JOINT IMPLEMENTATION PROJECT

Introduction of energy efficiency measures at PJSC "Ilyich Iron and Steel Works of Mariupol"

Position of the head of organization, company, entity being the developer of documents

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Mariupol, August 2012

JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
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Annexes

SECTION A. General description of the project

A.1. Title of the project:

Introduction of Energy Efficiency Measures at PJSC "Ilyich Iron and Steel Works of Mariupol".

Sectoral scopes: (9) Metal production.

Document Version: 1.8

Date: 04.12.2012

A.2. Description of the project:

The project aims to introduce energy efficiency measures resulting in reduction of greenhouse gas emissions into the atmosphere, decrease of specific energy consumption for steel and iron production, as well as increase of competitiveness in the metal market.

Background

PJSC "Ilyich Iron and Steel Works of Mariupol" (hereafter – PJSC "IISW") belongs to the largest integrated iron-and-steel works in Ukraine.

PJSC "IISW" is one of Ukraine's biggest and large-scale industrial plants distinctive by over a century history, glorious work traditions and more than 60 thousand team-oriented employees capable to meet the toughest production challenges. Today, the metallurgical plant is an integrated wide-profile corporation.

The plant's key activity is production of high quality steel sheet for critical structures, shipbuilding industry, oil, gas and water line pipes, and pressurized gas cans.

Principal finished products manufactured by the plant cover iron-ore sinter for iron casting, cold pig iron, granulated slag, graded ballast stone, block and rolled slab, hot-rolled stock, including etched, flat and coiled steel, cold-rolled steel (including galvanized steel) plate and coiled steel, steel straps, weldless and welded pipes, pressurized and liquefied gas cans.

PJSC "IISW" supplies steel sheets certified by authoritative world centres for the shipbuilding industry. Bodies of many vessels of the Ukrainian and Russian ice-breaking and military fleet are made of metal produced by the PJSC "IISW".

The Steel Works is the largest Ukrainian producer of galvanized cold rolled sheets.

Continuous technical and technological upgrade, and new technological processes are introduced using own resources, with research organizations involved.

One of the main manufacturing activities of the PJSC "IISW" is iron smelting. Steel and iron production implies significant energy consumption and, as a result, the blast furnace shop (BFS) is the main plant's source (around 70%) of greenhouse gas (GHG) emissions.

Project scenario

Situation existing prior to the project

Prior to the project implementation, the steel production process at PJSC "IISW" took place under the conditions as described below.

The blast furnaces #1, #2, #3, #4 and #5 were operated using the traditional mixed charge feeding technology which was less effective than the separate charge feeding implemented within the scope of the JI project. Blast furnaces #2, #3, #4 and #5 were not equipped with appropriate outfit and worked at lower efficiency compared to efficiency increased due to reconstruction of the blast furnaces within the scope of the JI project. Also, the blast furnaces #2 and #3 were operated at their volumes of 1033 m^3 and 1719 m^3 respectively which were increased due to the JI project implementation. The blast furnaces #1 - #5 did not support use of pulverized coal injection technology which is foreseen within the scope of the JI project.
Blast furnace slag, converter slag, and open-hearth furnace slag volumes resulting from the steel-making process were accumulated as a slug dump at a slug dump site.
The sinter production process did not include utilization of sludge as a partial replacement of iron-ore concentrate. The iron-ore concentrate with no sludge additives was used for sinter production.

The proposed JI project covers reconstruction of the blast furnace shop, upgrade of blast #1, #2, #3, #4 and #5 with further use of pulverized coal in blast furnaces #2, #3, #4 and #5, as well as construction of the new slag processing complexes AMCOM-1 and AMCOM-2, and partial replacement of the iron-ore concentrate with sludge during sinter production.

Brief history of the project

The upgrade of the blast furnaces #1 - #5 was implemented on June 2002 which is the starting date of the project.
Reconstruction of the blast furnace #3 was implemented on October 2003, the blast furnace # 2 – August 2005, the blast furnace #4 - July 2007, and the blast furnace #5 - December 2009.
New slag processing complexes AMCOM-1 and AMCOM-2 were installed on June 2005 and April 2006 respectively.
The sludge utilization for sinter production was implemented on January 2005.
The implementation of pulverized coal injection technology for the blast furnaces #2 - #5 is expected in the beginning of 2012.

The total investment in reconstruction of the PJSC “IISW” is over USD 500 mln.
The proposed project focuses on reduction of CO_2 emissions through decreased coke consumption at the PJSC “IISW”.

Baseline scenario

The baseline scenario implies further operation of the existing equipment, scheduled repair and maintenance without any significant investment. The baseline scenario is described in Section B.

A.3. Project participants:

Table A.1. Project participants

Party involved	Legal entity project participants (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (host Party)	PJSC “IISW”	No
The Netherlands	ING Bank NV	No

Switzerland	Metinvest International SA	No

PJSC "Ilyich Iron and Steel Works of Mariupol"

PJSC "Ilyich Iron and Steel Works of Mariupol" is the largest manufacturing enterprise in Donbas and one of the Ukrainian biggest exporters. PJSC "IISW" was founded in 1897. In November 2000, the Ukrainian Parliament adopted the Law of Ukraine on Peculiarities of Privatization of OJSC "Ilyich Iron and Steel Works of Mariupol", according to which the plant employees gained the right of company ownership. On 07 July 2010, at the General Meeting the plant shareholders made the decision on merger with Metinvest Holding.

PJSC "Ilyich Iron and Steel Works of Mariupol" is GHG source owner.

Code of single tax registry of enterprises of Ukraine: 00191129.
The type of economic activities according to the Code of Internal Economic Activities:
27.10.0 – iron and ferro-alloys industry.

ING Bank NV (the Netherlands)

The Emissions Products team within ING Wholesale Banking focuses on projects that reduce greenhouse gas emissions under the Kyoto Protocol. Based in Amsterdam and Shanghai, the team assists companies to identify Joint Implementation (JI) or Clean Development Mechanism (CDM) projects to reduce emissions and generate emission reduction units, commonly referred to as 'carbon credits'. The team uses ING's international network and client relationships to identify and develop the projects, and then acts as intermediary in the sale of the generated carbon credits to governments or to companies participating in schemes such as the EU Emissions Trading Scheme.

Metinvest International SA (Switzerland)

Metinvest International SA – metal trading company, established in 1997 in Switzerland, the member of group Metinvest. The company conducts export supplies of metal products to the markets of near abroad and far abroad countries. Metinvest International S.A. is the potential buyer of ERUs generated as a result of the proposed project.

A.4. Technical description of the project:

A.4.1. Location of the project:

PJSC "Ilyich Iron and Steel Works of Mariupol" (hereafter – PJSC "IISW"), where the proposed Joint implementation project is planned for implementation, is located in the city of Mariupol in Donetsk region (see Figure A.1). The city is situated in the southern part of Donetsk region on the Azov seacoast, at the mouth of the river Kalmius.

A.4.1.1. Host Party(ies):

Ukraine

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

Donetsk region.

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

The city of Mariupol.

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

Physical location of the project is the territory of PJSC “Ilyich Iron and Steel Works of Mariupol”, the city of Mariupol, Donetsk region ,Ukraine.
Location of the city of Mariupol and surrounding towns is depicted on Figure A.1.
Geographical coordinates of the PJSC “IISW” are as follows: latitude: 47° 9'32.22", longitude: 37°33'20.07".

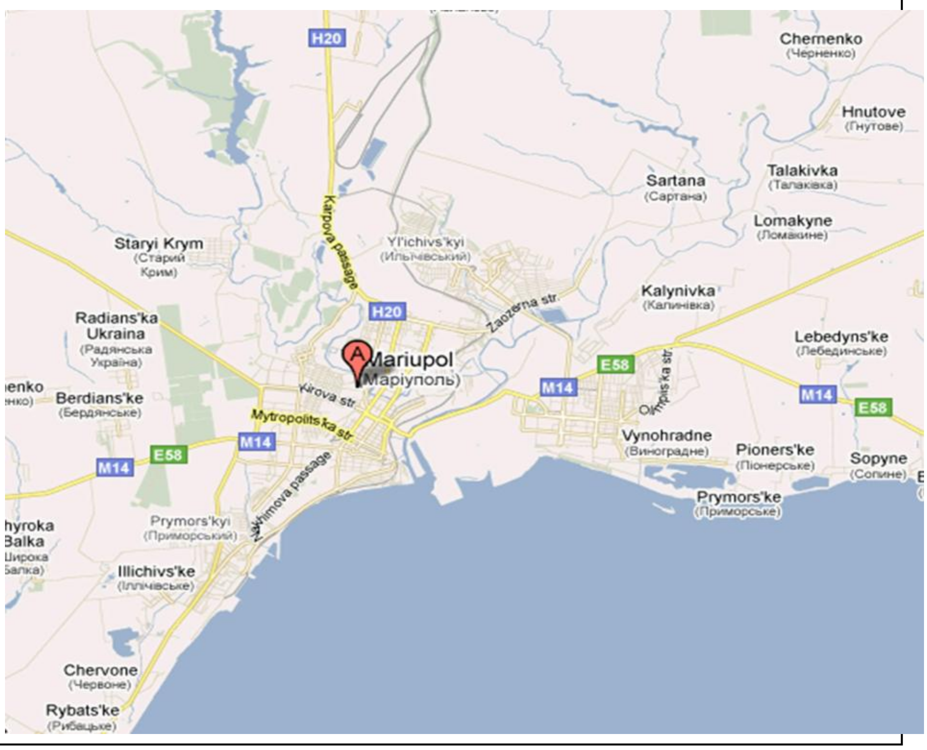

Fig. A.1. Mariupol city and surrounding populated localities.

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

Technological goal of the project is introduction of energy efficiency measures at the PJSC "IISW", in particular:

- Reconstruction of BFs 2-5;
- Upgrade of BFs 1-5 with implementation of separate charge feed of the furnaces;
- Implementation of pulverized coal technology in BFs 2-5;
- Construction of new metallurgical slag processing complexes AMCOM-1,2;
- Sludge use during sinter production.

Abovementioned measures not only allow reducing specific energy consumption (coke, natural gas and electricity), but also result in significant reduction of GHG emissions and harmful substances in the atmosphere at PJSC "IISW".

PJSC "IISW" includes the following production shops (Fig. A.2):

- Sinter shop;
- Blast-furnace shop;
- Open-hearth shop;
- Oxygen-converter shop;
- Limekiln department;
- Slag processing shop;
- Sheet rolling shops;
- Pipe-rolling shop;
- Cold rolling shop.

As it was mentioned before, basic finished products of the PJSC "IISW" include rolled steel and metal goods. Steel production chain at the enterprise includes the following steps:

- Raw material preparation;
- Iron production;
- Steel production;
- Steel processing and production of metal goods;

Iron ore is prepared for smelting in the sinter shop. Then sinter, coke and limestone are fed into the blast furnace for iron smelting. Slag is separated from iron, and then pig iron is supplied to the oxygen-converter shop. Pig iron supply to converters is followed by delivery of oxygen reacting with carbon and other additives, thus allowing to increase temperature significantly, smelt the scrap metal and remove unwanted chemical elements. Thereafter steel is supplied to sheet rolling shops, slabber and pipe-rolling shop.

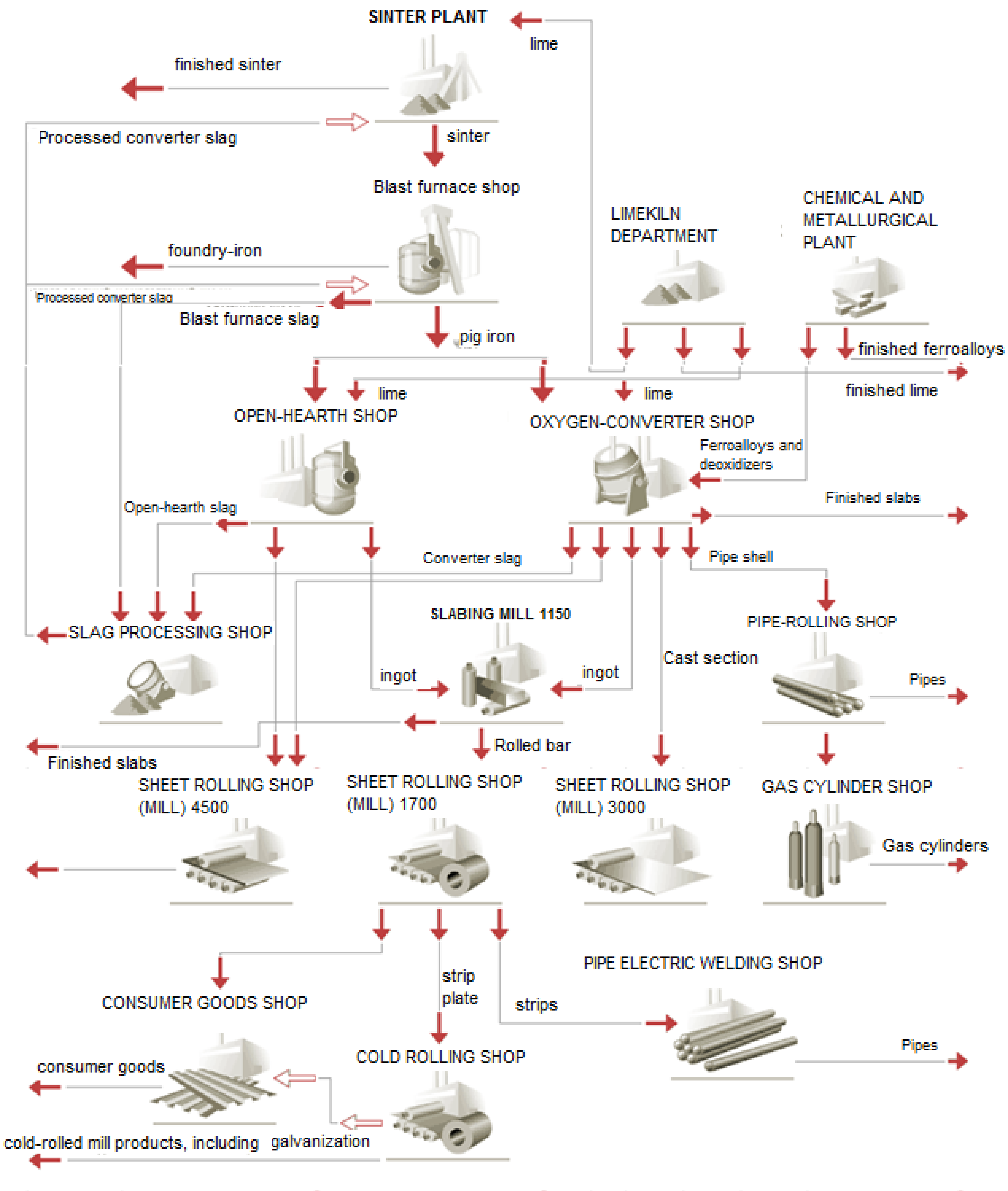

Fig. A.2. General diagram of product output by the plant

Below you can find the detailed description of measures covered by the project.

Reconstruction and upgrade of blast furnaces

For clearer understanding of this Joint Implementation (JI) project, let's consider a detailed description of the blast furnace process flow diagram.

Blast furnace operation is counter-flown. A simplified scheme of the blast furnace can be found on Fig. A.3. Iron-bearing materials (iron ore, sinter, steel pellets), fluxes (lime, limestone) and coke are continuously charged into the top of the blast furnace, while natural gas and the oxygen-rich hot blast are supplied into the bottom. This is how raw materials get top to bottom while gases go up.
Iron is a recovery product of iron-bearing materials. Iron recovery of oxides contained in steel pellets and sinter can be represented by the following chemical reaction equations:

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

As a result of smelting, iron and slag are cast from the cast-house, while hot gases leave through special outlets on the furnace top.

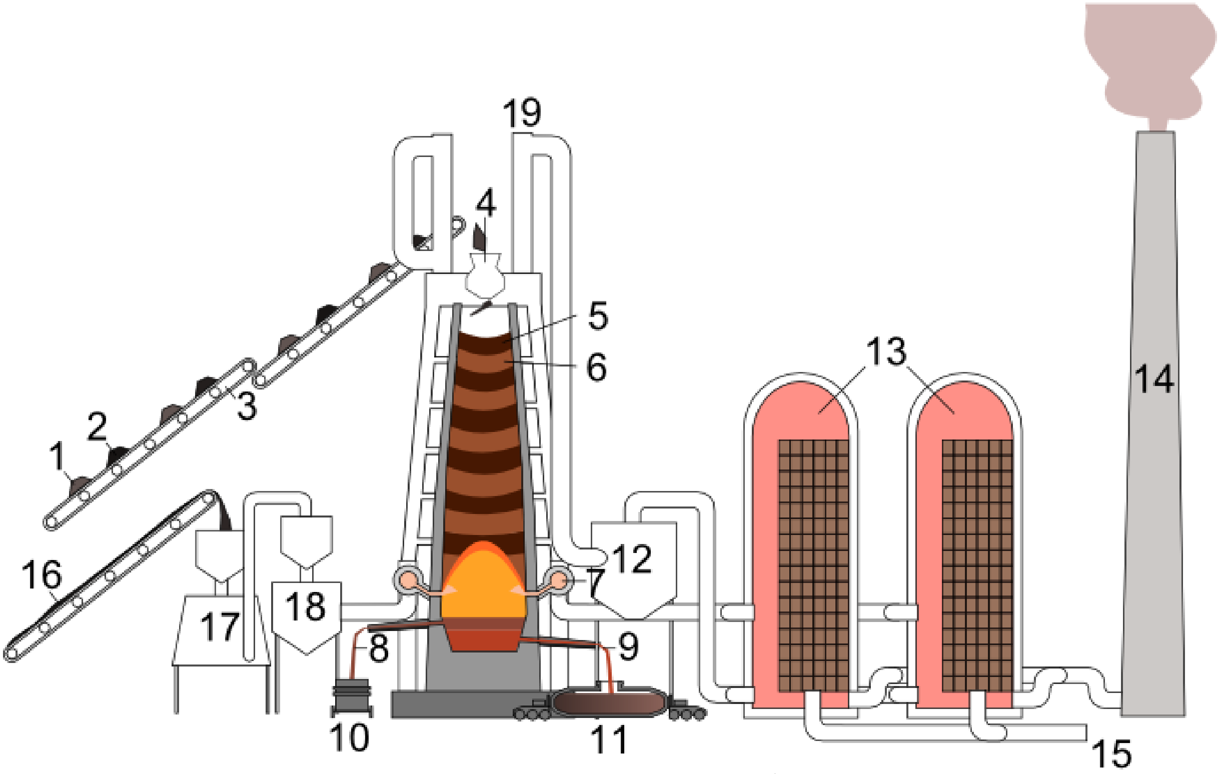

Fig.A.3. Blast furnace[1].

