 (paragraph 5.3.5).

Best available techniques are used in order to minimize uncertainties. Uncertainties are generally low - typically below 2% with as all parameters are or will be monitored. All the equipment used for monitoring purposes is in line with national legislative requirements and standards and also in line with ISO 9001 standards. Details are given in Guiding Metrological Instructions. The data will be cross checked as well as internal audits and corrective actions are taken as defined in Guiding Metrological Instructions.

Monitoring device table may be provided upon verifier's request. Monitoring database will be available for monitoring purposes.

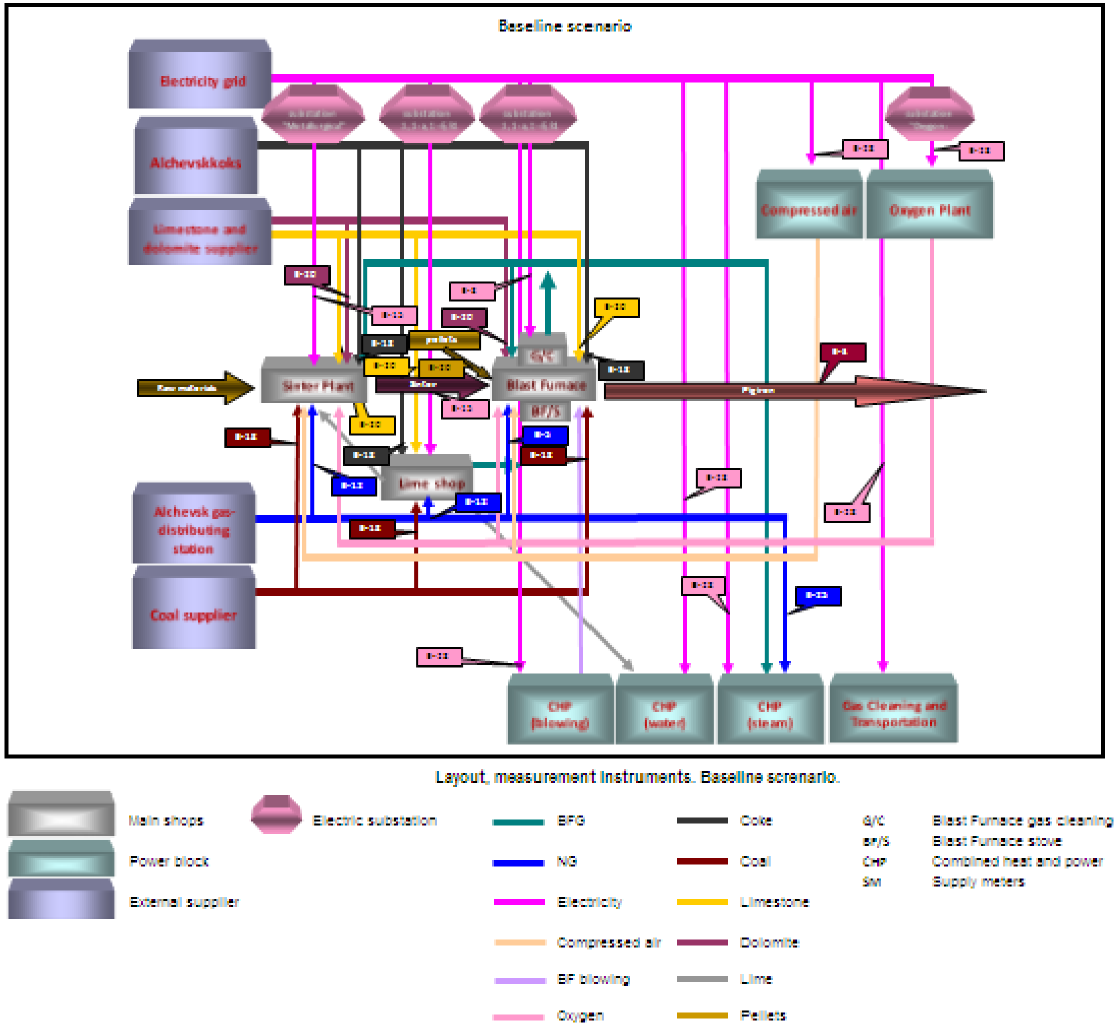


Fig. 5 Baseline monitoring outline for GHG emissions

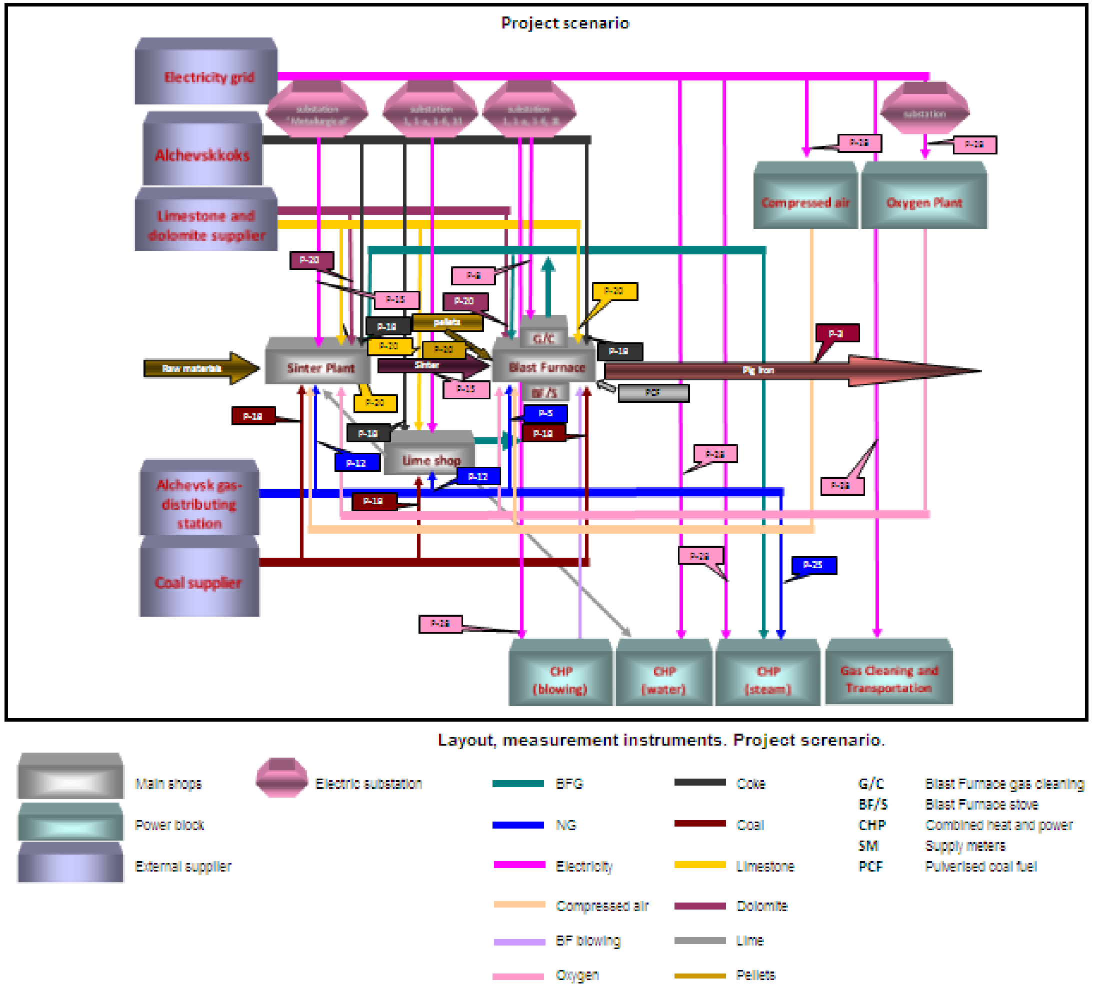
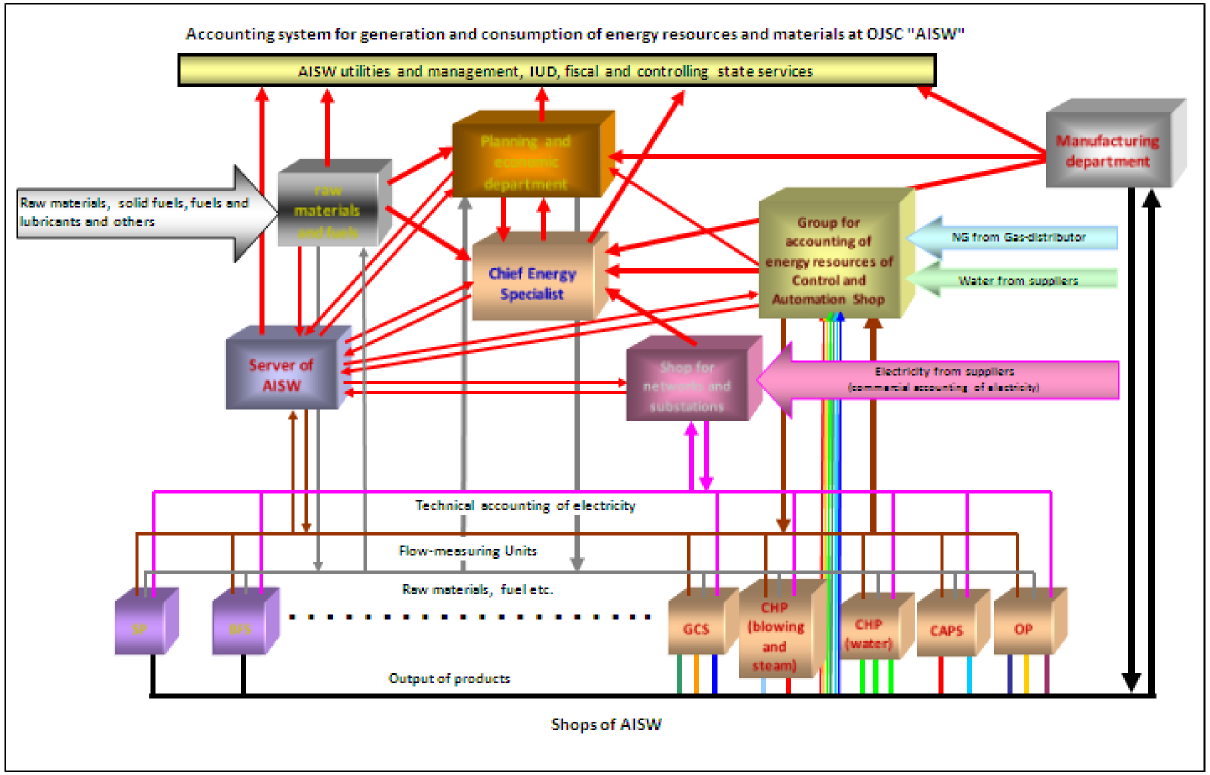


