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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Technical Upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Billet Continuous Casting Machines and Two Ladle Furnaces.

Sectoral scope: 3 (electricity consumption), 4 (manufacturing industries), 9 (metallurgy).

Project Design Document Version 8
12/07/2011

A.2. Description of the project:

Public Joint Stock Company Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky (DIISW) is one of the largest facilities in the Ukrainian mining and steelmaking complex and a top six country's leading iron and steel works for production output and sales. The Plant located in the town of Dniprodzerzhynsk, Dnipropetrovsk oblast, in the eastern part of Ukraine. DIISW is a part of Industrial Union of Donbass Corporation (ISD). ISD is one of the largest international steelmaking groups known to the world as a leader in the Central and Eastern European iron and steel sector. Apart from DIISW, ISD owns a number of steel works and mills in Ukraine and the EU, including such assets as PJSC Alchevsk Iron and Steel Works (Ukraine), ISD – Huta Częstochowa (Poland), CJSC ISD – Dunaferr (Hungary), and the coke plant PJSC Alchevskkoks (Ukraine).

Before implementation of the project, the following DIISW production units of the converter shop were used in the Plant's steel making and casting process:
- converter department with two converters;
- continuous casting department with two continuous bloom casters (CBCs);
- ingot casting mill with a mould yard.

Organisation of the steelmaking process was as follows. Prepared pig iron (with chemical properties and temperature homogenised in a holding furnace) blended with scrap and additives was loaded in converters where ferroalloys, desoxidants, lime and other materials were fed later in the course of the furnace process, and blowing of the melt was effected. Molten steel was then loaded into the dressing unit for temperature and chemical composition homogenisation before entering the ladle. Part of molten steel was further directed towards six-strand CBCs producing square billets for the rolling process; balance of molten steel was cast into ingots.

In 2007, DIISW produced 3,781.8 thousand tonnes of steel, using only part of its overall production capacity. Annual output increase to 4.2 – 4.5 million tonnes was planned to be achieved using existing equipment base, without any additional investments; workflows were expected to be distributed among existing facilities based on their available capacity. Therefore the baseline of the proposed project activity is steel production based on utilization of the existing process lines (Blooming Mill 1150, Blooming Mill 1050 with a structural mill, mill 500 and continuous bloom casters nos. 2 and 3 delivering billets for billet mill and other mills) based on steelmaking technology currently used in the iron and steel works.

In an attempt to strengthen competitiveness of steelmaking process and reduce load on the environment, including through reduction of greenhouse gas (GHG) emissions into atmosphere, management of DIISW and ISD decided to upgrade the Plant's process cycle by introducing two ladle furnaces (LF 1 and LF 2) and two new seven-strand billet continuous casting machines (CCM 1 and CCM 3).

The project scenario assumes that steel molten in converters will be dressed in the new two LFs where ferroalloys and other required additives will be fed. LFs will additionally consume electricity compared to the baseline scenario, however they would allow for shorter Furnace Process time and lower temperatures in converters. Generally, energy saving in converters as the result of LFs implementation will result in reduction of overall energy intensity and stabilisation of the furnace process. Thus, out-of-furnace treatment (secondary steelmaking) of steel at LFs will save time, energy, and will produce higher quality steel on a consistent basis.

The project scenario further assumes that steel treated at LFs will be fed into new seven-strand billet CCMs allowing direct square billet production. This, compared to the baseline scenario, will result in lower amount of clippings and energy saving. The expected steel output under the Joint Implementation (JI) Project is 3,400 thousand tonnes per year; together with existing process facilities that will remain in operation this will produce the required Plant's capacity of 4,200 – 4,500 thousand tonnes per year.

Fig. 1. below presents the generic diagram of the core steelmaking process to be adopted in the project.

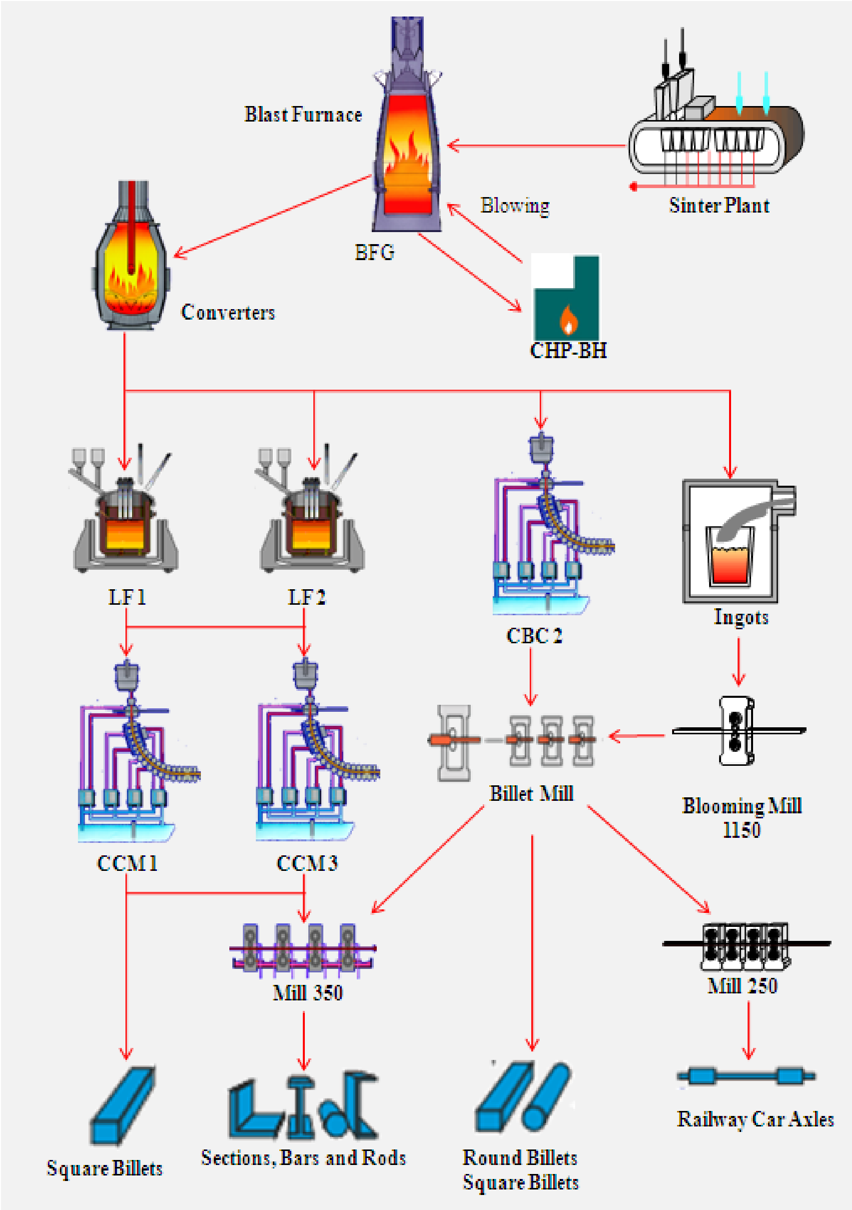

Fig. 1. DIISW Steelmaking Process Flow Diagram by Project Scenario

Therefore, the goal of the JI Project is to achieve steel production with lower energy consumption per unit of output through reduction of Furnace Process time in converters as the result of introduction of LFs and stabilisation of casting process at new CCMs, which would *inter alia* yield significant reduction of GHG emissions to atmosphere (mainly CO_2, as explained below).

The Project set off in April 2007 with beginning of construction works of LF 1. Therefore, 5 April 2007 should be considered as the actual starting date of the JI Project.

It should be noted that development of design documentation and implementation of the Project were delayed by adverse impact of global economy hurdles, manifesting most acutely during 2008 and 2009 and continuing to influence company business, inter alia by creating uncertainties regarding JI project funding. As the result, the Letter of Endorsement of the Government of Ukraine was only received in 2010, after implementation of two of the Project’s four components. The amount of investments required to implement the Project is estimated to be roughly US$ 182.4 million (more details will be provided in Section B).

The importance of addressing the GHG emissions reduction from the project activity was realised from the project’s outset, which can be seen from the Minutes of the Meeting on DIISW Refurbishment and Modernisation Project of 5 April 2007[1]. The proposed Project is virtually identical to the one implemented by ISD at PJSC Alchevsk Iron and Steel Works[2]. This demonstrates the commitment of ISD to principles of the Kyoto Protocol seen as a critical aspect of its production assets modernisation.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host Country)	PJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky (DIISW)	No
Spain	Endesa Carbono	No

A.4. Technical description of the project:

A.4.1. Location of the project:

The site of the Iron and Steel Works is located in the northern quarter of the part of the town of Dniprodzerzhynsk located on the right side of the Dnipro river, 12 km from Baglei station of Transdnipro Railways, serving deliveries of materials to the Plant and shipments of its finished products. The site is limited by the Dnipro river from the north, urban areas from the south, sites of Dniprodzerzhynsk HPP and cement factory from the west, and coke plant from the east.

A.4.1.1. Host Party(ies):

Ukraine

[1] The document could be available on relevant request by DIISW or the project developer, Institute for Environment and Energy Conservation.

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

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

Dnipropetrovsk Oblast

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

Town of Dniprodzerzhynsk

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

The project site is located in Dneprodzerzhynsk city. Dniprodzerzhynsk is one of the Ukraine's and Dnipropetrovsk oblast's largest industrial centres. Established in 1897, it covers both sides of the Dnipro river and its global position is 48°30′N – 34°37′E. The town has the area of approximately 138 square kilometers and the population of 251.4 thousand people. Location of the project site on the map of Ukrane is shown on Fig. 2 and on the map of Dneprodzerzhynsk city is shown on Fig. 3.

Fig. 2. Location of JI Project Site on the map of Ukraine

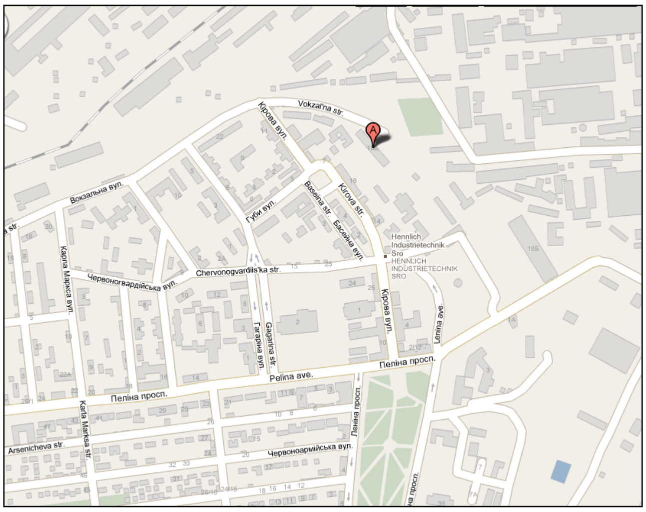

Fig. 3. Location of JI Project Site on the map of Dneprodzerzhynsk city

As it is shown on the map, the mill is located at Kirova street, 18-B. It's located in the north-western part of right riverside of Dneprodzerzhynsk and its global position is 48°31′N – 34°36′E.

Industrial estate of the town is comprised of 48 large productions representing 10 sectors of industry, predominantly steelmaking and chemical sector, but also heavy engineering, electric power, wood processing, food, light, printing and other economy sectors. The largest enterprises include Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky, DniproAzot, Dniprovagonmash, Bagliykoks, Dniprodzerzhynsk Coke Plant and Transdnipro Chemical Works.

Nearly 80% in the town's overall production output is on account of steelmaking and chemical industry. Articles produced include pig iron, steel, mill products, cement, coke, mineral fertilisers, electricity, mainline and industrial railway cars, and buses.

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

DIISW technical upgrade program and the relevant JI project are assumed to be implemented in four steps as follows:

Table 1. JI Project Implementation Schedule[3]

Phase	Activity	2007	2008	2009	2010	2011	2012
1.	Implementation of CCM 1						
2.	Implementation of LF 1						
3.	Implementation of CCM 3						
4.	Implementation of LF 2						

At the end of the first half of 2010 the first two phases of the JI Project were completed (LF 1 and CCM 1 are in operation). Date of completion of JI Project's Phase 1 (the commissioning of CCM 1) was set at November 2008. Installation, commissioning and completion works for LF 1 (Phase 2) were finished towards the end of 2009. LF 1 commercial commissioning is considered to have begun on 1 January 2010.

Completion of CCM 3 is anticipated at the end of 2010 or in the beginning of 2011 and commissioning LF 2 (finalisation of Phase 4) towards the end of 2011.

Contracts for process equipment were signed with Siemens VAI[4] (VOEST-ALPINE Industrieanlagenbau). The following equipment items are to be supplied:

- LF[5] 1: heat size 250 t, temperature rise rate 1.5 to 4 °C/min., number of phases – 3, transformer capacity 35 MVA, process time 30 to 45 minutes (provided heating rate of 15-20 minutes);
- LF 2: heat size 250 t, temperature rise rate 4.5 to 5 °C/min., number of phases – 3, transformer capacity 40 MVA, process time 35 minutes;
- bunker system for alloy and other additives storage, transfer and feed into ladles for out-of-furnace treatment of steel;
- individual gas treatment systems for each LF;
- two seven-strand billet CCMs[6], each having radius of 9,000 mm, operating speed range between 1.40 and 4.2 m/min., process length of 28,000 mm; ingot sections of 130x130…200x200 mm,

[3] Expected at the time of preparation of this document.
[4] http://www.industry.siemens.com/metals/en/
[5] http://www.industry.siemens.com/metals-mining/en/Steelmaking/secondary_metallurgy/SIMETAL_LF.htm
[6] http://www.industry.siemens.com/metals-mining/en/Continuous_Casting/slab_caster.htm

diameter of 150 mm and length between 6,000 and 1,200 mm; casting ladle capacity of 250 t and intermediate ladle capacity of 36 t;
- equipment for lining replacement, intermediate ladle maintenance and mould adjustment and maintenance;
- intermediate ladle drying and heating unit, etc.

Steel production technology proposed under this JI Project is based on melting pig iron in converters and feeding ferroalloys and slag-forming fluxes into the resulting steel, with converter ladle car subsequently being moved to the converter shop's casting bay. Overhead travel crane of the casting bay will place casting ladles on LF ladle car to be moved into position of out-of-furnace treatment under the water-cooled cap. There, required chemical composition and temperature of steel will be achieved, and its electromagnetic stirring and jet degassing will be completed.

After steel has been treated in LF casting ladle will be placed onto CCM rotating turret. A hydraulic cylinder will be connected to the ladle to govern sliding shutter. CCM rotating turret will move the ladle into the casting position. As intermediate ladle (nearly 10 t of molten steel) is filled up casting strands will be activated. Further molten metal will be continuously cast into the water-cooled mould. A DiaMold[7] special copper insert provided in the mould will allow achieving maximum casting rate. Cast slab skin will cool down inside the mould. After that, slab will move to the secondary cooling area where water is jet-sprayed on the steel, then will enter the stretcher where it is straightened and will then be moved towards a torch cutting machine. The product slab having the required length will then be marked and moved to the cooling bed.

Equipment supplied by Siemens VAI assures higher converter shop productivity and produces continuous billets of carbon, low-alloy, structural, and tube steel. Savings in materials and energy resources are achieved through higher quantity of steel undergoing out-of-furnace treatment and refined to the required chemical composition at LF. Out-of-furnace treatment of steel in LFs saves 10% to 15% of ferroalloys added to molten steel. Furthermore, implementation of CCM technology would achieve saving of up to 30 kg of equivalent fuel per tonne of rolled steel due to exclusion of blooming mills from finished steel production cycle, as well as 10% – 12% reduction of steel consumption index compared to ingot casting technology[8]. Productivity of a single seven-strand billet CCM within the Converter – LF – CCM process cycle is 1,700 thousand tonnes of continuously cast billets a year.

Process equipment by Siemens VAI is based on state-of-the-art engineering, automation and control developments geared to minimise non-productive losses of energy and achieve maximum recovery of heat of the molten steel.

Further reduction of heat losses and the resulting drop in the amount of energy used in the production cycle are secured by use of protective ladle caps and protective agents fed on metal surface during the casting process.

Project implementation is the responsibility of DIISW's Capital Construction Directorate. DIISW owns key infrastructure elements required, such as rail and road access, warehouses, precast concrete yard etc. Specially developed health and safety programme covers all civil and erection works in respect of new process systems[9].

Development of management resource and skill required to operate new equipment is an important component of the JI Project. DIISW has worked out a detailed personnel training programme assuming

[7] http://www.industry.siemens.com/metals-mining/en/Continuous_Casting/billet_caster/diamold.htm

[8] These numbers were taken from the project feasibility study; however, monitoring plan included in this PDD provides that measurement of consumption of all materials and energy shall be performed in real time.

[9] Said documents can be provided upon relevant request by the project developer, Institute for Environment and Energy Conservation.

creation of a dedicated Project Implementation Group, accountable directly to DIISW Director General, aimed to support smooth realisation of the JI project. The Project Implementation Group is responsible for reliable operation of equipment and efficient information exchange regarding JI Project implementation. Employees of DIISW undergo field training at partner Ukrainian steelmaking enterprises. Ultimate responsibility for staff training rests on DIISW Deputy Director. Training of DIISW technical specialists and managers is organised on a continuous basis; Siemens VAI representatives delegated to the Plant monitor and supervise implementation of the project and training staff required to operate the new equipment.

JI project maintenance will be in accordance with national requirements and DIISW internal routines with technical support on the part of Siemens VAI.

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:

Currently in Ukraine there are neither regulations and nor laws which would require the adoption or use of more efficient technologies for the proposed project. However, in the Energy Strategy of Ukraine[10], adopted in March 2006, it is stated that GDP rate will increase by three times by 2030 but the energy consumption will only grow by 47.5 %. Thus proposed JI Project activity is considered to be in line with the long-term energy strategy of Ukraine but not in any sense mandated.

In this context the project had to face a number of obstacles described in more detail in Section B. One of them is an investment barrier created by a high indebtedness rate of ISD and limited reliability margin of covenants amid challenging debt and banking market position and unstable demand for steelworks products. The situation reflected lack of development of the domestic financial market, ongoing financial hurdles, low credit rating of the Ukrainian economy, and modest attractiveness of ISD and DIISW as potential borrowers.

The proposed project is one of the groundbreaking ones in its area for Ukraine. Therefore, other barriers include lack of skill to operate new state-of-the-art international process equipment, and need to sustain precise operational practices as to load requirements etc.

Availability of Kyoto mechanisms was an incentive for the decision to invest in energy saving as these mechanisms open DIISW a door to extra financial resources, reduce risks related to new technology implementation, and make debt service more affordable.

As mentioned above, considering that within project activity amount of cutoff pieces will be reduced, respectively the amount of GHG – mainly CO_2 within the project's framework also will be reduced as a result of decreased consumption of materials and energy. This, in its turn, will cause drop in consumption of anthracite, coke, natural gas and electricity by other production departments, particularly sinter plant and blast furnace. Furthermore, replacement of continuous bloom casters and exclusion of the blooming mills will help to achieve savings of Blast Furnace gas (BFG), which will replace the consumption of natural gas (NG) under project scenario, as well as further savings on electricity. Generally, reduction of material resource consumption will be attained owing to implementation of more efficient process equipment in the proposed JI Project. Emissions reduction process will be explained in more detail in Section B.

[10] http://www.ukrenergo.energy.gov.ua/ukrenergo/control/uk/archive/docview?typeId=44577

A.4.3.1. Estimated amount of emission reductions over the crediting period:[11]

First commitment period

	5 Years
Length of the crediting period	
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	139 587
2009	824 526
2010	713 287
2011	1 779 799
2012	1 779 799
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**5 236 999**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 232 235

Period following first commitment period

	8 Years
Length of the crediting period	
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2013	1 779 799
2014	1 779 799
2015	1 779 799
2016	1 779 799
2017	1 779 799
2018	1 779 799
2019	1 779 799
2020	1 779 799
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	**14 238 396**
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 779 799

[11] Project emissions, baseline emissions together with emission reductions (which are provided in this section) are rounded to the whole figure (1t) and are based on the calculations which are demonstrated in the attached excel file. This file is provided to the Authorized Independent Entity (AIE).

A.5. Project approval by the Parties involved:

Letter of Endorsement of the Government of Ukraine No. 56/23/7 was received on 21 January 2010. The final version of the Project Design Document shall be submitted to the Government of Ukraine along with a positive determination report for the Letter of Approval (LoA), which is usually expected within 30 days. The State of the Netherlands, acting through the Ministry of Economic Affairs, Agriculture and Innovation has issued LoA on 5 July 2011.

SECTION B. Baseline

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

The baseline for the proposed project is identified and justified following the Annex B to the JI Guidelines[12] and the JISC *Guidance on Criteria for Baseline Setting and Monitoring*[13]. No applicable approved CDM methodologies are available for this project; however, JI Project "Revamping and Modernization of the Alchevsk Steel Mill," registered in 2008 and assuming implementation of CCMs and converters to replace open-hearth furnaces, may be treated as similar to the proposed project activity, therefore its methodology fully applies to the project in question.

The baseline scenario was determined based on JI-specific approach and refers to the DIISW project-specific conditions and parameters as they are described in this PDD.

A two-step approach is used to identify and chose the baseline scenario for the project:

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

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

Step 1: Identify alternatives to the project activity

Steel production typically occurs at integrated facilities from iron ore or at secondary facilities, which produce steel mainly from recycled steel scrap. Primary facilities typically include open hearth furnaces (OHFs) or oxygen converters, while secondary steelmaking most often occurs in electric arc furnaces. These facilities are integrated with CBCs or blooming mills processing molten steel into intermediate steel products such as blooms, slabs, square billets, etc. Basically all Ukrainian steel productions continue to one or another degree using "old-generation" CBCs and blooming mills. Documentation of the JI Project at Alchevsk Iron and Steel Works includes a detailed rundown of the technical steelmaking potential currently existing in Ukraine[14]. The information explained in the PDD for the JI project "Revamping and modernization of Alchevsk steel mill" states that by that time there were no new CCMs installed in Ukraine since it gained independence, which is confirmed by the relevant opinion of the Ukrainian Ministry of Industrial Policy[15]. This information is relevant for the proposed project activity taking into account that the AISW PDD received final determination report on 23.04.2008.

Regarding current situation in metallurgy sector, it should be noted that since 2005 the steel sector of Ukraine is improving really slow, though being one of the base elements of economy of the country[16]. Current standing of Ukrainian ferrous metallurgy is characterised by imperfect structure and lag in technology from developed countries and even Russia. Range and shares of products of Ukrainian metallurgy are inconsistent with world market demand. Ukrainian metallurgy sector requires radical modernisation and reconstruction, as well as optimising structure of range of final products[17]. Productive

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[12] Decision 9/CMP.1 Conference of the Parties serving as the Meeting of the Parties of the Kyoto protocol 30th of March 2006.
[13] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
[14] Page 12 of the PDD "Revamping and modernization of Alchevsk Steel Mill"
[15] May be provided upon request.
[16] http://www.ukrrudprom.com/digest/Metallurgiya_Ukraini_sostoyanie_konkurentosposobnost_perspektivi.html
[17] http://www.reportlinker.com/p0174533/Steel-Rolled-Steel-in-the-Ukraine.pdf

assets are worn and obsolete: by the end of 2008, depreciation of facilities operating exceeded 60% (including 54% depreciation of cokeoven batteries, 80% of available blast furnaces, 90% of open hearth furnaces and rolling mills; 26% depreciation of converters), and the completely depreciated facilities yield above a half of the country steel products[18]. By 2010 the level of technical rundown of Ukrainian steel enterprises was over 65%[19] which is twice higher than in European countries[20].

At the time of investment decision, i. e. in 2007, DIISW had two technically feasible alternatives for its planned development strategy assuming *inter alia* increase of market share and expansion of production output as there were no other intermediary solutions:

- **Alternative No. 1:** Production of steel using the existing technology: Blooming Mill 1150, Blooming Mill 1050, structural mill, Mill 500, continuous bloom casters 2 and 3 producing billets for the billet mill and other mills.
- **Alternative No. 2:** Modernization and refurbishment of steel production cycle using modern LFs and CCMs with the shutdown and decommissioning of Mill 500 (project itself without carbon component).

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

Step 2: Identify the most plausible alternative

Alternative No. 1: Production of steel using the existing technology.

Ukrainian iron and steel production facilities have inherited process equipment installed during the Soviet era. Iron and steel industry is today in need of a sector-wide reform. The criticality of transit to the innovative sectoral practices is discussed by production experts, designers, scientists, and members of the government, however, innovative development of the nation's mining and steel industry is largely non-existent. In the recent years, the Cabinet and the parliament of Ukraine have many times reviewed a concept and a national programme for the Ukrainian steelmaking sector reform, however documents developed and practical decisions made bumped against lack of reliable financial and institutional support[21].