1: Iron ore and sinter	11: Tap for pig iron
2: Coke	12: Dust cyclon for removing dust from exhaust gases before burning them in 13
3: Conveyor belt	13: Air heater
4: Feeding opening, with a valve that prevents direct contact with the internal parts of the furnace and outdoor air	14: Smoke outlet (can be redirected to carbon capture and storage tank)
5: Layer of coke	15: Feed of air
6: Layers of sinter, iron oxide pellets, ore	16: Powdered coal

[1] http://en.wikipedia.org/wiki/File:Blast_furnace_NT.PNG

7: Hot air (around 1200°C)	17: Coke oven
8: Slag	18: Coke bin
9: Liquid pig iron	19: Pipes for blast furnace gas
10: Mixer	

Emissions form iron production can be split into two following categories:

I. Direct emissions from:
   - Coke combustion;
   - Natural gas combustion;
   - Limestone decomposition;

II. Indirect emissions from:
   - Electricity consumption in the blast furnace shop
   - Coke production;
   - Blast production;
   - Sinter production;

Blast furnace shop of the PJSC "IISW" contains 5 Blast Furnaces (hereafter – BF): BF#1, 2, 3, 4 and 5 which are used for iron casting.

Reconstruction of blast furnaces # 2 - 5

The JI project foresees reconstruction of BF #2, 3, 4, 5 to reduce specific consumption of coke and natural gas during iron production. Also, BF # 2,3 reconstruction will include extension of the effective work volume of BF #2 – from 1033 m^3 to 1400 m^3, BF #3 – from 1719 m^3 to 2002 m^3. Implementation of this measure will subsequently increase the iron production volume.

BF #2-5 reconstruction foresees the following measures:

BF #2.
1. Extension of the furnace work volume from 1033 to 1400 m^3;
2. Support system replacement;
3. Elongation of the mounting beam to dust catcher (DC);
4. Reconstruction of the cut-off valve and sleeve on the DC;
5. Replacement of the relay-contactor system with thyristor system;
6. Installation of weigh batching system;
7. Installation of the automatic process control system in the pyrometer room;
8. Replacement of two drilling machines with 1 and 2 tapholes;
9. Installation of the new type discharging curves of the hoist incline.

BF #3.
1. Extension of the furnace working volume from 1719 to 2002 m^3;
2. Installation of new furnace carriages of 12 m volume;
3. Installation of cranes for replacement of furnace carriages;
4. Installation of the new mounting beam with the support on dust catcher (DC);
5. Installation of the automatic process control system in the pyrometer room;
6. Retrofit of the evaporation cooling system (ECS);
7. Installation of the additional shaking slag overflow gutter in the casthouse;
8. Iron tapholes coated with carbon blocks.

BF #4.
1. Installation of the new mounting beam with the support on dust catcher (DC);
2. Equipment of the furnace with the new furnace charge and computer control system;
3. Retrofit of the evaporation cooling system (ECS);

4. Iron tapholes coated with carbon blocks and bedded with fire-proof concrete;
5. Installation of the dust catching with nitrogen system.

BF #5.

1. Full replacement of the blast furnace with replacement of the support system;
2. Replacement of the six support leg rotary separator of the furnace with the three support leg separator;
3. Replacement of all furnace feed conveyors;
4. Replacement of the coke-screening arrangement with its moving apart for repairability;
5. Replacement of skip hoists of coke screenings;
6. Assembly of the annual pipe blowing system;
7. Extension of the tuyere area;
8. Mounting of the charging gas pipeline bridge;
9. Replacement of the cut-off valve sleeve and extension pipe;
10. Replacement of the pure gas pipeline in gas mixing stations behind the pyrometer room;
11. Replacement of squares under the beam crane;
12. Replacement of discharging curves of the skip hoist;
13. Mounting of pulverized coal fuel (PCF) separator site;
14. And other measures.

Reconstruction of BF #3 was finished in October 2003, BF #2 – in August 2005, BF #4 – in July 2007 and BF #5 – in December 2009.

As it was mentioned before, described reconstruction measures ensure increase of the blast furnace efficiency. Modernization and upgrade of the blast furnace equipment results in more effective iron smelting process, as well as higher control accuracy leading to reduced specific consumption of coke, natural gas and electricity. Thus, reconstruction measures under the JI project lead to reduction of GHG emissions from natural gas combustion in blast furnaces and generation of electricity consumed by the blast furnace shop.

Upgrade of blast furnaces (BFs) # 1 - 5

Introduction of separate charge feed of the BF # 1 - 5

Upgrade of BF # 1 – 5 implies implementation of separate charge feed of the furnaces meaning even distribution of the furnace components in the BF working volume to ensure more equal and effective gas flow in the BF, effective use of gas heat and more rational use of coke in the furnace[2].
Implementation of this measure results in reduced specific consumption of coke, as well as increase of the blast furnace efficiency.

Installation of the separate charge feed system in BF # 1 - 5 was completed in June 2002.

Reduced specific coke consumption resulting from implementation of the separate charge feed will lead to reduction of GHG emissions from combustion and production of coke consumed during iron smelting.

Implementation of pulverized coal technology in BFs # 2-5

The next stage of upgrade of BFs # 2-5 will include implementation of the pulverized coal fuel injection systems. Please see Fig. A.4 below for the PCF injection unit scheme.

[2] http://www.zaporizhstal.com/off-line/news/conference/solutions/reports/Gaz_potoki.pdf

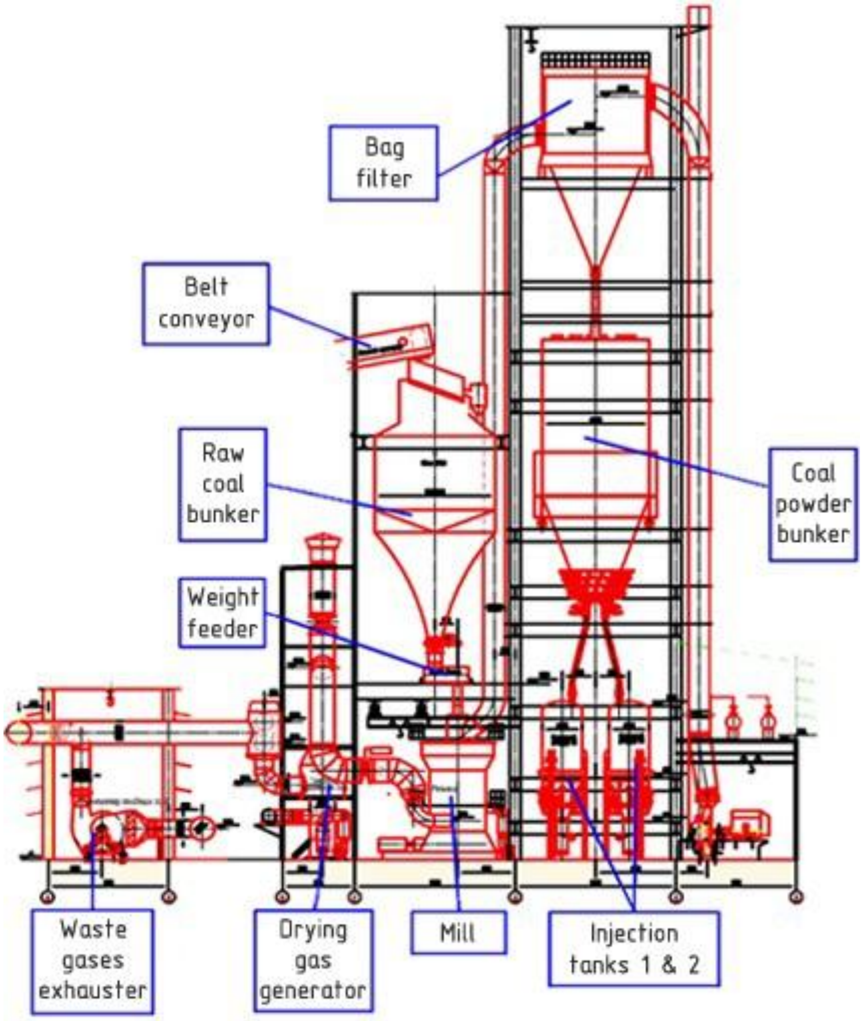

Fig.A.4. PCF injection unit (in section)[3]

Coal is supplied to the coal powder bunker for further pulverized coal preparation. Then, from the coal powder bunker the coal is supplied to the belt weight feeder and transported to the roller mill for its grinding and PCF output. The weight of coal is measured by electronic weighing system, and the volume is controlled by sensors of top and bottom levels. By means of hot gas produced by the drying gas generator, crushed coal is transported to the separator installed on the top of the roller mill. This is the way how large particles of coal are separated and returned for re-grinding, while fine PCF particles are carried by gas into the bag filter. In the bag filter drying gas is separated from coal powder. PCF settles down on the filter walls, and purified drying gas partially returns to the generator. Powder level controllers are installed in the filter bunkers. From bag filters the coal powder moves to the PCF collection bunker where PCF is mixed with nitrogen and further supplied to injection tanks 1&2 facilitating PCF injection into the blast furnace. Injection tanks are also equipped with the electronic weighing system, as well as temperature and pressure controllers.

Implementation of the PCF injection system is planned for 2012.

Usage of the PCF will allow refusing from natural gas for iron production. Thus, implementation of this measure will result in significant reduction of GHG emissions generated during natural gas combustion by the blast furnace shop.

Introduction of AMCOM metallurgical slag processing complexes

[3] http://www.kalugin.biz/en/technologies/pulverized-coal.html

Steel and iron production forms solid waste, including blast furnace slag, converter, and open-hearth furnace slag.
Implementation of smelter (metallurgical) slag processing complexes allows the enterprise: (1) to increase steel and iron smelting efficiency through iron scrap extraction from slag mucks and its further usage in the metallurgical process, (2) improve the environmental situation in the plant territory through removal of slag mucks since smelter slag is environmentally dangerous waste.

The JI project implies implementation of two smelter slag processing complexes – AMCOM 1 and AMCOM 2. Designed capacity of each complex is 300 t of slag per hour at material humidity of 5%, t ≤ 60°C.
Finished product fractional composition can be easily changed through screen replacement.

Key products of the complexes are as follows:

SLAG	0 – 10 mm	10 – 60 mm	60 – 250 mm

PURIFIED SCRAP	0-10 mm	10 – 60 mm	60 – 250 mm	over 250 mm

Hereafter, AMCOM products are used as sinter components consumed by the blast furnace during iron smelting.

Technology process

Technology description is based on the processing chart provided in Fig. A.5. The reflected process starts from charging following the material passing.

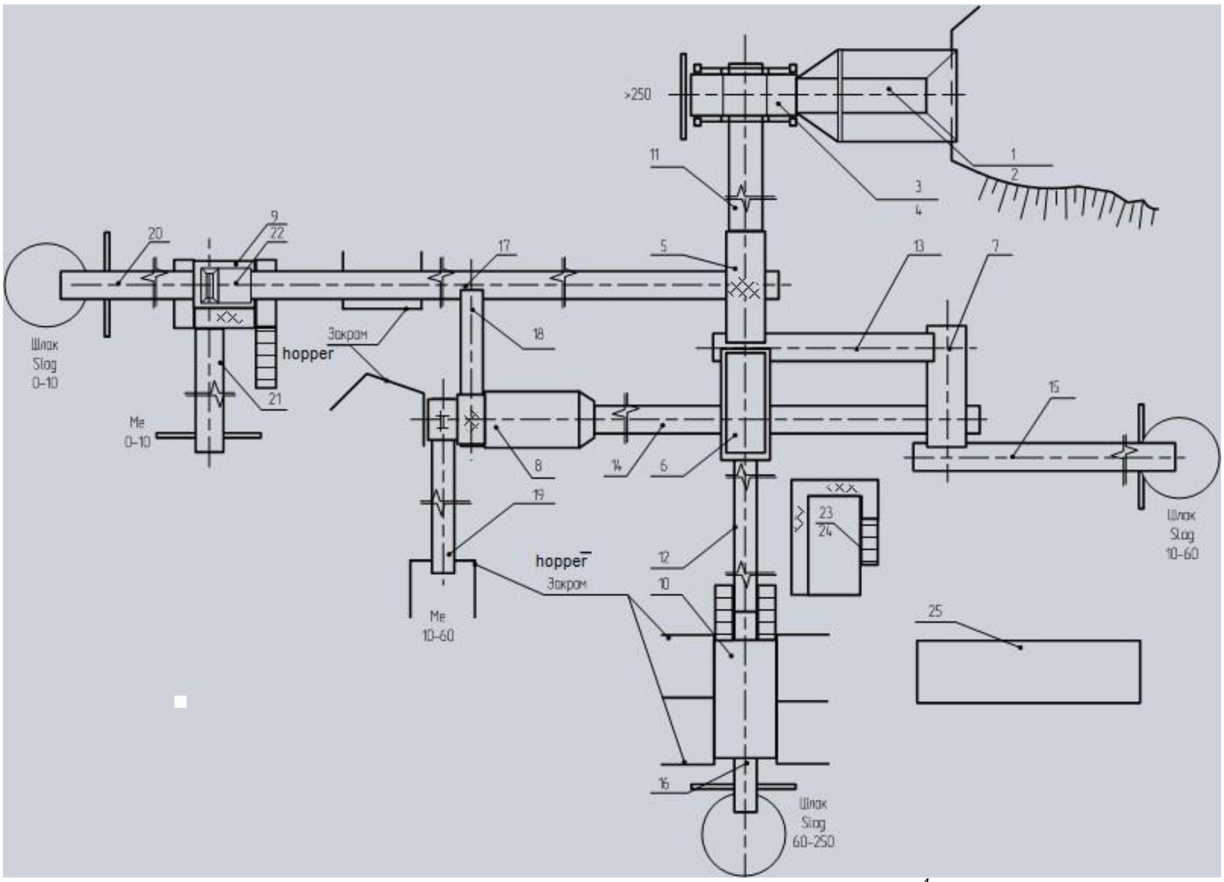

Fig. A.5. Metallurgical slag processing chart[4]

[4] *Source:* http://www.amcom-usa.com/eng/ilyich-tech.html

Slag is loaded to trucks by two hydraulic excavators. Trucks are unloaded into the receiver consisting of the hopper (pos. 1) and vibrofeeder (pos. 2). Additional heating of magnetic separators is provided in winter time. The vibrofeeder supplies slag to the drum screen (pos. 3), which separates pieces over 250 mm. Bigger parts (more than 250 mm) fall down from the screen to the ground, and then the frontal loader transports them to especially adjusted processing bridge. Excavator, along with attachments (the Dropper unit and magnetic washer) crashes big pieces of slag and completely separates metal scrap of over 250 mm.

Slag pieces below 250 mm, after the screen drum, are supplied to 2-deck screen (pos. 5) by vibrofeeder (pos. 4) through the conveyor (pos. 11). The screen drum then splits slag into 3 fractions: 0-10 mm, 10-60 mm and 60-250 mm. Each fraction is supplied to the magnet separators (pos. 9, 7, 6, respectively) where metal is separated from slag. 60-250 mm fractions are delivered to the cleaning drum (pos. 8) for cleaning from slag. Degree of cleaning by the drum is regulated by changing rpm of the drum.

After the cleaning drum, 0-10 mm fractions are brought through the drum’s sieving ring and to the conveyor (pos. 18), and then to the conveyor (pos. 17). Sieving section of the drum (pos. 8) with 60 mm cell directs material through the conveyor (pos. 19) to the finished product hopper. The fraction of 60-250 mm comes into the hopper for the final product. Separated from all flows, 0-10 mm fraction is delivered through the conveyor (pos. 17) to the magnet separation unit (pos. 9), where the non-metal parts are supplied through conveyor (pos. 20) to the hopper for 0-10 mm slag, and metal ones go through the conveyor (pos. 21) to the 0-10 mm metal fraction hopper. Scrap goes from the complex to the finished product store.
Magnet separators (pos. 6, pos. 7) are drum-type ones with the belts. Optimum efficiency and the degree of the separation are regulated by changing the speed of the cleaning drum.
It was planned to install AMCOM-1 in June 2005 and AMCOM-2 – in April 2006.

Metallurgical slag processing by AMCOM-1 and AMCOM-2 complexes with further use of processed slag fractions as sinter components is less energy intensive than sinter production. Thus, implementation of new complexes AMCOM-1 and AMCOM-2 will result in reduction of GHG emissions from consumption and production of energy resources required for sinter production.

Sludge use for sinter production in the sinter plant

This measure covers usage of sludge being by-product of the blast furnace, steel smelting processes, and production waste in sinter plant.
Sludge, depending on its type (blast furnace and steel smelting, etc.), contains from 30% to 50% of iron. This measure implies partial replacement of iron-ore concentrate as a sinter component with sludge in a certain proportion. This way sludge use will help reduce the volume of iron-ore concentrate consumed by the blast furnace shop for sinter production.

Since concentrate production requires natural gas and electricity consumption, decreased iron-ore concentrate demand for sinter production results in reduced need in natural gas and electricity.
In such a manner, implementation of this manner results in reduction of GHG emissions from natural gas consumption and electricity generation in the Ukrainian Unified Power Grid.

Measure implementation plan

Measure implementation milestones of the JI project are provided in the Table A.2 below.

Table A.2. Schedule of measures covered by the JI project[5].

Stage	Measures	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	BF reconstruction											
1.1	BF #2				VIII							
1.2	BF #3		X									
1.3	BF #4						VII					
1.4	BF #5								XII			
2	Implementation of the systems of separate charge feed of the furnaces											
2.1	BF #1	VI										
2.2	BF #2	VI										
2.3	BF #3	VI										
2.4	BF #4	VI										
2.5	BF #5	VI										
3	Implementation of the systems of pulverized coal fuel injection											
3.1	BF #2											I
3.2	BF #3											I
3.3	BF #4											I
3.4	BF #5											I
4	Introduction of new metallurgical slag processing complexes											
4.1	AMCOM-1				VI							
4.2	AMCOM-2					IV						
5	Sludge use for partial sinter replacement				I							

Please see Table A.3 below for the structure of investment expenditures with regard to implementation of measures covered by the JI project.

