JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
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CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Revamping and Modernization of the Alchevsk Steel Mill

PDD version 4
30/03/2008

A.2. Description of the project:

Background

OJSC Alchevsk Iron and Steel Works (AISW) is currently the 5th largest integrated iron and steel plant in Ukraine. It is located in the city of Alchevsk in Lugansk Oblast, Eastern Ukraine. It is part of the Industrial Union of Donbass (IUD), an industrial group that is a major shareholder in a number of metallurgical enterprises in Ukraine as well as in Poland and Hungary.

While one of the more modern integrated steel works in Ukraine, AISW was fairly typical of the Ukrainian iron and steel sector up to 2004 in terms of the vintage of technologies. The current facilities are mainly built in the 1950s and 1960s with the exception of new Open Hearth Furnace (TSU 1,2) commissioned in 2005. The plant has high energy intensity. AISW has a Sinter Plant, Lime Kilns, four Blast Furnaces, four old Open Hearth Furnaces and one recent Tandem Open Hearth Furnace, Ingot Casting, Blooming Mill and several other mills.

IUD is implementing a US$1.5 billion capital investment program to modernize operations in its two Ukrainian plants including AISW over the period of 2004 - 2010 with financing of currently committed components in part being supplied by IFC through a US$100 million direct loan and participation in a syndicated loan facility in the amount of US$250 million. The rest of the financing is being sourced from commercial banks.

Beginning in 2004 and now coming on stream, modernization program at AISW has the integrated objectives of applying more efficient technology, improving environmental performance, increasing capacity and therefore competitiveness (reducing costs per tonne of steel produced). This modernization program is planned to involve technology replacement or upgrade of all major components of the iron and steel making and finishing processes.

The program's initial focus at AISW has been on steel production with the replacement of the old OHFs with two modern basic oxygen furnaces (Converters) integrated with continuous Slab Casters to replace the existing Blooming Mill utilizing Joint Implementation with the total investment costs of US$ 944 million as described in this PDD.

Planned but as yet uncommitted due to lack of financing and other impediments are other upstream investments including replacement of the existing sinter machines and upgrading of Blast Furnaces on a progressive basis. These activities could be subject to additional JI projects. The overall capacity of the plant expressed as steel production will be increased approximately from 3.6 Mt/a to 6.9 Mt/a.

When the discussions concerning modernization and capacity increases at AISW were initiated in order to increase competitiveness, the business-as-usual choice would have been to base the project on the existing technology as occurred during a similar upgrade commissioned in 2005 as a result of an investment decision made in 2002. OHF technology was available, well known at the company and had considerably lower initial investment costs than other more efficient technologies. OHF, Ingot Casting, and Blooming Mills might not be state of art in some parts in the world, but it is still prevalent in Ukraine, i.e. competitiveness could have been increased with traditional technology.

As documented in minutes of Meeting of the Technical Council of the Plant, 26th May, 2003, possibility to utilize Kyoto mechanisms provided the incentive to invest in more energy efficient technology. In the baseline scenario, the AISW would add new facilities using the recent OHF technology. The project, however, will replace the old OHF process by modern Linz-Donawitz Method (LD) Converters, as well as the substitution of the current Ingot Casting and Blooming Mill by a modern Slab Caster. Due to the improvement in technology, less fossil fuels and material inputs (pig iron) will be needed after implementation of the project compared to the baseline case and therefore carbon dioxide emissions are reduced.

Steel making process

Steel is a metal alloy whose major component is iron, with carbon content between 0.02% and 1.7% by weight. Carbon and other elements act as hardening agents. The first part of the process of producing steel is to combine the main ingredients of coal (coke), iron ore in the pelletized form of sinter and lime in Blast Furnaces to produce pig iron. Pig iron is the immediate product of smelting iron ore with coke and limestone in a blast furnace. It has a very high carbon content, typically 3.5%, which makes it very brittle and not useful directly as a material except for limited applications.

In the basic oxygen process proposed in this project, molten pig iron and some scrap steel are placed in a ladle, and 99% pure oxygen are blown onto the steel and iron, causing the temperature to rise to about 1700°C. This melts the scrap, lowers the carbon content of the molten iron and helps remove unwanted chemical elements. Fluxes (like lime) are fed into the vessel to form slag which absorbs impurities of the steelmaking process. Steel is further refined in the Ladle Furnace and cast into slabs in a Continuous Caster.

AISW has used a traditional steel making technology - Open Hearth Furnaces (OHF), Ingot Casting, and Blooming Mills to produce semi-finished products. The pig iron, limestone and iron ore go into an Open Hearth Furnace which has a wide, saucer-shaped hearth and a low roof. It is heated to about 1600 ˚F (871 ˚C). The limestone and ore forms a slag that floats on the surface. Impurities, including carbon, are oxidized and float out of the iron into the slag.

The following generic diagram provides a simplistic overview the basic steel making process to be employed in the project.

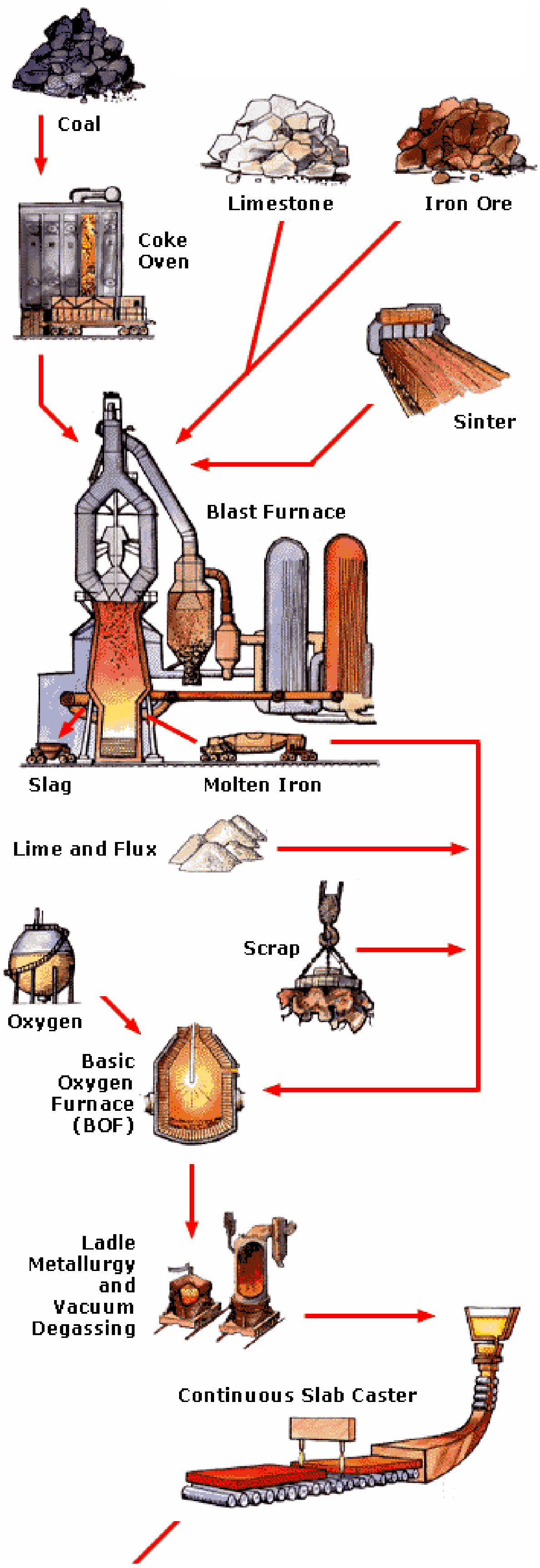

Figure 1. Overview the basic steel making (http://www.ltvsteel.com/htmfiles/diagram2.htm)

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host Party)	OJSC Alchevsk Iron and Steel Works (AISW)	No
Ukraine (Host Party)	Institute for Environment and Energy Conservation	No
The Netherlands	The International Bank for Reconstruction and Development (IBRD) acting as Trustee for the Netherlands European Carbon Facility	Yes

A.4. Technical description of the project:

A.4.1. Location of the project:

The project is located in the Town of Alchevsk in Ukraine. The project encompasses the steel-making furnace and the subsequent casting/blooming operations that produce steel slabs. The project also captures all the energy and material flows into these steel-making functions.

A.4.1.1. Host Party(ies):

Ukraine

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

Luhansk Oblast

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

Alchevsk

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

The city of Alchevsk is a rayon center and one of the biggest industrial centers of the Luhansk oblast and Donbas region. It is situated in the northwest of the Luhansk oblast, 45 kilometers from the city of Luhansk itself. The city of Alchevsk was founded in 1896. It has a territory of 50 square kilometers and a population of 118 000 people.

In the city, there are two major industrial production facilities representing the metallurgy industry of Ukraine – OJSC Alchevsk Iron and Steel Works and OJSC Alchevsk Coke. In addition, there are a number of plants producing construction materials and units, concrete products, and other industrial products. The volume of production in Alchevsk comprises over 25% of the industrial output of the entire Luhansk oblast. Among the main products produced by the two metallurgical giants are cast iron, steel, rolled metal, coke, and sulphuric acid. Also operating in the city are a bread-baking plant, a garment factory, as well as a variety of commercial outlets, schools and hospitals.

Figure 2. Location of proposed JI Project site, Alchevsk Iron & Steel Works.

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

The proposed JI project comprises following measures and commissioning years:

Table 1. Timeline for JI project.

	Title	2004	2005	2006	2007	2008	2009	2010
1	Construction of Slab Caster Shop and installation of Slab Caster 1							
2	Installation of Slab Caster 2 and Vacuumator							
3	Construction of Oxygen-Converter Shop, installation of LD Converter 1 with first furnace "Polisium"							
4	Installation of LD Converter 2 with second furnace "Polisium"							
5	Reconstruction of Oxygen Plant #4							
6	Installation of Oxygen Plant KAAP-60 #7							
7	Installation of Oxygen Plant KAAP-60 #8							

The decision to install 2-strand Slab Casters was made on December 18th 2003. The main purpose of the installation of the ladle furnace and the Slab Casters was to replace the Ingot Casting line in the OHF shop. Continuously casted slabs will cover a wide range of carbon grades for sheets and coils. The sheets will be rolled in AISW's own plate mill and slabs for coils will be sold worldwide. These outputs would have been the same in the baseline case as the new OHF technology package would have provided the same amount of steel.

The erection of the first Slab Caster started in March 2005 and start-up took place on August 24, 2005. The 2-Strand Slab Casters will have a capacity around 5 Mt/a. Casters are equipped with automation systems which allow the producer to have better control over the slab-making process.

Currently Ingot Casting and Slab Casting at AISW are used to shape the molten steel of the OHF. In the upper part of the ingots are conglomerations of cavities. Therefore around 21% of ingots have to be cut off at the exit of the Blooming Mill and put back to the OHFs. The remainder part can be used in Rolling Mills for the production of Slabs, blooms or billets. In Slab Casters only 3% of slab has to be cut off and put back to the OHF or Converter. In addition, around 1% of material flow is lost at Ladle Furnace and an additional 0.5% is lost when material goes from the OHF to Blooming Mill. So the difference between OHF-Blooming Mill line and new LD Converter-Slab Caster line in terms of material losses is around 17.5% leading to material savings and reduced emissions.

Industrial Union of Donbass, the majority owner of the steel works, signed a contract with VAI, VOEST-ALPINE Industrieanlagenbau (now part of Siemens) in May 2005 to install 2x300t LD Converters. According to the contract, the first Converter will be put into operation in 2007 and the second in 2008. The Converter Plant capacity will reach 5.4 Mt/liquid steel. The Converter Plant will include Desulphurization Plant, Converter Off-gas Cooling and Cleaning Facility, Secondary De-dusting System and Automation System. Old open–hearth furnaces (#1, 2, 5 and 6) will be shut down. Recent TSU-1,2 open –hearth furnaces will continue to operate.