Fig. 6 Project monitoring outline for GHG emissions



Abbreviations:

SP - Sinter plant with lime shop; BFS - blast furnace shop;
GCS - gas cleaning and transportation shop (cleaning and transportation of blast furnace, coke oven and natural gases);
CHP blowing and steam - combined heat and power plant (blowing and heat energy production);
CHP water - water supply shop (transmission of potable water, manufacturing and recycled water);
CAPS - production of compressed air and secondary heat power;
OP - oxygen plant (oxygen, nitrogen, argon production).

Fig. 7 Accounting system for generation and consumption of energy resources and materials at OJSC "AISW"

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)	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)	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 and requirements of *Guiding Metrological Instructions.*

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

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	**5 807 484**	**7 671 911**	**7 570 686**	**8 641 364**
P-2	Total CO_2 from Pig Iron ($TCPI_{p,i}$)	Tonnes CO_2	**5 747 845**	**7 587 500**	**7 506 439**	**8 564 185**
P-3	Total Pig Iron Output ($TPII_{p,i}$)	Tonnes	2 170 456	2 922 450	2 962 552	3 317 226
P-4	Total CO_2 from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$)	Tonnes CO_2	**360 999**	**480 820**	**499 586**	**544 008**
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	196 599,750	261 854,000	272 074,000	296 266,000
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	1,836	1,836	1,836	1,836
P-7	Total CO_2 from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$)	Tonnes CO_2	**141 496**	**185 399**	**214 616**	**292 635**
P-8	Electricity Consumed in producing Pig Iron ($ECPI_{p,i}$)	MWh	157 919	206 918	239 527	326 602
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	**5 245 350**	**6 921 282**	**6 792 237**	**7 727 542**
P-11	Total CO_2 from fuel used to prepare Iron Ore ($TCFIO_{p,i}$)	Tonnes CO_2	**65 413**	**85 372**	**74 725**	**32 843**
P-12	Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,p,i}$)	1000 m^3				
	Natural gas (NG)	1000 m^3	35 623,607	46 493,563	40 695,392	17 886,383
P-13	Emission factor of each fuel $EF_{f,p}$	Tonnes CO_2/1000 m^3				
	Natural gas (NG)	Tonnes CO_2/1000 m^3	1,836	1,836	1,836	1,836
P-14	Total CO_2 from electricity consumption in preparing iron ore ($TCEIO_{p,i}$)	Tonnes CO_2	**105 343**	**137 013**	**142 569**	**137 205**
P-15	Electricity Consumed in Sintering ($ECIO_{p,i}$)	MWh	117 570	152 916	159 117	153 131
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	**4 672 106**	**6 152 197**	**6 030 602**	**6 962 452**
P-18	Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p,i}$)	Tonnes				
	Reducing agent (coke)	Tonnes	1 236 346	1 564 948	1 395 974	1 742 702
	Reducing agent (coal)	Tonnes	58 832	169 795	368 535	233 665