Table A.3. Structure of investment expenditures

Nr.	Item	Expenses, USD thous.	Share of the full project cost
1	Upgrade of the BF #1	90 000	16.35%
2	Upgrade of the BF #2	107 947	19.61%
3	Upgrade of the BF #3	103 330	18.78%

[5] The Rome figures correspond to relevant month of the year mentioned above corresponding column, for example, "I" stands for January, "IV" stands for April, etc.

4	Upgrade of the BF #4	112 950	20.52%
5	Upgrade of the BF #5	130 565	23.73%
6	Construction of AMCOM-1	3 027	0.55%
7	Construction of AMCOM-2	2 505	0.46%
Total		**550 324**	**100%**

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 project implementation will ensure reduction of greenhouse gas emissions through decreased consumption of coke and natural gas, and will reduce greenhouse gas emissions from electricity generation in the national power grid.

There is no national legislation which would commit the PJSC "IISW" shareholders to invest in the project.

Implementation of the proposed reconstruction project requires significant funding. Currently, domestic project financing is available for a short term (three years), and interest rates are high. It's hard for the Ukrainian companies to obtain project funding in the foreign loan markets because of Ukraine's low international rating, and subsequent high risks associated with the country. The possibility of obtaining ERUs was taken into account when taking the investment decision.

Additional income from the JI mechanism will have a positive impact on the project economic indices. Implementation of the JI project will increase the internal rate of return and reduce the payback period.

Existing blast furnaces BF # 1, BF # 2, BF # 3, BF # BF # 4 and BF #5, and the sinter plant of the PJSC "IISW" may keep operating at least through 2020 subject to regularly performed scheduled repair of the equipment.

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

Providing that Ukrainian authorities issue approval of early credits for 2005 – 2007, proper JI activity monitoring and verification are performed, then emission reductions before the crediting period will be as follows:

Estimation of emission reductions before the commitment period is provided in Table A.4.

Table A.4. Estimation of emission reductions before the first commitment period

	Years
Length of the crediting period	3
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Year 2005	1 364 789
Year 2006	1 276 972

Year 2007	1 530 277
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4 172 038
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 390 679

Estimation of emission reductions within the commitment period is provided in Table A.5.

Table A.5. Estimation of emission reductions within the commitment period

	Years
Length of the crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Year 2008	1 251 633
Year 2009	566 614
Year 2010	1 345 490
Year 2011	1 353 897
Year 2012	2 334 646
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	6 852 280
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 370 456

Estimation of emission reductions after 2012 is provided in Table A.6.

Table A.6. Estimation of emission reductions after the first commitment period

	Years
Length of the crediting period	8
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
Year 2013	2 334 646
Year 2014	2 334 646
Year 2015	2 334 646
Year 2016	2 334 646
Year 2017	2 334 646
Year 2018	2 334 646
Year 2019	2 334 646
Year 2020	2 334 646

Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	18 677 168
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	2 334 646

A.5. Project approval by the Parties involved:

The Project Idea Note (PIN) was submitted to the State Environmental Investment Agency of Ukraine (SEIA) for review. The Letter of Endorsement # 1603/23/7 for the proposed project was issued by the SEIA on June 22, 2011. Upon completion of the Determination Report by the Accredited Independent Entity (AIE), the PDD and Determination Report will be submitted to the SEIA for review in order to obtain the Letter of Approval from the host Party. The Letter of Approval will be obtained from the investing party before the first periodic verification.

SECTION B. Baseline

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

Step 1. Identification and description of the baseline scenario setting approach.

At the time of this PDD preparation, there was no approved Clean Development Mechanism (CDM) methodology which could be used for the baseline scenario setting and calculation of baseline and project emissions. Hence, please see below the JI specific approach developed specifically for the Project "Introduction of Energy Efficiency Measures at PJSC "Ilyich Iron and Steel Works of Mariupol" based on the guidelines provided in the relevant Decision of the Conference of Parties to UNFCCC[6].
According to Guidance on Criteria for Baseline Setting and Monitoring, version 03[7], a JI-specific approach may use selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools, or selected elements of approaches for baseline setting and monitoring already taken in comparable JI cases.
The proposed JI specific approach includes elements of approach used for the baseline setting in the UNFCCC registered JI project, determination of which is deemed final: "Introduction of energy efficiency measures at OJSC "Enakievo Metallurgical Works", PDD version 2.21, ITL project ID: UA1000224[8], as a comparable JI case.
As a comparable case, the JI project "Introduction of energy efficiency measures at OJSC "Enakievo Metallurgical Works" encompasses the similar sources of GHG emissions within its project boundary, it is hosted by the same Party which is Ukraine, and the emission reductions are achieved by the similar measures, such as reconstruction of blast furnaces and implementation of PCI technology.

Also, the proposed JI specific approach includes application of the following methodological tools:

- "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1[9].
- "Tool to Calculate Project or Leakage CO2 Emissions from Fossil Fuel Combustion", Version 02[10].

The baseline scenario has been identified with regard to sectoral reform initiatives, economic situation in the project sector, power sector expansion plans, fuel availability.

Please refer to Section B.1 Step 2 and Section B.2 for detailed information as to the baseline setting approach.

Applicability
The proposed JI specific approach is applied to the project activity which includes the measures of blast furnace reconstruction and introduction of energy efficiency at the plant.

- The project should include only measures requiring capital investments. Maintenance, regular checks and repairs should not be included in the project activity;
- All basic equipment that was used before the project should have the residual life exceeding or equalling to the crediting period;
- The new equipment life should equal to or exceed the crediting period;

Step 2. Application of the chosen approach

Procedure of identification of the most plausible baseline scenario and estimation of additionality

6 Decision 9/CMP.1, Appendix B
7 http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
8 http://ji.unfccc.int/UserManagement/FileStorage/WPHQEOTL2JFDU65MR487XYC1ZB0VN9
9 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v3.0.1.pdf
10 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

To choose the most plausible baseline scenario and justify additionality, the “Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality”, Version 03.0.1, was used. Tool description and application to the project are provided in Section B.2.

Project boundaries

Project boundaries should include GHG emission sources controlled by the project parties and are engaged in the proposed project activity.

The boundaries cover the blast furnace shop (with all blast furnaces and pulverized coal injection systems of all furnaces), AMCOM-1,2 complexes, and sinter plant. All the facilities are located in the plant’s territory. Please see Section B.3 for detailed description of the project boundaries.

Baseline scenario

The baseline scenario assumes further use of existing equipment and performance of scheduled repairs and maintenance without any significant capital investments. Existing technological and investment barriers do not affect the scenario, hence, it’s the most plausible. Other possible scenarios and the baseline scenario justification are described in Section B.2.

When assessing the baseline scenario emissions, CO2 emissions from iron production in blast furnaces #1, #2, #3, #4, #5, from consumption of coke, natural gas, limestone, as well as from consumption of sinter replaced with MOS-2 fraction in the project scenario are taken into account. Emissions of other greenhouse gases, including methane and nitrous oxide, are excluded from the estimation. To calculate emission reductions due to reduced electricity consumption, one should use specific carbon dioxide emission factor for consumption of electricity from the Unified Power System (UPS) of Ukraine in the document "Ukraine - Assessment of new calculation of CEF"[11] and emission levels for class 1 electricity consumers (where the PJSC “IISW” belongs) approved by the orders of National Environmental Investment Agency.

According to approach used in JI project “Introduction of energy efficiency measures at OJSC “Enakievo Metallurgical Works”, PDD version 2.21, the JI specific approach uses historical data on material and energy consumption for the determination of specific consumption per unit of finished product (ex ante). Calculation of the material and energy specific consumption is based on historical data for 4 years preceding the start of project works. The finished product unit under the project is a ton of produced pig iron. For determining the baseline emissions, the actual (ex post) data of pig iron production will be used.

The baseline scenario includes emissions from production of iron ore concentrate replaced with less costly metallurgical sludge with lower GHG emission factor (CO_2-e) under the project. Herewith, this emission factor for concentrate production is calculated based on data of iron ore concentrate production-related energy consumption from three main suppliers of the concentrate to the PJSC “IISW”: Inguletskiy Mining and Processing Integrated Works (MPIW), Pivnichniy MPIW, and Central MPIW.

Also, the baseline scenario includes emissions from production of sinter replaced with the products of AMCOM metallurgical slag processing complex in the project scenario. AMCOM products list iron-bearing fractions of MOS-1 and MOS-2 slag ensuring resource saving during sinter production in the sinter plant and resulting in GHG emission reduction.

Estimation of the equipment residual life

Project crediting period is set as 16 years which is less than historical data on the life of plant’s existing equipment included in the JI project boundaries. Equipment life is provided in Table B.1.

[11] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

Table B.1. Residual life of the equipment included in the JI project boundaries

Facilities	Life period
Blast furnaces #1, 2, 3, 4, 5	till 2020 inclusive

Residual life of blast furnaces and other equipment being in use and included in the project boundaries may be significantly extended, if necessary, due to regular repairs and timely technical maintenance.

In addition, facilities within the JI project boundaries have the residual life exceeding the crediting period due to simultaneous operation of new facilities (system of separate charge feed of the furnaces in the blast furnace shop, AMCOM complex) and old equipment.

Baseline scenario emissions

Baseline emissions from the PJSC "IISW" contain the following components:

1. emissions from iron smelting in blast furnaces (subsequently, these emissions include emissions from consumption of coke, lime, natural gas, and electricity);
2. emissions from production of sinter that is partially replaced with AMCOM products under the project scenario;
3. emissions from production of iron-ore concentrate that is partially replaced with metallurgical sludge under the project scenario;
4. emissions from production of coke, consumption of which was reduced due to upgrade of blast furnaces;

Electricity consumption-related emissions are due to the fossil fuel use in the UPS of Ukraine. Thus, baseline emissions are calculated by the following equation:

$$BE_y = BE_{BF,y} + BE_{Sinter,y} + BE_{IOC,y} + BE_{CP,y} \quad \text{B.1}$$

where:

BE_y : baseline emissions, tCO_2e;
$BE_{BF,y}$: baseline emissions from blast furnaces, tCO_2e;
$BE_{Sinter,y}$: baseline emissions from sinter use, replaced with AMCOM products, tCO_2e;
$BE_{IOC,y}$: baseline emissions from iron-ore concentrate production, replaced with the metallurgical sludge, tCO_2e;
$BE_{CP,y}$: baseline emissions from coke production, consumption of which will be reduced due to the blast furnace upgrade, tCO_2e;
y : year covered by calculations;

Baseline emissions of CO_2 are calculated based on the total consumption of raw materials for iron production: natural gas, coke, lime, electricity. Blast furnace gas is the oxidation and decomposition product of the abovementioned materials. If the blast furnace gas is included in the emission sources, it will result in double calculation, therefore, direct emissions from blast furnace gas consumption are excluded from calculations.

Let's consider the carbon weight balance in blast furnaces. Carbon comes to the furnace together with materials and fuel and leaves as a part of blast furnace gas and iron:

$$C_{fuel} + C_{raw} = C_{BFG} + C_{Product} \quad \text{B.2}$$

where:

C_{fuel} : carbon content in fuel, %
C_{raw} : carbon content in raw materials, %
C_{BFG} : carbon content in blast furnace gas, %

$C_{Product}$: carbon content in product, %

In view that baseline and project scenarios have the equal amount of products, carbon content in products $C_{Product}$ is not taken into consideration hereafter for calculation simplification. Also, since reconstruction of blast furnaces implies significant changes in the auxiliary equipment, GHG emissions from blast furnaces include electricity consumption to cover the plant's needs.

Thus, calculation of emissions from blast furnaces can be represented by the following equation:

$$BE_{BF,y} = \sum_i (EF_{CO2,i,y} * FC_{BL,i,y}) + 44/12 * \sum_j (M_{BL,raw,j,y} * C_{raw,j} * OXID_j) + EC_{BL,BF,y} * EF_{BL,y} \, , \qquad B.3$$

where:

$BE_{BF,y}$: baseline emissions from blast furnaces, tCO_2e;
$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i* with account for oxidation, tCO_2e/TJ;
$FC_{BL,i,y}$: type *i* fuel consumption in the baseline scenario for iron production in year *y*, TJ;
$M_{BL,raw,j,y}$: weight of consumed materials of *j* type in baseline scenario for iron production in year *y*, t;
$C_{raw,j}$: carbon content in the material *j*, %
$OXID_j$: oxidation factor of the material *j*;
$EC_{BL,BF,y}$: electricity consumption by blast furnaces to cover the plant's needs, MWh;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;
44/12 : carbon to carbon dioxide conversion factor;

$$EF_{CO2,i,y} = C_{i,y} * OXID_i * 44/12; \qquad B.4$$

where:

$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i* with account for oxidation, tCO_2e/TJ;
$C_{i,y}$: carbon content in the fuel *i*, tC/TJ;
$OXID_{j,y}$: oxidation factor of the fuel *i;*
44/12 : carbon to carbon dioxide conversion factor.

Fuel and raw material consumption is based on historical data of specific consumption.

$$FC_{BL,i,y} = BSEC_i * P_y \, , \qquad B.5$$

where:
$FC_{BL,i,y}$: *i* type fuel consumption in the baseline scenario for iron production in year *y*, t;
$BSEC_i$: specific *i* fuel consumption, TJ/t;
P_y : iron production in year *y*, t;

Specific consumption is calculated as the ratio of total fuel consumption for the historical period to iron smelting data for the historical period. Historical data comply with actual data for the period of four years preceding to the project activity implementation.

$$BSEC_i = FC_{hist,i} / P_{hist} \, , \qquad B.6$$

where:
$BSEC_i$: specific *i* fuel consumption, TJ/t;
$FC_{hist,i}$: total consumption of *i* type fuel for the historical period, TJ;
P_{hist} : total iron production for the historical period, t;

$$FC_{hist,i} = FF_{hist,i} * NCV_{hist,i} \, , \qquad B.7$$

where:
$FC_{hist,i}$: total consumption of *i* type fuel for the historical period, TJ;
$FF_{hist,i}$: *i* type fuel consumption for the historical period, m^3 or t;
$NCV_{hist,i}$: average net calorific value of *i* fuel consumed for the historical period, TJ/t or TJ/1000 m^3;

$$M_{BL,raw,j,y} = BSMC_j * P_y \,, \qquad \textbf{B.8}$$

where:
$M_{BL,raw,j,y}$: weight of consumed material, type *j*, in the baseline scenario for iron production in year *y*, t;
$BSMC_j$: specific material consumption, *j* type, t/t ;
P_y : iron production in year *y*, t;

$$BSMC_j = M_{raw,hist,j} / P_{hist} \,, \qquad \textbf{B.9}$$

where:
$BSMC_j$: specific material consumption, t/t;
$M_{raw,hist,j}$: total consumption of *j* type materials for the historical period, t;
P_{hist} : total iron production for the historical period, t;

Electricity consumption to cover the plant's needs

$$EC_{BL,BF,y} = BSEEC_{BF} * P_y \,, \qquad \textbf{B.10}$$

where:
$EC_{BL,BF,y}$: electricity consumption by blast furnaces to cover the plant's needs, MWh;
$BSEEC_{BF}$: specific electricity consumption by blast furnaces to cover the plant's needs, MWh/t;
P_y : iron production in year *y*, t;

$$BSEEC_{BF} = EC_{BF,hist} / P_{hist} \,, \qquad \textbf{B.11}$$

where:
$BSEEC_{BF}$: specific electricity consumption by blast furnaces to cover the plant's needs, MWh/t;
$EC_{BF,hist}$: electricity consumption by blast furnaces to cover the plant's needs for the historical period, MWh;
P_{hist} : total iron production for the historical period, t;

Baseline emissions from sinter production replaced with AMCOM products in the project activity are calculated by the following equation:

$$BE_{Sinter,y} = SC_{BL,y} * EF_{BL,\,Sinter} \,, \qquad \textbf{B.12}$$

where:
$BE_{Sinter,y}$: baseline emissions from sinter use, replaced with AMCOM products, tCO_2e;
$SC_{BL,y}$: consumption of sinter, which is replaced with AMCOM products, in year *y*, t;
$EF_{BL,Sinter}$: CO_2 emission factor for sinter production, tCO_2e/t;

Baseline emissions from use of iron-ore concentrate replaced with metallurgical sludge in the project scenario are calculated by the following equation:

$$BE_{IOC,y} = (IOCC_{BL,y} + IOCR_{BL,y}) * EF_{BL,IOC} \,, \qquad \textbf{B.13}$$

where:
$BE_{IOC,y}$: baseline emissions from use of iron-ore concentrate, tCO_2e;
$IOCC_{BL,y}$: iron-ore concentrate consumption in the sinter plant in year *y*, t;
$IOCR_{BL,y}$: consumption of iron-ore concentrate replaced with metallurgical sludge in the project in year *y*, t;

$EF_{BL,IOC}$: CO_2 emission factor for iron-ore concentrate production, tCO_2e/t;

The value of $IOCC_{BL,y}$ is taken from technical reports of the PJSC "IISW" sinter plant.

$$IOCR_{BL,y} = SgC_{BL,y} * RF_{IOC} , \quad B.14$$

where:

$IOCR_{BL,y}$: consumption of iron-ore concentrate replaced with AMCOM products in the project in year *y*, t;

$SgC_{BL,y}$: metallurgical sludge consumption in year *y*, t;

RF_{IOC} : factor of iron-ore concentrate replacement with metallurgical sludge, t/t;

The value of RF_{IOC} is taken as the lowest one in the range of possible factors of concentrate replacement with sludge, which complies with the most conservative approach to calculation of emissions. The range of possible replacement factors was determined by the Technological Department of the PJSC "IISW" sinter plant and makes 0.55 – 0.597 t of iron-ore concentrate / t of sludge[12].