Along with LD Converters two new facilities will be built. Ladle Furnace (LF) will assure quality and/or productivity improvements in steelmaking process. The LF is put between the melting and casting areas of the steel Plant. It has a compact design which guarantees minimum space requirement and therefore can be easily installed at the Plant. The twin LF be installed at AISW will be equipped with twin ladle turrets and swing type gantry with two roofs. The installation of LF will reduce melting unit refining time and tapping temperature and refractory consumption; assure steel homogenization, improvements in productivity and casting performance.

Vacuum Tank Degassing Plant (VD Plant or Vacuumator) improves the quality of steel. A teeming ladle is placed in a vacuum tank, which is connected to a vacuum pump system. The ladle is equipped with porous plugs through which inert gas is injected into the melt to promote stirring. Thus during vacuum treatment the carbon, oxygen, nitrogen, hydrogen, and sulfur contents are reduced depending on melt composition. In addition, two Oxygen plants will be built and one reconstructed. Detailed technical information is available online.[1] See also Annex 3 for detailed information on production, energy and material consumption.

OHFs usually require approximately 70-75% of pig iron and 30-25% of scrap per tonne of liquid steel. This ratio is different for the LD Converter which typically uses 80% pig iron and 20% of scrap. This is calculated as percentage of the total input of pig iron and scrap into the steel making process. In practice these proportions can slightly fluctuate with regard to available material resources at the plant and will depend on market conditions. The share of pig iron is expected to reach 75% in the baseline. Currently OHFs use 72% of pig iron.

Approach is conservative since scrap is counted as a zero emission input which will reduce the baseline emissions per tonne of steel more than the project emissions.

In order to reach the planned output plans for slabs, AISW is planning to reconstruct all the existing Blast Furnaces (#1,3,4,5) and build a new one (#6).

Austrian company VAI is a supplier of technical equipment for Slab Casters-1, 2, Ladle Furnace, Vacuumator and LD Converters-1, 2. CJC “Azovstalstroj” is a General Contractor for the project consisting of construction LD Converters and Slab Casters along with secondary metallurgy (Vacuumator, Ladle Furnace etc).

Other following companies are also involved as contractors under coordination of General Contractor:

- “Donbasmontazhspetsstroy” is responsible for installation of the process equipment for Slab Casters;
- CJSC “Donbaspromelectromontazh” is responsible for installation of electric equipment for Slab Casters;
- OJSC “Ukrstal’konstruktsiya” is a supplier of fabricated metals for Slab Casters;
- Azovintex” Ltd is responsible for installation the main parts of fabricated metals and process equipment for LD Converters;
- CJSC “Donbaspromelectromontazh” is responsible for installation of an electric equipment for LD-Converters;
- “Ecorembud” Ltd, CJC “Krivorozhskaja construction company”, OJSC “Ukrstaljmontazhdnepr” are responsible for installation of fabricated metals and other elements of a complex for LD Converters.
- The installation of fabricated metals for Slab Caster -1 has been performed by Trust “Krivorozhstal’konstruktsiya”, the installation of fabricated metals for Slab Caster -2 will be done by “Ecorembud” Ltd.

[1] http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/LDBOF-SteelmakingSolutions_en.pdf
http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/Secondary_Metallurgy_Solutions_en.pdf
http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/Continuous_Slab_Casting_Solutions_en.pdf

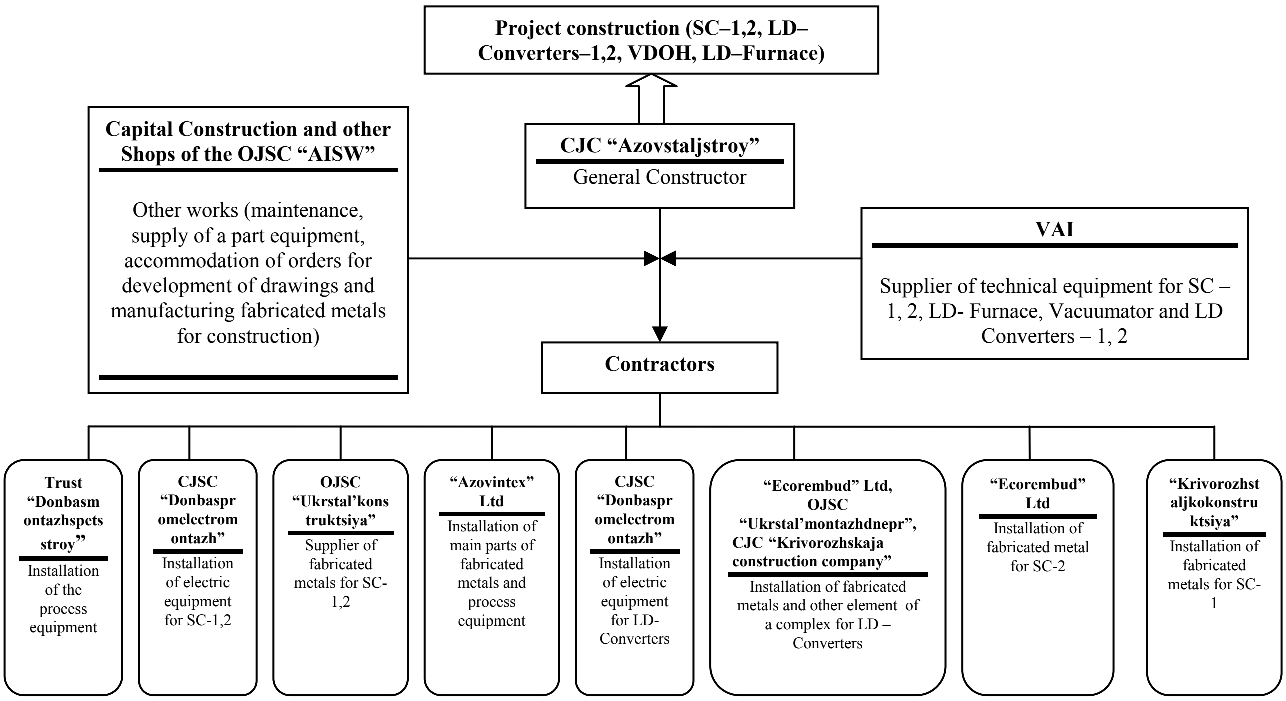

Figure 3. Project construction management and responsibilities.

Other necessary works such as maintenance, supply of a part of equipment, accommodation of orders for development of drawings and manufacturing fabricated metals for construction have been fulfilled by the Capital Construction Shop of AISW. Such necessary infrastructure as railway and road access, logistical shops, concrete plant etc have been developed and constructed by the AISW.

The project requires development of proper management capacity and experience in working with new equipment. Training is provided for technical specialists and managers of the AISW on continuous basis, and technical experts of VAI presented in Alchevsk continuously supervise the project and train the staff. To ensure prompt implementation a special project Staff has been hired and it reports directly to Director-General of the AISW. The project Staff is responsible for full operation and communication of the project related issues. The staff also has internships at partner steel plants. More detailed training program is available. Deputy Director of the Plant is responsible for training of personnel.

Maintenance of the project will be carried based on national requirements, AISW's internal requirements and supported by technical expertise from 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:

When the decision to replace the old OHFs and Blooming Mill and increase the production capacity was taken, no technology change was necessary. The upgrade could have been based using the OHF technology. This is because the existing technology was readily available, created fewer problems with training staff, and has considerably lower investment costs than the proposed project. In addition, a similar management decision was taken two years before this project to replace an existing old OHF and Ingot Casting/Blooming Mill with a new OHF and Ingot Casting/Blooming Mill.

Currently in Ukraine there are neither regulations and nor laws which require the adoption or use more efficient technologies for the proposed project. However in the Energy Strategy of Ukraine, 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.

The project faced therefore several barriers as discussed in detail in Section B. In 2003-2004, OHFs are widespread in Ukraine and building new OHFs instead of modern converters would have been the business-as-usual choice of AISW. The project faced e.g. strong investment barriers in terms of limited access to the external financial resources both from domestic and international capital markets and financial institutions. This was due to underdeveloped domestic financial market, low credit rating of Ukrainian economy as well as low credit profile of IUD and AISW. The project activity encompasses the first of its kind implementation of the modern Converter technology in Ukraine. Thus the project faced technical barriers.

The possibility of using the Kyoto mechanisms gave incentives (as documented in minutes of Meeting of the Technical Council of the Plant, 26th May, 2003) for investing into energy efficiency because it provides Alchevsk Iron and Steel Works with an opportunity to receive additional financial resources, reduce the risks inherent with adopting a new technology, and to reduce the cost of debt service.

Project generates emission reductions in the following ways:

- From a decrease in the direct energy required to create the same tonne of steel end product. The use of fossil fuels (mainly natural gas) is also reduced due to more efficient technology.
- The emission reductions derived from using less material input to create the same tonne of steel end product. The pig iron consumption is reduced in Converter and Casting processes which are more efficient than baseline OHF technology. This reduction is obtained even though the share of pig iron usage will slightly increase in the project case.

In addition, the project design allows more efficient use of zero emission blast furnace gas for on-site electricity generation which partially displaces the electricity consumption form the grid.

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

Length of the crediting period	5 Years
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	844,425
2009	877,465
2010	936,260
2011	936,484
2012	936,711
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4,531,345
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	906,269

In addition, the Government of Ukraine has expressed its support for the project and may consider allowing AISW to trade by so called early credits which will occur in 2007 if the relevant monitoring and verification of the project activity is completed. Such early credits would constitute the following:

Length of the crediting period before 1 January 2008	1 Years
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2007	584,692
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	584,692

A.5. Project approval by the Parties involved:

Letter of Endorsement of the Government of Ukraine was received in 2006. The final PDD will be sent along with the determination report to the Government of Ukraine for the Letter of Approval (LoA), which usually is expected within 30 days. A similar procedure will be used to obtain the LoA of the Dutch Government.

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 of the JI Guidelines and the JISC "Guidance on criteria for baseline setting and monitoring". No applicable approved CDM methodologies are available for this project.

The baseline scenario is chosen based on project-specific approach. Thus, the baseline selection refers to the AISW project-specific conditions and parameters as they are described in the PDD. [2]

[2] Therefore no broader applicability criteria for this approach were defined.

Two-steps 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. Integrated facilities typically include e.g. blast furnaces, and basic oxygen steelmaking furnaces (BOFs), i.e. converters or open hearth furnaces (OHFs). Secondary steelmaking most often occurs in electric arc furnaces. In 2003, BOFs accounted for approximately 63% of world steel production[3]. However, in Ukraine OHF is still a widely-used technology, as discussed below.

As an integrated steelmaking facility, the AISW had two technically feasible alternatives to increase efficiency and expand its production of slabs in 2003-2004 as there are no other intermediary technological solutions in terms of energy efficiency of the steel making process between the OHF technology and BOFs:

- **Alternative #1:** Replacement and expansion of the current capacities using existing technology of steel production with open hearth furnaces (OHFs) and casting/blooming.
- **Alternative #2:** Modernization and expansion of the current capacities using the modern converters and continuing casting (project itself without carbon component).

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

Another alternative to use electric arc furnaces was not a technically feasible option for AISW as it is a secondary steelmaking process.

Step 2: Identify the most plausible alternative (baseline scenario)

<u>Alternative #1: Replacement and expansion of the current capacity using the existing technology of steel production with OHF and blooming</u>

In 2003-2004, OHFs were widespread in Ukrainian and Russian steel industry even if it was considered not usual technology by OECD standards. Ukrainian steel plants are mostly operating with production facilities from Soviet era (including converters). According to International Iron and Steel Institute[4], in 2004, about 43.4% of crude steel in Ukraine was produced in OHFs, about 49% in old type Basic-Oxygen Furnaces (old-type LD converters) and about 7% in Electric Arc Furnaces.[5]

Building new OHFs instead of modern converters would have been the business-as-usual (BAU) choice of AISW, fully in compliance with applicable legislation and regulation. The advantages of the OHF technology for the project developers include: (i) low investment cost, (ii) easier access to finance due to smaller investment and known technology, (iii) shorter construction period, (iv) low technical risk due to historical

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

[4] International Iron and Steel Institute, 2005, World Steel in Figures.