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**	**402 489**	**546 700**	**544 341**	**595 041**
P-21	**Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p,i}$)**	**Tonnes**				
	Limestone	**Tonnes**	773 060	1 000 219	1 047 633	1 109 179
	Dolomite	**Tonnes**	121 431	201 372	156 851	153 890
	Pellets	**Tonnes**	147 340	351 625	285 471	1 119 905
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**	0,477	0,477	0,477	0,477
	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**	**59 639**	**84 411**	**64 247**	**77 180**
P-24	**Total CO_2 from fuel consumption for balance of process needs of project activity ($TCFCBPN_{p,i}$)**	**Tonnes CO_2**	**17 523**	**29 770**	**19 697**	**23 307**
P-25	**Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p,i}$)**	**1000 m^3**				
	Natural gas (NG)	**1000 m^3**	9 543,051	16 212,721	10 726,722	12 693,079
P-26	**Emission factor of each fuel $EF_{f,p}$**	**Tonnes CO_2/1000 m^3**				
	Natural gas (NG)	**Tonnes CO_2/1000 m^3**	1,836	1,836	1,836	1,836
P-27	**Total CO_2 from electricity consumption for balance of process needs of project activity ($TCEBPN_{p,i}$)**	**Tonnes CO_2**	**42 116**	**54 641**	**44 550**	**53 872**
P-28	**Electricity Consumed for balance of process needs ($ECBPN_{p,i}$)**	**MWh**	47 005	60 984	49 721	60 126
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**	**9 989 887**	**8 378 979**	**9 133 861**	**9 776 220**	**9 776 220**
P-2	**Total CO_2 from Pig Iron ($TCPI_{p,i}$)**	**Tonnes CO_2**	**9 908 972**	**8 321 682**	**9 036 567**	**9 672 084**	**9 672 084**
P-3	**Total Pig Iron Output ($TPII_{p,i}$)**	**Tonnes**	3 774 855	3 235 105	3 270 028	3 500 000	3 500 000
P-4	**Total CO_2 from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$)**	**Tonnes CO_2**	**554 973**	**423 752**	**232 369**	**248 711**	**248 711**

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**	302 238,000	230 775,000	126 548,000	135 447,770	135 447,770
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**	1,836	1,836	1,836	1,836	1,836
P-7	**Total CO_2 from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$)**	**Tonnes CO_2**	**514 571**	**346 553**	**408 175**	**436 881**	**436 881**
P-8	**Electricity Consumed in producing Pig Iron ($ECPI_{p,i}$)**	**MWh**	574 298	386 778	373 445	399 708	399 708
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**	**8 839 428**	**7 551 377**	**8 396 023**	**8 986 492**	**8 986 492**
P-11	**Total CO_2 from fuel used to prepare Iron Ore ($TCFIO_{p,i}$)**	**Tonnes CO_2**	**27 134**	**24 334**	**50 241**	**53 775**	**53 775**
P-12	**Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,p,i}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	14 777,123	13 252,168	27 361,395	29 285,646	29 285,646
P-13	**Emission factor of each fuel $EF_{f,p}$**	**Tonnes CO_2/1000 m^3**					
	Natural gas (NG)	**Tonnes CO_2/1000 m^3**	1,836	1,836	1,836	1,836	1,836
P-14	**Total CO_2 from electricity consumption in preparing iron ore ($TCEIO_{p,i}$)**	**Tonnes CO_2**	**137 011**	**132 871**	**174 084**	**186 327**	**186 327**
P-15	**Electricity Consumed in Sintering ($ECIO_{p,i}$)**	**MWh**	152 914	148 293	159 272	170 473	170 473
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**	**8 057 719**	**7 025 203**	**7 684 943**	**8 225 404**	**8 225 404**
P-18	**Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p,i}$)**	**Tonnes**					
	Reducing agent (coke)	**Tonnes**	2 140 169	1 859 843	1 931 285	2 067 107	2 067 107
	Reducing agent (coal)	**Tonnes**	89 880	87 271	246 576	263 917	263 917
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**	**617 564**	**368 969**	**486 754**	**520 986**	**520 986**
P-21	**Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p,i}$)**	**Tonnes**					