To calculate $EF_{BL,IOC}$, the factor of electricity consumption during iron-ore concentrate production by the key concentrate supplier, Inguletskiy Mining and Processing Integrated Works (MPIW), were applied. $EF_{BL,IOC}$ is calculated by the following equation:

$$EF_{BL,IOC} = (ElC_{IOCP,hist} * EF_{BL}) / P_{IOC,hist} , \quad B.15$$

where:

$EF_{BL,IOC}$: CO_2 emission factor for iron-ore concentrate production, tCO_2e/t;

$ElC_{IOCP,hist}$: electricity consumption during concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period (four years), MWh;

$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;

$P_{IOC,hist}$: total concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period, t;

Implementation of blast furnace upgrade results in reduced coke consumption at the PJSC "IISW". In its turn, it leads to decreased coke production. The amount of saved coke is calculated as follows:

$$BE_{CP,y} = M_{DCC,y} * EF_{BL,CP} - M_{DCCout,y}, * EF_{BL,CP} , \quad B.16$$

where:

$BE_{CP,y}$: CO_2 baseline emissions from production of coke, the consumption of which will be reduced through the blast furnace upgrade, tCO_2e;

$M_{DCC,y}$: weight of coke consumption reduction in the blast furnace shop (BFS), t;

$M_{DCCout,y}$: weight of coke consumption in the blast furnace shop (BFS) which was produced outside Ukraine, t

$EF_{BL,CP}$: CO_2 emission factor for coke production, tCO_2e/t;

Ex-ante value of the parameter $M_{DCCout,y} = 0$, actual value of the parameter $M_{DCCout,y}$ will be determined during the project verification.

The weight of coke consumption reduction at the PJSC "IISW" is calculated as the difference between coke consumption in the baseline and project scenario:

[12] Methodology of PJSC "IISW" Technological Department for the replacement factor calculation was provided to determination team during determination.

$$M_{DCC,y} = M_{BL,C,y} - M_{P,C,y} \, , \qquad \textbf{B.17}$$

where:
$M_{DCC,y}$: weight of coke consumption reduction in the BFS, t;
$M_{BL,C,y}$: coke consumption in the BFS in the baseline scenario, t;
$M_{P,C,y}$: coke consumption in the BFS in the project scenario, t;

Leakage

The approach used in the JI project "Introduction of energy efficiency measures at OJSC "Enakievo Metallurgical Works", PDD version 2.21[13] used for the baseline setting of the proposed project was used to estimate leakages. Within the proposed approach the emission sources from reconstruction of the PJSC "IISW" facilities (emissions from equipment and material transportation, energy resource consumption during construction and installation works) were neglected.
No other emission sources or emission increase outside the project boundaries from the existing sources outside the project have been identified.

Consequently:

$$LE_y = 0, \qquad \textbf{B.18}$$

where:
LE_y : leakage emissions in year y, tCO_2e;

Historical period

Within the historical period, the approach takes several years before implementation of specific projects on improvement of energy efficiency of existing equipment, plants or technologies, i.e. several years of the plant operation before the project activity. It does not cover new equipment and technologies that have been implemented by the PJSC "IISW" within the project boundaries.

Years taken as the historical period for the project activity components are listed in the table below:

Table B.2. Historical period years

Project activity components	Historical period years
Blast furnace upgrade and reconstruction	1998, 1999, 2000, 2001

Key parameters for the baseline setting

Data/Parameter	Total iron production for the historical period, P_{hist}
Data unit	Tonnes
Description	Total iron production by blast furnaces of the PJSC "IISW" four years before the BF reconstruction
Time of determination/monitoring	Once at the start of the project
Source of data (to be) used	PJSC "IISW"
Value of data applied (for ex ante calculations/determinations)	16,632,960

[13] http://ji.unfccc.int/JIITLProject/DB/FX1G65CCXNL6DMJKCKODRF3QL2Z3EF/details

Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	Consumed coke for the historical period, $FF_{hist\ Coke}$
Data unit	Tonnes
Description	Total coke consumption by blast furnaces of the PJSC “IISW” four years before the BF reconstruction
Time of determination/monitoring	Once at the start of the project
Source of data (to be) used	PJSC “IISW”
Value of data applied (for ex ante calculations/determinations)	9,679,676
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	Consumed natural gas for the historical period, $FF_{hist,NG}$
Data unit	1000 m^3
Description	Total natural gas consumption by blast furnaces of the PJSC “IISW” four years before the BF reconstruction
Time of determination/monitoring	Once at the start of the project
Source of data (to be) used	PJSC “IISW”
Value of data applied (for ex ante calculations/determinations)	1,240,404
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	Average net calorific value of natural gas consumed for the historical period, $NCV_{hist,i}$
Data unit	kcal/m^3
Description	Average net calorific value of natural gas four years before the BF reconstruction

Time of determination/monitoring	Once at the start of the project
Source of data (to be) used	PJSC "IISW"
Value of data applied (for ex ante calculations/determinations)	8012
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Value of 0.033545 TJ/1000 m^3 applied using the following conversion: 1 kcal/m^3 = (4.1868 TJ/m^3*1000)/1000000

Data/Parameter	Total coke consumption for the historical period, $M_{raw,hist,Coke}$
Data unit	tonnes
Description	Total limestone consumption for the period of four years before the BF reconstruction project.
Time of determination/monitoring	Not applicable
Source of data (to be) used	PJSC "IISW"
Value of data applied (for ex ante calculations/determinations)	9,679,676
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	Total limestone consumption for the historical period, $M_{raw,hist,Limestone}$
Data unit	tonnes
Description	Total limestone consumption for the period of four years before the BF reconstruction project.
Time of determination/monitoring	Not applicable
Source of data (to be) used	PJSC "IISW"
Value of data applied (for ex ante calculations/determinations)	693,987
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001

QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	Total electricity consumption by blast furnaces to cover the plant's needs for the historical period, $EC_{BF,hist}$
Data unit	MWh
Description	Electricity consumption by blast furnaces to cover the plant's needs four years before the BF reconstruction
Time of determination/monitoring	Not applicable
Source of data (to be) used	PJSC "IISW"
Value of data applied (for ex ante calculations/determinations)	117,524
Justification of the choice of data or description of measurement methods and procedures (to be applied)	data for 1998 – 2001
QA/QC procedures (to be) applied	Not applicable
Any comment	Not applicable

Data/Parameter	P_y
Data unit	Tonnes
Description	Amount of pig iron produced in year *y*
Time of determination/monitoring	Monitored throughout the crediting period
Source of data (to be) used	PJSC "IISW" records
Value of data applied (for ex ante calculations/determinations)	Not applicable
Justification of the choice of data or description of measurement methods and procedures (to be applied)	Measurement of the amount of produced iron is carried out using tensometric balance and tensometric wagon balance.
QA/QC procedures (to be) applied	Calibration is performed in accordance with GOST29329-92.
Any comment	Not applicable

Data/Parameter	$EF_{BL,CP}$
Data unit	tCO_2e/t
Description	CO_2 emission factor for coke production
Time of determination/monitoring	Monitored throughout the crediting period

Source of data (to be) used	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use Chapter 4: Metal Industry Emissions, Table 4.1, Pg. 4.25 *http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf*
Value of data applied (for ex ante calculations/determinations)	0.56
Justification of the choice of data or description of measurement methods and procedures (to be applied)	2006 IPCC default value applied
QA/QC procedures (to be) applied	CO_2 emission factor for coke production is checked on the annual basis
Any comment	Not applicable

Data/Parameter	$EF_{BL,Sinter}$
Data unit	tCO_2e/t
Description	CO_2 emission factor for sinter production
Time of determination/monitoring	Monitored throughout the crediting period
Source of data (to be) used	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use Chapter 4: Metal Industry Emissions, Table 4.1, Pg. 4.25 *http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf*
Value of data applied (for ex ante calculations/determinations)	0.20
Justification of the choice of data or description of measurement methods and procedures (to be applied)	2006 IPCC default value applied
QA/QC procedures (to be) applied	CO_2 emission factor for sinter production is checked on the annual basis
Any comment	Not applicable

Parameters subject to monitoring are provided in Tables D.1.1.1. and D.1.1.3. of Section D.

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:

GHG emissions will be reduced due to upgrade of the blast furnaces #1, #2, #3, #4 and #5, implementation of the pulverized coal injection into blast furnaces, construction of the new slag processing complex AMCOM-1 and AMCOM-2, and implementation of the technology of partial replacement of the iron-ore concentrate with metallurgical sludge. These measures result in decreased consumption of coke, electricity and natural gas for iron production. In the absence of the project, iron will be produced by old blast furnaces featured by inefficient consumption of coke and natural gas.

To choose the most plausible baseline scenario and analyze additionality, the JI specific approach is applied. The JI specific approach is based on the guidance provided by the "Joint Implementation Determination and Verification Manual", Version 01[14]. For the sake of transparency, selected steps from the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1[15] were applied.

According to the "Joint Implementation Determination and Verification Manual", Version 01, the additionality of a JI project can be proven by means of "Provision of traceable and transparent information that an AIE has already positively determined that a comparable project (to be) implemented under comparable circumstances (same GHG mitigation measure, same country, similar technology, similar scale) would result in a reduction of anthropogenic emissions by sources or an enhancement of net anthropogenic removals by sinks that is additional to any that would otherwise occur and a justification why this determination is relevant for the project at hand".

Three JI projects with positive determination by an AIE are used to justify the additionality of the proposed JI project at PJSC "IISW":

UA1000224: Introduction of Energy Efficiency Measures at OJSC "Enakievo Metallurgical Works"[16] (hereinafter referred as "EMW JI project")
UA1000266: Reconstruction of the Agglomerate and Blast-Furnace Production at the JSC "Zaporizhstal"[17] (hereinafter referred as "Zaporizhstal Blast Furnace JI project")
UA1000223: Energy Efficiency Measures at the "Public Joint Stock Company Azovstal Iron & Steel Works"[18] (hereinafter referred as "Azovstal JI project")

Analysis of the circumstances of the abovementioned projects compared to the proposed JI project at PJSC "IISW" is given below.

Host country
The regional location and host country of the reference projects and the JI project of PJSC "IISW" is summarized in the table below.

Table B.3. Geographical location of the reference projects and the JI project of PJSC "IISW"

Project name	Host country	Region
PJSC "IISW" JI project	Ukraine	Donetsk region
EMW JI project	Ukraine	Donetsk region
Zaporizhstal Blast Furnace JI project	Ukraine	Zaporizhzhya region
Azovstal JI project	Ukraine	Donetsk region

All the four projects are located in Ukraine. PJSC "IISW" JI project, EMW JI project and Azovstal JI are located in Donetsk region. Zaporizhstal Blast Furnace JI project is located in Zaporizhzhya region, neighbouring to Donetsk region. Thus, all the four projects shall have equal access to fuel and raw materials. All the projects above are located in the two neighbouring regions of Ukraine and operate under similar market conditions.

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[14] http://ji.unfccc.int/Ref/Documents/DVM.pdf

[15] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v3.0.1.pdf

[16] http://ji.unfccc.int/JIITLProject/DB/FX1G65CCXNL6DMJKCKODRF3QL2Z3EF/details

[17] http://ji.unfccc.int/JIITLProject/DB/G5P4Z3P4PMAT334JESD6O99RW4258V/details

[18] http://ji.unfccc.int/JIITLProject/DB/SH8R5WAZQ92CWBIXEZPJMSGCVXT2KS/details

Projects' scale

The expected emission reductions of the reference projects and the JI project of PJSC "IISW" within the Kyoto Protocol commitment period is summarized in the table below.

Table B.4. Scale of the reference projects and the JI project of PJSC "IISW"

Project name	Project starting date	Emission reductions (2008 – 2012), t CO2e
PJSC "IISW" JI project	01.06.2002	6 852 280
EMW JI project	01.01.2006	2 470 498
Zaporizhstal Blast Furnace JI project	01.01.2003	1 738 152
Azovstal JI project	06.02.2003	4 551 923

All the four projects are large-scale JI projects with annual average emission reductions above 300 000 t CO2e. Thus, all the projects presented above are of the same scale. All of the projects have started within the same time period between 2002 and 2006.

Technology and GHG mitigation measure

Technological measures used at PJSC "IISW" JI project are compared to the reference projects in the table below. Modernization measures are divided between the production shops which are typically present at any iron and steel facility.

Table B.5. GHG mitigation measures applied within the main facilities of the reference projects and the JI project of PJSC "IISW"

Project name	Blast furnace shop	Sinter shop
PJSC "IISW" JI project	Yes	Yes
EMW JI project	Yes	No
Zaporizhstal Blast Furnace JI project	Yes	Yes
Azovstal JI project	Yes	Yes (indirectly)

Major reconstruction of the existing blast furnaces is foreseen by all four of the abovementioned projects. Zaporizhstal Blast Furnace JI project foresees modernization of three blast furnaces, with further introduction of pulverized coal at four blast furnaces. Azovstal JI project foresees modernization of three blast furnaces. EMW JI Project foresees modernization of two blast furnaces with further introduction of pulverized coal at these two blast furnaces. Thus, all three of the reference projects above employ the same technologies aimed at GHG emissions reduction in the blast furnace department compared to PJSC "IISW", where five existing blast furnaces are reconstructed with further introduction of pulverized coal at all of the blast furnaces.

Measures aimed on GHG emissions reduction from sinter shop are foreseen by three of the abovementioned projects. Zaporizhstal Blast Furnace JI project envisages the construction of a new sintering machine. Azovstal JI project foresees increase of iron content in pellets, therefore reducing consumption of iron-containing products including sinter. This measure indirectly leads to decrease of GHG emissions from the sinter shop of Azovstal. PJSC "IISW" JI project involves construction of AMCOM-1 and AMCOM-2 units resulting in substantial decrease of sinter consumption and therefore decrease of GHG emissions from the sinter shop.

Thus, the technologies and GHG emissions mitigation measures applied within the PJSC "IISW" JI project are similar to those applied at EMW JI project, Zaporizhstal Blast Furnace JI project, and Azovstal JI project.

JI project of PJSC "IISW" is similar to three other JI projects already positively determined by AIEs in terms of same GHG mitigation measure, same country, similar technology and scale, as shown above. Therefore, the JI project of PJSC "IISW" is additional.

For the sake of transparency the following steps of the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1 were performed:

Step 1. Identifying project activity alternatives
Step 2. Barrier analysis
Step 3. Investment analysis
Step 4. Analysis of prevailing practices

Step 1. Identification of the project activity alternatives

The indicated step identifies all alternatives to the project activity that can be recognized as the baseline scenario.

Step 1a. Identification of alternative scenarios to the project activity
All possible realistic alternatives similar to the proposed project activity under the Joint Implementation mechanism can be alternatives to the baseline scenario.
According to the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1, the following alternatives should be included:

S1: The proposed project activity undertaken without being registered as a JI project activity;

S2: Where applicable, no investment is undertaken by the project participants but third party(ies) undertake(s) investments or actions which provide comparable outputs or services to users of the project activity;

S3: Where applicable, the continuation of the current situation, *not* requiring any investment or expenses to maintain the current situation;

S4: Where applicable, the continuation of the current situation, requiring an investment or expenses to maintain the current situation;

S5: Other plausible and credible alternative scenarios to the project activity scenario, including the common practices in the relevant sector, which deliver outputs or services (e.g. electricity, heat or cement) with comparable quality, properties and application areas, taking into account, where relevant, examples of scenarios identified in the underlying methodology;

S6: Where applicable, the proposed project activity undertaken without being registered as a JI project activity to be implemented at a later point in time (e.g. due to existing regulations, end-of-life of existing equipment, financing aspects).

The scenarios S2, S4, and S6 from the listed above are not applicable for the proposed JI project.
The following scenarios are applicable and possible:

- Planned project activity without JI mechanism implementation (S1);
- All other possible and plausible scenarios along with the prevailing practices in the relevant sector with similar production capacities (S5);
- If possible, continuation of the existing practice (S3).

There are three alternatives to the baseline scenario mentioned before the project implementation, in particular:

A.1. Upgrade of the blast furnaces #1 – 5, implementation of the pulverized coal injection into blast furnaces, construction of the new slag processing complexes AMCOM-1 and AMCOM-2, and implementation of the technology of partial replacement of the iron-ore concentrate with metallurgical sludge (project activity without JI mechanism implementation).

A.2. Continuation of operation of the existing blast furnaces without any reconstruction. It means continuation of the current situation at the PJSC "IISW" before the project activity implementation.

A.3. Construction of new blast furnaces with new auxiliary equipment, construction of the new sinter plant.

Outcome of Step 1a: Thus, the plausible alternative scenarios include A1, A2, and A3 alternative scenarios.

Step 1b. Compliance with current laws and regulations

All indicated alternatives do not conflict with the current law, and the legislation does not commit plants to use any of the proposed alternatives. The national metallurgical policy is represented by the Decree of the Cabinet of Ministers of Ukraine #967 "State Program of Development and Reforming of the Mining and Metallurgical Sector for the Period until 2011" as of 28.07.2004. This program implies upgrade of blast furnaces and use of pulverized coal fuel instead of natural gas. However, the program's provision is not compulsory for implementation. Also, the "Energy Strategy of Ukraine for the period up to 2030[19] approved on 15.03.2006 implies increasing of energy consumption efficiency and minimization of energy resources import dependency, such as natural gas. Other Ukrainian laws do not stipulate commitments to implementation of any proposed alternatives.

Outcome of Step 1b: Thus, all indicated alternatives A1, A2, and A3 are in compliance with mandatory legislation and regulations.

Step 2. Barrier analysis

Step2a. Identification of barriers that may hinder implementation of alternatives

Technological barriers
According to the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1, the technological barriers could be as follows:

- Skilled and/or properly trained labor to operate and maintain the technology is not available in the relevant geographical area, which leads to an unacceptably high risk of equipment disrepair, malfunctioning or other underperformance;
- Lack of infrastructure for implementation and logistics for maintenance of the technology (e.g. natural gas can not be used because of the lack of a gas transmission and distribution network);
- Risk of technological failure: the process/technology failure risk in the local circumstances is significantly greater than for other technologies that provide services or outputs comparable to those of the proposed JI project activity, as demonstrated by relevant scientific literature or technology manufacturer information;
- The particular technology used in the proposed project activity is not available in the relevant geographical area.