[5] According to the Ministry of Industrial Policy of Ukraine, for the same period, the OHF produced approximately 50% of the total amount of steel in Ukraine (OECD, OECD Special Meeting at High-level on Steel Issues, The Ukrainian steel industry, 11 January, 2005).

experience, familiarity and confirmed capacity to build, operate the facilities, and to manage related risks, and (v) availability of trained staff.

In fact, the planned slab output could have also been secured with existing older OHF units and with the construction of new OHF units. At the moment of the investment decision, as well as currently, there were no regulatory or technical limitations for the older OHF units to continue operating at least until the end of 2012. However, to ensure conservativeness of the assumptions used for the identification of the baseline alternatives, only the new OHFs will be considered in the baseline alternative, e.g. in terms of their energy efficiency and other technological parameters. In this case, the investment cost of installing the new OHFs would represent only around USD 200 million, or one fifth of the investment cost of the proposed project (USD 944 million).

In case of this technological choice, the time needed to build three new OHFs and oxygen blocks and to reach the planned output would have been 1.5 years compared to 4.5 years needed for project activities. In the context of high volatility of slab prices and limited long-term external financing, the choice of traditional technology would have significantly reduced the risk of financial exposure of AISW during the time necessary to mobilize resources for the project implementation.

In addition, an investment choice in favour of the traditional technology of OHF and Blooming Mill was made by the AISW management in 2002 (see the Protocol of the Technical Council of AISW, 2002[6]). Although considered as a possible alternative, the modern technology proposed by the project was evaluated as too risky and expensive in comparison to the BAU alternative. A new OHF that was put into operation in 2005, and is expected to operate for 40 years, during the whole life time of the project. This precedent investment decision further confirms that the choice of this alternative is a realistic and credible alternative to the proposed project activity.

- Alternative #2: Modernization and expansion of the current capacities using the modern converters and continuing casting (project itself without carbon component)

The project activity includes the replacement of the existing old OHF by 2x300 t LD Converters that will reach the same capacity as in the Alternative #1 (see section A.4.2.). The project also encompasses the installation of the Ladle Furnace and Slab Casters to replace the old Ingot Casting/Blooming line in the OHF shop. In addition, the project activity involves the replacement of the existing infrastructure which would otherwise not have sufficient remaining lifetime to operate until the whole duration of the proposed project activity.

In 2004 there were, and there still are, no legal or regulatory requirements in Ukraine for the adoption of new technologies such as modern converters for steel making. By early 2005, only "pilot" modernization projects in the steel sector were reported. The project is in line with non-mandatory, general government policies adopted after the 2004 investment decision, such as the Restructuring Program of the Iron and Steel Sector and with the long-term Energy Strategy of Ukraine (adopted in 2006).[7]

According to the Director of the National Institute of Strategic Studies, in 2005 around 60% of the existing equipment in Ukrainian Iron and Steel sector was technically outdated. At the same time, only USD 7-8/tonne was invested in modernization and new technologies in the Ukrainian metallurgy in comparison to USD 25-35/tonne in OECD countries and USD 80/tonne during the period of major technological modernization.[8] The amount of the project investment per tonne of produced slabs attains about USD 175/tonne in comparison to about USD 37/tonne for the Alternative #1 based on the traditional technologies.

[6] Provided to the determinator

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

[8] Makogon Yu., 2005, Gorno-Metallurgitcheskiy complex Ukraini: mifi i realnost (Zerkalo nedeli, #34(562)3, September 9,

With a total investment of USD 944 million, the project ranked among the largest investments made by private entity in Ukraine. In 2003-2004, securing adequate financing was one of the major barriers for the project implementation in terms availability of external long-term finance of such scale (see Section B.2.).

Furthermore, the estimated rate of return generated by the project was lower than the hurdle rate determined by the AISW/IUD management in 2003 for large scale modernization and expansion projects.

Thus, the implementation of the project activity was not the most plausible alternative given major investment, financial and technical barriers, which prevented its implementation without the JI component. Baseline approach captures all the CO_2 emissions related to baseline scenario and monitoring is based on detailed monitoring of the steel plant required also for process purposes (pls. see Section D for details).

As a result, the Alternative #1 is the most plausible and credible alternative and it represents the baseline scenario for the proposed project activity.

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 will be monitored and measured on the most recently installed OHF by AISW ("benchmark") that is identical to the technological solution that was identified as a baseline scenario. Thus, the emission factors per output of production can be quantified for the baseline technology in *ex-post* basis. As discussed above, the baseline selected is conservative as it will be based on the recent OHFs.
- The benchmark baseline OHFs have the remaining lifetime that goes well beyond the crediting period for the project and will not be replaced by any new technologies given that they were installed in 2005.
- The *ex-post* monitoring of the recent OHFs will ensure that the baseline will automatically reflect the improvements of the energy efficiency and processes that would be a part of a normal maintenance or operational improvements of the equipment in the baseline scenario during the crediting period.
- The baseline monitoring procedure excludes the possibility to overestimating the baseline emissions by capping the output on the basis of the Project output.
- The scrap used in baseline and project cases will be calculated as zero emission raw material. As per specifications of technologies used, more scrap will be used in baseline scenario in comparison with the project. The baseline emissions would be underestimated leading to the conservative quantification of the emission reductions.

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

This section analyses additionality of the project and demonstrates 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 main steps of the CDM additionality tool are used below even though the use of additionality tool is not required for JI projects.

Barrier analysis was deemed to be the most appropriate method of assessing additionality as the project faced clearly identifiable barriers. The step-by-step approach here consists in describing these barriers, in demonstrating why these barriers prevented the implementation of the project activity and how the Joint Implementation is expected to help alleviating these barriers. As per CDM additionality tool requirement, the last step consists in the common practice analysis that is intended to confirm the result of the barrier analysis.

From the first considerations in 2003 of the possibility to implement the modern technology proposed by the project, the management of AISW seriously considered using the Kyoto mechanisms as a potential strong incentive to selecting the project and going beyond prevailing technological choice and invest into more energy efficient technology and production process (see the Minutes of the Technical Council meeting, 2003, May, 26[9]).

Barrier analysis (Step 3 of the Additionality Tool)

Investment barriers

As discussed earlier, the project is one of the largest investment projects in industrial sector in Ukraine. Its main parameters are presented in the Table 2. Projected investment costs have been based on the estimates made by a technology provider (Voest-Alpine Industries), local contractors and AISW staff. The construction of the project facilities takes place from 2005 to 2010 for the period of 4.5 years.

Table 2. Key parameters of the Project activity.

Factor	Value (in constant 2004 USD)
Investment cost	USD 944 million
Implementation period[10]	4.5 years
Total annual output of slabs by 2010	5,274 thousand tonnes/year

The project faced strong investment barriers in terms of limited access to the external financial resources both from domestic and international capital markets and financial institutions. There were three main investment barriers, particularly related to the scale of the project:

1. Underdeveloped domestic financial market in Ukraine

As highlighted widely in literature, domestic financial market in 2004 in Ukraine was too thin to provide funding for a project of that size. Financial loans to Ukrainian industry by domestic banks were dominated by trade finance transactions of 18 months in maturity. Investment loans were rare and usually up to 3 years.[11,12] Project investments estimated at about USD 1 billion would have accounted for almost 30% of the total volume of long-term loans provided by all Ukrainian banks to by mid-2004 (about USD 3.5 billion).

In this context, the AISW needed to get loans from the foreign banks which were reluctant to provide long-term loans of such scale to the Ukrainian enterprises as highlighted below.

2. Low credit rating of Ukrainian economy

The Ukrainian sovereign credit rating remained at the B+ level (Fitch highly speculative grade) in 2004 due to the political instability, before being raised to BB- in January 2005 (Fitch speculative grade). Thus, according to Fitch and other two main crediting agencies (Standard & Poor's and Moody's Investor Service) the credit rating of Ukraine remained below investment grade.[13] This explained the extreme cautiousness of foreign banks with regard to the Ukraine country risk and business environment.

Foreign financiers were providing relatively small short-term loans (for less than one year) linked to the steel production cycle and securitized on sales of primary products to known foreign buyers of finished products (trade finance). Although the steel producers were seeking for the medium-to-long-term loans for investments, foreign banks were considering lending against locally provided collateral for local expenditures too risky.[14]

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[9] Provided to the determinator

[10] Before the project attains the planned output of slabs.

[11] Honchar, V, 2004 , Assessment of the access of Ukrainian industry to investment credit, World Bank, Washington DC.

[12] Didkovsky, A, 2003, Project Financing. Risk Allocation and Security Structure, The Ukrainian Journal of Business Law, May 2003.

[13] The Moscow Times, 2005, Fitch Lifts Ukraine's Credit Rating a Notch", Monday, January 24, 2005.
[14] Trade Finance, 2003, Getting stronger, London, September 2003.

In this context, getting the required long-term loans for the project of about USD 1 billion (one of the biggest private sector project in Ukraine) represented a major barrier for the project implementation. This barrier was triggered by the low credit profile of IUD and AISW.

3. Low credit profile of IUD and AISW

As of the time of the investment decision, the IUD had a relatively short operation track record and was approaching the foreign banks for the first time for the loan of such scale.

No group financial statements according to the International Financial Reporting Standards (IFRS) were available prior to the year 2005.[15] IFRS are typically required for international financing.

Also, the required financing structure for the project was unique for Ukrainian industry in terms of size and sophistication of financial instruments. At the same time, AISW had just emerged from major financial difficulties.[16, 17]

All these factors determined a low credit profile of the project developer in mid-2004 and represented a barrier for the access to the long-term financing for the project at the acceptable costs.

As a result, in 2004 only trade related financing packages were available to AISW, such as US$100 million arranged to purchase new production equipment. Backing by European banks and Export credit agencies was necessary albeit very costly. The first non-trade related lending product from the foreign banks for this project was developed only in 2006.

Barrier due to prevailing practice

Steel sector in Ukraine was created during the Soviet era. Energy efficiency was not a priority at that time and until recently no major reconstruction projects in the Ukrainian steel industry were reported.

The project activity encompasses the first of its kind implementation of the modern LD converter technology in Ukraine. This is confirmed by the letter from the Ministry of Industrial Policy.[18] This is further confirmed e.g. by OECD data as no other modern converter projects are reported in Ukraine by 2005. [19]

The project developer had no technical experience or trained staff in the country in operation of modern LD converters and continuous casting. The project risks, such as construction risks and operational risks, were difficult to estimate before its launching, but they were higher that for the traditional well-known technology. Thus, the project faced technical and managerial barriers for its implementation.

In addition, given the described investment barriers, the investment expenses by tonne of slab produced were more than 20 times higher for the project developer in comparison to the prevailing practice of investment in reconstruction and modernization in the Ukrainian iron and steel industry. As mentioned earlier, in average in 2003-2004 such investment represented only the USD 7-8/tonne.

In the beginning of 2005, the official estimates by the Ukrainian government of the investment necessary for the Iron and Steel Sector Restructuring Program were about USD 8 billion, from which 52% were expected to come from the steel companies and the 48% from the lending. However, as of 2004, only USD 600 million were invested in such reconstruction and modernization projects[20], in particular given the limited access of the companies to the to the financial markets (see above) and the short-term oriented profit maximization

[15] Ernst&Young, 2006, Special Purpose Auditors' Report on the Preliminary IFSR Consolidated Financial Statements.

[16] Mining And Metals Report, 2001, Alchevsk Steel Mill Creditors to Draft Recovery Plan.

[17] Decision of Ukrainian Court concerning completion of readjustment (bankruptcy) of AISW, January 2004.

[18] Ministry of Industrial Policy of Ukraine, # 12/2-4-200, 30. 05. 2007. Provided to the determinator.

[19] OECD, 2006, Developments in Steelmaking Capacity of Non-OECD Economies, Paris.