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

In fact, the planned billet output could have also been secured with existing older CBCs and with the redistribution of workflows towards blooming and ingot casting mills. At the moment of the investment decision, as well as currently, there were no regulatory or technical limitations for the operation of the older continuous bloom casters nos. 2 and 3 and the existing blooming mill equipment. Such limitations will continue to be absent at least until 2012 – possibly, during a longer period, say until 2020, if there persist current Ukrainian economy conditions and intentions for its reform

[18] http://www.reportlinker.com/p0174533/Steel-Rolled-Steel-in-the-Ukraine.pdf
[19] http://www.ukrrudprom.com/digest/Metallurgiya_Ukraini_sostoyanie_konkurentosposobnost_perspektivi.html
[20] http://www.metallurgy.at.ua/news/2008-07-24-319
[21] http://www.nbuv.gov.ua/portal/Natural/VDU/Ekon/2008_1/VDU1-2008/181.pdf

encouraging to hold back administrative barriers before commercial production activity carried out by private entities. However, in order to ensure conservativeness of the assumptions used for the identification of the baseline alternatives, energy efficiency and other technology parameters in this PDD will be found solely for DIISW equipment that was in operation from the starting date of the project, part of which will remain in operation following implementation of proposed CCMs and LFs.

Alternative No. 2: Modernization and refurbishment of steel production cycle using modern LFs and CCMs (project scenario without carbon component).

The project activity includes installation of two billet CCMs nos. 1 and 3, each with the production capacity of 1,7 m tonnes of steel, and two LFs: LF 1 producing 1 m tonnes of steel and LF 2 whose output is 2.4 m tonnes of steel per year. CCM 3 will replace the older CBC, currently operating under no. 3.

In 2007 there were, and there still are, no legal or regulatory requirements in Ukraine for the adoption of new technologies for steel making. The proposed project is in line with non-mandatory, general government policies, such as the Restructuring Program of the Iron and Steel Sector and with the long-term Energy Strategy for Ukraine (adopted in 2006)[22].

Against the backdrop of the global crisis whose effects were particularly acute for the Ukrainian iron and steel sector, a project requiring the total investment of US$ 182.4 million would be hard to accomplish, given its current status (see Section B.2.) Therefore, considering existing financial and technical barriers, project scenario without the JI component was not the most attractive one, which prevented its further implementation.

The above suggests that the Alternative No. 1 would be the most plausible and credible alternative and it represents the baseline scenario for the proposed project activity. For the baseline scenario, the full amount of CO_2 emissions related to this scenario is accounted for; its monitoring will be performed as part of detailed monitoring of steelworks processes required for the DIISW technical purposes (please see more detail in Section D). In order to ensure transparent and conservative estimates of the baseline emissions, the following key assumptions are verified for the selected baseline:

- The baseline parameters and variables for the old CBC 3, that is to be replaced by a new one of the same number under the project activity, will be monitored and measured on CBC 2 that will operate under both baseline and project scenarios. The old CBC 3 and CBC 2 are largely identical (the difference is in the commissioning time: 1999 for CBC 2 and 1994 for CBC 3) so specific consumption indicators for both of them will be the same. Accordingly, the emission factors per output of production will be quantified for the baseline technology on the *ex-post* basis for CBC 2 operation during the actual monitoring period. Thus the baseline selected is conservative as it will be based on the operational indicators for the newer CBC 2.

- The baseline CBC 2 has the remaining lifetime that goes well beyond the crediting period for the project and will not be replaced by any new technology until at least 2020.

- Actual data monitoring and further calculation of emissions reduction due to converter shop upgrade will permit to track the increase in energy efficiency of project scenario steelmaking process, being the result of reduction of the converter process time following implementation of the project LF technology, compared to the baseline scenario where emissions will be quantified based on the most recent data for the latest converter shop operation period without the LF in 2009 (LF 1 commenced commercial operation with steel production parameters monitoring in January 2010).

[22] OECD, OECD Special Meeting at High-level on Steel Issues, The Ukrainian Steel Industry, Paris, 11 January, 2006.

- The baseline monitoring procedure rules out the possibility to overestimate baseline emissions since production output indicator will be limited to the level adopted for the project scenario, being lower than the actual level of steel output at the plant. Furthermore, real performance indicators of CBC 2 and other baseline facilities will be used that meet market conditions characteristic also for the project scenario in the given time period, which will exclude the possibility baseline emissions overestimation.

The scrap used in baseline and project cases will be calculated as zero emission raw material.

Key Information and Data Used for Baseline Identification

Data/Parameter	TSO_b (B-2)
Data unit	Tonne
Description	Total steel output in the baseline scenario
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is equal to the total steel (square billet) output during the project activity
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$TPII_b$ (B-4)
Data unit	Tonne
Description	Total pig iron input into steel making process
Time of determination/monitoring	Measured constantly – regular result (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is the amount of pig iron that would have been required to produce the same volume of steel (square billets) as in the project line scenario
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fpi,b}$ (B-6)
Data unit	1000 m^3
Description	Quantity of each fuel (fpi) used in making pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$EF_{f,b}$[23] (B-7, B-14, B-27, B-41, B-48)
Data unit	Tonne CO_{2e}[24]/1000 m^3
Description	Emission factor of each fuel
Time of determination/monitoring	Fixed value based on DIISW average data
Source of data (to be) used	DIISW average data IPCC 1996 Potentially measured by DIISW laboratory or local fuel distributor
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with DIISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[25] Net calorific value is anticipated at nearly 33,913 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,893 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values of fuels will be received on regular basis.

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

Data/Parameter	$ECPI_b$ (B-9)
Data unit	MWh
Description	Electricity consumed in producing pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{e,b}$ (B-10, B-17, B-30, B-44, B-52)
Data unit	Tonne CO_{2e}/MWh
Description	Emission factor for electricity consumption
Time of determination/monitoring	Regular tabulation (applied on annual basis)
Source of data (to be) used	Carbon emission factors based on the Orders of the National environmental investment agency of Ukraine #43 dated 28th of March 2011, #62 dated 15th of April 2011, #63 dated 15th of April 2011 and #75 dated 12th of May 2011.
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[26]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[27]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[28]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period.

[26] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[27] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[28] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

Data/Parameter	$Q_{fio,b}$ (B-13)
Data unit	1000 m^3
Description	Quantity of each fuel (fio) used in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECIO_b$ (B-16)
Data unit	MWh
Description	Electricity consumed in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rapi,b}$ (B-19)
Data unit	Tonne
Description	Quantity of each reducing agent (rapi) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{ra,b}$[29] (B-20, B-34)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each reducing agent
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006 Potentially measured by DIISW laboratory
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne. For anthracite the anticipated factor is 2.62 tonnes CO_{2e}/tonne. For coal electrodes the anticipated factor is 3.6 tonnes CO_{2e}/tonne. The parameter is remained fixed throughout the crediting period, if no additional information regarding C-content is available. However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of anthracite. If information on actual carbon content or net calorific value is available, it would prevail over default factors.

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

Data/Parameter	$Q_{oipi,b}$ (B-22)
Data unit	Tonne
Description	Quantity of each other input ($oipi_p$) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{oi,b}$[30] (B-23, B-37)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each other input
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite. For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values and amount of additives of each other input will be received on regular basis.

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

Data/Parameter	$Q_{ffp,b}$ (B-26)
Data unit	1000 m^3
Description	Quantity of each fuel (ffp) used in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECFP_b$ (B-29)
Data unit	MWh
Description	Electricity consumed in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rafp,b}$ (B-33)
Data unit	Tonne
Description	Quantity of each reducing agent (rafp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{oifp,b}$ (B-36)
Data unit	Tonne
Description	Quantity of each other input (oifp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fcr,b}$ (B-40)
Data unit	1000 m^3
Description	Quantity of each fuel (fcr) used in casting/rolling
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECCR_b$ (B-43)
Data unit	MWh
Description	Electricity consumed in casting/rolling
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fbpn,b}$ (B-47)
Data unit	1000 m^3
Description	Quantity of each fuel (fbpn) used for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECBPN_b$ (B-50)
Data unit	MWh
Description	Electricity consumed for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$ECSG_b$ (B-51)[31]
Data unit	MWh
Description	Self-generated electricity consumed
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	In the baseline scenario is equal to zero
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

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

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

Step 1. Indication and description of the approach applied

A JI specific approach is used, therefore one of the approaches, defined in paragraph 2 of the annex I to the "Guidance on criteria for baseline setting and monitoring"[32], to demonstrate additionality of the project shall be used. As suggested by paragraph 2 (c) of the annex I to the "Guidance on criteria for baseline setting and monitoring" the most recent version of the Tool for the Demonstration and Assessment of Additionality approved by CDM Executive Board (version 05.2[33]) is used to demonstrate the additionality of the project.

Step 2. Application of the approach chosen

This section includes analysis of project additionality and is intended to demonstrate that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of GHG emissions in comparison to the baseline. The analysis below is performed following steps of the latest version (version 05.2) of the Tool for the Demonstration and Assessment of Additionality[34] approved by CDM Executive Board, which accordingly may be fully applied to Joint Implementation Projects.

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

[31] Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas is used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.
[32] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf
[33] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf
[34] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

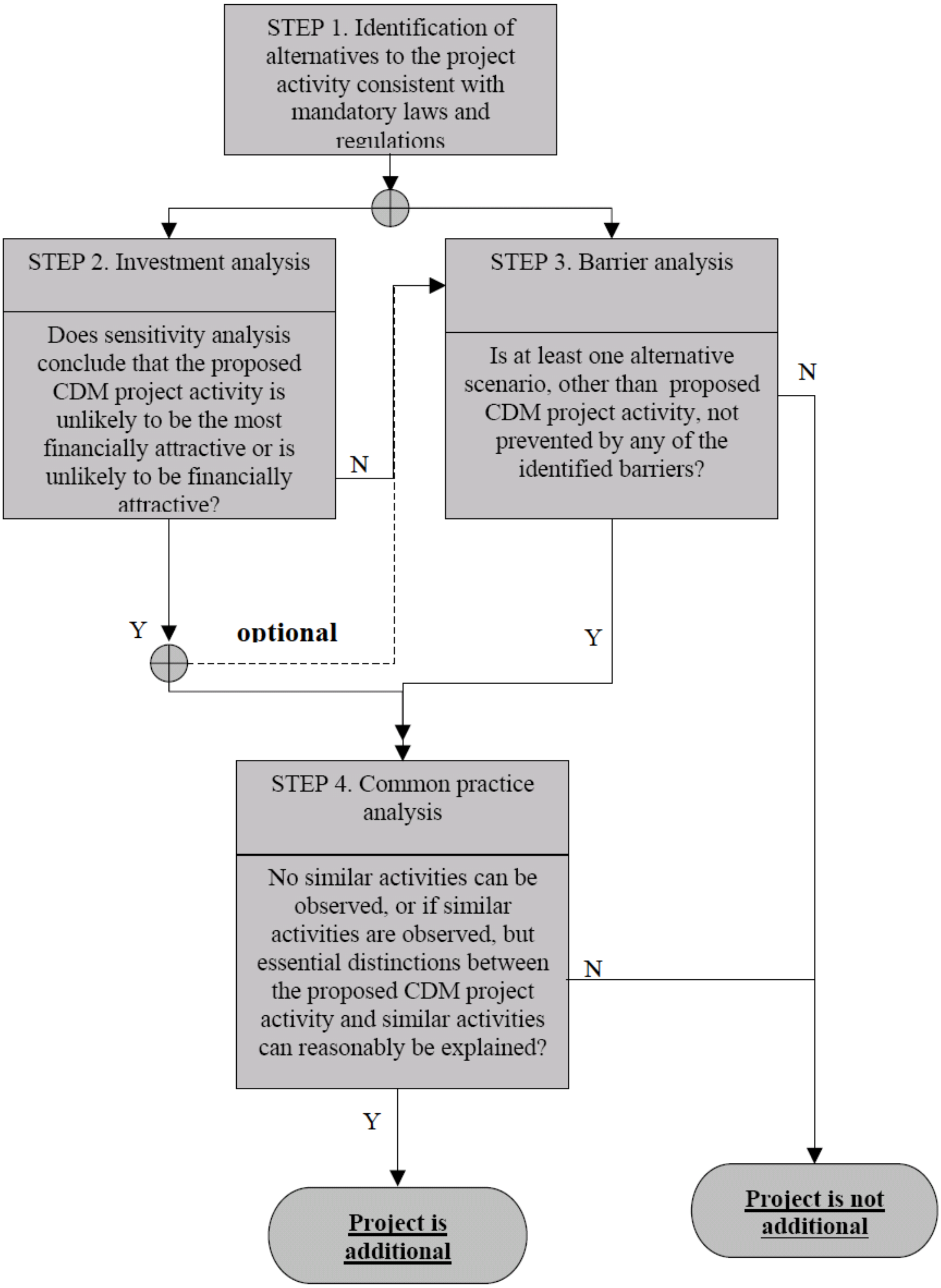

Fig. 4. JI Project Additionality Scheme Defined in the Tool for the Demonstration and Assessment of Additionality (version 05.2)

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

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

As described in Section B.1, the following scenarios could be considered as credible and realistic alternatives to the project activity:

- Alternative 1: Steel production based on utilization of the existing process lines (Blooming Mill 1150, Blooming Mill 1050 with a structural mill, mill 500 and continuous bloom casters nos. 2 and 3 delivering billets for billet mill and other mills) based on steelmaking technology currently used in the iron and steel works;
- Alternative 2: Modernisation and refurbishment of steelmaking process based on implementation of state-of-the-art LFs and CCMs (project scenario without JI component).

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

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

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

National policy of Ukraine regarding the emissions of pollutants into atmosphere is determined by the Law of Ukraine *On Protection of Atmospheric Air* of 21 June 2001 No. 2556-III[35]. The Oder of the Ministry for Environment of Ukraine dated 27.06.2006, No. 309 approves admissible level of emissions of polluting substances from stationary sources, both active and those being designed, developed, or retrofitted. Regulatory allowances for admissible level of emissions of polluting agents and their aggregates set limits on mass concentration of pollutants in point source emissions from stationary sources (in mg/m^3) and do not provide any specific requirements as to new technologies. Nonetheless, as specified above, most Ukrainian steelmaking enterprises continue successfully to operate equipment installed back during the Soviet era – this is particularly true for blooming mills, typically integrated with open hearth furnaces (OHFs) whose share in total steel production was 64% as of 2008[36], and continuous bloom casters operated by most of the Ukrainian steelworks (except PJSC AISW, as mentioned in more detail above).

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

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

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

[35] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=2707-12
[36] http://metallurgy.at.ua/news/u_poslednej_cherty/2010-03-04-1893

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

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method:

In this sub-step it should be determined which of the three analysis options provided in the Tool for the Demonstration and Assessment of Additionality applies the best:

Option I – simple cost analysis;
Option II – investment comparison analysis;
Option III – benchmark analysis.

In Step 1, two alternatives to the JI Project were identified. Since one of these alternatives, "Steel production based on utilization of the existing process lines (blooming mill 1150, blooming mill 1050 with a structural mill, mill 500 and continuous bloom casters nos. 2 and 3 delivering billets for billet mill and other mills) based on steelmaking technology currently used in the iron and steel works" (Alternative 1), is economically viable without additional revenue from ERU sales, simple cost analysis is not applicable as per the Tool for the Demonstration and Assessment of Additionality. Investment comparison analysis (Option II) does not apply either since the baseline scenario identified (Alternative 1) assumes no investment. Considering this, project developers chose the benchmark analysis (Option III) as a tool to demonstrate and assess additionality of the proposed JI project.

Sub-step 2b. – Option I. Apply simple cost analysis

Not applicable.

Sub-step 2b. – Option II. Apply investment comparison analysis

Not applicable.

Sub-step 2b – Option III. Apply benchmark analysis

Project IRR was chosen to demonstrate the additionality of the proposed JI Project. Economic attractiveness of the Alternative 2, corresponding to the project scenario, but without carbon emissions reduction component, was evaluated by this financial indicator, IRR. Base conditions and assumptions for the analysis are listed in Table 2. The selected Benchmark is the expected asset return, which consists of the following parameters:

- US risk-free rate (10 year treasury bill yield) – 4,69%[37]
- Market risk premium (E(m)-E(rfr) – 5,61%[38]
- Beta of sector average – 1,59[39]
- New project premium – 2,10%[40]
- Country risk premium Ukraine – 7,50%[41]

The expected asset return – 21% which shall be used as a benchmark for the investment analysis of the proposed project activity.

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[37] http://www.federalreserve.gov/releases/h15/data/Monthly/H15_TCMNOM_Y10.txt
[38] http://money.cnn.com/2008/02/29/magazines/fortune/bull_market.fortune/index.htm
[39] The calculations of the following parameter is presented in the Investment analysis excel spreadsheet.
[40] New project premium is estimated by market participants if the project is new, i.e. installation of new equipment. The estimate of 2.1% is taken from Harvard Business School's book «Project Finance».
[41] http://www.sjsu.edu/faculty/watkins/countryrisk.htm

Table 2. Major Project and Investment Analysis Indicators to Demonstrate Project Additionality[42]

Indicator	Value (in US $ as of 2007)
Investment	US$ 182.4 mln[43] (US$209,7mln with contingency 15% on top)
Implementation Period[44]	5 years
Planned Annual Output of Square Billets in Project Scenario	3,400 thousand t/year
Benchmark Sales Price	US$ 425 / t of steel billet
Profit Tax	25 %
ERU Sale Price, per tonne of CO_2 equivalent	EUR 12 / US$ 16.2

The company earns most of its revenues from square billet sales. Project income was estimated based on actual and expected DIISW billet sale price. The average price was US$ 425 per tonne of billets (see Table 2).

As seen from the table below, project IRR is below the benchmark. This means that project activity is not financially attractive and would not have been chosen by the management of DIISW as a potential investment option without the JI component.

Table 3. Project Internal Rate of Return

Project IRR	**11,45%**
Benchmark	21%

A more detailed dependence of IRR on square billet price is included in the sensitivity analysis. The benchmark equals ISD (DIISW) cost of equity using capital asset pricing model (CAPM) for new projects i.e. which is also a required return by the shareholders.

Sub-step 2c. Calculation and comparison of financial indicators:

The IRR for the operational period until 2020 of the proposed project activity without JI benefit can be calculated as 11,45% for the sales price of US$ 425 per tonne of square billets. The IRR for the 13-year operational period does not reach the benchmark value, even with inclusion of terminal value into the cash flows of the project. Therefore, the investment into the proposed project activity cannot be justified without JI benefits.

Sub-step 2d. Sensitivity analysis (only applicable to options II and III):

The IRR values for the change in price per tonne of square billets are calculated as listed in Table 4 and 5 below.

[42] In the investment analysis the raw material cost was used as one of the parameters required for the IRR calculation. The information for raw material cost was provided by the planned-economic department of DIISW.
[43] USD 182,4 mln is the value estimated in 2007 based on the draft contracts (to some extend fixed amounts) for the first two years of construction and further estimates based on experience for the 2009-2012 years of planned construction.
[44] Before project achieves planned slab output.

Table 4. IRR Sensitivity to Changes in Square Billet and Raw Materials by 10% price decrease

	%	0	1	2	3	4	5	6	7	8	9	10
%	Long-term average billet price, US$/tonne Price of raw materials, US$/tonne	425	421	417	412	408	404	400	395	391	387	383
0	345	**11,45%**	8,22	4,39	-1,96	-6,47	-9,30	-12,04	-14,88	-18,08	-22,17	-29,36
1	349	8,86	5,23	-0,51	-5,91	-8,79	-11,53	-14,33	-17,43	-21,29	-27,44	-100
2	352	5,95	0,81	-5,35	-8,27	-11,02	-13,79	-16,82	-20,47	-25,91	-100	-100
3	356	1,98	-4,76	-7,74	-10,51	-13,26	-16,22	-19,71	-24,62	-39,33	-100	-100
4	359	-4,16	-7,2	-10	-12,74	-15,64	-18,99	-23,50	-33,22	-100	-100	-100
5	363	-6,66	-9,48	-12,22	-15,08	-18,31	-22,5	-30,17	-100	-100	-100	-100
6	366	-8,97	-11,71	-14,52	-17,66	-21,59	-28,06	-100	-100	-100	-100	-100
7	370	-11,2	-13,98	-17,03	-20,75	-26,42	-100	-100	-100	-100	-100	-100
8	373	-13,45	-16,43	-19,97	-25,06	-45,83	-100	-100	-100	-100	-100	-100
9	377	-15,84	-19,24	-23,88	-34,75	-100	-100	-100	-100	-100	-100	-100
10	380	-18,54	-22,84	-31,1	-100	-100	-100	-100	-100	-100	-100	-100

Conclusion: Under stress test scenario, most likely for the steel downcycle, the project is very risky to undertake. At a downcycle scenario both the steel price and raw materials basket usually go down.

Table 5. IRR Sensitivity to Changes in Square Billet and Raw Materials by 10% price increase

	%	0	1	2	3	4	5	6	7	8	9	10
%	Long-term average billet price, US$/tonne Price of raw materials, US$/tonne	425	429	434	438	442	446	451	455	459	463	468
0		**11,45%**	14,40	17,24	19,5	21,31	22,97	24,54	26,03	27,46	28,85	30,22
1	349	8,86	12,02%	14,94	17,77	19,85	21,63	23,27	24,82	26,3	27,72	29,11
2	352	5,95	9,48	12,58%	15,47	18,21	20,20	21,94	23,57	25,1	26,57	27,98
3	356	1,98	6,65	10,08	13,13%	16	18,64	20,53	22,25	23,86	25,38	26,84
4	359	-4,16	3,05	7,34	10,67	13,67%	16,53	19,02	20,87	22,56	24,15	25,66
5	363	-6,66	-2,52	4,05	8	11,25	14,22%	17,06	19,38	21,19	22,87	24,44
6	366	-8,97	-6,11	-1	4,97	8,64	11,82	14,75%	17,59	19,73	21,52	23,17
7	370	-11,20	-8,45	-5,55	0,36	5,7	9,26	12,38	15,29%	18,06	20,08	21,83
8	373	-13,45	-10,69	-7,92	-4,97	1,59	6,41	9,87	12,94	15,82%	18,49	20,42
9	377	-15,84	-12,92	-10,17	-7,39	-4,38	2,68	7,1	10,47	13,48	16,35%	18,9
10	380	-18,54	-15,27	-12,4	-9,66	-6,85	-3,09	3,71	7,77	11,05	14,03	16,88%

It could be seen from Table 4 and 5 that IRR is very sensitive to square billet price variations, especially to raw materials costs.

Under market growth scenario the project can be sustainable only if the prices rise above $434 and the raw materials basket keeps below $349. It is important to note that such situation when steel price grows without the similar increase in raw material basket is not possible in the steel market. The iron ore is the main component of the raw material costs and its price is usually derived by the iron ore suppliers as a function of slab or billet price. Therefore, in case the billet price raises the iron ore price raises too and the Table 5 shows such relationship in the different color (magenta).

In addition, prior to and during 2007 there was a tendency when the spread between raw materials basket and billet price decreased, due to raising natural gas, iron ore and other material costs. In most of iron ore supply contracts the price for iron ore is calculated every month using steel billet index / price. Therefore the increase of the price is only possible with increase of cost, which is shown in corresonding part of the sensitivity table. The only ways to hedge against the raising iron ore prices is either to own a iron ore mine or produce finished products, rather than semi-finished like steel billet. Unfortunately ISD (DIISW) does not own the iron ore mines.

In order to demonstrate how the JI component helps to overcome the investment barrier the IRR was calculated including incomes from ERU sales. In case ERUs will be sold only for the 5-year horizon the IRR will reach the benchmark if the price for ERU will be around USD 30 (EUR 22). In case the 13-year horizon IRR reaches the benchmark at the ERU price of US$ 15.5 (EUR 11.5). Under initial assumption of ERUs price at the level EUR 12, IRR would reach 21,28% when benchmark is 21.08%. It is also obvious that in order to reach the required return on capital under proposed variations addition of revenue from ERUs becomes absolutely necessary. Since the 21.08% required return was reached under assumption of EUR 12 price per ERU the project received a green light in 2007. On this basis, the conclusion could be made that the benchmark analysis carried out in the previous section proves additionality of the proposed project. However, the barrier analysis appears to be more persuasive to secure better reliability and credibility, as well as higher level of conservatism of findings regarding the project additionality. Therefore, we also use Step 3 to verify additionality of this JI Project.

Step 3. Barrier analysis

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

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

Specific Barriers

The project has faced certain barriers of different nature. In accordance with paragraph 6 of the Annex 13 of Guidelines for objective demonstration and assessment of barriers[45] (Version 01), even in case if it is difficult to evaluate concretely whether a barrier actually prevents the investment from being done, the evidence of presence of the barrier can be based on barrier experience of other projects under similar circumstances, in particular taking into account the barrier for already determined and verified JI project at AISW UA1000022[46]. As it has been stated above the mentioned project is technologically the same with the proposed project activity.

[45] http://cdm.unfccc.int/EB/050/eb50_repan13.pdf
[46] http://ji.unfccc.int/JIITLProject/DB/V75OZ8TQOFTB325LEDMXE2628ZD548/details

However the "Guidelines for objective demonstration and assessment of barriers"[47] (Annex 13, version 01, page 2/5, Guideline 3) does not require that other JI projects should be the same technologically. For demonstrating additionality it is enough to show, based on reputed source, that already registered JI project is similar to the proposed one, in other words it realized in similar circumstances (in similar industries/sectors, in companies of similar size and ownership structure, in similar projects).