For the proposed JI project scenarios, the applicable barriers from the listed above are defined below.
At the time of commissioning of new equipment, there are risks which can substantially weaken scenarios related to implementation of projects, namely:

[19] http://zakon.rada.gov.ua/signal/kr06145a.doc

a) Production suspension risk due to the new equipment launch

Operation of blast furnaces is a technologically complex process. At the same time, the project has certain technological risks arising from reconstruction and subsequent operation of blast furnace equipment. Installation and operation of new equipment covered by the project can result in unforeseeable suspension of production because of the new equipment failure.

b) Loss of the market share risk

As indicated above, use of the newest technologies can be related to unforeseeable suspension and delays. At the same time, it can affect the finished product output and reduce the company's expected income or even may result in the partial loss of the market share. An additional profit from sale of ERUs will help to overcome this risk.

Investments barrier

PJSC "IISW" is a Public Joint-Stock Company registered in Ukraine since 30.12.1996. The company's main shareholders as of 2011 are "Ukrainian Depositary Company" LLC and "Illich Stal" CJSC[20]. Since 2010 PJSC "IISW" is a part of Metinvest Holding[21]. More detailed financial information is given under Annex 4 (Financial plan of the project).

Successful implementation of projects at the PJSC "IISW" is closely related to the world prices for iron industry and energy resources. Landslide of world prices for ferrous industry has substantially weakened possibilities of the plant to invest in new technologies and equipment.
Sale[22] of the Industrial Union of Donbass (IUD) is an example of difficult times faced by the iron industry in Ukraine, and the fact this industry is incapable to implement large-scale projects without any loans. Projects at Alchevsk Metallurgical Plant as a part of IUD are being implemented under the JI[23] mechanism, however, it was not enough to keep the IUD from the sale because of insufficient funds. Thus, the example of IUD, with its considerable debts caused by upgrade of industrial capacities, proves the fact of the investment barrier faced by the Ukrainian iron and steel plants.

Also, investing opportunities of the PJSC "IISW" are worsened by the energy price increase. The offered project's access to financial resources is extremely limited at the international level. An investment climate of Ukraine is considered to be rather bad, especially compared to the nearby countries. A confirmation of the mentioned above is Fitch's sovereign rating of Ukraine in comparison to some nearby East European states:
- Ukraine B-
- Poland A-
- Hungary BBB
- Slovakia A+

In view of considerable capital investments required for implementation of the offered project, receiving funds from the international institutions can be quite difficult. Funding opportunities at the national level are limited to. Nowadays, the practice of Ukrainian commercial banks in Ukraine is project financing at about 19.5% rate for up to three years in the national currency[24]. The examples are the largest bank institutions of Ukraine, such as Pravex Bank (www.pravex.com.ua), Raiffeisen Bank Aval (www.aval.ua), Privatbank (www.privatbank.com.ua).

[20] http://acc.smida.gov.ua/emitents/owners_zvit.php?id=00191129

[21] http://www.metinvestholding.com/upload/metinvest/report/22/Metinvest%20AR10_web.pdf
[22] http://www.bbc.co.uk/ukrainian/business/2010/01/100111_isd_analysis_it.shtml
[23] http://ji.unfccc.int/UserManagement/FileStorage/ETVRLX61BH8MDPQ4JK9YWZI20UGO37
http://ji.unfccc.int/UserManagement/FileStorage/AQF0TM19HROY38IC7WXLBPK5EDZV2U

[24] Cited 02.01.2012: http://bank.gov.ua/Fin_ryn/Pot_tend/2002.zip

Thus, the limited access to financing and the company's insufficient funds establish a substantial obstacle to implementation of the projects related to significant investments. Project registration as the JI project will allow to overcome this barrier and at least to complete the projects that have been already started.

Lack of prevailing practice
Lack of prevailing practice barrier is not applicable as each of the alternative scenarios is not the "first of its kind".

Outcome of Step 2a: The barriers mentioned above affect the projects on investing and new equipment installation, namely, they have an influence on the alternatives A.1 and A.3.

Step 2b. Exclusion of alternatives affected by the mentioned barriers

Alternative A.1. (Reconstruction without the JI mechanism) and A.3. (Constructions of new blast furnaces with new auxiliary equipment, new sinter shop) must be excluded from further consideration as possible alternatives of setting the baseline scenario since they are affected by the mentioned barriers. Scenario A.2. (Continued operation of old blast furnaces for iron smelting without reconstruction) is the only one not requiring considerable investments and new equipment installation.

Outcome of Step 2b: Only Alternative A.2. is not affected by the barriers.
Since only one Alternative A.2. is not affected by any of the barriers, and this Alternative is not the offered project without the JI mechanism, it is accepted as the baseline scenario.

Step 3. Investment analysis

"Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 03.0.1, states that the comparative analysis of investments is conducted for alternative scenarios left after Step 2. As after Step 2 there is only one alternative not affected by barriers, the investment analysis is not reasonable.
Outcome of Step 3: As there is only one alternative not affected by barriers and the investment analysis is not reasonable, we proceed to Step 4.

Step 4. Common practice analysis

Complete reconstruction of blast furnaces is not a common practice in Ukraine. As of today, besides PJSC "IISW", there are only four enterprises performing reconstruction of blast furnaces, in particular, OJSC Alchevsk Iron & Steel Works, OJSC Dniprovskiy Iron and Steel Works named after Dzerzhinsky, OJSC Enakievo Metallurgical Works, but all of them are using the JI mechanism.

Outcome of Step 4: The step 4 is satisfied as the observed activities similar to the proposed JI project activity are going to use JI mechanism, and, therefore, the project activity is not a common practice.

Conclusion:
Since all steps are fully completed, and the influence of the offered JI project will mitigate technological, economic, and financial obstacles, and will facilitate complete implementation of the project, the project is additional.

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

Project boundaries

The emission estimation approach takes into account carbon dioxide emissions from iron smelting in blast furnaces #1, #2, #3, #4, #5, use of pulverized coal fuel in blast furnace shop, implementation of AMCOM slag processing complex, and introduction of technology of partial replacement of iron-ore concentrate with metallurgical sludge. The abovementioned facilities are the sources of CO_2 emissions, and fall within the project boundaries. Fig. B.1 demonstrates the baseline and project scenario boundaries. All listed facilities are located within the PJSC "IISW".

The approach used in the JI project “Introduction of energy efficiency measures at OJSC “Enakievo Metallurgical Works”, PDD version 2.21[25] used for the baseline setting of the proposed project was used to estimate leakages. Within the proposed approach the emission sources from reconstruction of the PJSC “IISW” facilities (emissions from equipment and material transportation, energy resource consumption during construction and installation works) were neglected.

No other emission sources or emission increase outside the project boundaries from the existing sources outside the project have been identified.

[25] http://ji.unfccc.int/JIITLProject/DB/FX1G65CCXNL6DMJKCKODRF3QL2Z3EF/details

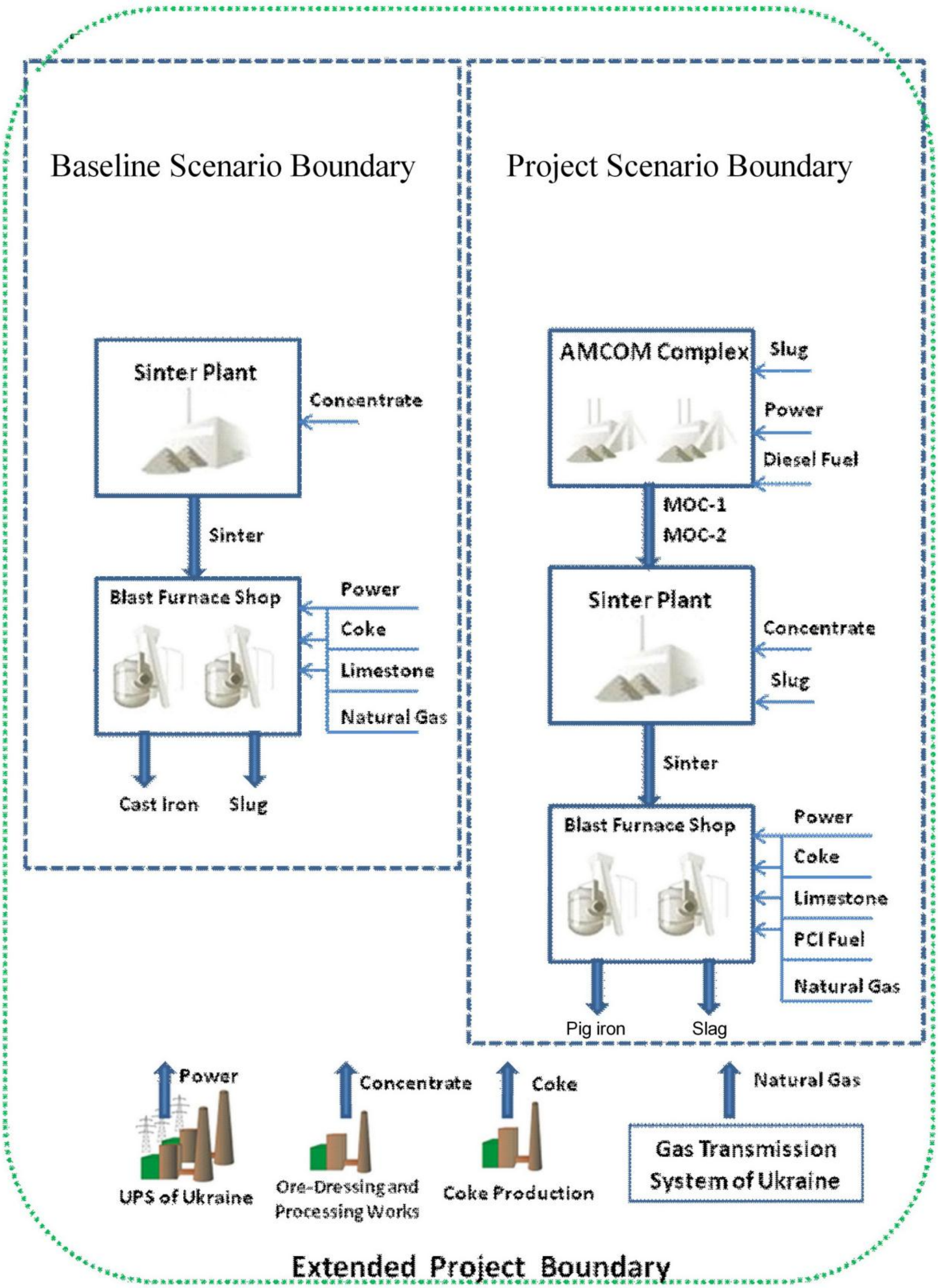

Fig. B.1. Project and baseline scenario boundaries

Please see Table B.6. below for the list of emission sources and greenhouse gases included in the project boundaries.

Table B.6. Sources of emissions and GHG emissions included in or excluded from the project boundaries

	Source	*GHG*	Included Yes/NO	Description
Baseline scenario	Emissions from coke oxidization in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from limestone use in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from natural gas consumption in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from fossil fuel consumption for electric power generation	CO_2	Yes	CO2 is a key source of GHG emissions
	Emissions from coke production	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from production of concentrate replaced by metallurgical sludge in the project.	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from production of sinter replaced by MOS-1 and MOS-2 fractions in the project	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
Project scenario	Emissions from coke oxidization in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification

	Emissions from coke production	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from production of concentrate	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from limestone use in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from natural gas consumption in blast furnaces	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from fossil fuel consumption for electric power generation	CO_2	Yes	CO2 is a key source of GHG emissions
	Emissions from coal consumption in the blast furnace shop	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from processing (transportation) of sludge partially replacing concentrate in the sinter shop	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification
	Emissions from slag processing by AMCOM complex	CO_2	Yes	CO2 is a key source of GHG emissions
		CH_4	No	Insignificant source, it is a conservative simplification
		N_2O	No	Insignificant source, it is a conservative simplification

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

Baseline study completion date - 01/07/2011.
The baseline was studied by GreenStream Network GmbH (not the project participant).

GreenStream Network GmbH
Address: Stralauer Platz 33/34,
10243 Berlin,
Germany

Responsible person: Yevgen Georgiyovych Groza
Title: Director, Ukraine
Phone: +380 67 379 09 13
Phone/fax: +49 30 701 7053 29
E-mail: yevgen.groza@greenstream.net
www.greenstream.net

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01.06.2002 is the starting date of upgrade implementation of the blast furnaces # 1 - 5.

C.2. Expected operational lifetime of the project:

The operational life of equipment is 19 years at least. Therefore, the operational lifetime of the project is 19 years or 228 months.

C.3. Length of the crediting period:

Crediting period starting date: 01/01/2005.
Duration of the crediting period: 16 years and 0 months or 192 months.

Crediting period before the Kyoto Protocol's period of validity is 3 years (36 months).

Crediting period during the Kyoto Protocol's period of validity starts on 01/01/2008, crediting period length is 5 years (60 months).

Post-Kyoto Protocol crediting period is 8 years (96 months).

The total length of the period of transfer of the approved anthropogenic GHG emission reductions is 16 years and 0 months.
Transfer starting date: 01/01/2005; transfer ending date: 31/12/2020.

The status of emission reductions or absorption extensions generated by the JI project after completion of the first commitment period can be determined by relevant decisions of the UNFCCC and is subject to approval by the host Party.

SECTION D. Monitoring Plan

D.1. Description of monitoring plan chosen:

According to Guidance on Criteria for Baseline Setting and Monitoring, version 03[26] paragraph 9 (a), a JI-specific approach may use selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools, or selected elements of approaches for baseline setting and monitoring already taken in comparable JI cases.
The proposed JI specific approach includes approach used for the monitoring in the UNFCCC registered JI project, determination of which is deemed final: "Introduction of energy efficiency measures at OJSC "Enakievo Metallurgical Works", PDD version 2.21, ITL project ID: UA1000224[27], as a comparable JI case.
As a comparable case, the JI project "Introduction of energy efficiency measures at OJSC "Enakievo Metallurgical Works" encompasses the similar sources of GHG emissions within its project boundary, it is hosted by the same Party which is Ukraine, and the emission reductions are achieved by the similar measures, such as reconstruction of blast furnaces and implementation of PCI technology.

Collected monitoring data shall be archived in electronic and/or paper format. The measurements are to be done by the calibrated metering equipment in accordance with the industrial standards. All data collected for monitoring are kept for two years at least after the last transfer of ERUs.

The key factor for blast furnaces objectively reflecting any GHG emission reduction (CO_2e) is reduction of specific consumption of coke and electricity per tonne of cast iron.
For AMCOM shop the GHG emission reduction factor is the difference between the emission volume before and after AMCOM complex implementation. This estimation approach will be applied to estimation of the effect of GHG emission reductions from implementation of the metallurgical sludge utilization through partial replacement of the iron-ore concentrate in the sinter plant.

Key parameters subject to monitoring in the crediting period are provided below. Parameters to be defined once for the whole crediting period and not subject to monitoring are provided in Section B.1. Other parameters out of monitoring are derivatives that should be calculated using initial parameters indicated in the monitoring plan or Section B.1.

Project emissions

To estimate project emissions, the parameters below are subject to monitoring:

$M_{raw,j,y}$: weight of *j* type material for iron production in the project scenario in year *y* , t;
$FF_{i,y}$: volume of consumed *i* fuel in year *y* (coke, natural gas, coal, diesel fuel), m^3 or t;

[26] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
[27] http://ji.unfccc.int/UserManagement/FileStorage/WPHQEOTL2JFDU65MR487XYC1ZB0VN9

$NCV_{i,y}$: average net calorific value of *i* fuel consumed in year *y*, TJ/t or TJ/10^3 m^3;
$C_{raw,j}$: carbon content in material *j*, %;
$EC_{BF,y}$: electricity consumption by blast furnaces in year *y*, MWh;
$EC_{AMCOM,y}$: electricity consumption by AMCOM complex in year *y*, MWh;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, kgCO_2e/kWh or tCO_2e/MWh;
$EF_{CO2,i}$: CO_2 emission factor for consumed fuel *i* (natural gas, coal, diesel fuel), tCO_2e/TJ or tCO_2e/t;
$DFC_{AMCOM,y}$: diesel fuel consumption by AMCOM complex in year *y*, t;
$SC_{,y}$: metallurgical sludge consumption by the sinter plant in year *y*, t;
$IOCC_{,y}$: iron-ore concentrate consumption by the sinter plant in year *y*, t;
$NCV_{dies,y}$: net calorific value of diesel fuel in year *y*, TJ/t;
$P_{AMCOM\ BF,y}$: quantity of processed slug by AMCOM complex for the blast furnace shop in year *y,* t;
$P_{AMCOM,y}$: total quantity of processed slug by AMCOM complex in year *y,* t.
$C_{i,y}$: carbon content in the fuel *i*, tC/TJ;
$OXID_{j,y}$: oxidation factor of the fuel *i;*
$C_{DF,y}$: carbon content in diesel fuel, tC/TJ;
$OXID_{DF,y}$: oxidation factor of diesel fuel.

Baseline emissions

For the blast furnace shop, baseline emissions are calculated based on the amount of produced iron and specific factor of emissions per one tone of produced iron. For AMCOM complex implementation and utilization of metallurgical sludge in the sinter plant, baseline emissions are calculated as emissions that would occur without implementation of the mentioned projects.

Thus, to estimate baseline emissions, the following parameters are subject to monitoring:

P_y : iron production in year *y*, t;
$C_{raw,j}$: carbon content in material *j*, %;
$EF_{CO2,CP}$: CO_2 emission factor for coke production, tCO_2e/t;
$EF_{BL,Sinter}$: CO_2 emission factor for sinter production, tCO_2e/t;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, kgCO_2e/kWh or tCO_2e/MWh;
$IOCC_{BL,y}$: iron-ore concentrate consumption in the sinter plant in year *y*, t;
$SC_{BL,y}$: consumption of sinter, which is replaced with AMCOM products, in year y, t;
$SgC_{BL,y}$: metallurgical sludge consumption in year *y*, t;
$C_{i,y}$: carbon content in the fuel *i*, tC/TJ;
$OXID_{i,y}$: oxidation factor of the fuel *i;*

Carbon content in limestone is determined based on the chemical analysis performed by the laboratory of PJSC "IISW". The laboratory determines composition of limestone for measurement testing of compliance of chemical composition with the approved technical standard TU U 14.1-00191827-001-2003 "Limestone fluxes". Measurements are taken in accordance with approved standards and methodologies:

- GOST 23581.20-81 "Iron ores, concentrates, sinters and pellets. Sulphur determination methods".
- " Methods of measurement of weight fraction of insoluble residue in the limestone and dolomite"
- " Methods of measurement of weight fraction of calcium and magnesium oxides in the limestone and lime"

Data collection and management scheme if provided in Section D.3.
ERUs monitoring is based on annual data. The project owner is responsible for document preparation and submission to the AIE.