[20] Makogon Yu., 2005, Gorno-Metallurgitcheskiy complex Ukraini: mifi i realnost (Zerkalo nedeli, #34(562)3, September 9.

strategies. This low level of investment represented a tangible contribution to the competitiveness of the Ukrainian steel producers at the international market.

In addition, the time of implementation of such a project was significantly longer that for traditional technology.

Thus, the level of investment in the project and its implementation timeline represented a barrier due to the significant financial exposure in comparison to the prevailing behaviour of local competitors.

Conclusion of the barriers analysis:

The barriers identified for the project would prevent its implementation in the business as usual conditions of the Ukrainian steel industry and financial sector in 2003-2004. At the same time, these barriers would not prevent the implementation of the baseline scenario which is characterized by a significantly smaller investment and is using well know traditional technology.

Alleviation of barriers

The contribution of the potential carbon revenues to "*enhance the credit profile of the project and mitigate some of its risks*" was considered from the beginning of negotiation for the fist share of the project loan in 2004 (as confirmed in the letter of one of the main foreign banks involved in project lending[21]). The potential carbon revenue could help to reduce costs of debt service by one third during the JI crediting period.

Thus, the JI component of the project estimated at 70 million USD helped to alleviate the investment barrier for this largest modernization and expansion project in the Ukrainian steel industry and to gain the first of its kind technical and managerial expertise by AISW in implementing and using the modern converter technology in Ukraine. It also helped to overcome the prevailing practice barrier through the reduction of the burden of the financial exposure in comparison to the prevailing behavior of local competitors.

It also helped to overcome the prevailing practice barrier through the reduction of the burden of the financial exposure in comparison to the prevailing behavior of local competitors in terms of very low investment rate into the modernization of the existing equipment and maximizing short term returns through the preference to the less capital-intensive projects with short pay-back periods.

Common practice analysis (Step 4 of the Additionality Tool)

The project encompasses the implementation of the modern technology of LD converters which was the first of its kind in Ukraine in 2003-2004. The support letter from the Ministry of Industrial Policy confirms that the project was the first of its kind in Ukraine. The AISW was not aware of other projects of such kind in Ukraine at the stage of design or implementation as by 2003-2004.

As demonstrated above (see Section B.1.), the traditional technologies of OHFs and ingot casting continue to dominate the steel production in Ukraine. This could be partly explained by the preference for short term profit maximization as well as by the competitive advantages in terms of low prices for raw materials and energy. The recent replacement by AISW of old OHF and Blooming Mill with a new OHF and Blooming Mill, is also confirming that the using of traditional technology was a realistic option for Ukrainian steel producers and represented a common practice by 2003-2004.

Thus, the proposed project activity is not a common practice in Ukrainian steel industry.

Conclusion

The project activity is not a common practice in Ukraine being the first of the kind and the largest investment project in industrial sector. It is also facing considerable investment and technological barriers. As detailed above, implementing the project as a JI project helps to alleviate the barriers. As a result, the project is considered additional.

[21] Letter has been provided to the determinator

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

The project boundary will encompass all of the technological changes resulting from the proposed project. OHFs/Converters, Blooming/Casting, Sinter Plant, Lime used, Blast Furnaces, CHP, oxygen and compressed air production are also included. Electricity grid, natural gas supply and Coke plant are excluded but electricity and coke used in baseline and project cases are included in emission calculations. All CO_2 emissions associated with the project are therefore captured. Emissions from upstream processes are proportionally taken into account based on pig iron consumption of the project and the baseline.

N_2O emissions from steel making process are likely to be small and no IPCC methodologies are provided for N_2O emissions calculation[22] 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_2 emissions. The both types of emissions are excluded from the quantification of baseline and project emissions. The exclusion of CH_4 is a conservative approach as more sinter and coke is consumed in absolute terms in the baseline in comparison with the project.

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

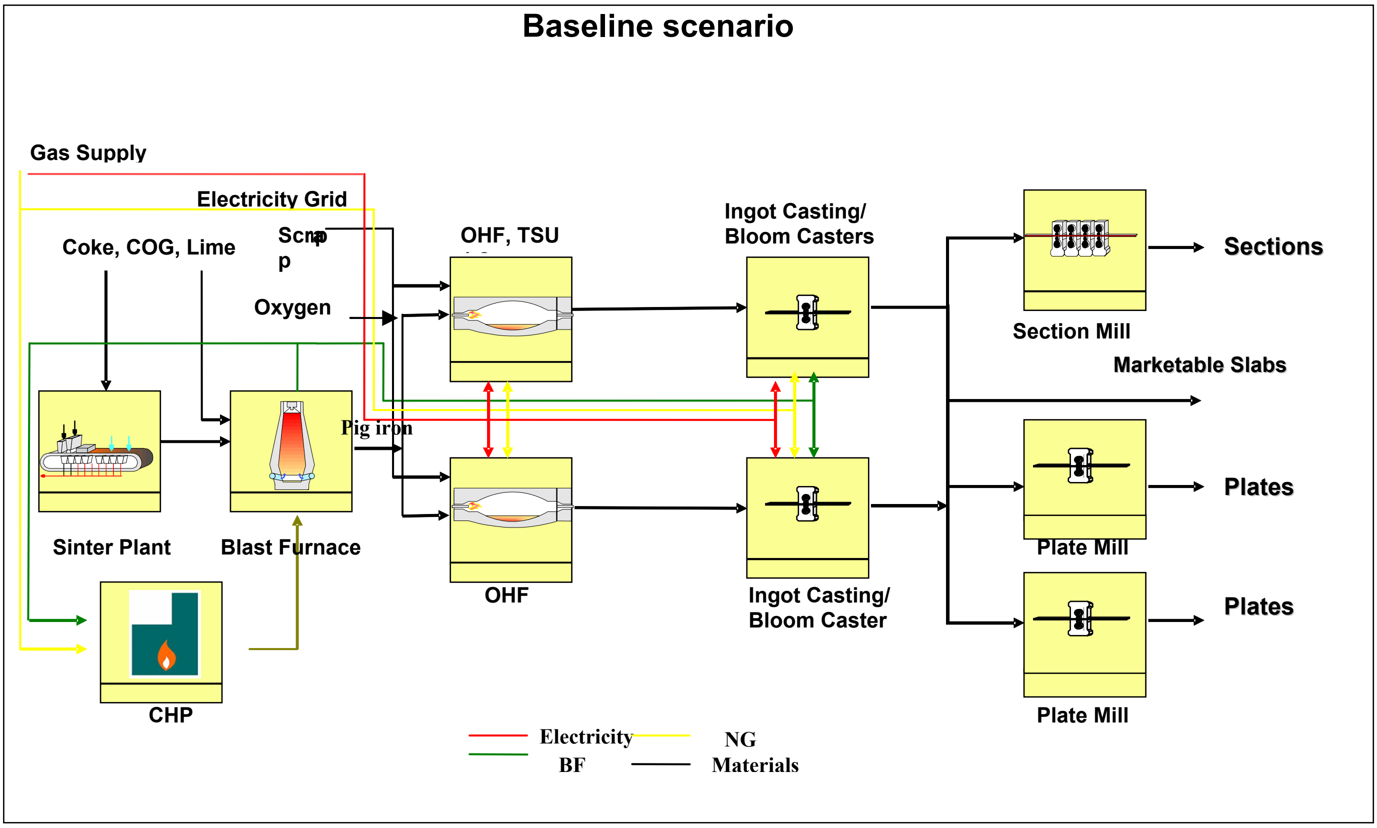
Table 3. Source of emissions.

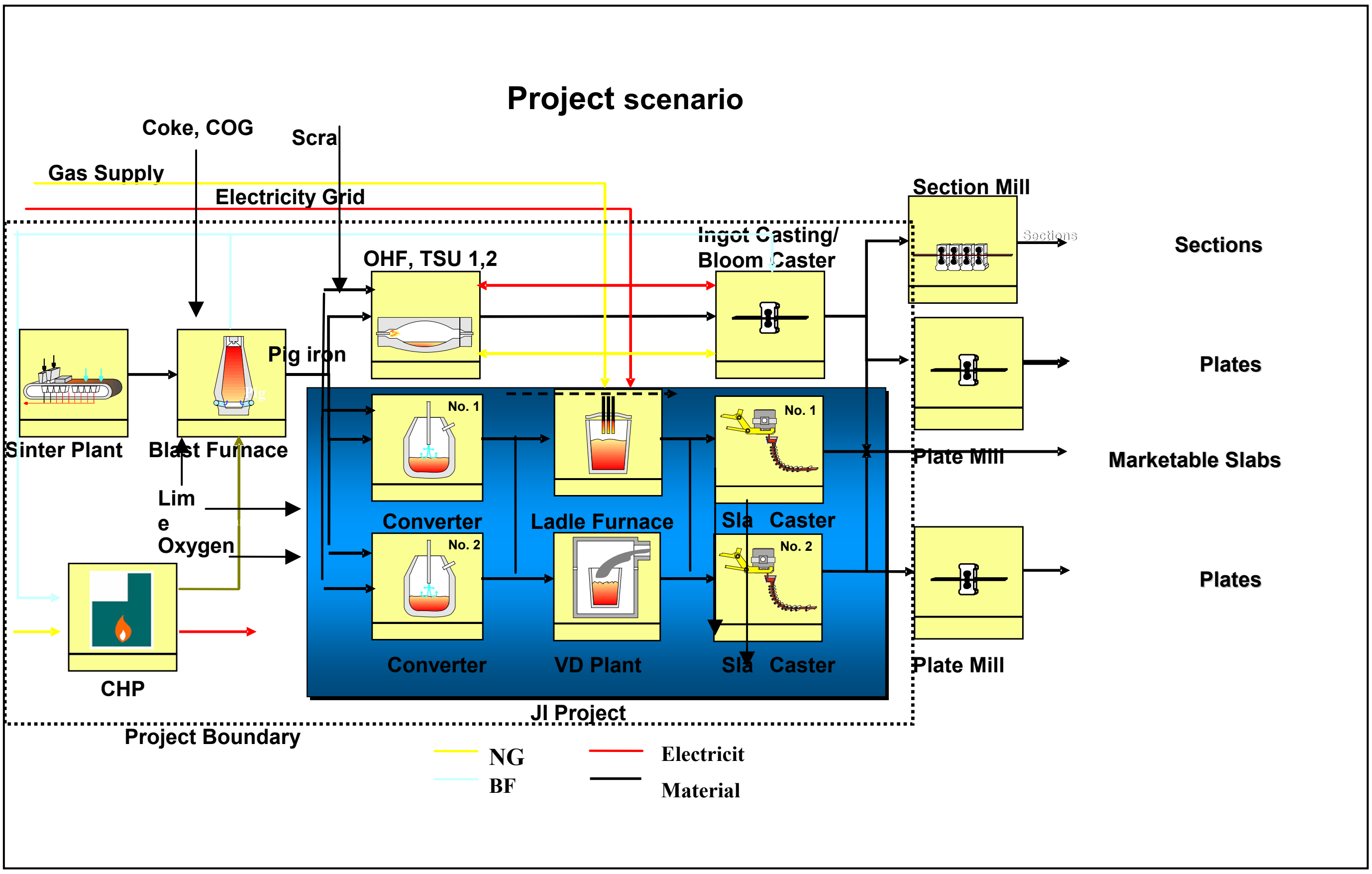
	Source	Gas	Included?	Justification / Explanation
Baseline	Fuels used	CO_2	Yes	Will be source of CO2 emissions.
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Electricity used	CO_2	Yes	Will be source of CO2 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 flows as part of production process into project	CO_2	Yes	Will be the main source of CO2 emissions.
		CH_4	No	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N_2O	No	This amount is likely to be insignificant and will not typically change from baseline to project case.

	Source	Gas	Included?	Justification / Explanation
Project Scenario	Fuels used	CO_2	Yes	CO2 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 CO2 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 flows as part of production process into project.	CO_2	Yes	CO2 will be reduce 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, coke oven gas and blast furnace gas. This fuel mix is specific to AISW and includes all the fuels related to steel making process. Material inputs having impact on GHG emissions include coke, lime, scrap, compressed air, oxygen and steam. Compressed air, oxygen and steam are currently and expected to be produced using electricity. The monitoring plan will also capture possible changes in compressed air, oxygen and steam production. Argon is a byproduct of oxygen.