Under both project activities the same supply companies are involved. Both projects are realised under similar circumstances, within the same industry and under the framework of ISD Corporation. Moreover, despite the fact that majority of Ukrainian steel plants required modernisation of steel section with involvement of state of the art slab or billet casting machines and ladle furnaces, at the time of investment decision no positive experience was demonstrated by other steel mills due to the existing market barriers.

These two JI projects are more than similar, they are technologically the same due to the fact that project lines for both projects are identical despite the natural initial differences of production processes. For instance, opposite to the case at AISW, LD-Converters were already installed at DIISW before the beginning of the proposed activity, but implementation of continuous casting machines together with ladle furnaces considered to be a part of the proposed project activity. The only difference between these two JI projects is that the continuous casting machines (state-of-the-art seven-strand billet CCMs) are different from the ones implemented at AISW (slab casting machines) and that the LD-Converters already existed at DIISW, but they were included to the project boundaries due to the influence of the ladle furnaces on their operation.

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

Together with this, in accordance with the "Guidelines for objective demonstration and assessment of barriers"[48] (Annex 13, version 01, page 2/5, Guideline 3) the technological barrier may be confirmed by showing evidence that the use of this technology in the considered sector is marginal (below 10%).

All mentioned above information proves that the project is additional.

Barriers due to Prevailing Practice and Technological Barriers

Project activity assuming development of two billet CCMs and two LFs is the most advanced alternative available at the market.

Some of the literature sources are indicating that at the moment of project initiation at least several steel plants already operated similar technologies, mostly slab casting machines and to lesser extent ladle furnaces. However, all of existing slab casting machines at the market were similar or even technologically outdated even in comparison with bloom casting machines used by DIISW under baseline scenario.

[47] http://cdm.unfccc.int/EB/050/eb50_repan13.pdf
[48] http://cdm.unfccc.int/EB/050/eb50_repan13.pdf

New casting machines supplied by Siemens-VAI have the following benefits of innovative character:

- shortest revamping time;
- extremely rapid start-up of facility;
- improved product flexibility and quality;
- higher degree of process reliability;
- special automation solutions;
- better productivity;
- simulation of phase transformations and of precipitation process in solidified steel[49].

Independent research conducted in 2010 states that proposed innovative billet casting machines at DIISW are the only present in Ukraine. Also, for the first time in Ukraine was envisaged introduction of two seven-strand billet CCMs[50]. The implemented complex equipment will ensure the total output of still billets at the level of 3,4 mio. tonnes per year. It is for the first time in Ukraine that such a large amount of steel billets is produced by two continuous casting machines.

Taking into account the text mentioned above, the new seven strand billet continuous casting machines are the first of its kind facilities in Ukraine.

The same arguments can be applied for innovative ladle furnaces at DIISW to be installed under the project line. Among the main benefits there are such as: “buffer function” between melting and casting; reduced melting unit refining time and tapping temperature; exact temperature adjustment for continuous casting; steel purification and homogenization; reduction of refractory consumption; fine-tuning etc. All of these benefits require technological innovations.

Therefore, the proposed project activity without any doubt is the most modern and innovative at the Ukrainian steel market at present time. This is also independently confirmed by letter from Ministry of Industrial Policy of Ukraine dated in May 2007[51].

To-date, a similar project has been implemented only at PJSC AISW within the framework of one of the mechanisms provided by the Kyoto protocol to UNFCCC.

Accordingly, at the time of project commencement DIISW did not have specialists qualified to operate novel equipment. The enterprise required an extensive human resource training programme to prepare personnel able to run new processes. However, training itself can not address all the technological difficulties related to the project implementation. New facilities are not operating separately; they need to be integrated into existing technologically sophisticated units of complex operational development of steel, which also requires its whole modernisation.

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

This also proves that project is additional.

Investment Barriers

It should be noted that all the information provided beyond April 2007, i.e., when the investment decision was made, are provided for information purpose only in order to show the complete picture related with the project investment.

[49] More details are on http://www.industry.siemens.com/industrysolutions/metals-mining/en/metals/continuous_casting/Pages/home.aspx
[50] www.nbuv.gov.ua/portal/natural/Tipm/2010_2/54.PDF
[51] The letter is available upon request of AIE

Project basic indicators are presented in Table 2. Planned capital investments were identified based on calculations made by process equipment supplier (Siemens VAI), local contractors, and DIISW personnel. Project construction works will continue from 2007 to 2011, i.e. will take 5 years.

Besides other barriers of investment character mostly related to limited access to finance from both domestic and international lenders and capital markets have prevented DIISW from project realisation. Furthermore, implementation of the project first stage coincided with the global economy crisis.

DIISW only emerged from its past bankruptcy proceeding in January 2006[52], and it has therefore not yet undergone any significant changes under the ISD ownership. The operations therefore were still suffering from significant emission, discharge, and solid waste issues. ISD and the DIISW management have used the period from the privatization (the end of 2003) to prepare plans for overcoming these issues[53].

Under such circumstances DIISW would not implement the proposed project activity, as it could not rely on financing from ISD and had lack of own funds. Implementation of the project under Kyoto mechanism was the only option for DIISW. Therefore in 2007 the decision was made by DIISW to implement the project under JI mechanism of the Kyoto protocol (Please see Alleviation of barriers below).

During the years 2007 – 2008 DIISW spent UAH 1,4 billion[54] on modernization of the plant. At the same time, during the same years net profit[55] of the plant and the attracted financing were much lower, therefore it was difficult for DIISW to complete even the first phase of the project activity due to the envisaged other investments, for instance construction of two CCGTs with a capacity of 303 MWe[56,57] (estimated more than US$ 300 m and around US$ 180 million were already spent project has been initiated as a potential JI project and has received the LoE, however was not started due to lack of investments to cover the local works) as well as into revamping of sintering and pig iron production (by the end of 2007 the total investments for the project reached almost US$ 200 m, the project has received positive determination report). Accordingly, viability of the project dropped substantially, to reach the uncompetitive level compared to available alternatives.

The following investment barriers could be pointed out:

1. Backwardness of the Ukrainian Domestic Financial Market

In 2007, as well as prior and after 2007 Ukraine’s domestic financial market was too weak to support a project of a similar level of magnitude. Any Ukrainian bank or Ukrainian bank with foreign ownership could not give a loan of more than USD 20-30mln in one hands and the tenor of the bank debt in the Ukrainian market seldom accedes 1 year, therefore Ukrainian banks could be ruled out from potentially being able to fund a like project like this on its own. Investment environment that developed by 2007 was unstable and hampered the improvement of the Ukraine’s investment ratings and the country’s ability to attract enough direct foreign investments in its economy to be able to borrow from International Financial Institutions.

2. Limited Access to International Loan Markets

DIISW, as part of ISD, was able to take only limited amount of loans amid financial and economy hurdles, either in the form of ECA finance or as a way to make up its operating capital requirements.

[52] http://www.ifc.org/ifcext/spiwebsite1.nsf/0/8522F5BCADA58BD4852576BA000E2884
[53] http://www.ifc.org/ifcext/spiwebsite1.nsf/0/8522F5BCADA58BD4852576BA000E2884
[54] http://dndz.tv/news-3558.html
[55] http://www.rosinvest.com/news/372996/
[56] The LoE, PIN and FS study for the project are not available online, however the information can be provided by the project developer upon request.
[57] http://metallurgy.at.ua/news/2009-04-25-1396

Global crisis prevented ISD and DIISW from achieving access to international capital markets. The attempt to raise money from Eurobonds issue was unsuccessful due to the start of global financial crisis in July 2007.

3. ISD Credit Rating And Its Decrease

On June 28, 2007 Fitch agency assigned B+ rating considered ISD Corporation as a company with a low income-to-debt ratio in comparison to Russian and other foreign companies, which could restrict financial flexibility of the corporation[58]. However, it is important to understand what B+ rating actually means for investor who considers a loan to a B+ borrower. B+ is sub-investment grade rating which is highly risky or in other words "junk bond" by definition and attracts only those investors who are interested to get higher yields on their capital in return for acceptance of very high risk. In such conditions it is very hard work to issue Eurobonds for a company with B+ rating at all but after July 2007 it became impossible as even A rated companies failed to raise financing and some even declared bankruptcy. In 2008, Fitch Ratings downgraded ISD's long-term IDR from "B+" to "B," keeping the negative forecast as economic situation in steel industry in general and in ISD in particular started to deteriorate rapidly. "B" group of ratings means presence of certain credit risk, namely company's weakened ability to favour its financial liabilities and, as the result, likely default on its financial covenants. The downgrading of the long-term IDR was caused by a 50% reduction of the company revenue and EBITDA resulting from reduced output and price against the backdrop of the global economy decline and potential volatility of the demand and prices for steelmaking products[59].

In early 2009, ISD's ratings were downgraded by a both rating agencies and soon the ratings were revoked. Namely, Fitch Ratings reduced its long-term IDR from "B" to "B–"[60]. At the same time Moody's revoked the ISD's "B1"corporate rating as, according to this agency's classifications, securities and issuers rated "B" are considered too risky for long-term investments[61]. It should be added that sovereign rating of Ukraine was downgraded by Fitch Ratings from "BB–" to "B+" during the same period. The short-term IDR was confirmed at "B". As mentioned above, "B" ratings suggest presence of certain credit risk against limited safety margin.

At the beginning of 2005, ISD management launched preparation of company financial accounts under International Financial Reporting Standards (IFRS)[62], typically required from companies seeking international funding. This gave the Corporation an opportunity to attract loans for complete modernisation necessary by Group's key plants, mainly AISW. As economy crisis unfolded, debt became unavailable; besides ISD's credit portfolio was on a higher side, in relation to profits when financial crisis met with economic recession and downfall of demand for steel and steel prices. In addition, financing structure of the JI project implemented at DIISW was of unique nature for the Ukrainian industry in terms of scale and sophistication of financial instruments required. All these factors contributed to low credit attractiveness of the project in 2007 – 2010 and created major barriers before the efforts to raise long-term funding needed to complete the project.

In a snapshot, ISD never had a high enough credit rating to be able to easily raise Eurobond financing (of any capital market instrument for that matter). Only with enormous efforts there would have been a chance to raise the capital market instrument but those chances evaporated once the American subprime crisis started in July 2007. ISD's ability to raise loan financing from international markets was not enough to be used at DMK, it was used to most extend at AISW. Possibility to finance the projects of USD 200m size with domestic financial institutions (Ukrainian commercial banks) never existed.

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[58] www.unian.net/ukr/products-60955.html
[59] http://www.cbonds.info/ua/rus/news/index.phtml/params/id/416644
[60] http://delo.ua/biznes/kompanii/fitch-ponizilo-i-otozvalo-isd-104261/
[61] http://delo.ua/biznes/kompanii/moody-otozvalo-rejting-isd-104649/
[62] Ernst &Young, Special Auditor Report of Preliminary IFRS Consolidated Financial Accounts

Accordingly, under the circumstances the need to raise nearly US$ 200 m in debt[63] was a significant barrier on the way of the project (one of the largest private projects in Ukraine). Integration of the potential ERU revenue component was for the company the only opportunity to finalise the project.

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

Barrier Analysis Conclusions:

All mentioned barriers to some extent hamper the realisation of proposed project activity. However additionality of the project is proven by a number of listed arguments in Guidelines for objective demonstration and assessment of barriers such as presence of specific barriers which are overcame by registration of similar JI project as well as presence of technological and common practice barriers (see below).

The mentioned barriers would hinder project scenario implementation without additional revenue from Kyoto benefits and would in fact prevent any alternative scenario except baseline.

This could also be seen from the following fact. In 2004 – 2007, at the time of the "steel boom," a number of Ukrainian financial industrial groups announced their intentions to develop new steelworks based on fully innovative process logistics chains built on state-of-the-art technologies moving away from blast furnace process. These included Vorskla Stal Limited who meant to use Midrex technology[64,65,66,67] and Eurofinance Limited that wished to operate the electric furnace process as well as all other steel companies[68].

However, none of these projects came true due to unattractive financial background in Ukraine and further development in the crisis environment. Furthermore, even those progressive technologies were meant to be integrated with CCMs. Thus it would be safe to say that introduction of the CCMs anticipated by the project is a state-of-the-art solution and has no alternative, except baseline scenario.

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

Alleviation of barriers:

Despite the fact that Guidelines does not specifically require to prove alleviation of barriers by means of project registration if additionality is already proven, it is well understood that contribution of the potential carbon incomes to "enhance the credit profile of the project and mitigate some of its risks, including of technological character" was taken into consideration before ISD made an official decision to start the project activity.

It is evident that the potential carbon incomes could help to decrease costs of debt service under the project activity by around one third from the total CAPEX of the project during the JI crediting period.

63 http://www.ukrrudprom.com/digest/ISD_dogovarivaetsya_o_restrukturizatsii.html
http://af.reuters.com/article/metalsNews/idAFLDE66Q19B20100727
http://www.ft.com/cms/s/0/bdb0f1d4-fa22-11de-beed-00144feab49a.html
64 http://delo.ua/biznes/kompanii/fitch-ponizilo-i-otozvalo-isd-104261/
65 http://delo.ua/biznes/kompanii/moody-otozvalo-rejting-isd-104649/
66 http://delo.ua/biznes/ukraina/fitch-ponizilo-nacionalnyj-rejting-ukrainy-101002/
67 http://www.kobelco.co.jp/p108/dri/e/dri04.htm
68 http://www.metaldaily.ru/news/news25929.html

Thus, the JI component of the Project estimated at around 60 million USD helped to alleviate the barriers for this particular modern large scale project in the Ukrainian iron and steel industry and to gain the first of its kind technical and managerial expertise by DIISW in implementing and using the state of the art billet casting technology in Ukraine.

Also, since 2007 ISD has conducted continuous negotiations with different potential buyers of ERUs regarding potential subscription of ERPA. As the result ISD has chosen Endesa company as a reliable potential buyer of ERUs. When the project was formalized, received the first Letter of Endorsement and when the PDD was developed, the ERPA[69] between DIISW and Endesa company was signed. The ERPA contains information regarding potential incomes from sales of emission reduction units (ERU). The agreement is confidential, but there is a possibility to provide a copy of an agreement to the AIE to prove the evidence of potential incomes from the sales of ERU. This is considered to the incentive ISD tool to demonstrate additionality and also to register the project under JI mechanism.

Registration of the proposed project under JI mechanism will allow to overcome barriers connected with financing (investment barriers) as well as to cope with barriers of technological character. The additional benefit obtained from emission reductions sale will help to overcome barriers connected with the existing practice.

As the result of the JI project activity implementation all the barriers will be alleviated and project activity corresponds to the requirements of additionality.

Step 4. Common Practice Analysis

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

The proposed JI Project "Technical upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Continuous Billet Slab Casters and Two Ladle Furnaces" is similar to another JI project of its kind in Ukraine. Earlier, demonstrative JI Project "Revamping and Modernization of the Alchevsk Steel Mill Based on CCMs Nos. 1 and 2 and LD Converters Nos. 1 and 2" was implemented in Alchevsk. Both projects belong to the category of improvement of energy consumption efficiency in industrial processes.

Differences between these projects are rather in favour of DIISW because the proposed billet CCMs allow to produce steel of better quality that the slab CCMs at AISW and there are more technologically advanced as it was described above. Therefore even in a comparison with the AISW JI Project, the proposed activity represents more modern alternative.

Pursuant to the Tool for the Demonstration and Assessment of Additionality, a project registered under Kyoto mechanism is excluded from common practice analysis, which makes the proposed project the only one of its kind for Ukraine.

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

Sub-step 4b. Discuss any similar options that are occurring:

Not applicable considering absence of similar projects in Ukraine.

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

[69] Can be provided to the AIE upon request

The project boundary covers directly LD-Converters #1 and #2, two LFs and two seven-strand continuous slab casters (see pictures below) and indirectly (as reflected in calculations) all technology modifications occurring as the result of the project implementation, including in sinter machines, blast furnaces, blooming line, billet mills etc. Power grid, natural gas supply network and material suppliers were not included in the project boundary directly, however Ukraine's typical greenhouse gas emission factors for production and/or supply of electricity and gas consumed under baseline and project scenarios have been factored in emission calculations. Thus all CO_2 emissions related to project and baseline cases have been taken into account. Emissions generated in upstream processes have been accounted on a proportionate basis, based on pig iron consumption in project and baseline scenarios.

N_2O emissions from steelmaking process are unlikely to be significant; IPCC does not provide for a methodology to calculate N_2O emissions[70]. They will not typically change from baseline to project case. CH_4 emissions are related to sinter and coke production in this type of project and are very minor in comparison with CO_{2e} emissions. Both types of emissions are excluded from the quantification of baseline and project emissions. The exclusion of CH_4 represents a conservative approach as more sinter and coke is consumed in absolute terms in the baseline in comparison with the project.

Table 6. Sources of Emissions

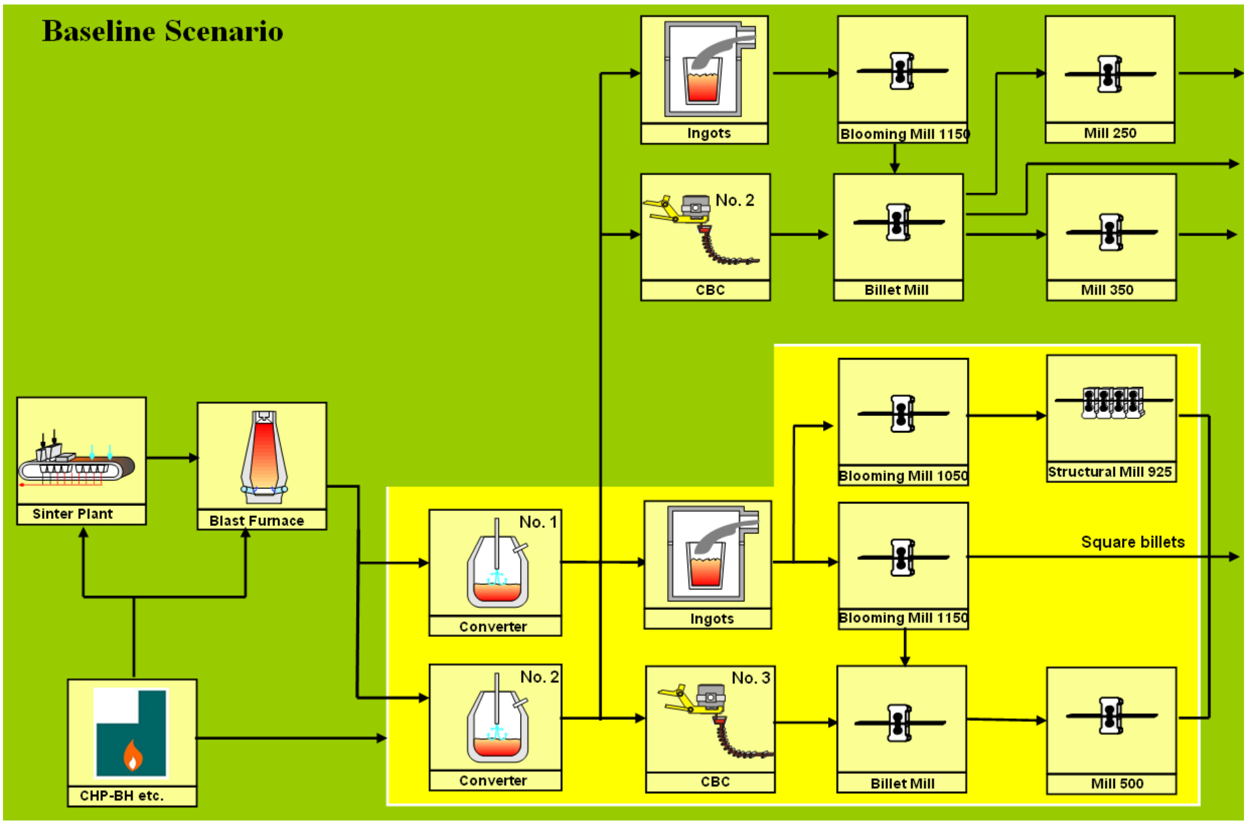
	Source	**Gas**	**Included?**	**Justification / Explanation**
Baseline Scenario	Fuel used	CO_2	Yes	Will be source of CO_2 emissions.
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and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

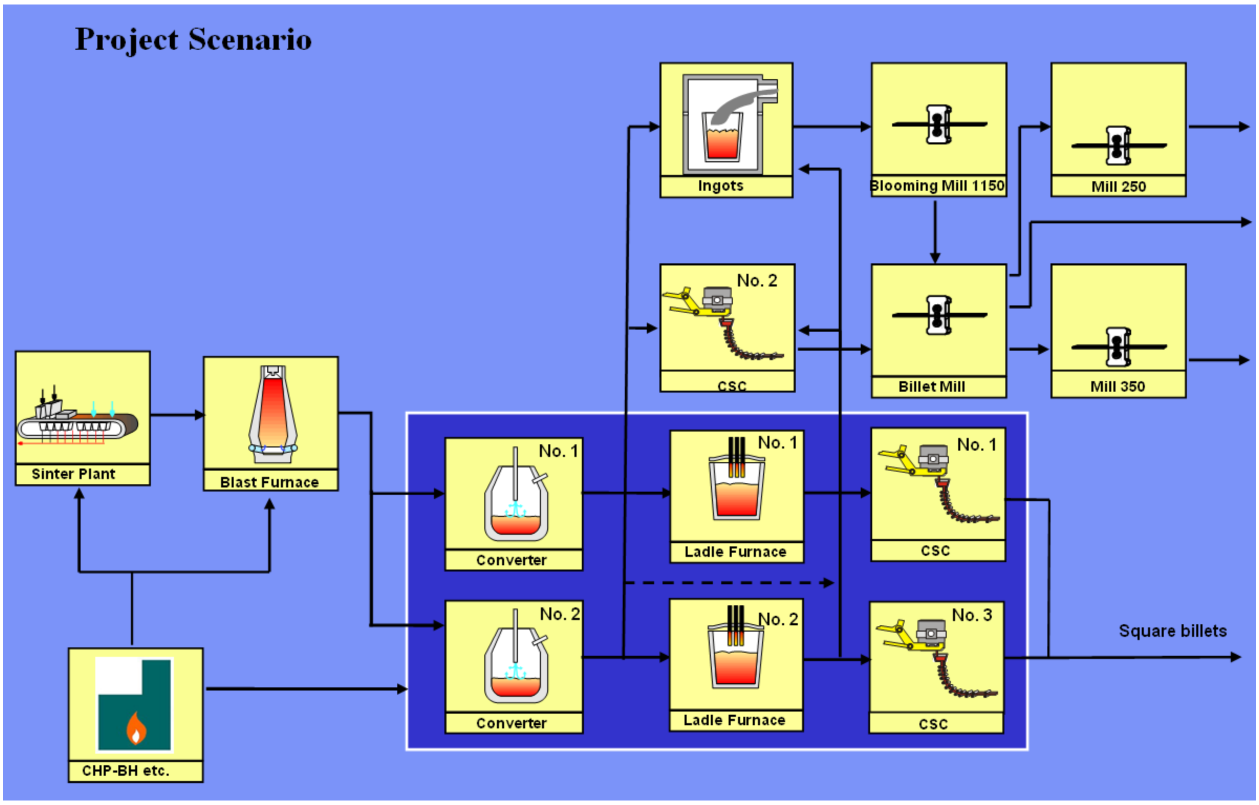
[70] IPCC, 2006, Guidelines for National Greenhouse Gas Inventories, Volume 3, Industrial Processes and Product Use.

	Source	Gas	Included?	Justification / Explanation
Project Scenario	Fuels used	CO_2	Yes	CO_2 emissions will be reduced due to reduced use of fossil fuels (mainly natural gas).
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Electricity used	CO_2	Yes	No major change for total CO_2 emissions.
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Material flow as part of production process	CO_2	Yes	CO_2 emissions will be reduced due to decreased use of pig iron
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.

Fuels include natural gas and Blast Furnace Gas. This fuel mix is specific to DIISW's steel making process. Material inputs having impact on GHG emissions include scrap, pig iron, coal, pulverised coal, carbon electrodes, small coke, coke, lime, limestone, dolomite, as well as electricity consumed in principal furnace processes and used to generate scrap, compressed air, oxygen, nitrogen and steam, as well as for process water supply.

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


Baseline Scenario
Ingots
Blooming Mill 1150
Mill 250
No. 2
CBC
Billet Mill
Mill 350
Blooming Mill 1050
Structural Mill 925
Sinter Plant
Blast Furnace
No. 1
Converter
Ingots
Blooming Mill 1150
Square billets
No. 2
Converter
No. 3
CBC
Billet Mill
Mill 500
CHP-BH etc.


Project Scenario
Ingots
Blooming Mill 1150
Mill 250
No. 2
CSC
Billet Mill
Mill 350
Sinter Plant
Blast Furnace
No. 1
Converter
No. 1
Ladle Furnace
No. 1
CSC
No. 2
Converter
No. 2
Ladle Furnace
No. 3
CSC
Square billets
CHP-BH etc.

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

Date of Completion of Baseline Identification and Monitoring Methodology Application

The implementation of the above baseline identification and monitoring plan was completed on 16/08/2010.