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

(a) Parameters that are not monitored throughout the crediting period, but are determined only once (and thus remain fixed throughout the crediting period) and that are available already at the stage of determination are given in the Section B.1.

(b) Parameters that are not monitored throughout the crediting period, but are determined only once (and thus remain fixed throughout the crediting period) but that are not already available at the stage of determination: not applicable.

(c) Data and parameters that are monitored throughout the crediting period are given below.

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.)*	Name of variable	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
P.1	$M_{raw,Coke,y}$	Coke consumption in year *y*	Tensometric wagon balance	t	m	daily	100%	Electronic and paper	

P.2	$M_{raw, Limestone,y}$	Limestone consumption in year *y*	Tensometric wagon balance	t	m	daily	100%	Electronic and paper	
P.3	$FF_{NG,y}$	Natural gas consumption in year *y*	Differential pressure sensor	m3	m	daily	100%	Electronic and paper	
P.4	$FF_{Coal,y}$	Coal consumption in year *y*	Tensometric wagon balance	t	m	daily	100%	Electronic and paper	
P.5	$NCV_{NG,y}$	Net calorific value of natural gas	Supplier certificate	TJ/1000 m3	m	monthly	100%	Electronic and paper	
P.6	$NCV_{Coal,y}$	Net calorific value of coal	Supplier certificate	TJ/t	m	monthly	100%	Electronic and paper	
P.8	$C_{raw,Coke}$	Carbon content in coke	Supplier certificate	%	m	monthly	100%	Electronic and paper	Complies with the requirements of approved technical standard TU U 322-00190443-114-96 “Blast furnace coke”
P.9	$C_{raw,Limestone}$	Carbon content in limestone	Supplier certificate or the plant’s laboratory	%	m	monthly	100%	Electronic and paper	Complies with the requirements of approved technical standard TU U 14.1-00191827-001-2003 “Limestone fluxes”
P.10	$EC_{BF, y}$	Electricity consumption by the blast furnaces	Meter	MWh	m	monthly	100%	Electronic and paper	

		in year *y*							
P.11	NCV_{dies}	Net calorific value of diesel fuel	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[28] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[29] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[30] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2007[31] Ukraine's	TJ/t	c	annually	100%	Electronic and paper	*Applied value for 2010 – 2012: 42.2 GJ/t* *Applied value for 2009: 42.8 GJ/t* *Applied value for 2008: 42.9 GJ/t* *Applied value for*

[28] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 468, Table P2.39:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[29] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 462, Table P2.33:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[30] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 456, Table P2.27:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[31] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2007, Page 266, Table P2.3:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr_2009_nir_25may.zip

			National Inventory Report of GHG Sources and Sinks 1990 to 2006[32] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2005[33]						*2007: 42.44 $TJ/10^3$ t* *Applied value for 2006: 42.47 $TJ/10^3$ t* *Applied value for 2005: 42.50 $TJ/10^3$ t* *The following conversion applied:* *1 GJ/t / 1000 = 1 TJ /t;* *1 $TJ/10^3$ t /1000 = 1 TJ/t.*

[32] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2006, Page 212, Table P2.3: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr_2008_nir_21may.zip

[33] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2005, Page 215, Table P2.4: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/x-zip-compressed/ukr_2007_nir_rus_23jul.zip

P.12	$EC_{AMCOM,y}$	Electricity consumption by AMCOM shop in year *y*	Meter	MWh	m	monthly	100%	Electronic and paper	
P.14	$DFC_{AMCOM,y}$	Diesel fuel consumption by AMCOM complex in year *y*	Meter	t	m	monthly	100%	Electronic and paper	
P.15	SC_y	Metallurgical sludge consumption by the sinter plant in year *y*	Meter	t	m	monthly	100%	Electronic and paper	
P.16	$IOCC_y$	Iron-ore concentrate consumption by the sinter plant in year *y*	Meter	t	m	monthly	100%	Electronic and paper	
P.17	$EF_{BL,y}$	Specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine	"Ukraine - Assessment of new calculation of CEF"[34] Order #62 as of 15.04.2011 "Regarding approval of specific carbon dioxide emission factors for 2008"[35] Order #63 as of 15.04.2011 "Regarding	tCO_2/MWh $kgCO_2/kWh$ $kgCO_2/kWh$	c	annually	100%	Electronic and paper	*Value for the period before 2008 and after 2011: 0.896 tCO_2/MWh* *Value for 2008: 1.082 $kgCO_2/kWh$* *Value for 2009: 1.096 $kgCO_2/kWh$*

[34] http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

[35] http://www.neia.gov.ua/nature/doccatalog/document?id=127171

			approval of specific carbon dioxide emission factors for 2009"[36] Order #43 as of 28.03.2011 "Regarding approval of specific carbon dioxide emission factors for 2010"[37] Order #75 as of 12.05.2011 "Regarding approval of specific carbon dioxide emission factors for 2011"[38]	$kgCO_2/kWh$ $kgCO_2/kWh$					*Value for 2010: 1.093 kgCO$_2$/kWh* *Value for 2011: 1.090 kgCO$_2$/kWh*
P.18	$C_{NG,y}$	Carbon content in natural gas	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[39]	tC/TJ	c	annually	100%	Electronic	*Applied value for 2008, 2010 – 2012: 15.17 tC/TJ* *Applied value for 2009: 15.2 tC/TJ* *Applied value for*

[36] http://www.neia.gov.ua/nature/doccatalog/document?id=127172

[37] http://www.neia.gov.ua/nature/doccatalog/document?id=126006

[38] http://www.neia.gov.ua/nature/doccatalog/document?id=127498

[39] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 437, Table P2.8: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[40]						*2007: 15.16 tC/TJ* *Applied value for 2006: 15.22 tC/TJ* *Applied value for 2005: 15.19 tC/TJ*
P.19	$C_{Coal,y}$	Carbon content in coal	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[41]	tC/TJ	c	annually	100%	Electronic	*25.3 tC/TJ*
P.20	$C_{DF,y}$	Carbon content in diesel fuel	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[42]	tC/TJ	c	annually	100%	Electronic	*Applied value for 2010 – 2012: 20.2 tC/TJ*

[40] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 438, Section P2.5.1: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[41] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 470, Table P2.41: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[42] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 470, Table P2.41: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[43] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[44] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2008[45]						*Applied value for 2009: 20.2 tC/TJ* *Applied value for 2008: 20.2 tC/TJ* *Applied value for 2005 – 2007: 20.2 tC/TJ*
P.21	$P_{AMCOM\ BF,y}$	Quantity of processed slug by AMCOM complex for the blast	Wagon balance	t	m	monthly	100%	Electronic and paper	

[43] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 464, Table P2.35: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[44] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 458, Table P2.29: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[45] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2008, Page 264, Table P2.27: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2010-nir-22may.zip

		furnace shop in the project scenario in year *y*							
P.22	$P_{AMCOM,y}$	Total quantity of processed slug by AMCOM complex in year *y*	Wagon balance	t	m	monthly	100%	Electronic and paper	
P.23	$OXID_{NG,y}$	Oxidation factor of natural gas	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[46] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[47] Ukraine's National Inventory Report of GHG Sources	-	c	Annually	100%	Electronic	*Applied value for 2010 – 2012: 0.995* *Applied value for 2009: 0.995* *Applied value for 2008: 0.995*

[46] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 471, Table P2.42: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[47] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 465, Table P2.36: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			and Sinks 1990 to 2010[48] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories[49]						*Applied default value for 2005 – 2007: 0.995*
P.24	$OXID_{Coal,y}$	Oxidation factor of coal	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[50]	-	c	Annually	100%	Electronic	*Applied value: 0.98*
P.25	$OXID_{DF,y}$	Oxidation factor of diesel fuel	Ukraine's National Inventory Report of GHG Sources	-	C	Annually	100%	Electronic	*Applied value for 2010 – 2012: 0.99*

48 Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 459, Table P2.30: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

49 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol.3 Reference Manual, Energy, Page 1.29, Table 1-6 http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref2.pdf

50 Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 471, Table P2.42: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			and Sinks 1990 to 2010[51] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[52] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[53] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories[54]						*Applied value for 2009: 0.99* *Applied value for 2008: 0.99* *Applied default value for 2005 – 2007 : 0.99*

[51] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 471, Table P2.42: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[52] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 465, Table P2.36: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[53] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 459, Table P2.30: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[54] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol.3 Reference Manual, Energy, Page 1.29, Table 1-6 http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref2.pdf

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 within the crediting period are calculated as total emissions from separate departments of the PJSC "IISW" included in the project boundaries (See Fig. B.1).

Project emissions

$$PE_y = PE_{BF,y} + PE_{AMCOM,y} + PE_{Sludge,y} \quad \text{, D.1}$$

where:

PE_y : CO_2e emissions from the project activity, tCO_2e;
$PE_{BF,y}$: project emissions from blast furnaces, tCO_2e;
$PE_{AMCOM,y}$: project emissions from AMCOM complex operation, tCO_2e;
$PE_{Sludge,y}$: project emissions from consumption of sludge partially replaced with concentrate, tCO_2e;

Emissions from blast furnaces are calculated as follows:

$$PE_{BF,y} = \sum_i (EF_{CO2,i,y} * FC_{i,y}) + 44/12 * \sum_j (M_{raw,j,y} * C_{raw,j} * OXID_j) + EC_{BF,y} * EF_y \quad \text{, D.2}$$

where:

$PE_{BF\,y}$: CO_2e emissions from the project activity, tCO_2e;
$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i*, taking into account oxidation, tCO_2e/TJ;
$FC_{i,y}$: *i* type fuel consumption for iron production in the project scenario in year *y*, TJ;
$M_{raw,j,y}$: weight of *j* type material for iron production in the project scenario in year *y* , t;
$C_{raw,j}$: carbon content in material *j*, %
$OXID_j$: *j* material oxidation factor;
$EC_{BF,y}$: electricity consumption by blast furnaces (including PCF production) in year *y*, MWh;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2$e/kWh or tCO_2e/MWh;
44/12 : carbon to carbon dioxide conversion factor;
y : year covered by calculations;

$$EF_{CO2,i} = C_{i,y} * OXID_{i,y} * 44/12; \quad D.3$$

where:

$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i* with account for oxidation, tCO_2e/TJ;
$C_{i,y}$: carbon content in the fuel *i*, tC/TJ;
$OXID_{j,y}$: oxidation factor of the fuel *i;*
44/12 : carbon to carbon dioxide conversion factor.

$$FC_{i,y} = FF_{i,y} * NCV_{i,y} , \quad D.4$$

where:

$FC_{i,y}$: *i* type fuel consumption for iron production in the project scenario in year *y*, TJ;
$FF_{i,y}$: amount of *i* fuel consumed in year *y*, t or m3;
$NCV_{i,y}$: average net calorific value of *i* fuel consumed in year *y*, TJ/t or TJ/1000 m^3;

Project emissions from AMCOM slug processing complex operation are calculated by the following equation:

$$PE_{AMCOM,y} = P_{AMCOM\ BF,y} * SPE_{AMCOM,y}, \quad D.5$$

where:
$PE_{AMCOM,y}$: project emissions from AMCOM slug processing complex operation in year *y*, tCO_2e;
$P_{AMCOM\ BF,y}$: quantity of processed slug by AMCOM complex for the blast furnace shop in the project scenario in year *y,* t;
$SPE_{AMCOM,y}$ specific project emissions from AMCOM slug processing complex operation in year *y*, tCO_2e /t;

$$SPE_{AMCOM,y} = SEC_{AMCOM,y} * EF_{BL,y} + SDFC_{AMCOM,y} * EF_{DF,y}, \quad D.6$$

where:
$SPE_{AMCOM,y}$: specific project emissions from AMCOM slug processing complex operation in year y, tCO2e /t;
$SEC_{AMCOM,y}$: specific electricity consumption by AMCOM complex in the project scenario in year *y*, MWh /t;

$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;
$SDFC_{AMCOM,y}$: specific consumption of diesel fuel by AMCOM complex in the project scenario in year *y*, TJ/t;
$EF_{DF,y}$: CO_2 emission factor for diesel fuel use in year *y*, tCO_2e/TJ

$$EF_{DF,y} = C_{DF,y} * OXID_{DF,y} * 44/12; \quad \text{D.7}$$

де:
$EF_{DF,y}$: CO_2 emission factor for diesel fuel use in year *y*, tCO_2e/TJ;
$C_{DF,y}$: carbon content in diesel fuel, tC/TJ;
$OXID_{DF,y}$: oxidation factor of diesel fuel;
44/12 : carbon to carbon dioxide conversion factor.

$$SEC_{AMCOM,y} = EC_{AMCOM,y} / P_{AMCOM,y}, \quad \text{D.8}$$

where:
$SEC_{AMCOM,y}$: specific electricity consumption by AMCOM complex in the project scenario in year *y*, MWh /t;
$EC_{AMCOM,y}$: electricity consumption by AMCOM complex in the project scenario in year *y*, MWh;
$P_{AMCOM,y}$: total quantity of processed slug by AMCOM complex in the project scenario in year *y,* t;

$$SDFC_{AMCOM,y} = [DFC_{AMCOM,y} * NCV_{dies,y}] / P_{AMCOM,y}, \quad \text{D.9}$$

where:
$SDFC_{AMCOM,y}$: specific consumption of diesel fuel by AMCOM complex in the project scenario in year *y*, TJ/t;
$DFC_{AMCOM,y}$: project consumption of diesel fuel by AMCOM complex in year *y*, t;
$NCV_{dies,y}$: net calorific value of diesel fuel in year *y*, TJ/t
$P_{AMCOM,y}$: total quantity of processed slug by AMCOM complex in the project scenario in year *y,* t;

Project emissions from the use of sludge partially replacing iron-ore concentrate in the sinter plant are calculated by the following equation:

$$PE_{Sludge,y} = IOCC_y * EF_{BL,IOC}, \quad \text{D.10}$$

where:
$PE_{Sludge,y}$: project emissions from the use of sludge partially replacing concentrate, tCO_2e;
$IOCC_y$: project consumption of iron-ore concentrate by the sinter plant in year *y*, t;
$EF_{BL,IOC}$: CO_2 emission factor for iron-ore concentrate production, tCO_2e/t;

Project consumption of iron-ore concentrate in the sinter plant in year *y* (the value of $IOCC_y$) is taken from technical reports of the sinter plant of PJSC "IISW" .

To calculate $EF_{BL,IOC}$, the factor of electricity consumption during iron-ore concentrate production by the key concentrate supplier, Inguletskiy Mining and Processing Integrated Works (MPIW), were applied. $EF_{BL,IOC}$ is calculated by the following equation:

$$EF_{BL,IOC} = (ElC_{IOCP,hist} * EF_{BL}) / P_{IOC,hist} , \qquad \textbf{D.11}$$

where:
$EF_{BL,IOC}$: CO_2e emission factor for iron-ore concentrate production, tCO_2e/t;
$ElC_{IOCP,hist}$: electricity consumption during concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period (four years), MWh;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;
$P_{IOC,hist}$: total concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period, t;

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.)*	Name of variable	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment

B.1	P_y	Amount of iron produced in year *y*	Wagon balance	т	m	daily	100%	Electronic and paper	
B.4	$EF_{CO2,CP}$	CO_2 emission factor for coke production	IPCC 2006 [55]	tCO_2e/t	c	annually	100%	Electronic and paper	*0.56 tCO_2e/t*
B.5	$EF_{BL,Sinter}$	CO_2 emission factor for sinter production	IPCC 2006 [56]	tCO_2e/t	c	annually	100%	Electronic and paper	*0.20 tCO_2e/t*
B.6	$C_{raw,Coke}$	Carbon content in coke	Supplier certificate	%	m	monthly	100%	Electronic and paper	Complies with the requirements of approved technical standard TU U 322-00190443-114-96 “Blast furnace coke”
B.7	$C_{raw,Limestone}$	Carbon content in limestone	Supplier certificate or the plant’s laboratory	%	m	monthly	100%	Electronic and paper	Complies with the requirements of approved technical standard TU U 14.1-00191827-001-2003 “Limestone fluxes”
B.8	$EF_{BL,y}$	Specific CO_2 emission	"Ukraine - Assessment of	tCO_2/MWh	c	annually	100%	Electronic and paper	*Value for the period before*

[55] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use Chapter 4: Metal Industry Emissions, Table 4.1, Pg. 4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

[56] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use Chapter 4: Metal Industry Emissions, Table 4.1, Pg. 4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

		factor for consumption of electricity from the Unified Power System of Ukraine	new calculation of CEF"[57] Order #62 as of 15.04.2011 "Regarding approval of specific carbon dioxide emission factors for 2008"[58] Order #63 as of 15.04.2011 "Regarding approval of specific carbon dioxide emission factors for 2009"[59] Order #43 as of 28.03.2011 "Regarding approval of specific carbon dioxide emission factors for 2010"[60]	$kgCO_2$/kWh $kgCO_2$/kWh $kgCO_2$/kWh $kgCO_2$/kWh					*2008 and after 2011: 0.896 tCO_2/MWh* *Value for 2008: 1.082 $kgCO_2$/kWh* *Value for 2009: 1.096 $kgCO_2$/kWh* *Value for 2010: 1.093 $kgCO_2$/kWh* *Value for 2011: 1.090 $kgCO_2$/kWh*

57 http://ji.unfccc.int/UserManagement/FileStorage/46JW2KL36KM0GEMI0PHDTQF6DVI514