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


Baseline scenario
Gas Supply
Electricity Grid
Coke, COG, Lime
Scrap
Oxygen
OHF, TSU
Ingot Casting/
Bloom Casters
Section Mill
Sections
Marketable Slabs
Pig iron
Sinter Plant
Blast Furnace
OHF
Ingot Casting/
Bloom Caster
Plate Mill
Plates
Plate Mill
Plates
CHP
Electricity
NG
BF
Materials


Project scenario
Coke, COG
Scra
Gas Supply
Electricity Grid
Section Mill
Sections
OHF, TSU 1,2
Ingot Casting/
Bloom Caster
Sections
Pig iron
Plates
Sinter Plant
Blast Furnace
No. 1
Plate Mill
Marketable Slabs
Lim
e
Oxygen
Converter
Ladle Furnace
Sla Caster
No. 2
Plates
CHP
Converter
VD Plant
Sla Caster
Plate Mill
JI Project
Project Boundary
NG
BF
Electricit
Material

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 4/12/2006
Kevin James, Quality Tonnes
Pokrovsky Hills, WL #55, Beregovaya Street, 3
Moscow, Russia 125367
+ (7 495) 737-5073
kjames@qualitytonnes.com

Mr. James is not a project participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

24 August 2005.

C.2. Expected operational lifetime of the project:

40 years.

C.3. Length of the crediting period:

1 January 2008 – 31 December 2012.
In case if agreement is reached on continuation of Kyoto protocol, the crediting period can be prolonged subject to relevant approvals.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The monitoring approach developed for this specific project is consistent with the assumptions and procedures adopted in the baseline approach (pls. 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 (new Open Hearth Furnace and Blooming Mills) was installed in 2005 as a separate project in the same integrated steel complex as a replacement as of an older Open Hearth Furnace. This technology was identified above as identical to the technological choice in the baseline scenario. This allows the project developer to use actual continuous monitored and measured data on the production and materials efficiency from the recently installed Open Hearth Furnace ("benchmark") 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 as applicable.

2. Project as well as baseline emissions depend e.g. on the composition of the input in the steel making process, in particular on the amount of pig iron consumed to produce a ton of steel (specific consumption). The optimization of the input composition in the steel making process is linked to the amounts of scrap and pig iron within the predetermined technical limits and depending on availability of scrap on the market conditions and market prices differential for scrap and pig iron. The historical specific consumption of pig iron has remained in the range of 70 – 72 % and is expected to increase to up to 75% (calculated as percentage of the total input of pig iron and scrap into the steel making process) due to above mentioned market conditions and also due to the fact that old OHFs that consume more scrap will be shut down. The specific consumption of pig iron for the remaining OHFs 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 observed (monitored) specific pig iron consumption per ton of steel in the project scenario. This approach is based on the recent reversion of approved CDM methodology AM0009 to deal with the uncertainly of a major parameter for calculation of baseline emissions (i.e. forecast of production of oil and flared gas).

3. This plant is an integrated steel mill. It has the project specific oversight and control, as wells as respects the high-level metering requirements, in accordance with national norms and regulations and is based on detailed Guiding Metrological Instructions of AISW. This will ensure accurate data on both the energy/material flows into the project boundary, but also the data required to determine the CO_2 impact of the materials. Monitoring.

4. 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_2 impact using equations (1) – (27).

5. As far as material inputs are concerned, pig iron increases in proportion to scrap from the baseline to the project. Since the remaining material input (scrap) has been calculated as having zero emission of CO_2 per tonne, the baseline emissions are underestimated, leading to the conservative quantification of emission reductions.

6. In the baseline, Blast Furnace gas is used as a fuel in the Blooming Mill. Blast furnace gas is a by-product of the Blast Furnace process. Its main embedded energy and carbon reside in CH4 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_2 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[23]. 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 in other purposes (as captured in 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_2 neutral fuel.

7. All parameters, with the exception of IPCC default values used for coke and lime, will be measured/monitored *ex-post* based on specific monitoring plan developed for this project, as well as on maintenance, and quality control and quality assurance procedures in accordance with Ukrainian and AISW'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 *ex-ante* assumptions.

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

Key Variables/Parameters	Data Sources
Electricity & Fuels used	Measured
Emissions Factors for Fuels and Electricity	Caloric value of fuels will be monitored by the suppliers and AISW Laboratory ERUPT defaults for electricity from the grid will be used (to be replaced by national defaults once available).
Steel produced	Measured
Quantities of materials used	Measured
Emissions factor of materials used	IPCC Defaults will be used for reducing agents

The monitoring plan meters, encompasses and monitors the energy and material flows into the project boundary and calculations are made as to the associated CO_2 emissions from those flows using the same formulas as the baseline approach:

1. Quantify all CO_2 contribution of all the material flows in the project scenario
2. Quantify the CO_2 contributions of all energy flows in the project scenario
3. Quantify the total annual production output in the project case

The material flows will include raw inputs of pig iron, steel scrap, as well as process inputs such as oxygen and compressed air (produced using electricity). Each material flow will be measured for impact on the tonnes of CO_2 emissions per tonne of steel production. Electricity consumed will be measured and converted to CO_2 emissions using a weighted average of local (combined heat and power plant) and grid data. Each fuel used within the project boundary will also be measured and its CO_2 emissions impact derived from local emissions factors based on the carbon content of the fuel. This will provide a comprehensive picture of the emissions of CO_2 from the project and from the baseline.

As the project is configured, part of Blast Furnace gas is used as a fuel in the existing combined heat and power plant to generate steam and electricity. The plant is currently not used to generate electricity and only produces some steam. This will change, however, in the project case when Blast Furnace gas ceases to be used in the project as a fuel in the Blooming Mill and instead is available to produce electricity. In this case, the emissions factor for electricity will take into account the total electricity generated from this source. The CO2 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 of the Blast Furnace gas comes from the coke and to a lesser extent natural gas used in the process and so is already counted as an emission in the calculation of the CO2 impact of pig iron.

As described in section B.3., to ensure that double counting does not occur and that emission reductions are accurately calculated, pig iron will be considered a material input into the steel making process. First, the total emissions from the Sinter Plant/Blast Furnace process will be calculated. The total pig iron output from the Blast Furnaces will also be monitored allowing the project developer to calculate the tonnes of CO_2 emissions per tonne of pig iron produced. The amount of pig iron used per tonne of steel slab output will be measured for both the baseline and for the project. The project consumption of pig iron will be measured and multiplied by the actual calculated tonnes of CO_2 per tonne of pig iron. The consumption of pig iron will also be measured in the baseline technology case. The baseline calculations will include the CO_2 emissions per tonne of pig iron in the project year multiplied by the baseline consumption of pig iron calculated for the project year as CO_2 emissions from material input.

There is no carbon stored at the end of each processes as carbon is either released or passed on in the next process stage. Since the final product in both the baseline and project case is exactly the same tonnage of steel, the exact same amount of carbon will be stored in both the baseline and project case in the final product of steel.

It should be noted that baseline and monitoring approach allows changes of fuels and materials used in baseline and project scenario. Therefore all parameters listed are not currently used in baseline and project scenarios for this specific project, e.g. oxygen is produced utilizing electricity, but monitoring plan takes into account the possible use of other fuels for oxygen production. Monitoring Plan therefore takes into account possible changes in 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 and the ongoing construction schedule of various parts of the process line, the project developer will take the following steps to ensure data quality.

- Each new meter installed will be selected and calibrated according to manufacturer's specifications, national requirements and Guiding Metrological Instructions of AISW.
- All new meters will be installed and calibrated before any flows are measured.
- All old meters that are used in new functions or are subject to some physical disruption in their use due to construction will be recalibrated according to manufacturer's specifications and AISW's Instructions 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 a part of normal operation process of AISW 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 AISW. Responsibilities for monitoring are defined in table 6, 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 (Guiding Metrological Instructions)

Monitoring Plan will be revised if needed during the initial/first verification.

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	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?	Comment
P-1	**Total Steel Output (TSO_p) of the Project**	AISW plant records	Tonnes	M	Continuous with annual tabulation	100%	Electronic and paper	Equation (2)
P-2	**Total CO2 of Pig Iron ($TCPI_p$)**	AISW plant records	Tonnes CO2	C	Annually	100%	Electronic and paper	Equation (3) Calculated from other variables- TCFCPI, TCEPI, TCIPI and PII. In this case, pig iron produced in the Blast Furnaces will supply to both the LD steel making and the new OHF. Since TCPI represents the total CO2 from all Pig Iron production (input for both lines) this number will be adjusted.
P-3	**Total CO2 from Fuel Consumption for Pig Iron ($TCFCPI_p$)**	AISW plant records	Tonnes CO2	C	Calculated once per year	100%	Electronic and paper	Equation (4) Calculated from other variables – Q_{fpi} and EF_{fpi}

P-4	**Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PII_p)**	AISW plant records	Share	C	Calculated once per year	100%	Electronic and paper	Equation (12) Calculated from other variables TPII and TPIP Since only a portion of the Pig Iron produced will be utilized in this project, the project developer will determine the share of the total upstream emissions associated with the project.
P-5	**Total Pig Iron Input into Steel Making Process ($TPII_p$)**	AISW plant records	Tonnes	M	Measured constantly-annual result	100%	Electronic and paper	
P-6	**Total Pig Iron Produced ($TPIP_p$)**	AISW plant records	Tonnes	M	Measured constantly-annual result	100%	Electronic and paper	
P-7	**Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,\ p}$)**	AISW plant records	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	M	Continuous with annual tabulation	100%	Electronic and paper	For this project fuels will include: Blast Furnace Gas measured in 1000 Normal cubic meters (1000 Nm3), Coke Oven Gas (Nm3) and Natural Gas (Nm3)
P-8	**Emission factor of each fuel in Pig Iron Production (fpi_p) $EF_{fpi,\ p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fpi}	M and C	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor. Natural Gas is anticipated at 0.00189 tonnes of CO2/Nm3 Coke Oven Gas is anticipated in 0.794 tonnes CO2/1000 m3 Blast Furnace Gas would be 0.00 since the associated emissions are already counted in the emissions from pig iron (Natural Gas and Coke). See also Annex 3.

P-9	**Total CO2 from Electricity used in Pig Iron production ($TCEPI_p$)**	AISW plant records	Tonnes CO2	C	Annual tabulation	100%	Electronic and paper	Equation (5) Calculated from other variables EPCI and EFEC. If both grid-imported and self-generated electricity is used, the totals will be combined to calculate TCEPI.
P-10	**Electricity Consumed in producing Pig Iron ($ECPI_p$)**	AISW plant records	MWh	M	Continuous with annual tabulation	100%	Electronic and paper	
P-11	**Emissions Factor for Electricity Consumption in Pig Iron Production ($EFECPI_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	Annual tabulation	100%	Electronic and paper	This will be calculated as the weighted average of the emissions factor of the grid and the emissions factor of the CHP plant. The average will be weighted based on the total amounts of electricity provided from each source. The ERUPT default factor for the grid is currently (year 2007) 0.856 tonnes CO2 /MWh [24]
P-12	**Total CO2 from inputs into Pig Iron ($TCIPI_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (6) Calculated from other data TTPI, TCFIO,TCEIO, TCRAPI,TCSPI, TCLPI
P-13	**Total CO2 from Fuel Consumption in Sintering ($TCFIO_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (7) Calculated from other variables – Qfpi and EFfpi
P-14	**Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,\ p}$)**	AISW plant records	m3	M	Annual	100%	Electronic and paper	
P-15	**Emission factor of each fuel in Sintering (fio_p) $EF_{fio,\ p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fpi}	M and C	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor

[24] Operational Guidelines for Project Design Documents of Joint Implementation Projects Volume 1: General guidelines, Version 2.3, Ministry of Economic Affairs of the Netherlands, May 2004. Emission factor can be replaced by official Ukrainian factor once available.