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

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

Institute for Environment and Energy Conservation Company Ltd. is a consultancy company with experience in application of the Clean Development and Joint Implementation Mechanisms. The company is not a project participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

5th of April 2007

C.2. Expected operational lifetime of the project:

The lifetime of the equipment will be at least 40 years. Therefore operational lifetime of the project will be 40 years or 480 months.

C.3. Length of the crediting period:

The crediting period starts on 01/10/2008 and lasts till 31/12/2020, and its total duration is 12 years and 3 months, including:

− The 1st commitment period: 01/10/2008 – 31/12/2012 (4 years and 3 months);
− Period following the 1st commitment period: 01/01/2013 – 31/12/2020 (8 years and 0 months).

Extension of the crediting period beyond 2012 is subject to the host Party approval.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

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

The monitoring approach developed for this specific project is consistent with the assumptions and procedures adopted in the baseline approach (please see Section B.1). This monitoring approach requires monitoring and measurement of variables and parameters necessary to quantify the baseline emissions and project emissions in a conservative and transparent way.

1. The baseline technology (two converters, two continuous bloom casters (CBCs), ingot casting shop with a mould yard, and rolling mills) reflects the existing practice and has been successfully operated at DIISW for an extended time period. This allows the project developer to use actual continuous monitored and measured data on the production and materials efficiency. Specifically, since both CBCs are identical under the baseline scenario and the project scenario assumes decommissioning of one of the CBCs monitoring will be based on the remaining ("benchmark") one to accurately quantify the baseline emission factor per unit of output. In case of major changes or disruptions in operations of this "benchmark" production line, baseline calculations can be based on most recent historical data collected for a previous statistically and technologically reliable period.

2. Considering that Ladle Furnaces (LFs) nos. 1 and 2 are to impact operation of Converters causing different Converter fuel and energy resources and materials consumption versus the baseline case, measurement of all variables and parameters needed to quantify baseline emission levels will be done based on actual Converter performance data adjusted for experimentally deduced Converter and, where possible, CCM (without LF) efficiency increase factor[71]. Such measurement for baseline case will be done in real time or, to the extent possible, based on the most recent historical data.

3. Since the project case provides, together with shutdown of one of the two existing CBCs, for the decommissioning of certain minor process elements (such as a blooming mill with a structural mill, mill 500 etc.), which rules out real time monitoring of efficiency of these elements, calculation of this part of baseline emissions will be based on statistically average parameters for the most recent year of operation.

4. Project as well as baseline emissions depend *inter alia* on the composition of inputs in the steel making process, in particular on the amount of pig iron consumed to produce a tonne of steel (specific consumption). The optimization of the input composition in the steel making process is linked to the amounts of

[71] Experimental melts that where conducted during 2010 in order to identify LF impact on the LD Converter did not demonstrate envisaged effect of fuel and energy resources economy at the LD Converter. Despite that fact, emission reductions estimations are calculated based on effect that was demonstrated during mentioned above experimental melts. Actual effects of LF's operation will be reflected in the 2010 Monitoring Report, as well as in subsequent Monitoring Reports.

scrap and pig iron within the predetermined technical limits and depending on availability of scrap on market conditions and market prices differential for scrap and pig iron. The historical specific consumption of pig iron in the Converter has remained in the range of 80 – 95 % (calculated as percentage of the total input of pig iron and scrap into the Converter process). The specific consumption of pig iron by the Converters will be monitored *ex-post* and baseline and project emissions are calculated respectively during monitoring. The pig iron specific consumption estimates in the PDD are based on the technical specifications of the equipment and expected market development. At verification stage, the verifying AIE shall check the specific consumption of pig iron in the baseline and compare it with the initial specific consumption estimates provided in the PDD. If the verified specific pig iron consumption differs significantly from initial specific consumption estimate, it should be verified that this is not intentional, and that the same economic and technical triggers were applied to the monitored specific pig iron consumption per tonne of steel in the project scenario. This approach is based on the recent version of the approved CDM methodology AM0009[72] to deal with the uncertainly of a major parameter for calculation of baseline emissions (i.e. forecast of production of oil and flared gas).

5. This Plant is an integrated steel mill. It has the project specific oversight and control and respects the high-level metering requirements, in accordance with national norms and regulations and based on DIISW's *Metrological Support of Measuring Equipment* corporate standard and *Guideline on Plant Metrology Department* internal document. In fact, monitoring under baseline and project cases is a routine activity whose quality was checked by certification companies on numerous occasions. This will ensure accurate data on both energy and material flows into the project boundary, but also the data required to determine the CO_{2e} impact of the materials in accordance with the Monitoring Plan.

6. All material and energy flows within the project boundary for the "benchmark" product line as well as for the project product line are measured and will be quantified as per their CO_{2e} impact using equations (1) – (22).

7. As scrap is accounted for a zero CO_2 emission material project and baseline emissions are underestimated, and therefore quantification of emission reductions is conservative.

8. In the baseline, Blast Furnace Gas is used as a fuel in the continuous bloom casters and (or) the ingot casting line with a mould yard, as well as for other process units. Blast Furnace Gas is a by-product of the Blast Furnace process. Its main embedded energy and carbon reside in CH_4 and CO which typically make up about 50% of blast furnace gas. The carbon content of the blast furnace gas comes from the coke and to a lesser extent natural gas used in the process. All carbon entering the Blast Furnace, mostly as combusted coke or natural gas, is calculated already as CO_{2e} emissions within the boundary including the carbon that ends up in blast furnace gas. Therefore, blast furnace gas is treated as a carbon free fuel for the blooming mill and other production unit of the Iron and Steel Works[73]. In the project case, where the Blast Furnace Gas is used not for blooming mill but partly for generation of electricity in the combined heat and power plant and/or for other purposes (as captured in the Monitoring Plan), blast furnace gas is similarly treated as a carbon free fuel. Remaining Blast Furnace Gas as well as Converter Gas (calculated as emissions for the project case) can be utilized elsewhere as CO_{2e} neutral fuel.

[72] http://cdm.unfccc.int/filestorage/42TMVA3X9WLUOI7KS6018HFCNGDQER/EB46_repan05_AM0009_ver04.pdf?t=Smx8MTI5MjE4NjU2NS42Ng==|Q26bvcruRHDi3gTGDf9duAG9CUg=

[73] If an emission factor was applied to BFG, these emissions would be double counted.

9. Since LD Converters produce liquid steel for more than one steel making process, only a certain proportion of CO_{2e} emissions generated by the converter process will be attributable to steel making within the project boundary.

10. All parameters, with the exception of IPCC default values used for coke and lime, pellets etc., as well as emission factors for grid electricity, will be measured/monitored *ex-post* based on specific Monitoring Plan developed for this project, as well as on maintenance, and maintenance and quality assurance procedures in accordance with Ukrainian and DIISW's requirements. This monitoring approach reduces the risk of overestimation of the emission reductions given that no key parameters/factors of quantification would be based on uncertain assumptions.

11. Carbon emission factor for natural gas is calculated based on fixed net calorific value (based on average data regarding net calorific value[74]), default emission factor which is in accordance with IPCC 1996.

12. This monitoring plan assumes accounting of all primary and secondary energy resources[75] consumed and to be consumed under the project case. Since in the project scenario secondary energy will be consumed not only by major equipment but also for process support purposes, DIISW will separately monitor such additional[76] secondary energy resources as compressed air, steam, oxygen, argon, nitrogen, water etc. since these secondary resources are necessarily consumed in the course of steel making process.

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

[74] Historical data means data which was observed in previous periods (in this PDD the data that was received during 2006 – 2010 is used). Net calorific value for natural gas is anticipated at the level of 8100 kcal/m^3 to follow the conservativeness of approach (usually calorific value equals to 8050-8300 kcal/m^3 with minimal fluctuations around the mentioned figure). In case if data regarding natural gas net calorific value will be received at DIISW on regular basis this will be accordingly reflected in the monitoring report.
[75] Secondary energy is mainly derived from electricity to be measured directly using relevant meters.
[76] For avoidance of double counting additional energy resource consumption will be accounted net of consumption by main equipment.

Key Variables/Parameters	Data Sources
Electricity & Fuels Used	Measured
Emission Factors for Fuels and Electricity	Carbon emission factors for fuel consumption will be based on average data regarding net calorific value of each fuel (Natural Gas) taking into account the their calorific value remains practically stable with very low level of fluctuations. Such decision ensures applicability of JI specific approach. In case if it is required by the AIE the actual calorific values of different fuels can be monitored and reflected in relevant monitoring reports. During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[77]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[78]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[79]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.
Steel Produced	Measured
Quantities of Materials Used	Measured.
Emission Factors of Materials Used	Factors will be calculated in accordance with governing principles for the National Greenhouse Gas Register (IPCC, 1996)[80]. Material production and delivery costs will be based on IPCC defaults or national defaults if applicable.

[77] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[78] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[79] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.
[80] http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

The monitoring plan[81] meters, encompasses and monitors the energy and material flows into the project boundary and calculations are made as to the associated CO_{2e} emissions from those flows using the same formulae as the baseline approach:

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

The material flows include raw inputs of pig iron, steel scrap, as well as process inputs such as dolomite, limestone, pellets etc. Volumes of each material consumption will be identified at each stage of production process starting from Slab Casters to the Sinter Plant. Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available[82]), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas and blast-furnace gas are used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.

The number of each kind of fuel used within the project boundary will also be measured or calculated and its role in the total CO_{2e} emissions will be defined on the basis of local and generally accepted emissions factors, which are identified based on carbon content of the fuel and its production/delivery costs. Monitoring of all mentioned above parameters will provide a general picture of CO_{2e} emissions from the project line and baseline scenarios.

In accordance with proposed project configuration, part of Blast Furnace Gas will be used as a fuel in the existing combined heat and power plant to generate steam and, potentially, electricity. The CO_{2e} emissions from Blast Furnace Gas are already counted in the context of the total emissions of the pig iron production process so the Blast Furnace Gas is a zero emission fuel. Blast Furnace Gas is created as a by-product of the pig iron production process. The carbon content in the Blast Furnace Gas comes from the coke, anthracite and to a lesser extent natural gas used in the process. That's why emissions from its consumption are included in emissions from pig iron production process.

To ensure that double counting is avoided and that emission reductions are accurately calculated, pig iron will be considered as the input material into the steel making process. The total emissions from the Sinter Plant and Blast Furnaces production processes will be calculated. Also, the total pig iron output will be monitored, allowing the project developer, to calculate the amount of CO_{2e} emissions per tonne of pig iron produced.

[81] The volume of steel output under the baseline scenario is equal to actual volume of steel output under the project line scenario. Under the project line scenario actual volumes of FER and materials consumption (that are required to produce necessary volume of steel output) are being measured. Under the baseline scenario the project developer calculates volumes of FER and materials consumption that would have been required to produce the same steel output as in the project line scenario, but on the production facilities that are used under the baseline scenario and by taking into consideration specific volumes of FER and materials consumption at each stage of production process, which are included in the project boundaries.

[82] Currently electricity at the plant is not generated.

It should be noted that baseline and monitoring approach allows changes of fuels and materials used in baseline and project scenarios. Therefore not all parameters listed are currently used in baseline and project cases for this specific project, e.g. oxygen is produced utilizing electricity, but Monitoring Plan takes into account the possible use of other fuels, depending on the market situation. Therefore Monitoring Plan takes into account possible changes in the project design. Several parameters are the same in baseline and project cases as indicated in table D.2.

Data Quality Management

Given the complexity of the data requirements for the project monitoring the project developer will take the following steps to ensure data quality.

- Each new meter installed will be calibrated according to manufacturer's specifications and frequency, national requirements, and the corporate standard STP 230-35-07, *Metrological Support of Measuring Equipment*.
- All new meters will be installed and calibrated before flows requiring monitoring commence.
- All existing meters that are used in new functions or are subject to some physical disruption in their use due to construction will be recalibrated according to STP 230-35-07, *Metrological Support of Measuring Equipment* and manufacturer's specifications before measuring any flow.

It is critical to note, that while there are numerous data flows to be collected, the data collected is rigorously monitored as part of normal operation process of DIISW to ensure the proper proportions of material flows are added to the steel making process at the correct time. Data required for the Monitoring Plan for the project will be closely tracked as integral part of the steel plant's core business. In addition, the project developer meticulously maintains records of energy consumption in relation to each part of the process and each material production shop. All the production facilities are equipped with metering facilities that have consistently been used, are well understood by operators and constantly calibrated. Control over consumption of energy resources, input material and production is further monitored by a separate unit of the steel mill (Unit for Control and Automation) with a help of different meters all operating in accordance to the national standards of Ukraine and documented in Guiding Metrological Instructions of DIISW. Responsibilities for monitoring are defined in Table 7, and training and maintenance is also discussed in Section A.4.2.

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

- the Monitoring Database (including also *ex-ante* estimates of materials and fuels used) that will be regularly updated with actual data to compile and calculate the emission reductions monthly and annually;
- the Investment Plan giving a schedule of construction activities, and
- detailed guidelines regulating the monitoring procedures and responsibilities (DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*)

Generally quality assurance procedures will be based on the Plant's ISO 9001:2001 quality management system (QMS) implemented in 2001. This QMS covers the whole of the Plant's production process. In 2010, the system was upgraded to the more recent ISO 9001:2008 version. Certificates were issued by UkrSEPRO (no. 2.008.04188 dd. 29/01/2010) and TÜV SÜD (no. 12 100 37982 dd. 22/03/2010).

Furthermore, an OHSAS 18000 industrial safety management system and an ISO 14000 environmental management system were implemented in 2009. Relevant certificates were issued by TÜV Thuringen (nos. TIC 1511610202 dd. 02/03/2010 and TIC 1510410697 dd. 02/03/2010, respectively).

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

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

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

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

Key Information and Data Used for Project Case Identification

Data/Parameter	TSO_p (P-2)
Data unit	Tonne
Description	Total steel output in the project scenario
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is equal to the total steel (square billet) output as the result of project activity
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$TPII_p$ (P-4)
Data unit	Tonne
Description	Total pig iron input into steel making process
Time of determination/monitoring	Measured constantly – regular result (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is equal amount of pig iron produced as the result of project activity
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fpi,p}$ (P-6)
Data unit	1000 m^3
Description	Quantity of each fuel (fpi) used in making pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$EF_{f,p}$[83] (P-7, P-14, P-27, P-41, P-48)
Data unit	Tonne CO_{2e}[84]/1000 m^3
Description	Emission factor of each fuel
Time of determination/monitoring	Fixed value based on DIISW average data
Source of data (to be) used	DIISW average data IPCC 1996 Potentially measured by DIISW laboratory or local fuel distributor
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with DIISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[85] Net calorific value is anticipated at nearly 33,913 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,893 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values of fuels will be received on regular basis.

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

Data/Parameter	$ECPI_p$ (P-9)
Data unit	MWh
Description	Electricity consumed in producing pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{e,p}$ (P-10, P-17, P-30, P-44, P-52)
Data unit	Tonne CO_{2e}/MWh
Description	Emission factor for electricity consumption
Time of determination/monitoring	Regular tabulation (applied on annual basis)
Source of data (to be) used	Carbon emission factors based on the Orders of the National environmental investment agency of Ukraine #43 dated 28th of March 2011, #62 dated 15th of April 2011, #63 dated 15th of April 2011 and #75 dated 12th of May 2011.
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[86]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[87]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[88]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period.

[86] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[87] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[88] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

Data/Parameter	$Q_{fio,p}$ (P-13)
Data unit	1000 m^3
Description	Quantity of each fuel (fio) used in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECIO_p$ (P-16)
Data unit	MWh
Description	Electricity consumed in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rapi,p}$ (P-19)
Data unit	Tonne
Description	Quantity of each reducing agent (rapi) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{ra,p}$[89] (P-20, P-34)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each reducing agent
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006 Potentially measured by DIISW laboratory
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne. For anthracite the anticipated factor is 2.62 tonnes CO_{2e}/tonne. For coal electrodes the anticipated factor is 3.6 tonnes CO_{2e}/tonne. The parameter is remained fixed throughout the crediting period for the calculations performed for estimation of emission reductions. However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of anthracite. If information on actual carbon content or net calorific value is available, it would prevail over default factors.

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

Data/Parameter	$Q_{oipi,p}$ (P-22)
Data unit	Tonne
Description	Quantity of each other input ($oipi_p$) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{oi,p}$[90] (P-23, P-37)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each other input
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for* CO_2, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite. For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values and amount of additives of each other input will be received on regular basis.

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

Data/Parameter	$Q_{ffp,p}$ (P-26)
Data unit	1000 m^3
Description	Quantity of each fuel (ffp) used in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECFP_p$ (P-29)
Data unit	MWh
Description	Electricity consumed in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rafp,p}$ (P-33)
Data unit	Tonne
Description	Quantity of each reducing agent (rafp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{oifp,p}$ (P-36)
Data unit	Tonne
Description	Quantity of each other input (oifp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fcr,p}$ (P-40)
Data unit	1000 m^3
Description	Quantity of each fuel (fcr) used in casting
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECCR_p$ (P-43)
Data unit	MWh
Description	Electricity consumed in casting
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fbpn,p}$ (P-47)
Data unit	1000 m^3
Description	Quantity of each fuel (fbpn) used for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECBPN_p$ (P-50)
Data unit	MWh
Description	Electricity consumed for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the project scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$ECSG_p$ (P-51)[91]
Data unit	MWh
Description	Self-generated electricity consumed
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 15
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Is equal to the amount of self-generated electricity as the result of project activity
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

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

Project emissions will equal the total tonnes of CO_{2e} from the Pig Iron Process and Sintering (iron ore preparation) added to the total tonnes of CO_{2e} from the Furnace Process, total tonnes of CO_{2e} from the Casting Process, and total tonnes from the energy consumed for the Balance of Process Needs. The data will be measured regularly. Equations capture the entire CO_{2e} impact from all material and energy flows into the project. Therefore the approach is both transparent and justifiable. Monitoring approach captures also potential changes in project design.

$$PE_i = TCPI_{p,i} + TCFP_{p,i} + TCCR_{p,i} + TCBPN_{p,i} \quad (1),$$

where:
$TCPI_{p,i}$ = total embodied CO_{2e} of pig iron entering into the project, t CO_{2e} (project case)
$TCFP_{p,i}$ = total CO_{2e} in the furnace process, t CO_{2e} (project case)

[91] Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas is used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.

$TCCR_{p,i}$ = total CO_{2e} in the casting process, t CO_{2e} (project case)
$TCBPN_{p,i}$ = total CO_{2e} in the balance of production processes, t CO_{2e} (project case)

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

To calculate project emissions, equations 3-22 are applied.[92]

This includes 4 clear steps determining the CO_{2e} emissions from pig iron entering the project (Step 1), the emissions from the furnace process (Step 2), emissions from steel casting (Step 3), and emissions from balance of process needs required to produce the intended steel quantity (Step 4).

The equations capture the entire CO_{2e} impacts of all material and energy flows into the project line. Therefore the approach is both transparent and justifiable. All the changes, e.g. the potential energy efficiency measures of production processes that are not related to project boundaries, will be directly reflected in project line emissions further supporting the conservativeness of the approach.

STEP 1. PIG IRON

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

$$TCPI_{p,i} = (TCFCPI_{p,i} + TCEPI_{p,i} + TCIPI_{p,i}) \quad (3),$$

where:

$TCFCPI_{p,i}$ = total CO_{2e} from fuel consumption in producing pig iron, t CO_{2e}
$TCEPI_{p,i}$ = total CO_{2e} from electricity consumption in producing pig iron, t CO_{2e}
$TCIPI_{p,i}$ = total CO_{2e} from inputs into pig iron, t CO_{2e}

Total CO_{2e} from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$) is the quantity of each fuel multiplied by the emission factor for that fuel[93]:

[92] In this project, the use of the combined heat and power plant to generate electricity is contingent on the availability of excess Blast Furnace Gas. In the baseline case there will be no excess Blast Furnace Gas as it is used in the Blooming Mill and therefore no electricity self-generated. So in baseline year the electricity emissions factor will be the grid electricity factor and in the project case it will be a weighted average of the self-generated electricity and the grid indicated in the Monitoring Plan.

$$TCFCPI_{p,i} = \sum_{1}^{fpi} \left(Q_{fpi,p,i} \times EF_{f,p} \right) \quad (4),$$

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

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

Total CO_{2e} from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$) is the quantity of electricity multiplied by the emission factor for electricity[94]:

$$TCEPI_{p,i} = ECPI_{p,i} * EF_{e,p} \quad (5),$$

where:
$ECPI_{p,i}$ = electricity consumed in producing pig iron, MWh [95]
$EF_{e,p}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

$TCIPI_{p,i}$ – the total CO_{2e} emissions from the material inputs into pig iron – include the CO_{2e} from fuel and electricity used to prepare iron ore, the total CO_{2e} from the reducing agents (coke, anthracite etc.) and the total CO_{2e} from limestone, dolomite, pellets etc.

$$TCIPI_{p,i} = TCFIO_{p,i} + TCEIO_{p,i} + TCRAPI_{p,i} + TCOIPI_{p,i} \quad (6),$$

[93] Net calorific value (NCV) for natural gas is identified as fixed value. Carbon emission factors will be calculated based on Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf).

[94] In accordance with order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127171), order of the National environmental investment agency of #63 dated 15th of April 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127172), order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=126006) and the order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127498).

[95] In this project, the amount of electricity generated from the combined heat and power plant is contingent on the availability of excess Blast Furnace Gas. In the baseline case there will be no excess Blast Furnace Gas as it is used in the Casting Process and therefore there is no electricity generated from the CHP plant. So in baseline the electricity emissions factor will be the grid emissions factor while in the project case it will be a weighted average of the emission factors of the electricity generated by CHP and the grid if blast furnace gas is used for this purpose as envisioned. If Blast Furnace Gas is used to displace any other fuel source this will be captured by the monitoring plan and will be included in the final emission reductions results.

where:
$TCFIO_{p,i}$ = total CO_{2e} from fuel used to prepare iron ore, t CO_{2e}
$TCEIO_{p,i}$ = total CO_{2e} from electricity consumption in preparing iron ore, t CO_{2e}
$TCRAPI_{p,i}$ = total CO_{2e} from reducing agents, t CO_{2e}
$TCOIPI_{p,i}$ = total CO_{2e} from the other consumed inputs, t CO_{2e}

Total CO_{2e} from fuel used to prepare iron ore ($TCFIO_{p,i}$) is the quantity of fuel multiplied by the emission factor for that fuel:

$$TCFIO_{p,i} = \sum_{1}^{fio} \left(Q_{fio,p,i} \times EF_{f,p} \right) \quad (7),$$

where:
$fio_{p,i}$ = number of fuels used in preparing iron ore
$Q_{p,i}$ = quantity of fuel fio used (1000 m^3)
$EF_{f,p}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

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

$$TCEIO_{p,i} = ECIO_{p,i} * EF_{e,p} \quad (8),$$

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

Total CO_{2e} from reducing agents[96] in pig iron production $TCRAPI_{p,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAPI_{p,i} = \sum_{1}^{rapi} \left(Q_{rapi,p,i} \times EF_{ra,p} \right) \quad (9),$$

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

The current and expected reducing agents include coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite[97] (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied.

Total CO_{2e} from the other inputs[98] such as limestone, dolomite, pellets etc. in pig iron production $TCOIPI_{p,i}$ is the quantity of each other input multiplied by the emission factor for that input:

$$TCOIPI_{p,i} = \sum_{1}^{oipi} \left(Q_{oipi,p,i} \times EF_{oi,p} \right) \quad (10),$$

where:

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

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

Default emission factor applied to limestone is equal to 0.440 t CO_{2e} per tonne of limestone consumed; default emission factor for dolomite is equal to 0.477 t CO_{2e} per tonne of dolomite consumed; emission factor applied to pellets is equal to 0.03 t CO_{2e} per tonne of pellets produced. If other materials are to be used, their default factors will be applied.