58 http://www.neia.gov.ua/nature/doccatalog/document?id=127171

59 http://www.neia.gov.ua/nature/doccatalog/document?id=127172

60 http://www.neia.gov.ua/nature/doccatalog/document?id=126006

			Order #75 as of 12.05.2011 "Regarding approval of specific carbon dioxide emission factors for 2011"[61]						
B.9	$IOCC_{BL,y}$	Iron-ore concentrate consumption by the sinter plant in year *y*	Meter	t	m	monthly	100%	Electronic and paper	
B.10	$SC_{BL,y}$	Consumption of sinter, which is replaced with AMCOM products, in year *y*	Wagon balance	t	m	monthly	100%	Electronic and paper	
B.11	$SgC_{BL,y}$	Metallurgical sludge consumption in year *y*	Meter	t	m	monthly	100%	Electronic and paper	
B.12	$C_{NG,y}$	Carbon content in natural gas	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[62]	tC/TJ	c	annually	100%	Electronic	*Applied value for 2008, 2010 – 2012: 15.17 tC/TJ* *Applied value for 2009: 15.2 tC/TJ* *Applied value*

[61] http://www.neia.gov.ua/nature/doccatalog/document?id=127498

[62] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 437, Table P2.8: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[63]						*for 2007: 15.16 tC/TJ* *Applied value for 2006: 15.22 tC/TJ* *Applied value for 2005: 15.19 tC/TJ*
B.13	$OXID_{NG,y}$	Oxidation factor of natural gas	Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[64] Ukraine's National Inventory Report of GHG Sources	-	c	Annually	100%	Electronic	*Applied value for 2010 – 2012: 0.995* *Applied value for 2009: 0.995*

[63] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 438, Section P2.5.1: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[64] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 471, Table P2.42: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

			and Sinks 1990 to 2010[65] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010[66] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories[67]						*Applied value for 2008: 0.995* *Applied default value for 2005 – 2007: 0.995*

[65] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 465, Table P2.36: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[66] Ukraine's National Inventory Report of GHG Sources and Sinks 1990 to 2010, Page 459, Table P2.30: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ukr-2012-nir-13apr.zip

[67] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol.3 Reference Manual, Energy, Page 1.29, Table 1-6 http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref2.pdf

B.14	P_{hist}	Total iron production for the historical period	PJSC "IISW"	t	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 16,632,960*
B.15	$FF_{hist\ Coke}$	Consumed coke for the historical period	PJSC "IISW"	t	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 9,679,676*
B.16	$FF_{hist,NG}$	Consumed natural gas for the historical period	PJSC "IISW"	1000 m^3	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 1,240,404*
B.17	$NCV_{hist,i}$	Average net calorific value of natural gas consumed for the historical period	PJSC "IISW"	kcal/m^3	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 8012* *Value of 0.033545 TJ/1000 m^3 applied using the following conversion: 1 kcal/m^3 = (4.1868 TJ/m^3*1000)/1000000*
B.18	$M_{raw,hist,Coke}$	Total coke consumption for the historical period	PJSC "IISW"	t	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 9,679,676*
B.19	$M_{raw,hist,Limestone}$	Total limestone consumption for the historical period	PJSC "IISW"	t	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 693,987*
B.20	$EC_{BF,hist}$	Total electricity consumption by blast	PJSC "IISW"	MWh	m	Once at the start of the project	100%	Electronic and paper	*Data for 1998 – 2001: 117,524*

		furnaces to cover the plant’s needs for the historical period							

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

Baseline emissions are calculated by the following equations:

$$BE_y = BE_{BF,y} + BE_{Sinter,y} + BE_{IOC,y} + BE_{CP,y}, \quad D.12$$

where:

BE_y : baseline emissions, tCO_2e;
$BE_{BF,y}$: baseline emissions from blast furnaces, tCO_2e;
$BE_{Sinter,y}$: baseline emissions from sinter use, replaced with AMCOM products;
$BE_{IOC,y}$: baseline emissions from iron-ore concentrate production, replaced with the metallurgical sludge;
$BE_{CP,y}$: baseline emissions from coke production, consumption of which will be reduced due to the blast furnace upgrade, tCO_2e;
y : year covered by calculations;

Baseline emissions of CO_2 are calculated based on the total consumption of raw materials for iron production: natural gas, coke, lime, electricity. Blast furnace gas is the oxidation and decay product of the abovementioned materials. If the blast furnace gas is included in the emission sources, it will result in double calculation, therefore, direct emissions from blast furnace gas consumption are excluded from calculations.

Let's consider the carbon weight balance in blast furnaces. Carbon comes to the furnace together with materials and fuel and leaves as a part of blast furnace gas and iron:

$$C_{fuel} + C_{raw} = C_{BFG} + C_{Product}, \quad D.13$$

where:

C_{fuel} : carbon content in fuel, %
C_{raw} : carbon content in raw materials, %
C_{BFG} : carbon content in blast furnace gas, %
$C_{Product}$: carbon content in product, %

In view that the baseline and project scenarios have the equal amount of products, carbon content in products $C_{Product}$ is not taken into consideration hereafter for calculation simplification. Also, since reconstruction of blast furnaces implies significant changes in the auxiliary equipment, GHG emissions from blast furnaces include electricity consumption to cover the plant's needs.

Thus, calculation of emissions from blast furnaces can be represented by the following equation:

$$BE_{BF,y} = \sum_i (EF_{CO2,i,y} * FC_{BL,i,y}) + 44/12 * \sum_j (M_{BL,raw,j,y} * C_{raw,j} * OXID_j) + EC_{BL,BF,y} * EF_{BL,y} \text{ ,} \qquad \textbf{D.14}$$

where:

$BE_{BF,y}$: baseline emissions from blast furnaces, tCO_2e;
$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i* with account for oxidation, tCO_2e/TJ;
$FC_{BL,i,y}$: type *i* fuel consumption in the baseline scenario for iron production in year *y*, TJ;
$M_{BL,raw,j,y}$: weight of consumed materials of *j* type in baseline scenario for iron production in year *y*, t;
$C_{raw,j}$: carbon content in the material *j*, %
$OXID_j$: oxidation factor for the material *j*;
$EC_{BL,BF,y}$: electricity consumption by blast furnaces to cover the plant's needs, MWh;
$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;
44/12 : carbon to carbon dioxide conversion factor;

$$EF_{CO2,i,y} = C_{i,y} * OXID_{i,y} * 44/12; \qquad \textbf{D.15}$$

where:

$EF_{CO2,i,y}$: carbon dioxide emission factor for fuel *i* with account for oxidation, tCO_2e/TJ;
$C_{i,y}$: carbon content in the fuel *i*, tC/TJ;
$OXID_{j,y}$: oxidation factor of the fuel *i;*
44/12 : carbon to carbon dioxide conversion factor.

Fuel and raw material consumption is based on historical data of specific consumption.

$$FC_{BL,i,y} = BSEC_i * P_y \text{ ,} \qquad \textbf{D.16}$$

where:

$FC_{BL,i,y}$: *i* type fuel consumption in the baseline scenario for iron production in year *y*, t;
$BSEC_i$: specific *i* fuel consumption, TJ/t;
P_y : iron production in year *y*, t;

Specific consumption is calculated as the ratio of total fuel consumption for the historical period to iron smelting data for the historical period. Historical data comply with actual data for the period of three years preceding to the project activity implementation.

$$BSEC_i = FC_{hist,i} / P_{hist} , \quad \textbf{D.17}$$

where:

$BSEC_i$: specific *i* fuel consumption, TJ/t;
$FC_{hist,i}$: total consumption of *i* type fuel for the historical period, TJ;
P_{hist} : total iron production for the historical period, t;

$$FC_{hist,i} = FF_{hist,i} * NCV_{hist,i} , \quad \textbf{D.18}$$

where:

$FC_{hist,i}$: total consumption of *i* type fuel for the historical period, TJ;
$FF_{hist,i}$: *i* type fuel consumption for the historical period, m^3 or t;
$NCV_{hist,i}$: average net calorific value of *i* fuel consumed for the historical period, TJ/t or TJ/1000 m^3;

$$M_{BL,raw,j,y} = BSMC_j * P_y , \quad \textbf{D.19}$$

where:

$M_{BL,raw,j,y}$: weight of consumed material, type *j*, in the baseline scenario for iron production in year *y*, t;
$BSMC_j$: specific material consumption, *j* type, t/t ;
P_y : iron production in year *y*, t;

$$BSMC_j = M_{raw,hist,j} / P_{hist} , \quad \textbf{D.20}$$

where:

$BSMC_j$: specific material consumption, t/t;
$M_{raw,hist,j}$: total consumption of *j* type material for the historical period, t;
P_{hist} : total iron production for the historical period, t;

Electricity consumption to cover the plant's needs.

$$EC_{BL,BF,y} = BSEEC_{BF} * P_y , \quad \textbf{D.21}$$

where:
$EC_{BL,BF,y}$: electricity consumption by blast furnaces to cover the plant's needs, MWh;
$BSEEC_{BF}$: specific electricity consumption by blast furnaces to cover the plant's needs, MWh/t;
P_y : iron production in year *y*, t;

$$BSEEC_{BF} = EC_{BF,hist} / P_{hist} ,$$ **D.22**

where:
$BSEEC_{BF}$: specific electricity consumption by blast furnaces to cover the plant's needs, MWh/t;
$EC_{BF,hist}$: electricity consumption by blast furnaces to cover the plant's needs for the historical period, MWh;
P_{hist} : total iron production for the historical period, t;

Baseline emissions from sinter production replaced with AMCOM products in the project activity are calculated by the following equation:

$$BE_{Sinter,y} = SC_{BL,y} * EF_{BL, Sinter} ,$$ **D.23**

where:
$BE_{Sinter,y}$: emissions from slag used in the sinter plant and replaced with AMCOM products in the project, tCO_2e;
$SC_{BL,y}$: consumption of sinter, which is replaced with AMCOM products, in year *y*, t;
$EF_{BL,Sinter}$: CO_2 emission factor for sinter production, tCO_2e/t;

Baseline emissions from use of iron-ore concentrate replaced with metallurgical sludge in the project scenario are calculated by the following equation:

$$BE_{IOC,y} = (IOCC_{BL,y} + IOCR_{BL,y}) * EF_{BL,IOC} ,$$ **D.24**

where:
$BE_{IOC,y}$: baseline emissions from use of iron-ore concentrate, tCO_2e;
$IOCC_{BL,y}$: iron-ore concentrate consumption in the sinter plant in year *y*, t;
$IOCR_{BL,y}$: consumption of iron-ore concentrate replaced with metallurgical sludge in the project in year *y*, t;
$EF_{BL,IOC}$: CO_2 emission factor for iron-ore concentrate production, tCO_2e/t;

The value of $IOCC_{BL,y}$ is taken from technical reports of the PJSC “IISW” sinter plant.

$$IOCR_{BL,y} = SgC_{BL,y} * RF_{IOC} \text{,} \qquad \text{D.25}$$

where:

$IOCR_{BL,y}$: consumption of iron-ore concentrate replaced with AMCOM products in the project in year *y*, t;

$SgC_{BL,y}$: metallurgical sludge consumption in year *y*, t;

RF_{IOC} : factor of iron-ore concentrate replacement with metallurgical sludge, t/t;

The value of RF_{IOC} is determined by the Technological Department of the PJSC “IISW” sinter plant and makes the possible value range of 0.55 – 0.597 t of iron-ore concentrate / t of sludge. In order to comply with the most conservative approach, the lowest replacement factor value of 0.55 is applied for calculation of emissions[68].

To calculate $EF_{BL,IOC}$, the factor of electricity consumption during iron-ore concentrate production by the key concentrate supplier, Inguletskiy Mining and Processing Integrated Works (MPIW), were applied. $EF_{BL,IOC}$ is calculated by the following equation:

$$EF_{BL,IOC} = (ElC_{IOCP,hist} * EF_{BL}) / P_{IOC,hist} \text{,} \qquad \text{D.26}$$

where:

$EF_{BL,IOC}$: CO_2 emission factor for iron-ore concentrate production, tCO_2e/t;

$ElC_{IOCP,hist}$: electricity consumption during concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period (four years), MWh;

$EF_{BL,y}$: specific CO_2 emission factor for consumption of electricity from the Unified Power System of Ukraine, $kgCO_2e/kWh$ or tCO_2e/MWh;

$P_{IOC,hist}$: total concentrate production by Inguletskiy Mining and Processing Integrated Works for the historical period, t;

Implementation of blast furnace upgrade results in reduced coke consumption at the PJSC “IISW”. In its turn, it leads to decreased coke production. The amount of saved coke is calculated as follows:

$$BE_{CP,y} = M_{DCC,y} * EF_{BL,CP} - M_{DCCout,y}, * EF_{BL,CP}, \qquad \text{D.27}$$

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[68] Methodology of PJSC “IISW” Technological Department for the replacement factor calculation was provided to determination team during determination.

where:

$BE_{CP,y}$: CO_2 baseline emissions from production of coke, the consumption of which will be reduced through the blast furnace upgrade, tCO_2e;

$M_{DCC,y}$: weight of coke consumption reduction in the blast furnace shop (BFS), t;

$M_{DCCout,y}$: weight of coke consumption in the blast furnace shop (BFS) which was produced outside Ukraine, t

$EF_{BL,CP}$: CO_2 emission factor for coke production, tCO_2e/t;

Ex-ante value of the parameter $M_{DCCout,y} = 0$, actual value of the parameter $M_{DCCout,y}$ will be determined during the project verification.

The weight of coke consumption reduction at the PJSC "IISW" is calculated as the difference between coke consumption in the baseline and project scenario:

$$M_{DCC,y} = M_{BL,C,y} - M_{P,C,y}\ , \qquad \textbf{D.28}$$

where:

$M_{DCC,y}$: weight of coke consumption reduction in the BFS, t;

$M_{BL,C,y}$: coke consumption the BFS in the baseline scenario, t;

$M_{P,C,y}$: coke consumption the BFS in the project scenario, t;

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

Not applicable.

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Left blank intentionally.

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. Left blank intentionally.

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

There are not leakages estimated in the proposed project.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

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

No leakage expected.

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

The annual emission reductions are calculated in accordance with the following formulae:

$$ER_y = BE_y - PE_y - LE_y , \qquad D.26$$

where:

ER_y : emission reductions in year y, tCO_2e;
BE_y : baseline emissions in the year y, tCO_2e;
PE_y : greenhouse gas emissions from the project activity in year y, tCO_2e;
LE_y : leakage emissions in year y, tCO_2e;

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

Please see Section F "Environmental impacts".

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
P.1	*Low*	Measurements are taken by means of tensometric wagon balance #14 (st. Sartana-2) and #17 (st. Rudna), balance Scalex Trapper 2200 manufactured by PIVOTEX, Finland. Measuring accuracy: ± 0.5%. The check complies with the DSTU 2708-2006 “Metrology. Verification of measuring instruments. Organization and procedures.”
P.2	*Low*	Measurements are taken by means of tensometric wagon balance #14 (st. Sartana-2) and #17 (st. Rudna), balance Scalex Trapper 2200 manufactured by PIVOTEX, Finland. Measuring accuracy: ± 0.5%. The check complies with the DSTU 2708-2006 “Metrology. Verification of measuring instruments. Organization and procedures.”

P.3	*Low*	Measurements are taken by means of the differential pressure sensor Rozemount-3051 and Flowtech meter. There are 2 inputs in the plant (passports for devices #291, 220). The check is performed in compliance with DSTU 2708-2006 “Metrology. Verification of measuring instruments. Organization and procedures.”
P.4	*Low*	Measurements are taken by means of tensometric wagon balance #14 (st. Sartana-2) and #17 (st. Rudna), balance Scalex Trapper 2200 manufactured by PIVOTEX, Finland. Measuring accuracy: ± 0.5%. The check complies with the DSTU 2708-2006 “Metrology. Verification of measuring instruments. Organization and procedures.”
P.5	*Low*	Net calorific value of the natural gas supplied by the third party (Donetskoblgas)
P.6	*Low*	The value is indicated in the coal supplier’s certificate
P.8, B.8	*Low*	The value is indicated in the coke supplier’s certificate or taken from data of the central laboratory of PJSC “IISW” during the entry control.
P.9, B.7	*Low*	The value is indicated in the limestone supplier’s certificate or taken from data of the central laboratory of PJSC “IISW” during the entry control.
P.10	*Low*	Measurements are taken by means of the meters.
P.11	*Low*	The value is checked according to the data of Ukraine's National Inventory Report of GHG Sources and Sinks
P.12	*Low*	Measurements are taken by means of the meters.
P.14	*Low*	Measurements are taken by means of the meters.
P.15, B.11	*Low*	Measurements are taken by means of tensometric wagon balance #14 for the transported sludge and by motor-truck scales #24 for the PJSC “IISW” sludge.
P.16, B.9	*Low*	Measurements are taken by means of wagon balance #14 and #17.
P21, P22, B.10	*Low*	Measurements are taken by wagon balance.

B.1	*Low*	Balances are used for measurements of: *1.* Liquid iron for casting: wagon balance #4 (st. Domenna), type ChZh200, weighing accuracy - ± 150kg. *2.* Liquid iron for the open-hearth furnace: wagon balance #5 (1,2 st. Stalna), type ChZh 250, weighing accuracy - ± 1250kg. *3.* Liquid iron for the oxygen-converter shop: tensometric wagon balance # 6A (st. Konverterna), type HP-25000RT, weighing accuracy - ± 300kg. Reserve balance: wagon balance #6 (st. Stalna), type 4181 P250, weighing accuracy - ± 1250kg. *4.* Commercial iron: wagon balance #3 (st. Rozlyvochna), type RS-150TS13A, weighing accuracy - ± 125kg. *5.* Commercial iron by motor transport: tensometric balance #2 (Checkpoint-20), type SV-40000A "Lakhta-U", weighing accuracy - ± 30kg. *6.* Commercial iron by motor transport: tensometric balance #19 (Checkpoint -8), type SV-60000A/18 "Lakhta-U", weighing accuracy - ± 50kg. Calibration of the balances is performed in accordance with GOST29329-92.
B.4, B.5	*Low*	Fixed value set in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use Chapter 4: Metal Industry Emissions, Table 4.1, Pg. 4.25 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf

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

Monitoring plan does not stipulate any additional measures on installation of new metering equipment or collection of additional parameters in contrast to the ones being implemented at the plant. The operational and management structure under the monitoring plan is provided in Fig. D.1 below.