P-16	**Total CO2 from Electricity used in Sintering ($TCEIO_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (8) Calculated from other variables EPCI and EFEC
P-17	**Electricity Consumed in Sintering ($ECIO_p$)**	AISW plant records	MWh	M	Annual	100%	Electronic and paper	
P-18	**Emissions Factor for Electricity Consumption in Sintering ($EFECIO_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	Annual	100%	Electronic and paper	
P-19	**Total CO2 from Reducing Agents in Pig Iron Production ($TCRAPI_p$)**	AISW plant records IPCC	Tonnes CO2	M and C	Annual	100%	Electronic and paper	Equation (9) Measurement of tonnes of reducing agent multiplied by IPCC default factor For Coke used here 3.1 tonnes CO2 per tonne of Reducing agent
P-20	**Total CO2 from limestone in Pig Iron Production ($TCLPI_p$)**	AISW plant records IPCC	Tonnes CO2	M and C	Annual	100%	Electronic and paper	Equation (10) Total limestone used in tonnes multiplied by IPCC default of 0.44 tonnes CO2 / tonne of limestone
P-21	**Total CO2 from steam production in Pig Iron Production ($TCSPI_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (11) Calculated from other variables Not expected to be used in the baseline case. However, it will be monitored if changes are made during the project period.
P-22	**Quantity of each fuel ($fspi_p$) used in steam production in Pig Iron Production ($Q_{fspi,\,p}$)**	AISW plant records	m3	M	annual	100%	Electronic and paper	
P-23	**Emission factor of each fuel in used in steam production ($fspi_p$) EF_{fspi}**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fspi}	M and C	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
P-24	**Total CO2 emissions from the furnace process ($TCFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (13) Calculated from other variables TCFCFP, TCECFP, and TCIFP

P-25	**Total CO2 emissions from fuel consumption in the furnace process ($TCFCFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (14) Calculated from other variables Qffp and EFffp
P-26	**Quantity of each fuel (ffp_p) used in furnace process ($Q_{ffp, p}$)**	AISW plant records	m3	M	Continuous with annual tabulation	100%	Electronic and paper	
P-27	**Emission factor of each fuel in the furnace process (ffp_p) $EF_{ffp, p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{ffp}	M and C	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor .
P-28	**Total CO2 emissions from electricity consumption in the furnace process ($TCECFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (15) Calculated from other variables ECFP and EFECFP
P-29	**Electricity Consumed in the furnace process ($ECFP_p$)**	AISW plant records	MWh	M	Continuous with annual tabulation	100%	Electronic and paper	
P-30	**Emissions Factor for Electricity Consumption in the furnace process ($EFECFP_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	annual tabulation	100%	Electronic and paper	This will be calculated as the weighted average of the emissions factor of the grid and the emissions factor of the CHP plant. The average will be weighted based on the total amounts of electricity provided from each source. The ERUPT default factor for the grid is currently 0.856 tonnes CO2 /MWh (2007)
P-31	**Total CO2 emissions from inputs to the furnace process ($TCIFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (16) Calculated from other variables TCAFP, TCSFP, TCCAFP, TCOFP, TCLFP
P-32	**Total CO2 from Argon entering the furnace ($TCAFP_p$)**	AISW plant records	Tonnes CO2	M	Continuous	100%	Electronic and paper	Equation (17) Argon is a by-product of oxygen and TCAFP would equal zero with all the

								emissions being covered by TCOFP
P-33	**Total CO2 from steam production in the furnace process ($TCSFP_p$)**	AISW plant records	Tonnes CO2	C	Annual tabulation	100%	Electronic and paper	Equation (18) Steam is produced as a by-product of electricity generation on site, therefore TCSFP will equal zero as the emissions are covered by another variable
P-34	**Quantity of each fuel (fsp) used in steam production in the furnace process ($Q_{fsp,\,p}$)**	AISW plant records	m3	M	Continuous with annual tabulation	100%	Electronic and paper	This parameter is collected for all fuels directly combusted in the steam production in the steel making process, electricity or fuels indirectly combusted for other inputs are counted in other variables. Not anticipated but will be monitored
P-35	**Emission factor of each fuel in the furnace process (fsp_p) $EF_{fsp,\,p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fsp}	M and C	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
P-36	**Total CO2 from compressed air production for the furnace process ($TCCAFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (19) Equation (20)
P-37	**Quantity of each fuel (fca_p) used in compressed air production ($Q_{fca,\,p}$)**	AISW plant records	m3	M	Continuous with annual tabulation	100%	Electronic and paper	Not expected in this project. However, it will be monitored if changes are made during project period .
P-38	**Emission factor of each fuel in compressed air production (fca_p) $EF_{fca,\,p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{faa}	M	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
P-39	**Electricity Consumed in making compressed air for the furnace process ($ECCA_p$)**	AISW plant records	MWh	M	Continuous with Annual tabulation	100%	Electronic and paper	Covered currently by P-29

P-40	**Emissions Factor for Electricity Consumption in compressed air production ($EFECCA_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	Annual tabulation	100%	Electronic and paper	This will be calculated as the weighted average of the emissions factor of the grid and the emissions factor of the CHP plant. The average will be weighted based on the total amounts of electricity provided from each source. The ERUPT default factor for the grid is currently 0.856 tonnes CO2 /MWh (2007)
P-41	**Total CO2 from oxygen production ($TCOFP_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (21) Equation (22) Calculated from other variables
P-42	**Quantity of each fuel (fop_p) used in oxygen production ($Q_{fop, p}$)**	AISW plant records	m3	M	Continuous with Annual tabulation	100%	Electronic and paper	Not expected in this project. however, it will be monitored if changes are made in project years.
P-43	**Emission factor of each fuel in oxygen production (fop_p) $EF_{fop, p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fop}	M	Annual average	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
P-44	**Electricity Consumed in making oxygen ($ECOP_p$)**	AISW plant records	MWh	M	Continuous with annual tabulation	100%	Electronic and paper	In cases that the consumed electricity comes from more than one source, the amount of electricity will be measured separately by source (on site CHP plant and additional grid electricity) Nitrogen is byproduct of oxygen production.
P-45	**Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	Annual tabulation	100%	Electronic and paper	This will be calculated as the weighted average of the emissions factor of the grid and the emissions factor of the CHP plant. The average will be weighted based on the total amounts of electricity provided from each source. The ERUPT default factor for the grid is currently 0.856 tonnes CO2 /MWh.
P-46	**Total CO2 from limestone for furnace process ($TCLFP_p$)**	AISW plant records IPCC	Tonnes CO2	M and C	Continuous with annual tabulation	100%	Electronic and paper	Equation (23) Total limestone used in tonnes multiplied by IPCC default of 0.44 tonnes of CO2 / tonne of limestone

P-47	**Total CO2 from casting ($TCBM_p$)**	AISW plant records	Tonnes CO2	C	Continuous with Annual tabulation	100%	Electronic and paper	Equation (24) Calculated from other variables TCFCBM and TCECBM
P-48	**Total CO2 from fuel consumption in casting ($TCFCBM_p$)**	AISW plant records	Tonnes CO2	C	Continuous with annual tabulation	100%	Electronic and paper	Equation (25) Calculated from other variables Qfbm and EFfbm
P-49	**Quantity of each fuel (fbm_p) used in casting ($Q_{fbm, p}$)**	AISW plant records	m3	M	Continuous with annual tabulation	100%	Electronic and paper	For this project the fuels will include Natural Gas m3
P-50	**Emission factor of each fuel used in casting (fbm_p) $EF_{fbm, p}$**	AISW plant records Local fuel distributor.	Tonnes CO2 perm3 corresponding to Q_{fbm}	M	Annual	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
P-51	**Total CO2 from electricity consumption in casting ($TCECBM_p$)**	AISW plant records	Tonnes CO2	C	Annual	100%	Electronic and paper	Equation (25) Calculated from other variables ECBM and EFECBM
P-52	**Electricity Consumed in casting ($ECBM_p$)**	AISW plant records	MWh	M	Continuous with annual tabulation	100%	Electronic and paper	In cases that the electricity comes from more than one source, the amount of electricity should be measured separately by source (on site CHP plant and additional grid electricity)
P-53	**Emissions Factor for Electricity Consumption in casting ($EFECBM_p$)**	AISW plant records/ERUPT/ National defaults	Tonnes CO2/MWh	M and C	Annual tabulation	100%	Electronic and paper	This will be calculated as the weighted average of the emissions factor of the grid and the emissions factor of the CHP plant. The average will be weighted based on the total amounts of electricity provided from each source. The ERUPT default factor for the grid is currently 0.856 tonnes CO2 /MWh

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

Project emissions will equal the total tonnes of CO2 from the Pig Iron Process and Sintering (Iron ore preparation) added to the total tonnes of CO2 from the Furnace Process and total tonnes of CO2 from the Casting process. The data will be measured in the project year y. Equations capture the entire CO2 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.

$$PE_y = TSO_{p,y} \times \left(\frac{TCPI_{p,y} + TCFP_{p,y} + TCBM_{p,y}}{TSO_{p,y}} \right) = \left(TCPI_{p,y} + TCFP_{p,y} + TCBM_{p,y} \right) \quad (1)$$

Where

TSO_p= Total steel output, t of steel (project case)
$TCPI_p$= Total embodied CO2 of Pig Iron entering into project measured, t CO2 (project case)
$TCFP_p$= Total CO2 in the furnace process, t CO2 (project case)
$TCBM_p$=Total CO2 in the casting, t CO2 (project case)
y= project year

The formulae for determining TCPI, TCFP, TCBM are identical to those described in the baseline section D.1.1.4.equations 2 – 26. To calculate project emissions, equations 2-26 are applied and baseline data is replaced by project data as applicable. [25]

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	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?	Comment
B-1	**Total Steel Output (TSO_b) representing the baseline OHF.**	AISW plant records	Tonnes	M	Annually through entire course of the project including baseline year and prior two years	100%	Electronic and paper	Equation (2)
B-2	**Total CO2 of Pig Iron ($TCPI_b$)**	AISW plant records	Tonnes CO2	C	Annually	100%	Electronic and paper	Equation (3) Calculated from other variables- TCFCPI, TCEPI, TCIPI and PII

[25] 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 Database.

B-3	**Total CO_2 from Fuel Consumption in Pig Iron production ($TCFCPI_b$)**	AISW plant records	Tonnes CO_2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (4) Calculated from other variables – Qfpi and EFfpi
B-4	**Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PII_b)**	AISW plant records	Share	C	annually	100%	Electronic and paper	Equation (12) Calculated from other variables TPII and TPIP Since only a portion of the the Pig Iron Produced will be used for this project, the project developer will determine the share of total blast furnace emissions associated with the baseline.
B-5	**Total Pig Iron Input into Steel Making Process ($TPII_b$)**	AISW plant records	Tonnes	M	Measured constantly-annual result	100%	Electronic and paper	
B-6	**Total Pig Iron Produced ($TPIP_b$)**	AISW plant records	Tonnes	M	Measured constantly- annual result	100%	Electronic and paper	
B-7	**Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Natural Gas in normal cubic meters (Nm3), Blast Furnace Gas m3, and Coke Oven Gas m3.