STEP 2. FURNACE PROCESS

The total CO_{2e} emissions from the furnace process ($TCFP_{p,i}$) include emissions from three sources: fuel, electricity and inputs into the furnace process.

$$TCFP_{p,i} = TCFCFP_{p,i} + TCECFP_{p,i} + TCIFP_{p,i} \qquad (11),$$

where:
$TCFCFP_{p,i}$ = total CO_{2e} from fuel consumption in furnace process, t CO_{2e}
$TCECFP_{p,i}$ = total CO_{2e} from electricity consumption in furnace process, t CO_{2e}
$TCIFP_{p,i}$ = total CO_{2e} from inputs into furnace process, t CO_{2e}

Tonnes of CO_{2e} for fuel used in the furnace process ($TCFCFP_{p,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCFP_{p,i} = \sum_{1}^{ffp} \left(Q_{ffp,p,i} \times EF_{f,p} \right) \qquad (12),$$

where:
$ffp_{p,i}$ = number of fuels used in the furnace process
$Q_{p,i}$ = quantity of fuel ffp used (1000 m^3)
$EF_{f,p}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

Tonnes of CO_{2e} for electricity used in the furnace process ($TCECFP_{p,i}$) will be the quantity of electricity multiplied by the emissions factor for electricity:

$TCECFP_{p,i} = ECFP_{p,i} * EF_{e,p}$ (13),

where:
$ECFP_{p,i}$ = electricity consumed in the furnace process, MWh
$EF_{e,p}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

The total tonnes of CO_{2e} from inputs into the furnace process ($TCIFP_{p,i}$) will include total tonnes of CO_{2e} from reducing agents (coke, anthracite etc.) and total tones of CO_{2e} from the other inputs in the furnace process (limestone, dolomite, pellets etc.):

$TCIFP_{p,i} = (TCRAFP_{p,i} + TCOIFP_{p,i})$ (14),

where:
$TCRAFP_{p,i}$ = total CO_{2e} from reducing agents entering furnace process, t CO_{2e}
$TCOIFP_{p,i}$ = total CO_{2e} from the other inputs entering furnace process, t CO_{2e}

Total CO_{2e} from reducing agents[99] entering furnace process $TCRAFP_{p,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAFP_{p,i} = \sum_{1}^{rafp} \left(Q_{rafp,p,i} \times EF_{ra,p} \right) \quad (15),$$

where:
$rafp_{p,i}$ = number of reducing agents entering furnace process
$Q_{rafp,p,i}$ = quantity of each reducing agent rafp used (tonnes)
$EF_{ra,p}$ = emission factor for reducing agent, t CO_{2e}/tonne in the relevant period

[99] For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

The current and expected reducing agents include coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite[100] (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied.

Total CO_{2e} from the other inputs[101] such as limestone, dolomite, pellets etc. entering furnace process $TCOIFP_{p,i}$ is the quantity of each other input multiplied by the emission factor for the other input:

$$TCOIFP_{p,i} = \sum_{1}^{oifp} \left(Q_{oifp,p,i} \times EF_{oi,p} \right) \quad (16),$$

where:
$oifp_{p,i}$ = number of the other inputs entering furnace process
$Q_{oifp,p,i}$ = quantity of each other input oifp used (tonnes)
$EF_{oi,p}$ = emission factor for the other inputs, t CO_{2e}/tonne in the relevant period

Default emission factor applied to limestone is equal to 0.440 t CO_{2e} per tonne of limestone consumed; default emission factor for dolomite is equal to 0.477 t CO_{2e} per tonne of dolomite consumed; emission factor applied to pellets is equal to 0.03 t CO_{2e} per tonne of pellets produced. If other materials are to be used, their default factors will be applied.

STEP 3. CASTING

The total tonnes CO_{2e} from the square billet casting process ($TCCR_{p,i}$) will be calculated from both the fuel and the electricity inputs into the process:

$$TCCR_{p,i} = TCFCR_{p,i} + TCECR_{p,i} \quad (17),$$

[100] NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).
[101] For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

where:
$TCFCR_{p,i}$ = total CO_{2e} from fuel consumption in square billet casting, t CO_{2e}
$TCECR_{p,i}$ = total CO_{2e} from electricity consumption in square billet casting

Tonnes of CO_{2e} for fuel used in square billet casting ($TCFCR_{p,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCR_{p,i} = \sum_{1}^{fcr} \left(Q_{fcr,p,i} \times EF_{f,p} \right) \qquad (18),$$

where:
$fcr_{p,i}$ = number of fuels used in the casting
$Q_{p,i}$ = quantity of each fuel fcr used (1000 m^3)
$EF_{f,p}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

Tonnes of CO_{2e} for electricity used in square billet casting ($TCECFP_{p,i}$) will be the quantity of electricity multiplied by the emissions factor for electricity:

$$TCECR_{p,i} = ECCR_{p,i} * EF_{e,p} \qquad (19),$$

where:
$ECCR_{p,i}$ = electricity consumed in square billet casting, MWh
$EF_{e,p}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

STEP 4. BALANCE OF PROCESS NEEDS

Total tones of CO_2 related to the balance of process needs of the project, namely production of secondary energy from the CHP-BH (that produces blast-furnace blowing and potentially self-generated electricity), as well as processes that ensures supply of compressed air, steam, oxygen, nitrogen, argon[102] and water required in the technological process. The relevant parameters are calculated based on the amounts of fuel and electricity consumed by the said processes:

$TCBPN_{p,i}$ = total tones of CO_2 related to the balance of process need of energy required for the project activity, being the sum of numbers of tones of CO_2 from fuel and electricity consumed:

$$TCBPN_{p,i} = TCFCBPN_{p,i} + TCEBPN_{p,i} \qquad (20),$$

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

Tonnes of CO_{2e} for fuel used for balance of process needs of project activity ($TCFCBPN_{p,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCBPN_{p,i} = \sum_{1}^{fbpn}(Q_{fbpn,p,i} \times EF_{f,p}) \qquad (21),$$

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

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

Tonnes of CO_{2e} for electricity used for balance of process needs of project activity ($TCEBPN_{p,i}$) will be the quantity of electricity multiplied by the emissions factor:

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

$$TCEBPN_{p,i} = (ECBPN_{p,i} – ECSG_{p,i}{}^{103}) * EF_{e,p} \quad (22),$$

where:
$ECBPN_{p,i}$ = electricity used for production of secondary energy used for the balance of process needs (MWh)
$ECSG_{p,i}$ = self-generated electricity used in the project activity (MWh)[104]
$EF_{e,p}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

103 Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas is used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.

104 Since self-generated electricity is delivered to the Plant's common grid, which makes it difficult to separate quantities of self-generated electricity consumed by major equipment in the project scenario, the decision was made to calculate actual consumption of fuel and energy in self-generated electricity production and to substitute electricity from the national grid with self-generated electricity. This helps avoid double calculation and demonstrates conservativeness of the analysis.

Key Information and Data Used for Baseline Identification

Data/Parameter	TSO_b (B-2)
Data unit	Tonne
Description	Total steel output in the baseline scenario
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is equal to the total steel (square billet) output during the project activity
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$TPII_b$ (B-4)
Data unit	Tonne
Description	Total pig iron input into steel making process
Time of determination/monitoring	Measured constantly – regular result (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is the amount of pig iron that would have been required to produce the same volume of steel (square billets) as in the project line scenario
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fpi,b}$ (B-6)
Data unit	1000 m^3
Description	Quantity of each fuel (fpi) used in making pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$EF_{f,b}$[105] (B-7, B-14, B-27, B-41, B-48)
Data unit	Tonne CO_{2e}[106]/1000 m^3
Description	Emission factor of each fuel
Time of determination/monitoring	Fixed value based on DIISW average data
Source of data (to be) used	DIISW average data IPCC 1996 Potentially measured by DIISW laboratory or local fuel distributor
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Emission factor for natural gas consumption is calculated based on estimated net calorific value which is in accordance with DIISW average data and based on carbon content stated in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[107] Net calorific value is anticipated at nearly 33,913 TJ/ 1 000 000 Nm^3. Therefore the carbon emission factor for Natural Gas combustion is anticipated at nearly 1,893 tonnes of CO_{2e}/1000 Nm^3 and is calculated based on mentioned above net calorific value.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values of fuels will be received on regular basis.

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

Data/Parameter	$ECPI_b$ (B-9)
Data unit	MWh
Description	Electricity consumed in producing pig iron
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{e,b}$ (B-10, B-17, B-30, B-44, B-52)
Data unit	Tonnes CO_{2e}/MWh
Description	Emission factor for electricity consumption
Time of determination/monitoring	Regular tabulation (applied on annual basis)
Source of data (to be) used	Carbon emission factors based on the Orders of the National environmental investment agency of Ukraine #43 dated 28th of March 2011, #62 dated 15th of April 2011, #63 dated 15th of April 2011 and #75 dated 12th of May 2011
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[108]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[109]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[110]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter is remained fixed throughout the crediting period.

[108] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[109] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[110] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

Data/Parameter	$Q_{fio,b}$ (B-13)
Data unit	1000 m^3
Description	Quantity of each fuel (fio) used in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECIO_b$ (B-16)
Data unit	MWh
Description	Electricity consumed in sintering process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rapi,b}$ (B-19)
Data unit	Tonne
Description	Quantity of each reducing agent (rapi) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{ra,b}$[111] (B-20, B-34)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each reducing agent
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006 Potentially measured by DIISW laboratory
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For coke it is anticipated at 3.66 tonnes CO_{2e}/tonne. For anthracite the anticipated factor is 2.62 tonnes CO_{2e}/tonne. For coal electrodes the anticipated factor is 3.6 tonnes CO_{2e}/tonne. The parameter is remained fixed throughout the crediting period for the calculations performed for estimation of emission reductions. However in the monitoring reports these factors will be calculated based on carbon content in coke and net calorific value of anthracite. If information on actual carbon content or net calorific value is available, it would prevail over default factors.

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

Data/Parameter	$Q_{oipi,b}$ (B-22)
Data unit	Tonne
Description	Quantity of each other input ($oipi_p$) in Pig Iron Production
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$EF_{oi,b}$[112] (B-23, B-37)
Data unit	Tonne CO_{2e}/Tonne
Description	Emission factor of each other input
Time of determination/monitoring	Fixed and monitored values
Source of data (to be) used	IPCC 1996 IPCC 2006
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for* CO_2, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf). Also see Annex 3
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For limestone it is anticipated at 0.44 tonnes CO_{2e}/tonne of limestone. For dolomite it is anticipated at 0.477 tonnes CO_{2e}/tonne of dolomite. For pellets it is anticipated at 0.03 tonnes CO_{2e}/tonne of pellets produced. The parameter is remained fixed throughout the crediting period. Together with this, parameter may be updated at the stage of monitoring report development if the data regarding net calorific values and amount of additives of each other input will be received on regular basis.

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

Data/Parameter	$Q_{ffp,b}$ (B-26)
Data unit	1000 m^3
Description	Quantity of each fuel (ffp) used in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECFP_b$ (B-29)
Data unit	MWh
Description	Electricity consumed in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{rafp,b}$ (B-33)
Data unit	Tonne
Description	Quantity of each reducing agent (rafp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of reducing agents consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{oifp,b}$ (B-36)
Data unit	Tonne
Description	Quantity of each other input (oifp) in furnace process
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on volume of other inputs consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fcr,b}$ (B-40)
Data unit	1000 m^3
Description	Quantity of each fuel (fcr) used in casting/rolling
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECCR_b$ (B-43)
Data unit	MWh
Description	Electricity consumed in casting/rolling
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	Accounts for all sources of electricity consumption for primary and secondary production needs. The parameter will be monitored throughout the crediting period.

Data/Parameter	$Q_{fbpn,b}$ (B-47)
Data unit	1000 m^3
Description	Quantity of each fuel (fbpn) used for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on quantity of fuel consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	For this project natural gas is considered to be a fuel measured in 1000 m^3.

Data/Parameter	$ECBPN_b$ (B-50)
Data unit	MWh
Description	Electricity consumed for balance of process needs
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	This parameter is based on amount of electricity consumption in the baseline scenario.
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting period.

Data/Parameter	$ECSG_b$ (B-51)[113]
Data unit	MWh
Description	Self-generated electricity consumed
Time of determination/monitoring	Continuous with regular tabulation (collected on monthly basis)
Source of data (to be) used	Recorded by DIISW. The data is stored in electronic and paper format
Value of data applied (for ex ante calculations/determinations)	See Table 16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	In the baseline scenario is equal to zero
QA/QC procedures (to be) applied	See Section D.2.
Any comment	The parameter will be monitored throughout the crediting 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):

$$BE = TCPI_{b,i} + TCFP_{b,i} + TCCR_{b,i} + TCBPN_{b,i} \qquad (2),$$

where:
$TCPI_{b,i}$ = total embodied CO_{2e} of pig iron entering into the project, t CO_{2e}
$TCFP_{b,i}$ = total CO_{2e} in the furnace process, t CO_{2e}
$TCCR_{b,i}$ = total CO_{2e} in the casting/rolling, t CO_{2e}
$TCBPN_{b,i}$ = total CO_{2e} in the balance of production processes, t CO_{2e}

$_b$ = baseline

[113] Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas is used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.

This includes 4 clear steps determining the CO_{2e} emissions from pig iron entering the project/baseline (Step 1), the emissions from the furnace process (Step 2), emissions from steel casting/rolling (Step 3), and emissions from balance of process needs required to produce the intended steel quantity (Step 4).

The equations capture the entire CO_{2e} impacts of all material and energy flows into the baseline. Therefore the approach is both transparent and justifiable. All the changes, e.g. the potential energy efficiency measures of production processes that are not related to project boundaries, will be directly reflected in baseline emissions further supporting the conservativeness of approach.

STEP 1. PIG IRON

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

$$TCPI_{b,i} = (TCFCPI_{b,i} + TCEPI_{b,i} + TCIPI_{b,i}) \quad (3),$$

where:

$TCFCPI_{b,i}$ = total CO_{2e} from fuel consumption in producing pig iron, t CO_{2e}
$TCEPI_{b,i}$ = total CO_{2e} from electricity consumption in producing pig iron, t CO_{2e}
$TCIPI_{b,i}$ = total CO_{2e} from inputs into pig iron, t CO_{2e}

Total CO_{2e} from fuel consumption in producing Pig Iron ($TCFCPI_{b,i}$) is the quantity of each fuel multiplied by the emission factor for that fuel[114]:

$$TCFCPI_{b,i} = \sum_{1}^{fpi} \left(Q_{fpi,b,i} \times EF_{f,b} \right) \quad (4),$$

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

[114] Net calorific value (NCV) for natural gas is identified as fixed value. Carbon emission factors will be calculated based on Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf).

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

Total CO_{2e} from electricity consumption in producing Pig Iron ($TCEPI_{b,i}$) is the quantity of electricity multiplied by the emission factor for electricity[115]:

$$TCEPI_{b,i} = ECPI_{b,i} * EF_{e,b} \quad (5),$$

where:
$ECPI_{b,i}$ = electricity consumed in producing pig iron, MWh [116]
$EF_{e,b}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

$TCIPI_{b,i}$ – the total CO_{2e} emissions from the material inputs into pig iron – include the CO_{2e} from fuel and electricity used to prepare iron ore, the total CO_{2e} from the reducing agents (coke, anthracite etc.) and the total CO_{2e} from limestone, dolomite, pellets etc.

$$TCIPI_{b,i} = TCFIO_{b,i} + TCEIO_{b,i} + TCRAPI_{b,i} + TCOIPI_{b,i} \quad (6),$$

where:
$TCFIO_{b,i}$ = total CO_{2e} from fuel used to prepare iron ore, t CO_{2e}
$TCEIO_{b,i}$ = total CO_{2e} from electricity consumption in preparing iron ore, t CO_{2e}
$TCRAPI_{b,i}$ = total CO_{2e} from reducing agents, t CO_{2e}
$TCOIPI_{b,i}$ = total CO_{2e} from the other consumed inputs, t CO_{2e}

Total CO_{2e} from fuel used to prepare iron ore ($TCFIO_{b,i}$) is the quantity of fuel multiplied by the emission factor for that fuel:

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[115] In accordance with order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127171), order of the National environmental investment agency of #63 dated 15th of April 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127172), order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=126006) and the order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011 (http://www.neia.gov.ua/nature/doccatalog/document?id=127498).

[116] In this project, the amount of electricity generated from the combined heat and power plant is contingent on the availability of excess Blast Furnace Gas. In the baseline case there will be no excess Blast Furnace Gas as it is used in the Casting Process and therefore there is no electricity generated from the CHP plant. So in baseline the electricity emissions factor will be the grid emissions factor while in the project case it will be a weighted average of the emission factors of the electricity generated by CHP and the grid if blast furnace gas is used for this purpose as envisioned. If Blast Furnace Gas is used to displace any other fuel source this will be captured by the monitoring plan and will be included in the final emission reductions results.

$$TCFIO_{b,i} = \sum_{1}^{fio} \left(Q_{fio,b,i} \times EF_{f,b} \right) \quad (7),$$

where:
$fio_{b,i}$ = number of fuels used in preparing iron ore
$Q_{b,i}$ = quantity of fuel fio used (1000 m^3)
$EF_{f,b}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

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

$$TCEIO_{b,i} = ECIO_{b,i} * EF_{e,b} \quad (8),$$

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

Total CO_{2e} from reducing agents[117] in pig iron production $TCRAPI_{b,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAPI_{b,i} = \sum_{1}^{rapi} \left(Q_{rapi,b,i} \times EF_{ra,b} \right) \quad (9),$$

[117] For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

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

The current and expected reducing agents include coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite[118] (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied.

Total CO_{2e} from the other inputs[119] such as limestone, dolomite, pellets etc. in pig iron production $TCOIPI_{b,i}$ is the quantity of each other input multiplied by the emission factor for that input:

$$TCOIPI_{b,i} = \sum_{1}^{oipi} \left(Q_{oipi,b,i} \times EF_{oi,b} \right) \qquad (10),$$

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

Default emission factor applied to limestone is equal to 0.440 t CO_{2e} per tonne of limestone consumed; default emission factor for dolomite is equal to 0.477 t CO_{2e} per tonne of dolomite consumed; emission factor applied to pellets is equal to 0.03 t CO_{2e} per tonne of pellets produced. If other materials are to be used, their default factors will be applied.

STEP 2. FURNACE PROCESS

The total CO_{2e} emissions from the furnace process ($TCFP_{b,i}$) include emissions from three sources: fuel, electricity and inputs into the furnace process.

[118] NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).
[119] For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

$TCFP_{b,i} = TCFCFP_{b,i} + TCECFP_{b,i} + TCIFP_{b,i}$ (11),

where:
$TCFCFP_{b,i}$ = total CO_{2e} from fuel consumption in furnace process, t CO_{2e}
$TCECFP_{b,i}$ = total CO_{2e} from electricity consumption in furnace process, t CO_{2e}
$TCIFP_{b,i}$ = total CO_{2e} from inputs into furnace process, t CO_{2e}

Tonnes of CO_{2e} for fuel used in the furnace process ($TCFCFP_{b,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCFP_{b,i} = \sum_{1}^{ffp} \left(Q_{ffp,b,i} \times EF_{f,b} \right)$$ (12),

where:
$ffp_{b,i}$ = number of fuels used in the furnace process
$Q_{b,i}$ = quantity of fuel ffp used (1000 m^3)
$EF_{f,b}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

Tonnes of CO_{2e} for electricity used in the furnace process ($TCECFP_{b,i}$) will be the quantity of electricity multiplied by the emissions factor for electricity:

$TCECFP_{b,i} = ECFP_{b,i} * EF_{e,b}$ (13),

where:
$ECFP_{b,i}$ = electricity consumed in the furnace process, MWh
$EF_{e,b}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

The total tonnes of CO_{2e} from inputs into the furnace process ($TCIFP_{b,i}$) will include total tonnes of CO_{2e} from reducing agents (coke, anthracite etc.) and total tones of CO_{2e} from the other inputs in the furnace process (limestone, dolomite, pellets etc.):

$TCIFP_{b,i} = (TCRAFP_{b,i} + TCOIFP_{b,i})$ (14),

where:
$TCRAFP_{b,i}$ = total CO_{2e} from reducing agents entering furnace process, t CO_{2e}
$TCOIFP_{b,i}$ = total CO_{2e} from the other inputs entering furnace process, t CO_{2e}

Total CO_{2e} from reducing agents[120] entering furnace process $TCRAFP_{b,i}$ is the quantity of each reducing agent multiplied by the emission factor for the reducing agent:

$$TCRAFP_{b,i} = \sum_{1}^{rafp} \left(Q_{rafp,b,i} \times EF_{ra,b} \right) \quad (15),$$

where:
$rafp_{b,i}$ = number of reducing agents entering furnace process
$Q_{rafp,b,i}$ = quantity of each reducing agent rafp used (tonnes)
$EF_{ra,b}$ = emission factor for reducing agent, t CO_{2e}/tonne in the relevant period

The current and expected reducing agents include coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite[121] (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied.

Total CO_{2e} from the other inputs[122] such as limestone, dolomite, pellets etc. entering furnace process $TCOIFP_{b,i}$ is the quantity of each other input multiplied by the emission factor for the other input:

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[120] For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf) and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf). For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

[121] NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf).

[122] For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10 (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf). For default carbon emission

$$TCOIFP_{b,i} = \sum_{1}^{oifp} \left(Q_{oifp,b,i} \times EF_{oi,b} \right) \quad (16),$$

where:
$oifp_{b,i}$ = number of the other inputs entering furnace process
$Q_{oifp,b,i}$ = quantity of each other input oifp used (tonnes)
$EF_{oi,,b}$ = emission factor for the other inputs, t CO_{2e}/tonne in the relevant period

Default emission factor applied to limestone is equal to 0.440 t CO_{2e} per tonne of limestone consumed; default emission factor for dolomite is equal to 0.477 t CO_{2e} per tonne of dolomite consumed; emission factor applied to pellets is equal to 0.03 t CO_{2e} per tonne of pellets produced. If other materials are to be used, their default factors will be applied.

STEP 3. CASTING/ROLLING

The total tonnes CO_{2e} from the square billet casting/rolling process ($TCCR_{b,i}$) will be calculated from both the fuel and the electricity inputs into the process:

$$TCCR_{b,i} = TCFCR_{b,i} + TCECR_{b,i} \quad (17),$$

where:
$TCFCR_{b,i}$ = total CO_{2e} from fuel consumption in square billet casting/rolling, t CO_{2e}
$TCECR_{b,i}$ = total CO_{2e} from electricity consumption in square billet casting/rolling

Tonnes of CO_{2e} for fuel used in square billet casting/rolling ($TCFCR_{b,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCR_{b,i} = \sum_{1}^{fcr} \left(Q_{fcr,b,i} \times EF_{f,b} \right) \quad (18),$$

factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf).

where:
$fcr_{b,i}$ = number of fuels used in the casting/rolling
$Q_{b,i}$ = quantity of each fuel fcr used (1000 m^3)
$EF_{f,b}$ = tonnes of CO_{2e} per 1000 m^3 of each fuel

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

Tonnes of CO_{2e} for electricity used in square billet casting/rolling ($TCECFP_{b,i}$) will be the quantity of electricity multiplied by the emissions factor for electricity:

$$TCECR_{b,i} = ECCR_{b,i} * EF_{e,b} \quad (19),$$

where:
$ECCR_{b,i}$ = electricity consumed in square billet casting/rolling, MWh
$EF_{e,b}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

STEP 4. BALANCE OF PROCESS NEEDS

Total tones of CO_2 related to the balance of process needs of the project, namely production of secondary energy from the CHP-BH (that produces blast-furnace blowing and potentially self-generated electricity), as well as processes that ensures supply of compressed air, steam, oxygen, nitrogen, argon[123] and water required in the technological process. The relevant parameters are calculated based on the amounts of fuel and electricity consumed by the said processes:

$TCBPN_{b,i}$ = total tones of CO_2 related to the balance of process need of energy required for the project activity, being the sum of numbers of tones of CO_2 from fuel and electricity consumed:

$$TCBPN_{b,i} = TCFCBPN_{b,i} + TCEBPN_{b,i} \quad (20),$$

where:
$TCFCBPN_{b,i}$ = total CO_{2e} from fuel consumption for balance of process needs of project activity, t CO_{2e}:

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

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

Tonnes of CO_{2e} for fuel used for balance of process needs of project activity ($TCFCBPN_{b,i}$) will be the quantity of each fuel multiplied by the emissions factor for that fuel:

$$TCFCBPN_{b,i} = \sum_{1}^{fbpn}(Q_{fbpn,b,i} \times EF_{f,b}) \qquad (21),$$

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

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

Tonnes of CO_{2e} for electricity used for balance of process needs of project activity ($TCEBPN_{b,i}$) will be the quantity of electricity multiplied by the emissions factor:

$$TCEBPN_{b,i} = (ECBPN_{b,i} - ECSG_{b,i}{}^{[124]}) * EF_{e,b} \qquad (22),$$

where:
$ECBPN_{b,i}$ = electricity used for production of secondary energy used for the balance of process needs (MWh)
$ECSG_{b,i}$ = self-generated electricity used in the project activity (MWh)[125]
$EF_{e,b}$ = emission factor for electricity, t CO_{2e}/MWh in the relevant period

[124] Electricity consumed will be measured and converted to CO_{2e} emissions using aggregate data of local combined heat and power plant (when available), and grid data. During the monitoring of the electricity which will be generated at the plant the volumes and calorific values of gases (usually natural gas is used for electricity generation) will be taken into account and therefore the emission factor will be calculated on actual data during monitoring period. The electricity generated at the plant will replace the grid electricity consumption.
[125] Since self-generated electricity is delivered to the Plant's common grid, which makes it difficult to separate quantities of self-generated electricity consumed by major equipment in the project scenario, the decision was made to calculate actual consumption of fuel and energy in self-generated electricity production and to substitute electricity from the national grid with self-generated electricity. This helps avoid double calculation and demonstrates conservativeness of the analysis.

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

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

Not applicable.

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

Not applicable.

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

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

Not applicable.

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

There should be no leakages caused by the project as long as the old technology employed is decommissioned and not used again somewhere else. The project developer will document that the previous equipment is decommissioned. The emissions from installing the new equipment will not be significant. The emissions from transport of materials will not be significantly higher for the baseline, however this will not be taken into account to secure conservativeness of the analysis.