	Limestone	**Tonnes**	1 098 641	725 809	998 083	1 068 275	1 068 275
	Dolomite	**Tonnes**	148 835	17 461	9 725	10 409	10 409
	Pellets	**Tonnes**	2 105 597	1 376 150	1 431 950	1 532 655	1 532 655
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**	0,477	0,477	0,477	0,477	0,477
	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**	**80 915**	**57 297**	**97 294**	**104 136**	**104 136**
P-24	**Total CO_2 from fuel consumption for balance of process needs of project activity ($TCFCBPN_{p,i}$)**	**Tonnes CO_2**	**25 726**	**12 593**	**30 035**	**32 147**	**32 147**
P-25	**Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p,i}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	14 010,419	6 857,960	16 356,917	17 507,254	17 507,254
P-26	**Emission factor of each fuel $EF_{f,p}$**	**Tonnes CO_2/1000 m^3**					
	Natural gas (NG)	**Tonnes CO_2/1000 m^3**	1,836	1,836	1,836	1,836	1,836
P-27	**Total CO_2 from electricity consumption for balance of process needs of project activity ($TCEBPN_{p,i}$)**	**Tonnes CO_2**	**55 189**	**44 704**	**67 259**	**71 989**	**71 989**
P-28	**Electricity Consumed for balance of process needs ($ECBPN_{p,i}$)**	**MWh**	61 594	49 893	61 536	65 864	65 864
P-29	**Emissions Factor for Electricity Consumption $EF_{f,p}$**	**Tonnes CO_2/MWh**	0,896	0,896	1,093	1,093	1,093

Tables 28 - 30 provide detailed estimations of baseline emissions before and during Kyoto protocol crediting period.

Table 28. Detailed information regarding identification of Baseline emissions estimations subject to variable emission factor for electricity consumption[162]

ID number	Data variable	Units	1998 - 2002	
			01/04/2004 - 31/12/2009	**01/01/2010 - 31/12/2020**
B-1	**Total CO_{2e} in the baseline scenario (BE_i) based on fixed pig iron output during 1998-2002**	**Tonnes CO_2**	**30 975 771**	**31 286 129**
B-2	**Total CO_2 from Pig Iron ($TCPI_{b,i}$)**	**Tonnes CO_2**	**29 551 875**	**29 825 467**
B-3	**Total Pig Iron Output ($TPII_{b,i}$)**	**Tonnes**	9 730 767	9 730 767

[162] The table is required for identification of baseline emissions, which are based on historical data (1998 - 2002) for further identification of baseline CO_2 emissions per 1 ton of pig iron produced during the project activity.

B-4	**Total CO_2 from fuel consumption in producing Pig Iron ($TCFCPI_{b,i}$)**	**Tonnes CO_2**	**1 540 010**	**1 540 010**
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**	838 688,000	838 688,000
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**	1,836	1,836
B-7	**Total CO_2 from electricity consumption in producing Pig Iron ($TCEPI_{b,i}$)**	**Tonnes CO_2**	**651 845**	**795 164**
B-8	**Electricity Consumed in producing Pig Iron ($ECPI_{b,i}$)**	**MWh**	727 506	727 506
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**	**27 360 020**	**27 490 293**
B-11	**Total CO_2 from fuel used to prepare Iron Ore ($TCFIO_{b,i}$)**	**Tonnes CO_2**	**311 198**	**311 198**
B-12	**Quantity of each fuel (fio_b) used in Sintering ($Q_{fio,b,i}$)**	**1000 m^3**		
	Natural gas (NG)	**1000 m^3**	169 478,156	169 478,156
B-13	**Emission factor of each fuel $EF_{f,b}$**	**Tonnes CO_2/1000 m^3**		
	Natural gas (NG)	**Tonnes CO_2/1000 m^3**	1,836	1,836
B-14	**Total CO_2 from electricity consumption in preparing iron ore ($TCEIO_{b,i}$)**	**Tonnes CO_2**	**592 510**	**722 783**
B-15	**Electricity Consumed in Sintering ($ECIO_{b,i}$)**	**MWh**	661 284	661 284
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**	**24 253 678**	**24 253 678**
B-18	**Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b,i}$)**	**Tonnes**		
	Reducing agent (coke)	**Tonnes**	6 539 173	6 539 173
	Reducing agent (coal)	**Tonnes**	128 122	128 122
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**	**2 202 633**	**2 202 633**
B-21	**Quantity of each other input ($oipi_b$) in Pig Iron Production ($Q_{oipi,b,i}$)**	**Tonnes**		
	Limestone	**Tonnes**	3 521 707	3 521 707
	Dolomite	**Tonnes**	1 345 800	1 345 800
	Pellets	**Tonnes**	371 188	371 188