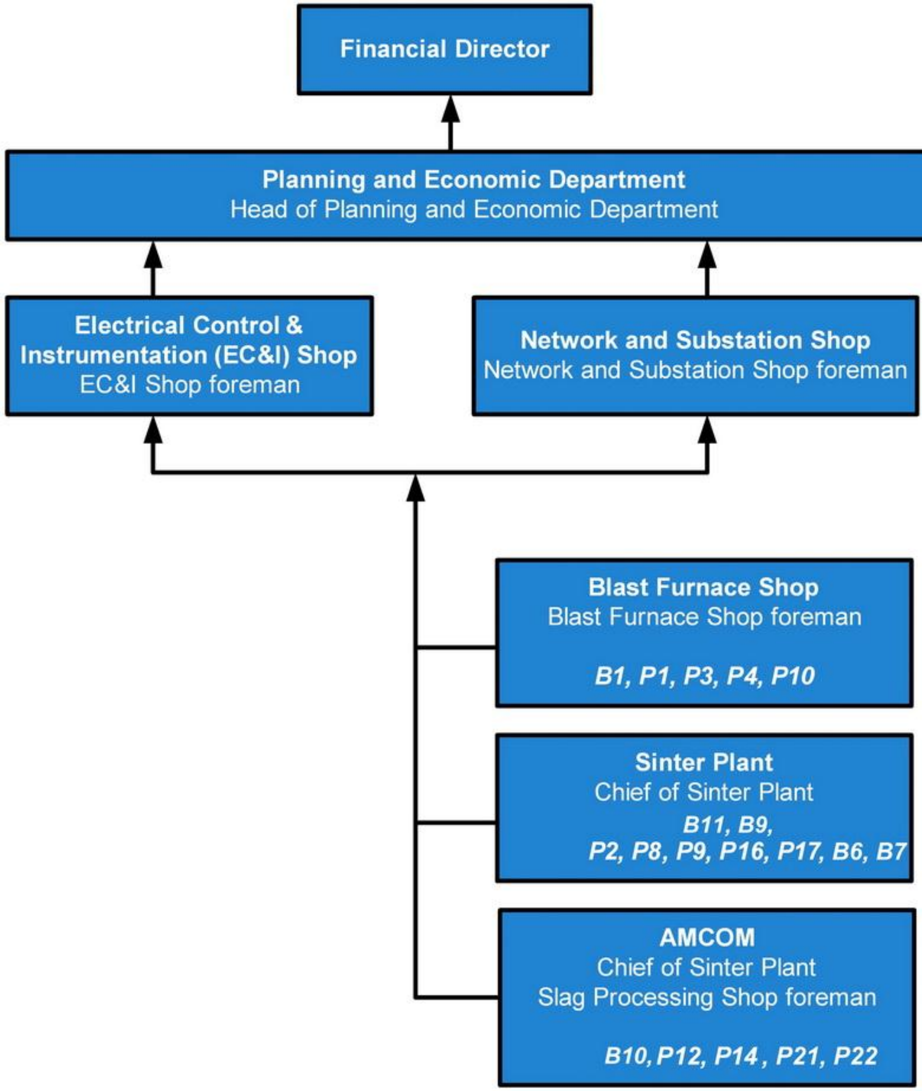

Fig. D.1. Operational and management structure at PJSC "IISW"

The following shops and departments of PJSC "IISW" are involved in data collection and archiving:
Blast Furnace Shop:
The BFS collects data on fuel and material consumption for iron production.
AMCOM:
Data on slag processing volumes and energy consumption for this processing is collected at AMCOM complex.
Sinter Plant:
Data on the average annual concentrate and sludge consumption, as well as data on energy consumption for mentioned furnace charge processing is collected. Carbon content in the limestone is analyzed.
Network and Substation Shop:
This shop is responsible for collection of data on electricity consumption by the plant's departments.
EC&I Shop:
This shop is responsible for storing metering devices in the proper state and initial information collection from the shops.
Planning and Economic Department:
Data is processed and stored.

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

PJSC "Ilyich Iron and Steel Works of Mariupol" (project participant)
GreenStream Network GmbH (not the project participant)
See contact information in Annex 1.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Project emissions	Units	2005	2006	2007	Total
Blast furnace shop reconstruction	tCO_2e	10 418 030	10 921 008	10 663 280	32 002 318
Implementation of AMCOM complex	tCO_2e	103	510	665	1 278
Sludge utilization	tCO_2e	955 451	839 429	1 000 495	2 795 375
Project emissions before the first commitment perio	tCO_2e	**11 373 584**	**11 760 947**	**11 664 440**	**34 798 971**

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

Project emissions	Units	2008	2009	2010	2011	2012	Total
Blast furnace shop reconstruction	tCO_2e	8 949 714	7 532 992	9 225 360	9 225 262	8 242 455	43 175 783
Implementation of AMCOM complex	tCO_2e	549	647	712	621	678	3 207
Sludge utilization	tCO_2e	878 495	552 995	916 599	916 599	916 599	4 181 287
Project emissions during the commitment period	tCO_2e	**9 828 758**	**8 086 634**	**10 142 671**	**10 142 482**	**9 159 732**	**47 360 277**

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

Project emissions	Units	2013	2014	2015	2016	2017
Blast furnace shop reconstruction	tCO_2e	8 242 455	8 242 455	8 242 455	8 242 455	8 242 455
Implementation of AMCOM complex	tCO_2e	678	678	678	678	678
Sludge utilization	tCO_2e	916 599	916 599	916 599	916 599	916 599
Project emissions after the commitment period	tCO_2e	**9 159 732**	**9 159 732**	**9 159 732**	**9 159 732**	**9 159 732**

Project emissions	Units	2018	2019	2020	Total
Blast furnace shop reconstruction	tCO_2e	8 242 455	8 242 455	8 242 455	65 939 640
Implementation of AMCOM complex	tCO_2e	678	678	678	5 424
Sludge utilization	tCO_2e	916 599	916 599	916 599	7 332 792
Project emissions after the commitment period	tCO_2e	**9 159 732**	**9 159 732**	**9 159 732**	**73 277 856**

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

E.2. Estimated leakages:

No leakage expected as a result of the project.

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

Since the leakage emissions LEy = 0, the sum of leakage and project activity emissions equals the project emissions, as provided in Tables *E.4, E.5* and *E.6*.

Project emissions	Units	2005	2006	2007
Sum of E.1.and E.2.	tCO_2e	11 373 584	11 760 947	11 664 440

Table E.4. Estimated sum of project emissions before the first commitment period

Project emissions	Units	2008	2009	2010	2011	2012
Sum of E.1. and E.2.	tCO_2e	9 828 758	8 086 634	10 142 671	10 142 482	9 159 732

Table E.5. Estimated sum of project emissions during the commitment period

Project emissions	Units	2013	2014	2015	2016	2017
Sum of E.1.and E.2.	tCO_2e	9 159 732	9 159 732	9 159 732	9 159 732	9 159 732

Project emissions	Units	2018	2019	2020
Sum of E.1.and E.2.	tCO_2e	9 159 732	9 159 732	9 159 732

Table E.6 Estimated sum of project emissions after the first commitment period

E.4. Estimated baseline emissions:

Baseline emissions	Units	2005	2006	2007	Total
Blast furnace shop reconstruction	tCO_2e	11 661 665	12 097 948	12 085 272	**35 844 885**
Implementation of AMCOM complex	tCO_2e	1 588	7 718	9 725	**19 031**
Sludge utilization	tCO_2e	1 075 120	932 253	1 099 720	**3 107 093**
Baseline emissions before the first commitment period	tCO_2e	**12 738 373**	**13 037 919**	**13 194 717**	**38 971 009**

Table E.7. Estimated baseline emissions before the first commitment period

Baseline emissions	Units	2008	2009	2010	2011	2012	Total
Blast furnace shop reconstruction	tCO_2e	10 134 543	8 038 252	10 533 397	10 540 978	10 540 978	49 788 148
Implementation of AMCOM complex	tCO_2e	8 614	8 622	7 663	8 300	6 299	39 498
Sludge utilization	tCO_2e	937 234	606 374	947 101	947 101	947 101	4 384 911
Baseline emissions during the commitment period	tCO_2e	**11 080 391**	**8 653 248**	**11 488 161**	**11 496 379**	**11 494 378**	**54 212 557**

Table E.8. Estimated baseline emissions during the commitment period

Baseline emissions	Units	2013	2014	2015	2016	2017
Blast furnace shop reconstruction	tCO_2e	10 540 978	10 540 978	10 540 978	10 540 978	10 540 978
Implementation of AMCOM complex	tCO_2e	6 299	6 299	6 299	6 299	6 299
Sludge utilization	tCO_2e	947 101	947 101	947 101	947 101	947 101
Baseline emissions after the commitment period	tCO_2e	11 494 378	11 494 378	11 494 378	11 494 378	11 494 378

Baseline emissions	Units	2018	2019	2020	Total
Blast furnace shop reconstruction	tCO_2e	10 540 978	10 540 978	10 540 978	84 327 824
Implementation of AMCOM complex	tCO_2e	6 299	6 299	6 299	50 392
Sludge utilization	tCO_2e	947 101	947 101	947 101	7 576 808

Baseline emissions after the commitment period	tCO_2e	**11 494 378**	**11 494 378**	**11 494 378**	**91 955 024**

Table E.9. Estimated baseline emissions after the commitment period

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

Emission reductions	**Units**	**2005**	**2006**	**2007**
Difference between E.4. and E.3.	tCO_2e	1 364 789	1 276 972	1 530 277

Table E.10. Estimated emission reductions before the crediting period

Emission reductions	**Units**	**2008**	**2009**	**2010**	**2011**	**2012**
Difference between E.4. and E.3.	tCO_2e	1 251 633	566 614	1 345 490	1 353 897	2 334 646

Table E.11. Estimated emission reductions over the crediting period

Emission reductions	**Units**	**2013**	**2014**	**2015**	**2016**	**2017**
Difference between E.4. and E.3.	tCO_2e	2 334 646	2 334 646	2 334 646	2 334 646	2 334 646

Emission reductions	**Units**	**2018**	**2019**	**2020**
Difference between E.4. and E.3.	tCO_2e	2 334 6462	2 334 6462	2 334 6462

Table E.12. Estimated emission reductions after the crediting period

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

Years	Estimated project emissions (tCO_2e)	Estimated leakage (tCO_2e)	Estimated baseline emissions (tCO_2e)	Estimated emission reductions (tCO_2e)
2005	11 373 584	0	12 738 373	1 364 789
2006	11 760 947	0	13 037 919	1 276 972
2007	11 664 440	0	13 194 717	1 530 277
Total (tCO_2-e)	**34 798 971**	**0**	**38 971 009**	**4 172 038**

Table E.13. Estimated balance of emissions under the proposed project before the first commitment period

Years	Estimated project emissions (tCO_2e)	Estimated leakage (tCO_2e)	Estimated baseline emissions (tCO_2e)	Estimated emission reductions (tCO_2e)
2008	9 828 758	0	11 080 391	1 251 633
2009	8 086 634	0	8 653 248	566 614
2010	10 142 671	0	11 488 161	1 345 490
2011	10 142 482	0	11 496 379	1 353 897
2012	9 159 732	0	11 494 378	2 334 646
Total (tCO_2-e)	**47 360 277**	**0**	**54 212 557**	**6 852 280**

Table E.14. Estimated balance of emissions under the proposed project during the commitment period

Years	Estimated project emissions (tCO_2e)	Estimated leakage (tCO_2e)	Estimated baseline emissions (tCO_2e)	Estimated emission reductions (tCO_2e)
2013	9 159 732	0	11 494 378	2 334 646
2014	9 159 732	0	11 494 378	2 334 646
2015	9 159 732	0	11 494 378	2 334 646
2016	9 159 732	0	11 494 378	2 334 646
2017	9 159 732	0	11 494 378	2 334 646
2018	9 159 732	0	11 494 378	2 334 646
2019	9 159 732	0	11 494 378	2 334 646
2020	9 159 732	0	11 494 378	2 334 646
Total (tCO_2-e)	**73 277 856**	**0**	**91 955 024**	**18 677 168**

Table E.15. Estimated balance of emissions under the proposed project after the first commitment period

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

The Project of Introduction of Energy Efficiency Measures at PJSC "Ilyich Iron and Steel Works of Mariupol" covers measures requiring Environmental Impact Assessment (EIA). The following EIAs have been performed and approved under the project design documentation:

- Statement on environmental impact of construction of the unit for pulverized coal fuel preparation and injection into blast furnaces #1...5 in PJSC "Ilyich Iron and Steel Works of Mariupol", prepared by Azovgipromez Ltd.
- Statement on environmental impact of construction of slag separation unit in PJSC "Ilyich Iron and Steel Works of Mariupol", prepared by the collective research enterprise "Donbasekologiya".

Environmental impact of measures under the proposed JI project was assessed in accordance with the documents below:

- State Building Standard DBN A.2.2-1-2003 "Structure and content of materials required to assess environmental impact (EIA) when designing and building enterprises, buildings and facilities";
- State Building Standard DBN A.2.2-3-2004 "Content, procedure of developing, agreeing approving the project documentation for construction";
- Law of Ukraine On Environmental Expertise.

As long as iron and steel plants are listed in the Decree # 554 of the Cabinet of Ministers of Ukraine of 27.07.95 On the List of Activities and Facilities of High Environmental Hazard, the IEA was performed in full scope in accordance with DBN A.2.2-1-2003.

Key conclusions

Use of the pulverized coal fuel along with implementation of measures in the blast furnace shop will annually reduce dust emissions into the atmosphere by 2.5 thous. t and carbon monoxide – by 6 thous. t.
At the time of construction of pulverized coal fuel preparation and injection unit, provided that air protection measures listed in the IEA, annual pollutant emissions do not exceed 487.7 t, including 103.7 t of dust per year and 380 t of sulphuric anhydride per year (totally for the plant). Thus, air pollution by relevant sources on the sanitary zone border and in the nearby residential areas will only increase by 5...14% admissible concentration limit, which does not exceed the maximum admissible value. Chemical pollution does not exceed the existing level before the measure implementation.

Polluted wastewater is not disposed in naturally impounded reservoirs. Industrial wastewater purification to the level set by sanitary requirements is performed by the local waste disposal plants WAVIN-LABKO.
Unit construction implies application of low-noise equipment components (low-noise moderate speed mill), as well as acoustic absorbent reducing the noise level in the plant's area and nearby residential areas to the level set by sanitary requirements.
All production waste from implementation of pulverized coal fuel (for example, blast-furnace slag) is either processed at the plant or utilized following the existing scheme.
Construction of the pulverized coal fuel preparation and injection unit is performed within the existing plant, with involvement of the existing technological specifics, that's why this measure does not require any additional land assignment.
Implementation of the new slag processing complex AMCOM-1 and AMCOM-2 facilitates utilization of waste slag being the production waste of the 4^{th} hazard class; it is transformed into commodity output (fractional sand and broken stone), and used in main production (metal scrap). After completion of the accumulated slag dump processing, its harmful environmental impact stops.

Slag dust emissions into the air during waste slag processing, with the dust trapping system used, reach 47 t per year. Annual emissions of fuel combustion products into the air make up 53 t. Thus, air contamination with suspended matter in the plant's area will increase only by 6...10% admissible concentration limit, which does not exceed the maximum admissible value. Also, manganese oxide emissions do not exceed the acceptable level.
Since during slag processing, when water is used for slag flushing, no wastewater is formed, there is no negative impact on the water basin.
The acoustic contamination in the nearby residential areas does not increase compared to the pre-project conditions.

PJSC "Ilyich Iron and Steel Works of Mariupol" has all permits and licenses for the project, in particular:

- Permit for performance of reconstruction (or construction) of blast furnaces BF#1-5;
- Permit for performance of construction of slag processing complexes AMCOM-1 and AMCOM-2;
- Permit for performance of construction of the pulverized coal fuel preparation and injection system;
- State inspection board's certificate of commissioning of the reconstructed blast furnaces BF# 1-5;
- State inspection board's certificate of commissioning of slag processing complexes AMCOM-1 and AMCOM-2;
- Positive expert conclusion on FS of construction of slag processing complexes AMCOM-1 and AMCOM-2;

Transboundary impacts

While as a result of implementation of the proposed JI project, pollutant emissions into the air do not exceed the permissible concentration in the territory of PJSC "IISW" and nearby residential buildings, as well as a result of reduction of emissions of specific pollutants (carbon monoxide), no transboundary impacts are identified.

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

The proposed project will have a general positive environmental impact compared to the current situation, since the proposed measures will improve the efficiency of energy resource consumption and restrict concentration of pollutant emissions within allowable limits, as well as ensure reduction of pollutant emissions in the environment. Thus, in general, the impact of implementation of the proposed project measures is insignificant.

SECTION G. Stakeholders' comments

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

Stakeholders are the residents of Mariupol. They were informed on the implemented project through mass media, in particular, Ilyichevets newspaper. For example, information on intended installation of the pulverized coal fuel preparation and injection unit can be found in Ilyichevets newspaper, issue Nr. 21 as of 24.02.2011. Information on construction of new slag processing complexes AMCOM-1 and AMCOM-2 was published in Ilyichevets newspaper, issues as of 20.12.2005 and 29.07.2006. Since the project has a positive impact through environmental and the city's social improvements, the project got only a positive feedback.

Annex 1

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Annex 2

BASELINE INFORMATION

Parameter	Parameter name	Unit	Data source	1998	1999	2000	2001
P_{hist}	Iron production	t	PJSC "IISW" technical reports	3,588,520	4,029,986	4,232,127	4,782,327
$FF_{hist,Coke}$	Coke consumption	t	PJSC "IISW" technical reports	2,198,502	2,339,851	2,408,183	2,733,140
$FF_{hist,NG}$	Natural gas consumption	1000m3	PJSC "IISW" technical reports	204,631	305,208	353,823	376,742
$M_{raw,Limestone}$	Limestone consumption	t	PJSC "IISW" technical reports	140,052	194,868	209,736	149,331
$EC_{BF,hist}$	Electricity consumption by the blast furnace shop	MWh	PJSC "IISW" technical reports	29,282	26,396	30,090	31,755
$C_{hist,Coke}$	Carbon content in coke	%	PJSC "IISW" technical reports	84%	84%	84%	84%
$NCV_{hist,i}$	Net calorific value of natural gas	TJ / $1000m^3$	PJSC "IISW" technical reports	0.033545	0.033545	0.033545	0.033545

Annex 3

MONITORING PLAN

Please refer to Section D for the detailed description of the monitoring plan.