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

$$ER_i = BE_i – PE_i \quad (23),$$

where:
ER =Emission Reductions
BE= Baseline Emissions
PE= Project Emissions

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:

DIISW has historical experience in dealing with environmental impacts by different steelmaking processes. Environmental activity is one of the core activities of the plant due to location of the plant in the quite populated city Dniprodzerzhynsk.

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

In its operation SED is regulated by the national and local documents. Overall environmental influence is under manageable control and fully in compliance with national and local regulations.

The environmental management standard ISO 14001[126] is implemented and certified at DIISW.

[126] http://www.dmkd.dp.ua/node/237

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

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:			
Data *(Indicate table and ID number)*	Data variable	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
P-2	Total steel output (TSO_p) (Project)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-4	Total Pig Iron Input into Steel Making Process ($TPII_p$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-6	Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,p}$)	Low, 0.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-7, 14, 27, 41, 48	Emission factor for each fuel $EF_{f,p}$	Low	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.
P-9	Electricity Consumed in producing Pig Iron ($ECPI_p$)	Low, ±0.5-2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
P-10, 17, 30, 44, 52	Emissions factor for electricity ($EF_{e,p}$)	Low	During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[127]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[128]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[129]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.

[127] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[128] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[129] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

P-13	Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,p}$)	Low, 0.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-16	Electricity Consumed in Sintering ($ECIO_p$)	Low, ±0.5-2.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
P-19	Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p}$)	Low, 0.1-1.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-20, 34	Emission factor of each reducing agent, $EF_{ra,p}$	Low	For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25. NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18. The PDD is using default factors for coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on carbon content and the net calorific value of coke and anthracite are available, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations.
P-22	Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p}$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-23, 37	Emission factor of each other input, $EF_{oi,p}$	Low	For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10. For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25.
P-26	Quantity of each fuel (ffp_p) used in furnace process ($Q_{ffp,p}$)	Low, 0.1%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.

P-29	Electricity consumed in the furnace process ($ECFP_p$)	Low, 0.5-2.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
P-33	Quantity of each reducing agent ($rafp_p$) in the furnace process ($Q_{rafp,p}$)	Low, 0.1-1.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-36	Quantity of each other input ($oifp_p$) in the furnace process ($Q_{oifp,p}$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-40	Quantity of each fuel (fcr_p) used in casting ($Q_{fcr,p}$)	Low, ±50-150rg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-43	Electricity Consumed in casting ($ECCR_p$)	Low, 0.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
P-47	Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p}$)	Low	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
P-50	Electricity Consumed for balance of process needs ($ECBPN_p$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
P-51	Self-generated electricity used in the project activity ($ECSG_p$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-2	Total steel output (TSO_b) (Baseline)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-4	Total Pig Iron Input into Steel Making Process ($TPII_b$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-6	Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi,b}$)	Low, 0.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-7, 14, 26, 41, 48	Emission factor for each fuel $EF_{f,b}$	Low	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. Emission factor for fuel in this case is based on fixed net calorific value. During the monitoring report development emission factor will be modified by taking into account actual net calorific value of fuel.

B-9	Electricity Consumed in producing Pig Iron ($ECPI_b$)	Low, ±0.5-2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-10, 17, 30, 44, 52	Emissions factor for electricity ($EF_{e,b}$)	Low	During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[130]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[131]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[132]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011. If any other emission factors will be officially approved, the project developer will make an appropriate modification at the stage of monitoring report development. For more detailed information please also see Annex 2.
B-13	Quantity of each fuel (fio_b) used in Sintering ($Q_{fio,b}$)	Low, 0.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-16	Electricity Consumed in Sintering ($ECIO_b$)	Low, ±0.5-2.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-19	Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b}$)	Low, 0.1-1.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.

[130] http://www.neia.gov.ua/nature/doccatalog/document?id=127171
[131] http://www.neia.gov.ua/nature/doccatalog/document?id=127172
[132] http://www.neia.gov.ua/nature/doccatalog/document?id=126006.

B-20, 34	Emission factor of each reducing agent, $EF_{ra,b}$	Low	For default carbon emission factors of various reducing agents consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26 and Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13. For default carbon emission factors of various reducing agents production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25. NCV for anthracite is based on default value in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors*, Table 1.2, page 18. The PDD is using default factors for coke (emission factor 3.66 t CO_{2e}/tonne, which includes the default factor for coke burning (3.1 t CO_{2e}/tonne) and the default factor for coke production (0.56 t CO_{2e}/tonne)), anthracite (default emission factor 2.62 t CO_{2e}/tonne). If other reducing agents are to be used, their default emission factors will be applied. In case if actual data on carbon content and the net calorific value of coke and anthracite are available, the emission factor for these parameters will be recalculated and these data would prevail over PDD estimations.
B-22	Quantity of each other input ($oipi_b$) in Pig Iron Production ($Q_{oipi,b}$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-23, 37	Emission factor of each other input, $EF_{oi,b}$	Low	For default carbon emission factors of various other inputs consumption please see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for* CO_2, page 2.10. For default carbon emission factors of various other inputs production please see 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25.
B-26	Quantity of each fuel (ffp_b) used in furnace process ($Q_{ffp,b}$)	Low, 0.1%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-29	Electricity consumed in the furnace process ($ECFP_b$)	Low, 0.5-2.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-33	Quantity of each reducing agent ($rafp_b$) in the furnace process ($Q_{rafp,b}$)	Low, 0.1-1.25%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-36	Quantity of each other input ($oifp_b$) in the furnace process ($Q_{oifp,b}$)	Low, ±50-150kg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.

B-40	Quantity of each fuel (fcr_b) used in casting ($Q_{fcr,b}$)	Low, ±50-150rg	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-43	Electricity Consumed in casting ($ECCR_b$)	Low, 0.5%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-47	Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b}$)	Low	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards.
B-50	Electricity Consumed for balance of process needs ($ECBPN_b$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.
B-51	Self-generated electricity used in the project activity ($ECSG_b$)	Low, 2%	Metering and measuring devices will be calibrated as per manufacturer's instructions and in line with DIISW's *Metrological Support of Measuring Equipment* and *Guideline on Plant Metrology Department*, as well as national standards. Detailed monitoring device listing is available.

Uncertainties of measurement results are limited in chosen approach. Monitoring/measuring methodologies and QA/QC procedures are basically the same for the baseline and project scenarios leading to similar uncertainties (pls. see the Section D.2 for details). In fact, the main source of emission reductions is reduced use of materials. The monitoring/measurement procedures are exactly the same both for the baseline and project production line as far the use of pig iron is concerned and errors have similar implications in both cases. The exception is partly different source of electricity, but uncertainty in measuring electricity is low. In addition, for processes that differ in baseline (converters – continuous bloom casters) and project (converters – LFs – CCMs) emission reductions are mainly generated due to reduced use of natural gas with again very low measuring uncertainties.

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

The data required to monitor the ERs is routinely collected within the normal operations of the DIISW therefore monitoring is integral part of routine monitoring. All data will be stored in paper format and, partly, collected into electronic database of DIISW. Data is compiled in (i) day-to-day records, (ii) monthly records, (iii) quarterly records, and (iv) annual records. All records are finally stored in chief accountant department and used by the Planning Department. The appropriate data for GHG monitoring will be fed into the Monitoring Database. All the documents will be translated into Ukrainian by initial verification stage.

The Monitoring Plan will be implemented by different specialists of the DIISW under supervision of Head of Technical Directorate's Technical Department and managed by top management of the Plant. Chief Engineer has overall project responsibility. All the main production shops and specialists of the plant will be involved into the preparation of monitoring report under coordination of Head of Technical Directorate's Technical Department. The Institute for Environment and Energy Conservation will also supervise the implementation of the Monitoring Plan for the project at regular intervals. See also Annex 3 for additional information.

Table 7. Specialists Responsible for Monitoring

Responsibility	Specialist Responsible	Data Variable	
		Baseline	Project
Overall project responsibility	Chief Engineer		
Overall responsibility for Monitoring Report	Technical Department Head	B-7, B-10, B-14, B-17, B-20, B-23, B-27, B-30, B-34, B-37, B-41, B-44, B-48, B-52	P-7, P-10, P-14, P-17, P-20, P-23, P-27, P-30, P-34, P-37, P-41, P-44, P-48, P-52
Data for Converters, LFs, Casting and CCMs	Converter Shop Manager	B-2, B-4, B-26, B-29, B-33, B-36, B-40, B-43	P-2, P-4, P-26, P-29, P-33, P-36, P-40, P-43
Data for Blooming Mill, Billet Mill, and Structural Mill	Mill Supervisor	B-40, B-43	NA
Data for Blast Furnaces	Blast Furnace Shop Manager	B-4, B-6, B-9, B-19, B-22	P-4, P-6, P-9, P-19, P-22
Data for Sinter Plant	Sinter Plant Manager	B-13, B-16, B-19, B-22	P-13, P-16, P-19, P-22
Data for balance of process needs	Head of CHP, Deputy Chief Energy Specialist	B-47, B-50, B-51	P-47, P-50, P-51

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

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

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

SECTION E. Estimation of greenhouse gas emission reductions[133]

E.1. Estimated project emissions:

Detailed calculation is provided in Table 15.

Table 8. Estimated project emissions

Project emissions (PE)		2008	2009	2010	2011	2012
Pig Iron	t CO_{2e}/a[134]	469 004	3 088 330	4 149 573	8 245 407	8 245 407
Furnace process	t CO_{2e}/a	20 546	102 102	179 515	420 459	420 459
Casting	t CO_{2e}/a	3 100	16 403	15 630	43 376	43 376
Balance of process needs	t CO_{2e}/a	12 134	61 911	82 186	159 670	159 670
Totally	t CO_{2e}/a	504 784	3 268 745	4 426 904	8 868 912	8 868 912
Totally, 2008-2012	t CO_{2e}	25 938 257				

Project emissions (PE)		2013	2014	2015	2016	2017
Pig Iron	t CO_{2e}/a	8 245 407	8 245 407	8 245 407	8 245 407	8 245 407
Furnace process	t CO_{2e}/a	420 459	420 459	420 459	420 459	420 459
Casting	t CO_{2e}/a	43 376	43 376	43 376	43 376	43 376
Balance of process needs	t CO_{2e}/a	159 670	159 670	159 670	159 670	159 670
Totally	t CO_{2e}/a	8 868 912	8 868 912	8 868 912	8 868 912	8 868 912
Totally, 2013-2017	t CO_{2e}	44 344 559				

Project emissions (PE)		2018	2019	2020
Pig Iron	t CO_{2e}/a	8 245 407	8 245 407	8 245 407
Furnace process	t CO_{2e}/a	420 459	420 459	420 459
Casting	t CO_{2e}/a	43 376	43 376	43 376
Balance of process needs	t CO_{2e}/a	159 670	159 670	159 670
Totally	t CO_{2e}/a	8 868 912	8 868 912	8 868 912
Totally, 2018-2020	t CO_{2e}	26 606 736		
Totally, 2013-2020	t CO_{2e}	70 951 295		

E.2. Estimated leakage:

Not applicable.

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

Project emissions (PE)		2008	2009	2010	2011	2012
Pig Iron	t CO_{2e}/a	469 004	3 088 330	4 149 573	8 245 407	8 245 407
Furnace process	t CO_{2e}/a	20 546	102 102	179 515	420 459	420 459
Casting	t CO_{2e}/a	3 100	16 403	15 630	43 376	43 376
Balance of process needs	t CO_{2e}/a	12 134	61 911	82 186	159 670	159 670
Totally	t CO_{2e}/a	504 784	3 268 745	4 426 904	8 868 912	8 868 912
Totally, 2008-2012	t CO_{2e}	25 938 257				

Project emissions (PE)		2013	2014	2015	2016	2017
Pig Iron	t CO_{2e}/a	8 245 407	8 245 407	8 245 407	8 245 407	8 245 407
Furnace process	t CO_{2e}/a	420 459	420 459	420 459	420 459	420 459

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

[134] Annually

Casting	**t CO_{2e}/a**	**43 376**	**43 376**	**43 376**	**43 376**	**43 376**
Balance of process needs	**t CO_{2e}/a**	**159 670**	**159 670**	**159 670**	**159 670**	**159 670**
Totally	**t CO_{2e}/a**	**8 868 912**	**8 868 912**	**8 868 912**	**8 868 912**	**8 868 912**
Totally, 2013-2017	**t CO_{2e}**	**44 344 559**				
Project emissions (PE)		**2018**	**2019**	**2020**		
Pig Iron	**t CO_{2e}/a**	**8 245 407**	**8 245 407**	**8 245 407**		
Furnace process	**t CO_{2e}/a**	**420 459**	**420 459**	**420 459**		
Casting	**t CO_{2e}/a**	**43 376**	**43 376**	**43 376**		
Balance of process needs	**t CO_{2e}/a**	**159 670**	**159 670**	**159 670**		
Totally	**t CO_{2e}/a**	**8 868 912**	**8 868 912**	**8 868 912**		
Totally, 2018-2020	**t CO_{2e}**	**26 606 736**				
Totally, 2013-2020	**t CO_{2e}**	**70 951 295**				

E.4. Estimated baseline emissions:

Detailed calculation is provided in Table 16.

Table 9. Estimated baseline emissions

Baseline emissions (BE)		**2008**	**2009**	**2010**	**2011**	**2012**
Pig Iron	**t CO_{2e}/a**	**552 451**	**3 630 360**	**4 628 638**	**9 561 730**	**9 561 730**
Furnace process	**t CO_{2e}/a**	**24 200**	**120 020**	**147 893**	**298 172**	**298 172**
Casting/Rolling	**t CO_{2e}/a**	**53 207**	**268 974**	**270 797**	**600 676**	**600 676**
Balance of process needs	**t CO_{2e}/a**	**14 513**	**73 918**	**92 863**	**188 133**	**188 133**
Totally	**t CO_{2e}/a**	**644 371**	**4 093 271**	**5 140 191**	**10 648 711**	**10 648 711**
Totally, 2008-2012	**t CO_{2e}**	**31 175 256**				

Baseline emissions (BE)		**2013**	**2014**	**2015**	**2016**	**2017**
Pig Iron	**t CO_{2e}/a**	**9 561 730**	**9 561 730**	**9 561 730**	**9 561 730**	**9 561 730**
Furnace process	**t CO_{2e}/a**	**298 172**	**298 172**	**298 172**	**298 172**	**298 172**
Casting	**t CO_{2e}/a**	**600 676**	**600 676**	**600 676**	**600 676**	**600 676**
Balance of process needs	**t CO_{2e}/a**	**188 133**	**188 133**	**188 133**	**188 133**	**188 133**
Totally	**t CO_{2e}/a**	**10 648 711**	**10 648 711**	**10 648 711**	**10 648 711**	**10 648 711**
Totally, 2013-2017	**t CO_{2e}**	**53 243 557**				
Baseline emissions (BE)		**2018**	**2019**	**2020**		
Pig Iron	**t CO_{2e}/a**	**9 561 730**	**9 561 730**	**9 561 730**		
Furnace process	**t CO_{2e}/a**	**298 172**	**298 172**	**298 172**		
Casting	**t CO_{2e}/a**	**600 676**	**600 676**	**600 676**		
Balance of process needs	**t CO_{2e}/a**	**188 133**	**188 133**	**188 133**		
Totally	**t CO_{2e}/a**	**10 648 711**	**10 648 711**	**10 648 711**		
Totally, 2018-2020	**t CO_{2e}**	**31 946 134**				
Totally, 2013-2020	**t CO_{2e}**	**85 189 691**				

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

Table 10. Emission reductions estimations

Emission reductions (ER)		**2008**	**2009**	**2010**	**2011**	**2012**
Pig Iron	**t CO_{2e}/a**	**83 447**	**542 030**	**479 066**	**1 316 323**	**1 316 323**
Furnace process	**t CO_{2e}/a**	**3 654**	**17 918**	**-31 622**	**-122 287**	**-122 287**
Casting/Rolling	**t CO_{2e}/a**	**50 106**	**252 571**	**255 167**	**557 300**	**557 300**
Balance of process needs	**t CO_{2e}/a**	**2 379**	**12 006**	**10 677**	**28 463**	**28 463**

Totally	**t CO_{2e}/a**	**139 587**	**824 526**	**713 287**[135]	**1 779 799**[136]	**1 779 799**
Totally, 2008-2012	**t CO_{2e}**	**5 236 999**				

Emission reductions (ER)		**2013**	**2014**	**2015**	**2016**	**2017**
Pig Iron	**t CO_{2e}/a**	**1 316 323**	**1 316 323**	**1 316 323**	**1 316 323**	**1 316 323**
Furnace process	**t CO_{2e}/a**	**-122 287**	**-122 287**	**-122 287**	**-122 287**	**-122 287**
Casting	**t CO_{2e}/a**	**557 300**	**557 300**	**557 300**	**557 300**	**557 300**
Balance of process needs	**t CO_{2e}/a**	**28 463**	**28 463**	**28 463**	**28 463**	**28 463**
Totally	**t CO_{2e}/a**	**1 779 799**	**1 779 799**	**1 779 799**	**1 779 799**	**1 779 799**
Totally, 2013-2017	**t CO_{2e}**	**8 898 997**				

Emission reductions (ER)		**2018**	**2019**	**2020**
Pig Iron	**t CO_{2e}/a**	**1 316 323**	**1 316 323**	**1 316 323**
Furnace process	**t CO_{2e}/a**	**-122 287**	**-122 287**	**-122 287**
Casting	**t CO_{2e}/a**	**557 300**	**557 300**	**557 300**
Balance of process needs	**t CO_{2e}/a**	**28 463**	**28 463**	**28 463**
Totally	**t CO_{2e}/a**	**1 779 799**	**1 779 799**	**1 779 799**
Totally, 2018-2020	**t CO_{2e}**	**5 339 398**		
Totally, 2013-2020	**t CO_{2e}**	**14 238 396**		

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

Year	**Estimated project emissions (Tonnes CO_{2e})**	**Estimated leakage (Tonnes CO_{2e})**	**Estimated baseline emissions (Tonnes CO_{2e})**	**Estimated emission reductions (Tonnes CO_{2e})**
2008	**504 784**	**0**	**644 371**	**139 587**
2009	**3 268 745**	**0**	**4 093 271**	**824 526**
2010	**4 426 904**	**0**	**5 140 191**	**713 287**
2011	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2012	**8 868 912**	**0**	**10 648 711**	**1 779 799**
Totally (Tonnes CO_{2e})	**25 938 257**	**0**	**31 175 256**	**5 236 999**
2013	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2014	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2015	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2016	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2017	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2018	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2019	**8 868 912**	**0**	**10 648 711**	**1 779 799**
2020	**8 868 912**	**0**	**10 648 711**	**1 779 799**
Totally (Tonnes CO_{2e})	**70 951 295**	**0**	**85 189 691**	**14 238 396**

[135] This figure is estimated based on 2009 specific fuel and energy resources consumption per 1 t of output and planned steel output during 2010. It is expected that during determination process this figure will be recalculated by taking into account actual and most recent historical data that will be available.
[136] Emission reductions for the period starting from 2011 and till 2020 are calculated based expected annual volume of steel output (3 400 000 tonnes of square billets).

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:

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

EIA was developed by Ukrainian State Steelworks Design Institute (Ukrdipromez). The document provides assessment of impact of the project activity on various components of natural, social, and man-made environment.

EIA describes current condition of the site selected for the project activity, registers changes in subsurface, air, water and ground condition, animal and plant communities, social environment, man-made environment, and waste generation and disposal.

EIA incorporates an Environmental Statement (ES), which is a legally binding instrument describing the nature of effects the project will have, and providing warranties that measures required to provide environmental safety throughout the project lifetime will be undertaken; in fact, ES is a summary of EIA.

Pursuant to Article 35 of the Law of Ukraine *On Environmental Due Diligence* requiring ES publication in the media, the ES for the project was published in *Dniprodzerzhynsk Town Council's Bulletin* issues nos. 26 of 28/06/2006 and 41 of 10/10/2007.

EIA compares two factors with opposite effect. The first one is a potential increase in emissions, discharges and wastes as the result of Plant capacity increase. The second one is noxious emissions reduction due to implementation of state-of-the-art technology typically allowing to curtail emissions, discharges and wastes per unit of output. EIA opinion is that the project will in general create positive environmental impact and that its negative impacts are believed to be minor and subject to mitigation by special measures to be implemented within the project[137]. This opinion was used as the basis for the required permits and approvals that have been or are being obtained locally.

Recognizing the incremental nature of the overall project's implementation covering the installation of Ladle Furnaces (LFs) and seven-strand Billet Continuous Casting Machines (CCMs), the EIA was undertaken for each project phase as the first and the second parts of the design and engineering documents were prepared for the mandatory technical approvals, one step in which was the formal State Environmental Due Diligence. As a result, the EIA for DIISW was presented in two volumes: one as part of the project proposal for refurbishment of the Converter shop and installation of LF 1, and the other one as part of the project proposal for refurbishment of Continuous Casting section at the converter shop with installation of two billet CCMs and LF 2. The interval of 2005 – 2007 was chosen as a baseline period.

EIA Volume 1 relates to LF 1 installation at the converter shop as a way to achieve consistently high steel quality and process compliance with international standards. Following project implementation

[137] Section 6 of EIA DT 345668 for the DIISW Converter Shop Refurbishment Project with Ladle Furnace Installation.
Section 5 of EIA 70017-3A for the DIISW Converter Shop Continuous Casting Machines Refurbishment Project with Two Billet CCMs and One Ladle Furnace Installation.

concentration of pollutants in the air will not exceed one time maximum permissible concentration in mg/m^3, as approved by the Ministry for Environment Protection of Ukraine, considered a national standard[138].

According to EIA, project activity will lead to annual reduction of pollutant emissions from LF by 1136.845 tonnes. Residual emissions will amount to 129.193 t/year. The decommissioning of ingot pits nos. 1, 9 and 10 and two shaft furnaces nos. 1 and 2 of the limestone shop will reduce gross emissions of pollutants by further 200.191 t/year. Maximum ground level concentrations of pollutants at the sanitary zone boundary are marginal and their impact on the environment is next to zero.

The other volume of EIA relates to the installation of two seven-strand billet CCMs and LF 2 to increase overall production output to 4,200 – 4,500 thousand tonnes of steel per year (due to operation of existing and new facilities for steel ingot casting and processing in the blooming mill and section mills). This volume was completed in 2007 (both volumes may be available upon relevant request)[139].

By EIA conclusions, the project intends to implement a series of environment protection measures to minimise project's environmental impact[140]. Following the commissioning of the two CCMs and LF 2 gross noxious emissions reduction will reach 1,331.0 t/year.

Compensatory actions set forth by the Plant will reduce gross noxious emissions by 1,405.1 t/year versus their current level.

Project's sanitary zone boundary is located within the boundary of Plant sanitary zone and therefore does not require revision.

The conclusion was made also that pollutants concentration in the surrounding environment as the result of CCM and LF operation will not be in excess of permissible levels and will even be lower than the current level formed by operation of the existing process lines. This result will be achieved despite the fact that application of new CCMs will cause the increased water consumption. The project will use close recirculation water supply scheme that will be included in the converter shop's recirculation cycle. The project also provides for a LF emergency water supply scheme.

Reserves available to improve productivity of the recirculation cycle and medium- and high-pressure pumping capacity will suffice to allow for additional water flows. Operation of project facilities will not have noticeable impact on social environment considering that their impact on natural environment is minimised or reduced to zero.

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

It may generally be stated that the project activity is in line with the EU best available technology principle.

Project activity will cause no harmful transboundary impacts.

[138] Standard Maximum Permissible Noxious Emissions from Stationary Sources, as approved by the order of the Ministry for Environment Protection dd. 27/06/2006 No. 309.
[139] 11 Kotovskogo street, Kiev 04060, Ukraine. Tel./fax +380 44 206 4940, e-mail: ipee@ipee.org.ua
[140] EIA Section 7.

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

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

Ukrainian Ministry for Environment Protection has formally approved project activities within EIA Part 1 in 2007, and relevant consents were obtained from the Ukrainian Health Ministry and Ministry for Emergencies Chief Directorate, as follows:
a) Ministry for Environment: No. 501 dd. 08/06/07;
b) Health Ministry: No. 05/03/02-03/18047 dd. 12/04/07;
c) Ministry for Emergencies: No. 97/18 dd. 25/04/07.

EIA Part 2 received the following positive opinions in 2008:
d) Ministry for Environment: No. 8924/12/10-08 dd. 11/07/08 (for environmental safety);
e) Kryvy Rih Technology Expert Centre: No. 12.2-01-05-0713.08 dd. 17/07/08 (for occupational health & safety);
f) Ministry for Emergencies: No. 31/4/4682 dd. 14/07/08 (for fire safety);
g) Health Ministry: No. 05.03.02-07/42357 dd. 09/07/2008 (public health due diligence).

Hard copies of the said documents in Russian and Ukrainian could be available upon relevant request from the Institute for Environment and Energy Conservation or DIISW.

Positive opinions of the number of government agencies evidence that the proposed project activity will have comprehensive positive impact on various aspects of activity of the local community, and that decisions that were made were transparent and independent to the extent required by the Ukrainian law.