B-8	**Emission factor of each fuel in making Pig Iron (fpi_b) $EF_{fpi,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fpi}	M	Annually throughout project years	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor Natural Gas is anticipated at 0.00189 tonnes of CO2/Nm3 Blast Furnace Gas at of tonnes of CO2 per m3, and Coke oven gas at 0.794 tonnes of CO2 per 1000 m3
B-9	**Total CO2 from Electricity used in Pig Iron production ($TCEPI_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (5) Calculated from other variables EPCI and EFEC
B-10	**Electricity Consumed in producing Pig Iron ($ECPI_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B-11	**Emissions Factor for Electricity Consumption in making Pig Iron ($EFECPI_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	M	Annual tabulation through project years	100%	Electronic and paper	
B-12	**Total CO2 from inputs into Pig Iron ($TCIPI_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (6) Calculated from other variables TTPI, TCFIO,TCEIO, TCRAPI,TCSPI, TCLPI
B-13	**Total CO2 from Fuel Consumption in Sintering ($TCFIO_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (7) Calculated from other variables – Qfpi and EFfpi
B-14	**Quantity of each fuel (fio_b) used in Sintering ($Q_{fio,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	

B -15	**Emission factor of each fuel in Sintering (fio_b) $EF_{fio, b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fpi}	M	Annually throughout project years	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
B-16	**Total CO2 from Electricity used in Sintering ($TCEIO_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (8) Calculated from other variables EPCI and EFEC
B -17	**Electricity Consumed in Sintering ($ECIO_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B -18	**Emissions Factor for Electricity Consumption in Sintering ($EFECIO_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	M	Annual tabulation through project years	100%	Electronic and paper	
B -19	**Total CO2 from Reducing Agents in Pig Iron Production ($TCRAPI_b$)**	AISW plant records IPCC	Tonnes CO2	M and C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (9) IPCC default factor For Coke used here- 3.1 tonnes CO2 per tonne of Reducing agent
B -20	**Total CO2 from limestone in Pig Iron Production ($TCLPI_b$)**	AISW plant records IPCC	Tonnes CO2	M and C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (10) Total limestone used in tonnes multiplied by IPCC Good practice default of 0.44 tonnes of CO2/tonne of limestone
B -21	**Total CO2 from steam production in Pig Iron Production ($TCSPI_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (11) Calculated from other variables Not expected to be used in the baseline case. However, it will be monitored if changes are made in project years. And adjustments to the baseline are needed.

B -22	**Quantity of each fuel ($fspi_b$) used in steam production in Pig Iron Production ($Q_{fspi,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B -23	**Emission factor of each fuel in steam production ($fspi_b$) $EF_{fspi,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3) corresponding to Q_{fspi}	M and C	annual average for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
B -24	**Total CO2 emissions from the furnace process ($TCFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (13) Calculated from other variables TCFCFP, TCECFP, and TCIFP
B -25	**Total CO2 emissions from fuel consumption in the furnace process ($TCFCFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (14) Calculated from other variables Qffp and EFffp
B -26	**Quantity of each fuel (ffp_b) used in furnace process ($Q_{ffp,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B -27	**Emission factor of each fuel in furnace process (ffp_b) $EF_{ffp,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{ffp}	M and C	Annual average for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
B -28	**Total CO2 emissions from electricity consumption in the furnace process ($TCECFP_b$)**		Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (15) Calculated from other variables ECFP and EFECFP
B -29	**Electricity Consumed in furnace process ($ECFP_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	

B -30	**Emissions Factor for Electricity Consumption in furnace process ($EFECFP_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	C	Annual for each project year	100%	Electronic and paper	
B -31	**Total CO2 emissions from inputs to the furnace process ($TCIFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (16) Calculated from other variables TCAFP, TCSFP, TCCAFP, TCOFP, TCLFP
B -32	**Total CO2 from Argon entering the furnace ($TCAFP_b$)**	AISW plant records	Tonnes CO2	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (17) Argon is a by-product of oxygen production. TCAFP equals zero with all the emissions being covered by TCOFP
B -33	**Total CO2 from steam production in furnace process ($TCSFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (18) Calculated from other variables Not expected to be used in the baseline case in but will be monitored if changes are made in project years and adjustments to the baseline are needed.
B -34	**Quantity of each fuel (fsp_b) used in steam production in furnace process ($Q_{fsp,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B -35	**Emission factor of each fuel in furnace process (fsp_b) $EF_{fsp,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fsp}	M	Annual average for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor

B -36	**Total CO2 from compressed air production in furnace process ($TCCAFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (19) Equation (20) Calculated from other variables
B -37	**Quantity of each fuel (fca_b) used in compressed air production in furnace process ($Q_{fca,b}$)**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Not expected in this project but will be monitored if changes are made in project years
B -38	**Emission factor of each fuel in furnace process (fca_b) $EF_{fca,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{faa}	M and C	Annual average for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
B -39	**Electricity Consumed in making compressed air for the furnace process ($ECCA_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Covered currently by B-29
B -40	**Emissions Factor for Electricity Consumption in compressed air production ($EFECCA_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	C	Continuous with annual tabulation for each project year	100%	Electronic and paper	
B -41	**Total CO2 from oxygen production ($TCOFP_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (21) Equation (22) Calculated from other variables
B -42	**Quantity of each fuel (fop_b) used in oxygen production (Q_{fopb})**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Not expected in this project but will be monitored if changes are made in project years

B -43	**Emission factor of each fuel in oxygen production (fop_b) $EF_{fop,b}$**	AISW plant records Local fuel distributor	Tonnes CO2 per m3 corresponding to Q_{fop}	M and C	Annual average for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor.
B -44	**Electricity Consumed in making oxygen ($ECOP_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B-45	**Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	C	Annual tabulation for each project year	100%	Electronic and paper	
B-46	**Total CO2 from limestone for furnace process ($TCLFP_b$)**	AISW plant records IPCC	Tonnes CO2	E	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (23) Total limestone used in tonnes multiplied by IPCC default value of 0.44 tonnes of CO2/tonne of limestone
B-47	**Total CO2 from casting/blooming ($TCBM_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (24) Calculated from other variables TCFCBM and TCECBM
B-48	**Total CO2 from fuel consumption in casting/blooming ($TCFCBM_b$)**	AISW plant records	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Equation (25) Calculated from other variables Qfbm and EFfbm
B-49	**Quantity of each fuel (fbm) used in casting/blooming (Q_{fbm})**	AISW plant records	m3	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	Natural Gas in normal cubic meters (Nm3), Blast Furnace Gas 1000 m3, and Coke Oven Gas 1000 m3.
B -50	**Emission factor of each fuel in casting/blooming (fbm_b) $EF_{fbm,b}$**	AISW plant records Local fuel distributor.	Tonnes CO2 per m3 corresponding to Q_{fbm}	M and C	Annual for each project year	100%	Electronic and paper	Caloric value is measured and EF is calculated based on caloric value and Ukrainian conversion factor
B-51	**Total CO2 from electricity**	AISW plant records	Tonnes CO2	C	Calculated once per year for the	100%	Electronic and paper	Equation (26) Calculated from other

	consumption in casting/blooming ($TCECBM_b$)				baseline and prior two years			variables ECBM and EFECBM
B-52	**Electricity Consumed in casting/blooming ($ECBM_b$)**	AISW plant records	MWh	M	Calculated once per year for the baseline and prior two years	100%	Electronic and paper	
B-53	**Emissions Factor for Electricity Consumption in casting/blooming ($EFECBM_b$)**	ERUPT/ National defaults	Tonnes CO2/MWh	C	Annual tabulation for each project year	100%	Electronic and paper	

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

$$BE_y = TSO_{p,y} \times \left(\frac{TCPI_{b,y} + TCFP_{b,y} + TCBM_{b,y}}{TSO_{b,,y}} \right) \quad (2)$$

where

TSO_p= Total steel output for the project, tonnes
TSO_b= Total steel output for the OHF representing the baseline, tonnes
$TCPI_b$= Total embodied CO2 of Pig Iron entering project boundary measured in tonnes CO2
$TCFP_b$= Total CO2 in the furnace process, t CO2
$TCBM_b$=Total CO2 in the blooming milling, t CO2
y= project year
p=project
b=baseline

This includes 3 clear steps determining the CO2 emissions from Pig Iron entering the project/baseline (Step 1), the emissions from the furnace process (Step 2) and emissions from casting casting/blooming (Step 3).

Equations capture the entire CO2 impacts of all material and energy flows into the baseline. Therefore the approach is both transparent and justifiable. All the changes, e.g. the potential energy efficiency measures will be directly reflected into the baseline emissions further supporting the conservativeness of the baseline approach.

STEP 1 PIG IRON

CO2 due to the production of Pig Iron ($TCPI_b$) come from three sources: electricity, fuel, and material inputs.

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

where

$TCFCPI_b$= Total CO2 from fuel consumption in producing Pig Iron, t CO2
$TCEPI_b$= Total CO2 from electricity consumption in producing Pig Iron, t CO2
$TCIPI_b$= Total CO2 from Inputs into Pig Iron, t CO2
PII_b= the share of the total Pig Iron Produced that would be used as an input in the steel making process[26]

The CO2 emissions from fuel consumed in the Pig Iron process is the quantity of fuel multiplied by the emission factor of the fuel:

$$TCFCPI_{b,y} = \sum_{1}^{fpi} (Q_{fpi,b,y} \times EF_{fpi,b,y}) \quad (4)$$

where
fpi_b= number of fuels used in making pig iron
Q_b= quantity of fuel fpi used (m3)
EF_b= tonnes of CO2 per m3 of fuel fpi

The CO2 emissions from electricity consumed in the Pig Iron process is the quantity of electricity multiplied by the emission factor of electricity:

[26] Because the Blast Furnace produces Pig Iron for more than one steel making line, only a percentage of the total CO2 emitted from the Blast Furnace Process will be counted as the project's steel making emissions. In the baseline case this will be also monitored in OHFs representing the baseline scenario.

$$TCEPI_{b,y} = ECPI_{b,y} * EFECPI_{b,y} \quad (5)$$

where
$ECPI_b$ =Electricity Consumed in producing pig iron, MWh[27]
$EFECPI_b$= Emissions factor for electricity, t CO2/MWh in year y

The total CO2 emissions from the material inputs into pig iron include the CO2 from fuel and electricity used to prepare iron ore, the total CO2 from the reducing agent and lime, and the total CO2 from the steam used in the process. This is divided by the Total Pig Iron produced in year y to get a Tonnes of CO2/ Tonne of Pig Iron produced. This is then multiplied by the baseline value for tonnes of Pig Iron produced to get a total baseline tonnes of CO2 for Pig Iron inputs.

$$TCIPI_{b,y} = TPIP_{b,y} \times \frac{(TCFIO_{b,y} + TCEIO_{b,y} + TCRAPI_{b,y} + TCLPI_{b,y} + TCSPI_{b,y})}{TPIP_{p,y}} \quad (6)$$

$TCFIO_{b,y}$= Total CO2 from fuel used to prepare Iron Ore, t CO2
$TCEIO_{b,y}$= Total CO2 from electricity consumption preparing iron Ore, t CO2
$TCRAPI_{by}$= Total CO2 from Reducing Agent (t) CO2= t Reducing agent × Reducing Agent Default Emission Factor[28]
$TCLPI_{b,y}$=Total CO2 from the consumed lime entering Blast Furnace process, t CO2
$TCSPI_{b,y}$=Total CO2 from steam production entering Blast Furnace process, t CO2 (not expected in current project design

$$TCFIO_{b,y} = \sum_{1}^{fio} (Q_{fio,b,y} \times EF_{fio,b,y}) \quad (7)$$

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[27] 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 Blooming Mill 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 emissions 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 reduction results.

[28] For default factors for various reducing agents see the reference section which documents IPCC Good Practice Guideline defaults. If in the future several are used then a simple weighted average default will be used. For example, if 60% of the reducing agent is from coke from coal (3.1 tonnes CO2 per tonne reducing agent) and 40% is from petrol coke (3.6 tonnes of CO2 per tonne of reducing agent) then the default value would be 3.3 tonnes of CO2 per tonne of reducing agent.

where
fio_b= number of fuels used in preparing iron ore
Q_b= quantity of fuel fio used (m3)
EF_b= emission factor of each fuel (fio) in the tonnes of CO2 per m3 of fuel fio

$$TCEIO_{b,y} = ECIO_{b,y} * EFECIO_{b,y} \quad (8)$$

where
$ECIO_b$ =Electricity Consumed in preparing Iron Ore, MWh
$EFECIO_b$= Emissions factor for electricity, t CO2/MWh in year y

$$TCRAPI_{by} = \text{t Reducing agent} \times \text{Reducing Agent Default Emission Factor}^{29} \quad (9)$$

The current and expected reducing agent is coke with a default value of 3.1 t CO2/ tonne

$$TCLPI_{b,y} = \text{Total lime, tonnes} \times 0.440 \text{ t CO2/t limestone}^{30} \quad (10)$$

[29] For default factors for various reducing agents see the reference section which documents IPCC Good Practice Guideline defaults. If in the future several are used then a simple weighted average default will be used. For example, if 60% of the reducing agent is from coke from coal (3.1 tonnes CO2 per tonne reducing agent) and 40% is from petrol coke (3.6 tonnes of CO2 per tonne of reducing agent) then the default value would be 3.3 tonnes of CO2 per tonne of reducing agent.