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**	0,477	0,477
	Default emission factor	**Tonnes CO_2/Tonne**	0,030	0,030
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**	**1 423 895**	**1 460 662**
B-24	**Total CO_2 from fuel consumption for balance of process needs of project activity ($TCFCBPN_{b,i}$)**	**Tonnes CO_2**	**1 256 673**	**1 256 673**
B-25	**Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b,i}$)**	**1000 m^3**		
	Natural gas (NG)	**1000 m^3**	684 383,059	684 383,059
B-26	**Emission factor of each fuel $EF_{f,b}$**	**Tonnes CO_2/1000 m^3**		
	Natural gas (NG)	**Tonnes CO_2/1000 m^3**	1,836	1,836
B-27	**Total CO_2 from electricity consumption for balance of process needs of project activity ($TCEBPN_{b,i}$)**	**Tonnes CO_2**	**167 222**	**203 988**
B-28	**Electricity Consumed for balance of process needs ($ECBPN_{b,i}$)**	**MWh**	186 632	186 632
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	2004	2005	2006	2007
B-2	**Total CO_2 from Pig Iron ($TCPI_{b,i}$)**	**Tonnes CO_2**	**29 551 875**	**29 551 875**	**29 551 875**	**29 551 875**
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**	**1 423 895**	**1 423 895**	**1 423 895**	**1 423 895**
B-3	**Total Pig Iron Output ($TPII_{b,i}$)**	**Tonnes**	9 730 767	9 730 767	9 730 767	9 730 767
B-30	**Total CO_2 per 1 tonne of Pig Iron produced ($TCPTPIP_b$)**	**Tonnes CO_2/1 t. of Pig Iron Produced**	**3,183**	**3,183**	**3,183**	**3,183**
P-3	**Total Pig Iron Output ($TPII_{p,i}$)**	**Tonnes**	2 170 456	2 922 450	2 962 552	3 317 226
B-1	**Total CO_2 in the project scenario (BE_i)**	**Tonnes CO_2**	**6 909 172**	**9 302 981**	**9 430 637**	**10 559 664**

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**	**29 551 875**	**29 551 875**	**29 825 467**	**29 825 467**	**29 825 467**

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**	**1 423 895**	**1 423 895**	**1 460 662**	**1 460 662**	**1 460 662**
B-3	**Total Pig Iron Output ($TPII_{b,i}$)**	**Tonnes**	9 730 767	9 730 767	9 730 767	9 730 767	9 730 767
B-30	**Total CO_2 per 1 tonne of Pig Iron produced ($TCPTPIP_b$)**	**Tonnes CO_2/1 t. of Pig Iron Produced**	**3,183**	**3,183**	**3,215**	**3,215**	**3,215**
P-3	**Total Pig Iron Output ($TPII_{p,i}$)**	**Tonnes**	3 774 855	3 235 105	3 270 028	3 500 000	3 500 000
B-1	**Total CO_2 in the project scenario (BE_i)**	**Tonnes CO_2**	**12 016 426**	**10 298 250**	**10 513 716**	**11 253 116**	**11 253 116**

Table 31. Abbreviations[163]

AISW	Open Joint Stock Company Alchevsk Iron and Steel Works
BFG	Blast Furnace gas
NG	Natural Gas
N/A	Not applicable
ERU	Emission reduction unit
ER	Emission reductions
CHP	Combined heat and power

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