The fact that the Industrial Union of Donbass Corporation was provided international loans, *inter alia* from the International Finance Corporation and EBRD, for modernisation of its steel making assets (including DIISW) proves that that the said modernisation projects demonstrate sufficient focus on environmental issues.[141]

The public was informed on potential environmental impacts of the project via the media, as required per Ukrainian law. The relevant information on the project was published in the *Znamya Dzerzhynki* newspaper issues nos. 20 of 20/05/2009 and 25 of 24/06/2009.

The developer of the "Technical Upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Continuous Section Slab Casters and Two Ladle Furnaces" Joint Implementation Project came forward with public hearings that took place in Dniprodzerzhynsk on 12 May 2010.

The hearings were attended by representatives of public organisations The Town, Dniprodzerzhynsk Human Rights Union, Strength of Our Town, Youth Power, as well as media representatives and members of the local parliament. The minutes of the hearings witness the support expressed to this Joint Implementation Project.[142]

[141] IFC report "View Environmental & Social Review Summary" for Company "Industrial Union of Donbass", November 2007. http://www.ifc.org/ifcext/spiwebsite1.nsf/f451ebbe34a9a8ca85256a550073ff10/7ee7d93c8f24294c852576ba000e2aee?opendocument

[142] Minutes of public hearings on the "Technical Upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Billet Continuous Casting Machines and Two Ladle Furnaces" Joint Implementation Project, Dniprodzerzhynsk, 20/05/2010.

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

Note also that Dniprodzerzhynsk Town Council expressed its total support for the "Technical Upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Continuous Section Slab Casters and Two Ladle Furnaces" Joint Implementation Project in its letters to Head of the UN Joint Implementation Supervisory Committee, Head of the National Environmental Investment Agency of Ukraine, and the Institute for Environment and Energy Conservation[143].

SECTION G. Stakeholders' comments

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

Information on stakeholder comments is included in the EIA completed in accordance with Ukrainian statutory requirements.

A letter in support of the "Technical Upgrade of OJSC Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky by Installation of Two Continuous Section Slab Casters and Two Ladle Furnaces" Joint Implementation Project was signed by Dniprodzerzhynsk Mayor Mr. Korchevsky. The letter was addressed to all parties concerned (is available upon request).

It should be noted that, although Ukrainian laws do not require any separate public hearings, *inter alia* regarding project activity impact on reduction of greenhouse gas emissions into atmosphere, relevant consultations with local stakeholders were organised in May 2010 by representatives of the Institute for Environment and Energy Conservation jointly with DIISW personnel; furthermore, information of the project was published in Dniprodzerzhynsk media (information and minutes of the hearings could be available upon request).

[143] Letters by Dniprodzerzhynsk Town Council dd. 22/06/2010 No. 232-mr and 18/06/2010 No. 226-mr.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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State/Region:	Dnipropetrovsk oblast
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Represented by:	Mr Illia Dmytrovych Bouga
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Annex 2

BASELINE INFORMATION

The baseline will be calculated for each project year using the actual production in the given project year to determine the baseline emissions.

In this case, the most plausible baseline technology for steel production is represented by major steelmaking equipment such as converters, old CBC, blooming mills etc. These allow most of baseline parameters to be measured in real time. Apart from this, for some metallurgic equipment that is included in the baseline project boundary but is decommissioned baseline calculations can be based on most recent historical data available as applicable, based on specific consumption parameters per unit of output. Impact of LF on converter operation will be found experimentally or if it's possible, immediately. The described baseline represents the most probable technology scenario for additional capacity and will provide real-time data for the efficiency of steel production using the baseline technology. Should there be any major changes in operations in this production line, baseline calculations can be based on most recent historical data available as applicable.

The baseline tonnes CO_{2e} emissions per tonne of steel output will be measured using the actual efficiency parameters, as well as calculated based on the average and estimated values. These will be used to calculate the baseline for each project year to adjust to the amount of steel actually produced by the project line. In order to develop data in the baseline case that is comparable to the emissions data derived in the project case, the baseline CO_{2e} emissions per output figure will include both the material flows and energy flows by project in the portion that exceed the immediate bounds of project, particularly, into sinter plant, blast-furnace shop and so on. The material flows will include major raw inputs of pig iron, steel scrap, as well as process inputs such as oxygen, compressed air and so on. Each material flow will be measured for its necessary consumption per tonne of integrated products based on actual and historical data of the work of all equipped units.

Table 11. Emission Factors for Inputs and Reducing Agents (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13[144], Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Table 2-12, page 2.26[145], Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 3), Chapter 2 (Industrial Processes), Section 2.5.2 *Emissions estimation methodology for CO_2*, page 2.10[146] and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Section 1.4.2 *Emission Factors,* Table 1.2, page 18[147])

Table 11
Emission Factors for CO_2 from Inputs and Reducing Agents Consumption (tonnes CO_2 / tonne of material or reducing agent)

Reducing Agent	Emission Factor
Coke	3.1
Anthracite	2.62
Prebaked Anodes and Coal Electrodes	3.6
Limestone	0.44
Dolomite	0.477

[144] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf
[145] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref2.pdf
[146] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref1.pdf
[147] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Table 12. Emission Factors for Inputs and Reducing Agents Production and Transportation (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3 Industrial Processes and Product Use, Chapter 4 Metal Industries Emissions, Section 4.2.2.3 *Choice of Emission Factors*, Table 4.1, page 4.25[148])

Table 12 **CO_2 Emission Factors for Inputs and Reducing Agents Production and Transportation (tonnes CO_2 / tonne of material or reducing agent)**	
Reducing Agent	Emission Factor
Coal Coke	0.56
Pellets	0.03

Table 13 Emission Factors for Fuels (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference Manual (Volume 2), Chapter 1 (Energy), Table 1-1 (continued), page 1.13[149])

	TJ/ 1,000,000 m^3	t CO_{2e}/TJ	Oxidising Factor	t CO_{2e}/m^3	t CO_{2e}/1,000 m^3
Natural Gas[150]	33.91308	56.1	0.995	0.00189301	1.89301

Baseline Emission Factor for Ukrainian Electricity Grid

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

During 2008 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #62 dated 15th of April 2011[151]. During 2009 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #63 dated 15th of April 2011[152]. During 2010 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #43 dated 28th of March 2011[153]. Starting from year 2011 the carbon emission factor for electricity consumption is based on the Order of the National environmental investment agency of Ukraine #75 dated 12th of May 2011.

In accordance with mentioned above decrees issued by NEIA for the 1st – class electricity consumers the carbon emission factor for electricity consumption is equal to:

- 1,082 kgCO_2/kWh in 2008;
- 1,096 kgCO_2/kWh in 2009;
- 1,093 kgCO_2/kWh in 2010.
- 1,090 kgCO_2/kWh starting from 2011.

The use of the emission factor for the 1st-class electricity consumers is justified by the resolution of National Electricity Regulatory Commission of Ukraine № 1052 of 13 August 1998[154], according to the resolution the 1st – class electricity consumers are the consumers, who:

148 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf
149 http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf
150 Default emission factors will only be used where there's no possibility to identify calorific value of gas entering the Plant.
151 http://www.neia.gov.ua/nature/doccatalog/document?id=127171
152 http://www.neia.gov.ua/nature/doccatalog/document?id=127172
153 http://www.neia.gov.ua/nature/doccatalog/document?id=126006.
154 http://energetik.org.ua/node/90

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

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

Summary of the Key Baseline Elements in Tabular Form

ID number	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?	Comments
B-2	Total steel output in the baseline scenario (TSO_b)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-4	Total pig iron input into steel making process ($TPII_b$)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-6	Quantity of each fuel (fpi) used in making pig iron ($Q_{fpi,b}$)	Recorded by DIISW	m^3	m	Monthly	100%	electronic and paper format	
B-7, B-14, B-27, B-41, B-48	Emission factor of each fuel ($EF_{f,b}$)	IPCC 1996	Tonne CO_{2e}/m^3	m, c	Calculated based on DIISW's fixed average data regarding net calorific value for each fuel	100%	electronic and paper format	
B-9	Electricity consumed in producing pig iron ($ECPI_b$)	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	
B-10, B-17, B-30, B-44, B-52	Emission factor for electricity consumption ($EF_{e,b}$)	Approved carbon emission factors for electricity consumption	Tonne CO_{2e}/MWh	m, c	Monthly	100%	electronic and paper format	
B-13	Quantity of each fuel (fio) used in sintering process ($Q_{fio,b}$)	Recorded by DIISW	m^3	m	Monthly	100%	electronic and paper format	
B-16	Electricity consumed in sintering process ($ECIO_b$)	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	

B-19	Quantity of each reducing agent (rapi) in Pig Iron Production ($Q_{rapi,b}$)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-20, B-34	Emission factor of each reducing agent ($EF_{ra,b}$)	IPCC 1996 IPCC 2006	Tonne CO_{2e}/Tonne	m, c	Constant values	100%	electronic and paper format	
B-22	Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,b}$)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-23, B-37	Emission factor of each other input ($EF_{oi,b}$)	IPCC 1996 IPCC 2006	Tonne CO_{2e}/Tonne	m, c	Constant values	100%	electronic and paper format	
B-26	Quantity of each fuel (ffp) used in furnace process ($Q_{ffp,b}$)	Recorded by DIISW	m^3	m	Monthly	100%	electronic and paper format	
B-29	Electricity consumed in furnace process ($ECFP_b$)	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	
B-33	Quantity of each reducing agent (rafp) in furnace process ($Q_{rafp,b}$)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-36	Quantity of each other input (oifp) in furnace process ($Q_{oifp,b}$)	Recorded by DIISW	Tonne	m	Monthly	100%	electronic and paper format	
B-40	Quantity of each fuel (fcr) used in casting/rolling ($Q_{fcr,b}$)	Recorded by DIISW	m^3	m	Monthly	100%	electronic and paper format	

B-43	Electricity consumed in casting/rolling ($ECCR_b$)	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	
B-47	Quantity of each fuel (fbpn) used for balance of process needs ($Q_{fbpn,b}$)	Recorded by DIISW	m^3	m	Monthly	100%	electronic and paper format	
B-50	Electricity consumed for balance of process needs ($ECBPN_b$)	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	
B-51	Self-generated electricity consumed ($ECSG_{b)}$	Recorded by DIISW	MWh	m	Monthly	100%	electronic and paper format	

Annex 3

MONITORING PLAN

The monitoring procedures for the most part are straightforward in terms of what DIISW already does to collect energy consumption data and measure inputs and outputs. See Chapter D for details.

The monitoring procedure will centre on the collection of baseline data from the existing Converter – Blooming Mill/CBC – Rolling production cycle and historical data for decommissioned equipment, as well as annual project year data from the project boundary including:

- The types and amounts of different fuels used at various stages of the process;
- The amount and source of electricity consumed at various points of the process;
- The data required to formulate the Electricity Emissions Factor;
- The quantities of material inputs entering into the project for the steel making process;
- The electricity and fuel used to produce the material inputs into the process;
- CO_{2e} emissions released during the preparation of inputs and during the steel making process;
- Quantity of output.

The approach accounts for two types of emission reductions.

- Emission reductions from a decrease in the direct energy required to create the same tonne of steel end product
- The emission reductions derived from using less material input to create the same tonne of steel end product

Specifically, the project developer gathers information on fuel consumption, electricity consumption and the CO_{2e} impact of the material inputs into the project boundary steel making process. This data will be used to determine in the baseline emissions for each year based on monitoring operation of the Converter, Blooming Mill, CBC and other indirect process lines included in project boundaries, as well as on historical data regarding the decommissioned equipment, and measuring the CO_{2e} emissions per tonne of output. This is then multiplied by the actual steel product output each project year in the project steel making line to get the baseline CO_{2e} emissions. This is then compared to the total CO_{2e} produced in the actual project year. The difference is the emission reductions for that year.

It is expected that in the baseline case electricity will come from the grid as well as from the in-house CHP. In the project case since Blast Furnace Gas will no longer be needed in the Blooming Mill, the project developer plans to use more Blast Furnace Gas to generate electricity in an existing combined heat and power plant. The project developer will calculate the amount of saved Blast Furnace Gas for its further use in electricity generation. This situation will be dealt with by calculating the emissions factor for grid electricity and electricity generated by the CHP using Blast Furnace Gas and natural gas added to boost gas mix calorific value in both project and baseline cases. If saved Blast Furnace gas is used to replace fossil fuels in other processes, this will be captured by the Monitoring Plan.

Data Quality Management

Quality assurance for data collection process is a part of Plant's routine activity whose compliance is regularly audited as specified in Section D above.

Nevertheless, given the complexity of the basic data requirements for the project, the project developer will take the following steps to ensure data quality:

- Each new meter installed will be calibrated according to manufacturer's specifications and frequency, national requirements, and the corporate standard STP 230-35-07, *Metrological Support of Measuring Equipment*.
- All new meters will be installed and calibrated before flows requiring monitoring commence.
- All existing meters that are used in new functions or are subject to some physical disruption in their use due to construction will be recalibrated according to STP 230-35-07, *Metrological Support of Measuring Equipment* and manufacturer's specifications before measuring any flow.

The monitoring procedures and responsibilities at DIISW are regulated by STP 230-35-07 *Metrological Support of Measuring Equipment* and national standards, including:

1) *Metrological Product Quality Assurance* (RMI-I-19.0.1-07)
2) *Metrological Due Diligence of Documentation* (RMI-I-19.0.2-07) and STP 11.02-00 *Organisation and Performance of Metrological Due Diligence of Standards and Technical Documentation*
3) *Management of Metering Devices* (RMI-I-19.1.1-07)

The procedures for calibration of all monitoring equipment are described in RMI-I.19.0.1-07 and RMI-I.19.1.1-07.

Control of metering process and requirements to metrological support of metering equipment is assured as provided in DSTU 3921.1-1999 (ISO 10012-1:1992) *Requirements to Quality Assurance of Metering Equipment* and DSTU 3921.2- 2000 (ISO 10012-2:1997) *Quality Assurance by Means of Metering Equipment*.

These instructions have been developed in accordance with ISO 9001:2001 requirements. They secure accuracy of all the measurements done using monitoring equipment. The Chief Metrological Specialist (Head of Unit for control and automatics (UCA)) is in charge for maintenance of the monitoring equipment and installations as well as for their accuracy required by paragraphs 2.1.1, 3.1.1, 7.1 of the Regulation PP 229-Э-056-863/02-2005 *On Metrological Services of the Iron Works*, STP 230-35-07 *Metrological Support of Measuring Equipment*, *Guideline on Plant Metrology Department*, and I.19.0.1-07. In case of defect discovered in the monitoring equipment the actions of the personnel are determined by STP 230-35-07 *Metrological Support of Measuring Equipment*, *Guideline on Plant Metrology Department*, and I.19.0.1-07 (p.5.4.4)

The measurement of the parameters included into the monitoring plan of the project is envisaged by the provisions of the STP 230-35-07 *Metrological Support of Measuring Equipment*, *Guideline on Plant Metrology Department*, and I.19.0.1-07 (paragraph 5.3.2).

The measurements are conducted on continuous basis and automatically according to the STP 230-35-07 *Metrological Support of Measuring Equipment* and I-19.1.1-07 (p. 5.4).

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

The results of the measurements are being used by relevant services and technical personnel of the iron works. They will be reflected in the technological instructions for the regimes of conducting the technological processes and in the document I.19.1.1-07.

Best available techniques are used in order to minimize uncertainties. Uncertainties are generally low (with the exception of the use of limestone in furnace process in baseline case) - typically below 2% for all parameters that are or will be monitored. All the equipment used for monitoring purposes is in line with national legislative requirements and standards and also with ISO 9001:2001 standards. Details are given in STP 230-35-07 *Metrological Support of Measuring Equipment*. The data will be cross checked as well as internal audits and corrective actions are taken as defined in STP 230-18-03 *Quality Management System Internal Audits*. For the project case, similar procedures will be followed based on forthcoming Order of Director General of the Plant defining the exact JI monitoring procedures. Responsibilities for JI monitoring are indicated in table 7.

No major emergencies are expected having major influence on ERs. Should there be unusual events related to emissions, these can be captured at monitoring and verification stage.

Monitoring device table is included in Monitoring Database and schematic is provided in figure 5 and 6. Detailed device listing for Converters and Continuous Casting will be available by initial verification. Monitoring Database will be available for monitoring purposes.

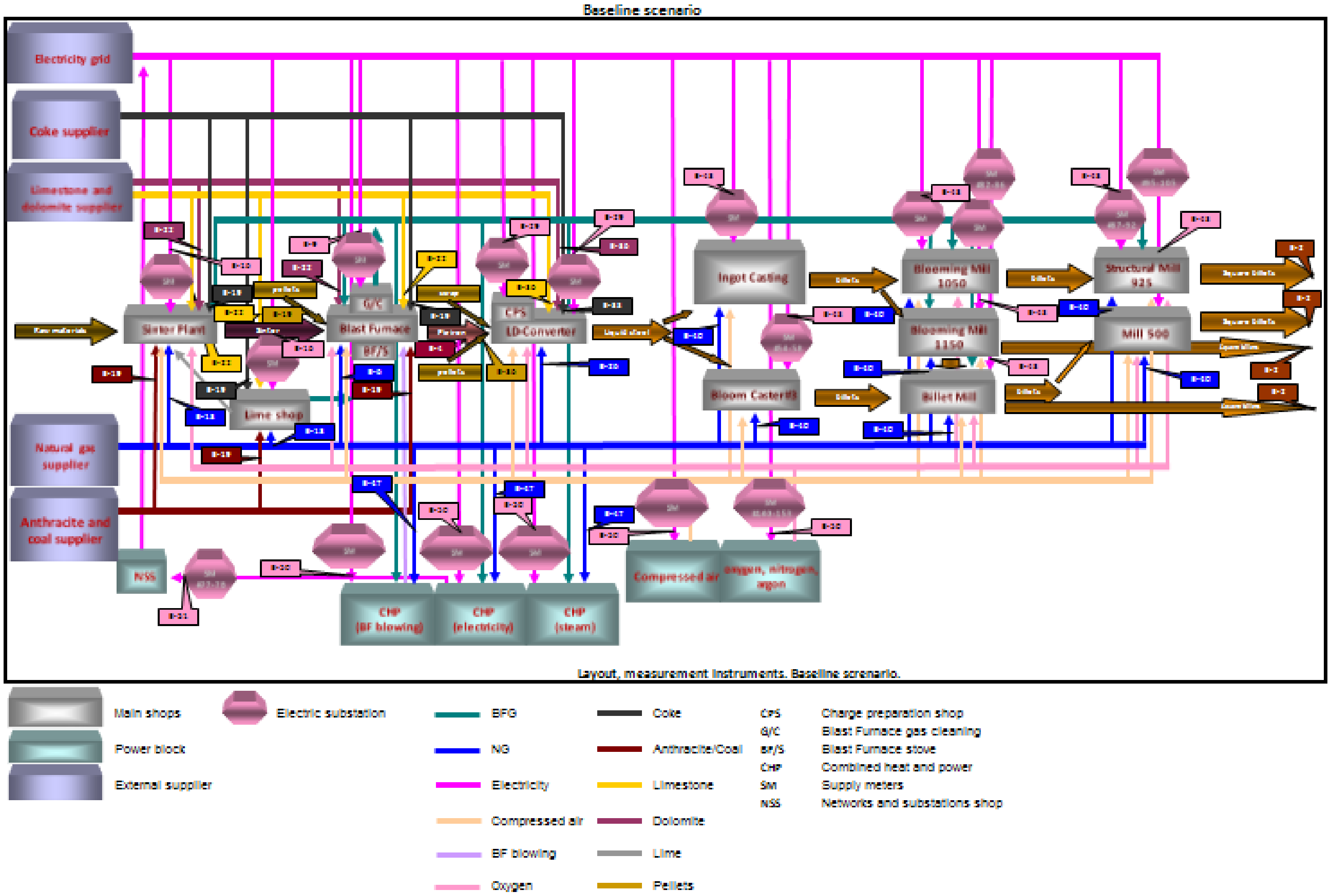

Fig. 5 Baseline monitoring outline for GHG emissions

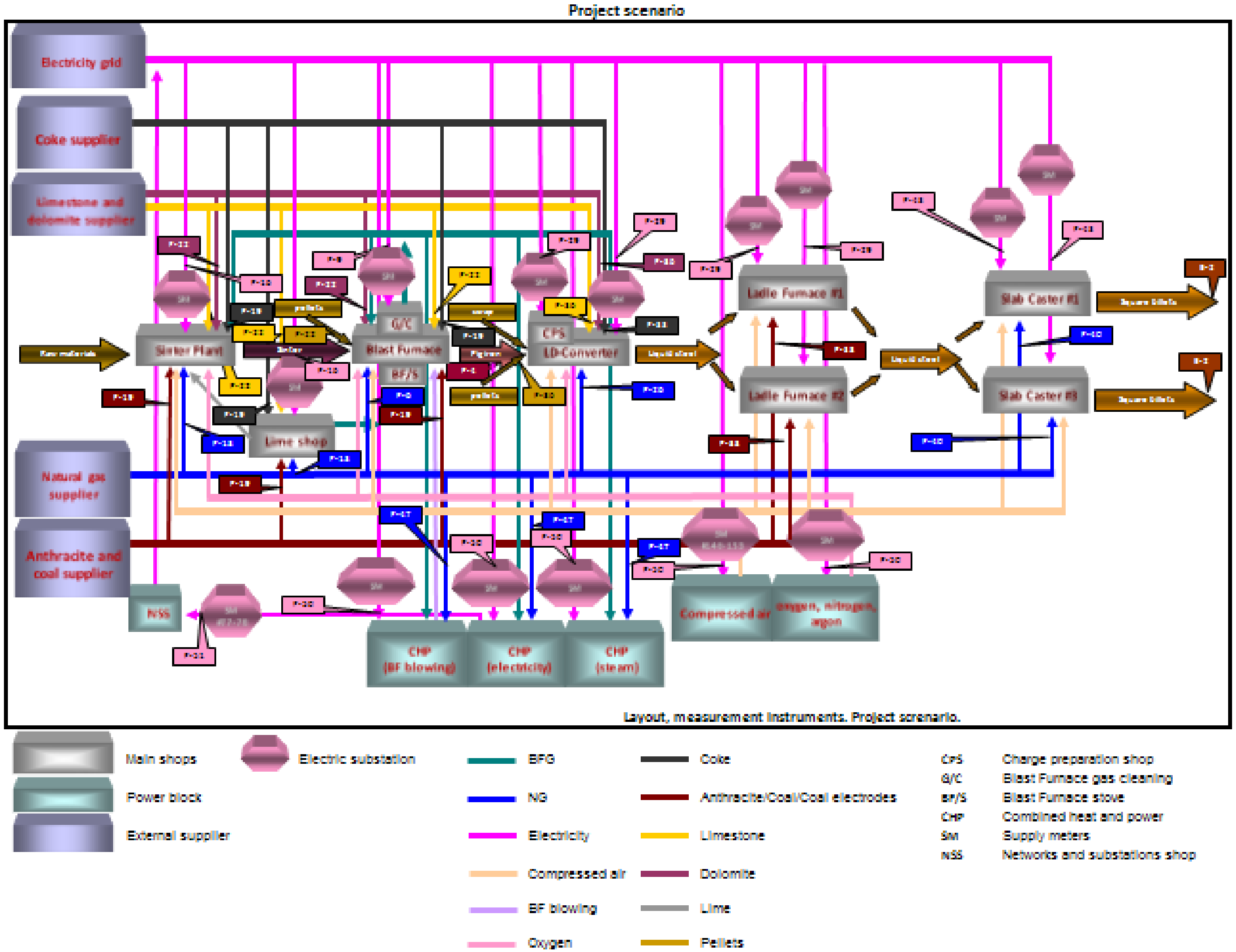

Fig. 6 Project monitoring outline for GHG emissions

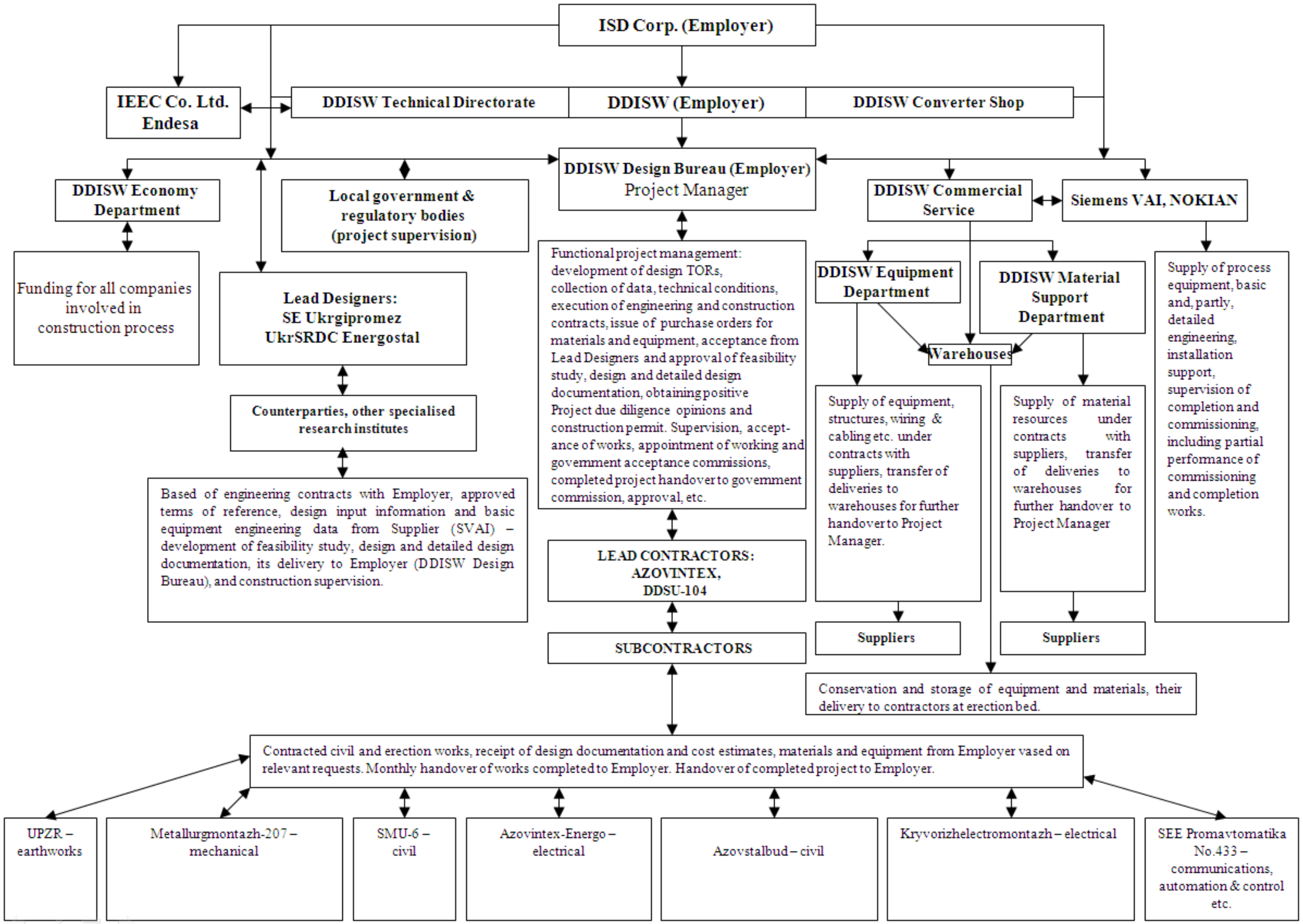

Fig. 7 Organization chart of DIISW JI Project management

Table 14. Outline for monitoring methods for the project scenario

Pig Iron		
P-4	Volume of pig iron consumption, Tonnes	scales
P-6, 13	Fuel consumption for pig iron production, (1000 m^3)	flow meter
P-9, 16	Electricity consumption for pig iron production, MWh	supply meter
P-19, P-22	Materials consumption for pig iron production, Tonnes	scales
Furnace process		
P-26	Fuel consumption for steel production, (1000 m^3)	flow meter
P-29	Electricity consumption for steel production, MWh	supply meter
P-33, P-36	Materials consumption for steel production, Tonnes	scales
Casting		
P-2	Volume of square billets output, Tonnes	scales
P-40	Fuel consumption for square billets production, (1000 m^3)	flow meter
P-43	Electricity consumption for steel production, MWh	supply meter
Balance of process needs		
P-47	Fuel consumption for balance of process needs, (1000 m^3)	flow meter
P-50	Electricity consumption for balance of process needs, MWh	supply meter
P-51	Self-generated electricity used in the project activity, MWh	supply meter

All devices used will be in line with applicable Ukrainian standards and requirements of STP 230-35-07 *Metrological Support of Measuring Equipment*.

Tables 15 and 16 provide detailed estimations of project and baseline emissions.

Table 15. Detailed Project emissions estimations

ID number	Data variable	Unit	2008	2009	2010	2011	2012
P-1	Total CO_2 in the project scenario (PE)	Tonne CO_{2e}	**504 784**	**3 268 745**	**4 426 904**	**8 868 912**	**8 868 912**
P-2	Total steel output in the project scenario (TSO_p)	Tonne	179 940	1 192 995	1 162 378	3 400 000	3 400 000
P-3	Total embodied CO_{2e} of Pig Iron entering into the project ($TCPI_{p,i}$)	Tonne CO_{2e}	**469 004**	**3 088 330**	**4 149 573**	**8 245 407**	**8 245 407**
P-4	Total Pig Iron Input into Steel Making Process ($TPII_p$)	Tonne	182 234	1 163 920	1 554 035	3 021 397	3 021 397
P-5	Total CO_{2e} from fuel consumption in producing Pig Iron ($TCFCPI_{p,i}$)	Tonne CO_{2e}	**26 218**	**161 304**	**215 369**	**418 727**	**418 727**
P-6	Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,p}$)	1000 m^3					
	Natural gas (NG)	1000 m^3	13 850	85 211	113 771	221 196	221 196
P-7	Emission factor for each fuel $EF_{f,p}$	Tonne $CO_{2e}/1000m^3$					
	Natural gas (NG)	Tonne $CO_{2e}/1000m^3$	1,89301	1,89301	1,89301	1,89301	1,89301
P-8	Total CO_{2e} from electricity consumption in producing Pig Iron ($TCEPI_{p,i}$)	Tonne CO_{2e}	**14 859**	**94 722**	**126 121**	**244 537**	**244 537**
P-9	Electricity Consumed in producing Pig Iron ($ECPI_p$)	MWh	13 733	86 425	115 390	224 346	224 346
P-10	Emissions factor for electricity ($EF_{e,p}$)	Tonne CO_{2e}/MWh	1,082	1,096	1,093	1,090	1,090
P-11	Total CO_{2e} from Inputs into Pig Iron ($TCIPI_{p,i}$)	Tonne CO_{2e}	**427 927**	**2 832 303**	**3 808 082**	**7 582 143**	**7 582 143**
P-12	Total CO_{2e} from fuel used to prepare iron ore ($TCFIO_{p,i}$)	Tonne CO_{2e}	**2 094**	**10 935**	**15 219**	**33 741**	**33 741**
P-13	Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,p}$)	1000 m^3					
	Natural gas (NG)	1000 m^3	1 106	5 777	8 040	17 824	17 824
P-14	Emission factor for each fuel $EF_{f,p}$	Tonne $CO_{2e}/1000m^3$					
	Natural gas (NG)	Tonne $CO_{2e}/1000m^3$	1,89301	1,89301	1,89301	1,89301	1,89301
P-15	Total CO_{2e} from electricity consumption in preparing iron ore ($TCEIO_{p,i}$)	Tonne CO_{2e}	**5 793**	**55 516**	**77 054**	**170 364**	**170 364**
P-16	Electricity Consumed in Sintering ($ECIO_p$)	MWh	5 354	50 653	70 498	156 297	156 297
P-17	Emissions factor for electricity ($EF_{e,p}$)	Tonne CO_{2e}/MWh	1,082	1,096	1,093	1,090	1,090
P-18	Total CO_{2e} from Reducing Agents in Pig Iron Production ($TCRAPI_p$)	Tonne CO_{2e}	**399 294**	**2 662 050**	**3 571 922**	**7 062 791**	**7 062 791**
P-19	Quantity of each reducing agent ($rapi_p$) in Pig Iron Production ($Q_{rapi,p}$)	Tonne					
	Reducing agent (coke)	Tonne	104 206	705 814	945 981	1 863 316	1 863 316
	Reducing agent (anthracite)	Tonne	6 832	30 065	41 844	92 769	92 769
P-20	Emission factor of each reducing agent, $EF_{ra,p}$	Tonne CO_{2e}/Tonne					
	Default emission factor	Tonne CO_{2e}/Tonne	3,66	3,66	3,66	3,66	3,66
	Default emission factor	Tonne CO_{2e}/Tonne	2,62	2,62	2,62	2,62	2,62
P-21	Total CO_{2e} from other inputs ($TCOIPI_p$)	Tonne CO_{2e}	**20 746**	**103 803**	**143 887**	**315 246**	**315 246**
P-22	Quantity of each other input ($oipi_p$) in Pig Iron Production ($Q_{oipi,p}$)	Tonne					
	Limestone	Tonne	34 998	191 992	267 040	590 939	590 939

	Dolomite	**Tonne**	8 998	21 680	30 172	66 894	66 894
	Pellets	**Tonne**	35 171	299 511	399 900	777 496	777 496
P-23	**Emission factor of each other input, $EF_{oi,p}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,44	0,44	0,44	0,44	0,44
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,477	0,477	0,477	0,477	0,477
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,03	0,03	0,03	0,03	0,03
P-24	**The total CO_{2e} emissions from the furnace process ($TCFP_{p,i}$)**	**Tonne CO_{2e}**	**20 546**	**102 102**	**179 515**	**420 459**	**420 459**
P-25	**Total CO_{2e} from fuel consumption in Furnace Process ($TCFCFP_{p,i}$)**	**Tonne CO_{2e}**	**1 482**	**7 607**	**10 321**	**20 210**	**20 210**
P-26	**Quantity of each fuel (ffp_p) used in furnace process ($Q_{ffp,p}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	783	4 018	5 452	10 676	10 676
P-27	**Emission factor for each fuel $EF_{f,p}$**	**Tonne CO_{2e}/1000m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000m^3**	1,89301	1,89301	1,89301	1,89301	1,89301
P-28	**Total CO_{2e} from electricity consumption in Furnace Process ($TCECFP_{p,i}$)**	**Tonne CO_{2e}**	**16 295**	**94 392**	**168 028**	**396 058**	**396 058**
P-29	**Electricity consumed in the furnace process ($ECFP_p$)**	**MWh**	15 060	86 124	153 731	363 356	363 356
P-30	**Emissions factor for electricity ($EF_{e,p}$)**	**Tonne CO_{2e}/MWh**	1,082	1,096	1,093	1,090	1,090
P-31	**Total CO_{2e} from Inputs into Furnace Process measured ($TCIFP_{p,i}$)**	**Tonne CO_{2e}**	**2 769**	**103**	**1 166**	**4 191**	**4 191**
P-32	**Total CO_{2e} from Reducing Agents in the furnace process ($TCRAFP_p$)**	**Tonne CO_{2e}**	**2 760**	**0**	**1 026**	**3 917**	**3 917**
P-33	**Quantity of each reducing agent ($rafp_p$) in the furnace process ($Q_{rafp,p}$)**	**Tonne**					
	Reducing agent (coke)	**Tonne**	754	0	0	0	0
	Reducing agent (coal electrodes)	**Tonne**	0	0	285	1 088	1 088
P-34	**Emission factor of each reducing agent, $EF_{ra,p}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	3,66	3,66	3,66	3,66	3,66
	Default emission factor	**Tonne CO_{2e}/Tonne**	3,6	3,6	3,6	3,6	3,6
P-35	**Total CO_{2e} from other inputs in the furnace process ($TCOIFP_p$)**	**Tonne CO_{2e}**	**10**	**103**	**140**	**274**	**274**
P-36	**Quantity of each other input ($oifp_p$) in the furnace process ($Q_{oifp,p}$)**	**Tonne**					
	Pellets	**Tonne**	325	3 442	4 670	9 144	9 144
P-37	**Emission factor of each other input, $EF_{oi,p}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,03	0,03	0,03	0,03	0,03
P-38	**The total tonnes CO_{2e} from the square billet casting ($TCCR_{p,i}$)**	**Tonne CO_{2e}**	**3 100**	**16 403**	**15 630**	**43 376**	**43 376**
P-39	**Total CO_{2e} from fuel consumption in square billet casting ($TCFCR_{p,i}$)**	**Tonne CO_{2e}**	**635**	**2 326**	**2 221**	**6 179**	**6 179**
P-40	**Quantity of each fuel (fcr_p) used in casting ($Q_{fcr,p}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	335	1 229	1 173	3 264	3 264
P-41	**Emission factor for each fuel $EF_{f,p}$**	**Tonne CO_{2e}/1000m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000m^3**	1,89301	1,89301	1,89301	1,89301	1,89301

P-42	Total CO_{2e} from electricity consumption in square billet casting ($TCECR_{p,i}$)	Tonne CO_{2e}	**2 466**	**14 077**	**13 409**	**37 197**	**37 197**
P-43	Electricity Consumed in casting ($ECCR_p$)	MWh	2 279	12 844	12 268	34 126	34 126
P-44	Emissions factor for electricity ($EF_{e,p}$)	Tonne CO_{2e}/MWh	1,082	1,096	1,093	1,090	1,090
P-45	Total tones of CO_2 related to the balance of process need of energy required for the project activity ($TCBPN_{p,i}$)	Tonne CO_{2e}	**12 134**	**61 911**	**82 186**	**159 670**	**159 670**
P-46	Total CO_{2e} from fuel consumption for balance of process needs of project activity ($TCFCBPN_{p,i}$)	Tonne CO_{2e}	**8 981**	**41 039**	**54 773**	**106 492**	**106 492**
P-47	Quantity of each fuel ($fbpn_p$) used for balance of process needs ($Q_{fbpn,p}$)	1000 m^3					
	Natural gas (NG)	1000 m^3	4 744	21 679	28 935	56 255	56 255
P-48	Emission factor for each fuel $EF_{f,p}$	Tonne CO_{2e}/1000m^3					
	Natural gas (NG)	Tonne CO_{2e}/1000m^3	1,89301	1,89301	1,89301	1,89301	1,89301
P-49	Total CO_{2e} from electricity consumption for balance of process needs of project activity ($TCEBPN_{p,i}$)	Tonne CO_{2e}	**3 153**	**20 872**	**27 412**	**53 178**	**53 178**
P-50	Electricity Consumed for balance of process needs ($ECBPN_p$)	MWh	2 914	19 044	25 080	48 787	48 787
P-51	Self-generated electricity used in the project activity ($ECSG_p$)	MWh	0	0	0	0	0
P-52	Emissions factor for electricity ($EF_{e,p}$)	Tonne CO_{2e}/MWh	1,082	1,096	1,093	1,090	1,090

Table 16. Detailed Baseline emissions estimations

ID number	Data variable	Unit	2008	2009	2010	2011	2012
B-1	Total CO_{2e} in the baseline scenario (BE)	Tonne CO_{2e}	**644 371**	**4 093 271**	**5 140 191**	**10 648 711**	**10 648 711**
B-2	Total Steel Output (TSO_b) (Baseline)	Tonne	179 940	1 192 995	1 162 378	3 400 000	3 400 000
B-3	Total CO_{2e} due to the production of Pig Iron ($TCPI_{b,i}$)	Tonne CO_{2e}	**552 451**	**3 630 360**	**4 628 638**	**9 561 730**	**9 561 730**
B-4	Total Pig Iron Input into Steel Making Process ($TPII_b$)	Tonne	214 665	1 368 196	1 733 448	3 503 743	3 503 743
B-5	Total CO_{2e} from fuel consumption in producing Pig Iron ($TCFCPI_{b,i}$)	Tonne CO_{2e}	**30 884**	**189 615**	**240 234**	**485 574**	**485 574**
B-6	Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi,b}$)	1000 m^3					
	Natural gas (NG)	1000 m^3	16 315	100 166	126 906	256 509	256 509
B-7	Emission factor for each fuel $EF_{f,b}$	Tonne CO_{2e}/1000 m^3					
	Natural gas (NG)	Tonne CO_{2e}/1000 m^3	1,89301	1,89301	1,89301	1,89301	1,89301
B-8	Total CO_{2e} from electricity consumption in producing Pig Iron ($TCEPI_{b,i}$)	Tonne CO_{2e}	**17 488**	**111 345**	**140 684**	**283 577**	**283 577**
B-9	Electricity Consumed in producing Pig Iron ($ECPI_b$)	MWh	16 163	101 592	128 714	260 162	260 162
B-10	Emissions factor for electricity ($EF_{e,b}$)	Tonne CO_{2e}/MWh	1,082	1,096	1,093	1,090	1,090
B-11	Total CO_{2e} from Inputs into Pig Iron ($TCIPI_{b,i}$)	Tonne CO_{2e}	**504 079**	**3 329 400**	**4 247 720**	**8 792 580**	**8 792 580**
B-12	Total CO_{2e} from fuel used to prepare iron ore ($TCFIO_{b,i}$)	Tonne CO_{2e}	**2 466**	**12 854**	**16 976**	**39 128**	**39 128**
B-13	Quantity of each fuel (fio_b) used in Sintering ($Q_{fio,b}$)	1000 m^3					
	Natural gas (NG)	1000 m^3	1 303	6 790	8 968	20 670	20 670

B-14	**Emission factor for each fuel $EF_{f,b}$**	**Tonne CO_{2e}/1000 m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000 m^3**	1,89301	1,89301	1,89301	1,89301	1,89301
B-15	**Total CO_{2e} from electricity consumption in preparing iron ore ($TCEIO_{b,i}$)**	**Tonne CO_{2e}**	**6 823**	**65 260**	**85 950**	**197 560**	**197 560**
B-16	**Electricity Consumed in Sintering ($ECIO_b$)**	**MWh**	6 306	59 544	78 637	181 248	181 248
B-17	**Emissions factor for electricity ($EF_{e,b}$)**	**Tonne CO_{2e}/MWh**	1,082	1,096	1,093	1,090	1,090
B-18	**Total CO_{2e} from Reducing Agents in Pig Iron Production ($TCRAPI_b$)**	**Tonne CO_{2e}**	**470 351**	**3 129 265**	**3 984 295**	**8 190 318**	**8 190 318**
B-19	**Quantity of each reducing agent ($rapi_b$) in Pig Iron Production ($Q_{rapi,b}$)**	**Tonne**					
	Reducing agent (coke)	**Tonne**	122 750	829 691	1 055 193	2 160 781	2 160 781
	Reducing agent (anthracite)	**Tonne**	8 048	35 342	46 675	107 580	107 580
B-20	**Emission factor of each reducing agent, $EF_{ra,b}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	3,66	3,66	3,66	3,66	3,66
	Default emission factor	**Tonne CO_{2e}/Tonne**	2,62	2,62	2,62	2,62	2,62
B-21	**Total CO_{2e} from other inputs ($TCOIPI_b$)**	**Tonne CO_{2e}**	**24 439**	**122 021**	**160 499**	**365 574**	**365 574**
B-22	**Quantity of each other input ($oipi_b$) in Pig Iron Production ($Q_{oipi,b}$)**	**Tonne**					
	Limestone	**Tonne**	41 227	225 688	297 870	685 279	685 279
	Dolomite	**Tonne**	10 600	25 484	33 656	77 573	77 573
	Pellets	**Tonne**	41 430	352 078	446 068	901 618	901 618
B-23	**Emission factor of each other input, $EF_{oi,b}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,44	0,44	0,44	0,44	0,44
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,477	0,477	0,477	0,477	0,477
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,03	0,03	0,03	0,03	0,03
B-24	**The total CO_{2e} emissions from the furnace process ($TCFP_{b,i}$)**	**Tonne CO_{2e}**	**24 200**	**120 020**	**147 893**	**298 172**	**298 172**
B-25	**Total CO_{2e} from fuel consumption in Furnace Process ($TCFCFP_{b,i}$)**	**Tonne CO_{2e}**	**1 745**	**8 942**	**11 407**	**23 056**	**23 056**
B-26	**Quantity of each fuel (ffp_b) used in furnace process ($Q_{ffp,b}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	922	4 723	6 026	12 180	12 180
B-27	**Emission factor for each fuel $EF_{f,b}$**	**Tonne CO_{2e}/1000 m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000 m^3**	1,89301	1,89301	1,89301	1,89301	1,89301
B-28	**Total CO_{2e} from electricity consumption in Furnace Process ($TCECFP_{b,i}$)**	**Tonne CO_{2e}**	**19 197**	**110 957**	**136 331**	**274 803**	**274 803**
B-29	**Electricity consumed in the furnace process ($ECFP_b$)**	**MWh**	17 742	101 238	124 731	252 113	252 113
B-30	**Emissions factor for electricity ($EF_{e,b}$)**	**Tonne CO_{2e}/MWh**	1,082	1,096	1,093	1,090	1,090
B-31	**Total CO_{2e} from Inputs into Furnace Process measured ($TCIFP_{b,i}$)**	**Tonne CO_{2e}**	**3 258**	**121**	**155**	**313**	**313**
B-32	**Total CO_{2e} from Reducing Agents in the furnace process ($TCRAFP_b$)**	**Tonne CO_{2e}**	**3 246**	**0**	**0**	**0**	**0**
B-33	**Quantity of each reducing agent ($rafp_b$) in the furnace process ($Q_{rafp,b}$)**	**Tonne**					
	Reducing agent (coke)	**Tonne**	887	0	0	0	0

	Reducing agent (coal electrodes)	**Tonne**	0	0	0	0	0
B-34	**Emission factor of each reducing agent, $EF_{ra,b}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	3,66	3,66	3,66	3,66	3,66
	Default emission factor	**Tonne CO_{2e}/Tonne**	3,6	3,6	3,6	3,6	3,6
B-35	**Total CO_{2e} from other inputs in the furnace process ($TCOIFP_b$)**	**Tonne CO_{2e}**	**11**	**121**	**155**	**313**	**313**
B-36	**Quantity of each other input ($oifp_b$) in the furnace process ($Q_{oifp,b}$)**	**Tonne**					
	Pellets	**Tonne**	383	4 046	5 161	10 432	10 432
B-37	**Emission factor of each other input, $EF_{oi,b}$**	**Tonne CO_{2e}/Tonne**					
	Default emission factor	**Tonne CO_{2e}/Tonne**	0,03	0,03	0,03	0,03	0,03
B-38	**The total tonnes CO_{2e} from the square billet casting/rolling process ($TCCR_{b,i}$)**	**Tonne CO_{2e}**	**53 207**	**268 974**	**270 797**	**600 676**	**600 676**
B-39	**Total CO_{2e} from fuel consumption in square billet casting/rolling ($TCFCR_{b,i}$)**	**Tonne CO_{2e}**	**28 878**	**111 117**	**118 521**	**230 852**	**230 852**
B-40	**Quantity of each fuel (fcr_b) used in casting/rolling ($Q_{fcr,b}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	15 255	58 699	62 610	121 950	121 950
B-41	**Emission factor for each fuel $EF_{f,b}$**	**Tonne CO_{2e}/1000 m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000 m^3**	1,89301	1,89301	1,89301	1,89301	1,89301
B-42	**Total CO_{2e} from electricity consumption in square billet casting/rolling ($TCECR_{b,i}$)**	**Tonne CO_{2e}**	**24 329**	**157 857**	**152 276**	**369 824**	**369 824**
B-43	**Electricity Consumed in casting ($ECCR_b$)**	**MWh**	22 485	144 030	139 319	339 288	339 288
B-44	**Emissions factor for electricity ($EF_{e,b}$)**	**Tonne CO_{2e}/MWh**	1,082	1,096	1,093	1,090	1,090
B-45	**Total tones of CO_2 related to the balance of process need of energy required for the project activity ($TCBPN_{b,i}$)**	**Tonne CO_{2e}**	**14 513**	**73 918**	**92 863**	**188 133**	**188 133**
B-46	**Total CO_{2e} from fuel consumption for balance of process needs of project activity ($TCFCBPN_{b,i}$)**	**Tonne CO_{2e}**	**10 585**	**48 258**	**61 114**	**123 533**	**123 533**
B-47	**Quantity of each fuel ($fbpn_b$) used for balance of process needs ($Q_{fbpn,b}$)**	**1000 m^3**					
	Natural gas (NG)	**1000 m^3**	5 591	25 493	32 284	65 257	65 257
B-48	**Emission factor for each fuel $EF_{f,b}$**	**Tonne CO_{2e}/1000 m^3**					
	Natural gas (NG)	**Tonne CO_{2e}/1000 m^3**	1,89301	1,89301	1,89301	1,89301	1,89301
B-49	**Total CO_{2e} from electricity consumption for balance of process needs of project activity ($TCEBPN_{b,i}$)**	**Tonne CO_{2e}**	**3 929**	**25 660**	**31 748**	**64 600**	**64 600**
B-50	**Electricity Consumed for balance of process needs ($ECBPN_b$)**	**MWh**	3 631	23 412	29 047	59 266	59 266
B-51	**Self-generated electricity used in the project activity ($ECSG_b$)**	**MWh**	0	0	0	0	0
B-52	**Emissions factor for electricity ($EF_{e,b}$)**	**Tonne CO_{2e}/MWh**	1,082	1,096	1,093	1,090	1,090

Table 17. Abbreviations

DIISW	Public Joint Stock Company Dniprovsky Integrated Iron and Steel Works named after Dzerzhynsky
BFG	Blast Furnace gas
NG	Natural gas
N/A	Not applicable
ERU	Emission reduction unit
ER	Emission reductions
CCM	Continuous casting machine
CBC	Continuous bloom caster
LF	Ladle Furnace
CHP	Combined heat and power
IPCC	Intergovernmental Panel on Climate Change
EF	Emission factor
NCV	Net calorific value
IUD	Industrial Union of Donbas
CDM	Clean Development Mechanism
EIA	Environmental impact assessment
JI	Joint Implementation
RMI	Guiding Metrological Instructions
STP	Enterprise Standard
UCA	Unit for control and automatics