[30] PCC Good Practice 2.5.1 - http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2wb1.pdf

$$TCSPI_{b,y} = \sum_{1}^{fsp} (Q_{fspi,b,y} \times EF_{fspi,b,y}) \qquad (11)$$

where
fsp_b= number of fuels used in steam production for the pig iron Process
Q_b= quantity of fuel fspi used
EF_b= tonnes of CO_2 per m3 of fuel fspi

The share of the total Pig Iron Produced that would be used as an input in the steel making process:

$$PII_{b,y} = \frac{TPII_{b,y}}{TPIP_{b,y}} \qquad (12)$$

where
$TPII_b$= Total Pig Iron Input into the steel process OHF representing the baseline, tonnes
$TPIP_b$= Total Pig Iron Produced, tonnes

STEP 2 Furnace Process

The total CO2 emissions from the furnace process ($TCFP_b$) include emissions from the total fuel and electricity used and CO2 emissions associated with the inputs into the furnace process.

$$TCFP_{b,y} = (TCFCFP_{b,y} + TCECFP_{b,y} + TCIFP_{b,y}) \qquad (13)$$

where

$TCFCFP_b$= Total CO2 from fuel consumption in Furnace Process, t CO2
$TCECFP_b$= Total CO2 from electricity consumption in Furnace Process, t CO2
$TCIFP_b$= Total CO2 from Inputs into Furnace Process measured, t CO2

Tonnes of CO2 for fuel used in the furnace will be the quantity of fuel multiplied by the emissions factor of that fuel:

$$TCFCFP_{b,y} = \sum_{1}^{fpi} (Q_{ffp,b,y} \times EF_{ffp,b\,y}) \quad (14)$$

where
ffp_b= number of fuels used in Furnace Process
Q_b= quantity of fuel ffp used
EF_b= tonnes of CO2 per m3 of fuel ffp

Tonnes of CO2 for electricity used in the furnace will be the quantity of electricity multiplied by the emissions factor:

$$TCECFP_{b,y} = ECFP_{b,y} * EFECFP_{b,y} \quad (15)$$

where
$ECFP_b$ =Electricity Consumed in Furnace Process, MWh
$EFECFP_b$= Emissions factor for electricity, t CO2/MWh in year y

The total tonnes of CO2 from inputs into the furnace process will include tonnes of CO2 from argon, steam, compressed air, oxygen, and lime:

$$TCIFP_{b,y} = (TCAFP_{b,y}+TCSFP_{b,y}+TCCAFP_{b,y}+TCOFP_{b,y}+TCLFP_{b,y}) \quad (16)$$

where

$TCAFP_{b,y}$ =Total CO2 from Argon production entering Furnace process, t CO2:[31]

$$TCAFP_{b,y} = (\text{Total argon used in m3} \times \text{MWh/m3 argon}) \times EFEC_{b,y} \quad (17)$$

(Argon will be produced as a byproduct of oxygen and this will not apply under current project design)

[31] Argon production is a byproduct of Oxygen production therefore will not double counted.

$TCSFP_{b,y}$ =Total CO2 from steam production entering Furnace process measured in tonnes CO2 (not expected in current project design):

$$TCSFP_{b,y} = \sum_{1}^{fpi} (Q_{fsp,\, b,y} \times EF_{fsp,b,y}) \qquad (18)$$

where
fsp_b= number of fuels used in steam production for the Furnace Process
Q_b= quantity of fuel fsp used
EF_b= tonnes of CO2 per m3 of fuel fsp

$TCCAFP_{b,y}$=Total CO2 from compressed air production entering Furnace process, t CO2

If compressed air is generated using electricity:

$$TCCAFP_{b,,y} = ECCA_{b,y} * EFECCA_{b,y,} \qquad (19)$$

where
$ECCA_b$ =Electricity Consumed in producing compressed air for the Furnace Process in MWh
$EFECCA_{b,}$= Emissions factor for electricity in t CO2/MWh in year y

If compressed air is generated using fossil fuels (not expected in current project design):

$$TCCAFP_{b,,y} = \sum_{1}^{fca} (Q_{fca,\, b,y} \times EF_{fca,b\ y}) \qquad (20)$$

where
fca_b= number of fuels used in compressed air production for the Furnace Process
Q_b= quantity of fuel fca used (m3)
EF_{by}= tonnes of CO2 per m3 of fuel fca in year y

$TCOFP_{,b,y}$ =Total CO2 from oxygen production entering Furnace process, t CO2:

If oxygen is generated using electricity

$$TCOFP_{b,y} = ECOP_{y,b} * EFECOP_{b,y} \qquad (21)$$

where
$ECOP_b$ =Electricity Consumed in producing oxygen for the Furnace Process, MWh
$EFECOP_b$= Emissions factor for electricity, t CO2/MWh in year y

If oxygen is generated using fossil fuels

$$TCOFP_{b,,y} = \sum_{1}^{fop} (Q_{fob,\,b,y} \times EF_{fob,\,b,y}) \qquad (22)$$

where

fop_b= number of fuels used in oxygen production for the Furnace Process (not expected in current project design)
Q_b= quantity of fuel fop used (m3)
EF_b= tonnes of CO2 per m3 of fuel fop

$TCLFP_{b,y}$=Total CO2 from consumed lime entering Furnace process, t CO2:

$TCLFP_b$= Total lime used, t × 0.440 t CO2/t limestone[32] (23)

[32] Taken from IPCC Good Practice 2.5.1 - http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2wb1.pdf

STEP 3 Casting/Blooming

The total tonnes CO2 from the casting/blooming process ($TCBM_b$) will be calculated from both the fuel and electricity input into the process:

$$TCBM_{b,y} = (TCFCBM_{b,y} + TCEBM_{b,y}) \quad (24)$$

where

$TCFCBM_b$= Total CO2 from fuel consumption in the casting/blooming, t CO2
$TCECBM_b$= Total CO2 from electricity consumption in the casting/blooming, t CO2

$$TCFPBM_{b,y} = \sum_{1}^{fbm} (Q_{fbm,b,y} \times EF_{fbm,b,y}) \quad (25)$$

where
fbm_b= number of fuels used in the casting/blooming
Q_b= quantity of fuel fbm used (m3)
EF_b= tonnes of CO2 per m3 of fuel fbm

$$TCECBM_{b,y} = ECBM_{b,y} * EFECBM_{b,y} \quad (26)$$

where
$ECBM_b$=Electricity Consumed in the casting/blooming, MWh
$EFECBM_b$= Emissions factor for electricity, t CO2/MWh in year y

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

Not applicable

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

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

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 expected from 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 different in the two cases.

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):

$$ER_y = BE_y - PE_y \quad (27)$$

where
ER =Emission Reductions
BE= Baseline Emissions
PE= Project Emissions
y= Project Year

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:

See section F1.

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-1	Total Steel Output (TSO_p) (Project)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-5	Total Pig Iron Input into Steel Making Process ($TPII_p$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-6	Total Pig Iron Produced ($TPIP_p$)	See B-6	Pls. refer to B-6
P-7	Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,\ p}$)	See B-7	Pls. refer to B-7
P-8	Emission factor of each fuel in Pig Iron Production (fpi_p) $EF_{fpi,p}$	See B-8	Pls. refer to B-8
P-10	Electricity Consumed in producing Pig Iron ($ECPI_p$)	See B-10	Pls. refer to B-10
P-11	Emissions Factor for Electricity Consumption in Pig Iron Production ($EFECPI_p$)	Low	Weighted average EF will be calculated based on grid electricity (monitored annually based on National grid EF) and electricity produced by own CHP plant. All metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-14	Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,p}$)	See B-14	Pls. refer to B-14
P-15	Emission factor of each fuel in Sintering (fio_p) $EF_{fio,\ p}$	See B-15	Pls. refer to B-15
P-17	Electricity Consumed in Sintering ($ECIO_p$)	See B-17	Pls. refer to B-17
P-18	Emissions Factor for Electricity Consumption in Sintering ($EFECIO_p$)	See P-11	Pls. refer to P-11
P-19	Total CO2 from Reducing Agents in Pig Iron Production ($TCRAPI_p$)	See B-19	Pls. refer to B-19
P-20	Total CO2 from limestone in Pig Iron Production Sintering ($TCLPI_p$)	See B-20	Pls. refer to B-20

P-22	Quantity of each fuel ($fspi_p$) used in steam production in Pig Iron Production ($Q_{fspi,p}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design
P-23	Emission factor of each fuel in in steam production Pig Iron Production ($fspi_p$) $EFfspi_{,p}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in current project design
P-26	Quantity of each fuel (ffp_p) used in furnace process ($Q_{ffp,p}$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-27	Emission factor of each fuel in the furnace process (ffp_p) $EF_{ffp,p}$	See B-27	Pls. refer to B-27
P-29	Electricity Consumed in the furnace process ($ECFP_p$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-30	Emissions Factor for Electricity Consumption in the furnace process ($EFECFP_p$)	See P-11	Pls. refer to P-11
P-34	Quantity of each fuel (fsp_p) used in steam production in the furnace process ($Q_{fsp,p}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design
P-35	Emission factor of each fuel in steam production in the furnace process (fsp_p) $EF_{fsp,p}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in current project design
P-37	Quantity of each fuel (fca_p) used in compressed air production ($Q_{fca,p}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design
P-38	Emission factor of each fuel in compressed air production (fca_p) $EF_{fca,p}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in current project design
P-39	Electricity Consumed in making compressed air for the furnace process ($ECCA_p$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design
P-40	Emissions Factor for Electricity Consumption in compressed air production ($EFECCA_p$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design

P-42	Quantity of each fuel (fop) used in oxygen production ($Q_{fop,p}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in current project design
P-43	Emission factor of each fuel in oxygen production (fop_p) EFfop	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in current project design
P-44	Electricity Consumed in making oxygen ($ECOP_p$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-45	Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_p$)	See P-11	Pls. refer to P-11
P-46	Total CO2 from limestone for furnace process ($TCLFP_p$)	Low -Medium	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. IPCC default will be used for emission factor.
P-49	Quantity of each fuel (fbm_p) used in casting ($Q_{fbm,p}$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-50	Emission factor of each fuel used in casting (fbm_p) $EF_{fbm,p}$	Low	The project developer will document the source(s) of data. Caloric value of fuels will be measured and Ukrainian conversion factors will be utilized.
P-52	Electricity Consumed in casting ($ECBM_p$)	Low	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
P-53	Emissions Factor for Electricity Consumption in casting ($EFECBM_p$)	See P-11	Pls. refer to P-11
B-1	Total Steel Output (TSO_b) of OHF (representing the baseline)	Low, ±20kg	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-5	Total Pig Iron Input into Steel Making Process ($TPII_b$) of OHF representing the baseline	Low, ±500kg	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-6	Total Pig Iron Produced ($TPIP_b$)	Low, ±500kg	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-7	Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi,b}$)	Low, ±1.8%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.

B-8	Emission factor of each fuel in making Pig Iron (fpi_b) $EF_{fpi,b}$	Low	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable Ukrainian conversion factors will be utilized in order to calculate EF.
B-10	Electricity Consumed in producing Pig Iron ($ECPI_b$)	Low, ±2%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-11	Emissions Factor for Electricity Consumption in making Pig Iron ($EFECPI_b$)	Low	Default value will be used (annual monitoring of national grid EF).
B-14	Quantity of each fuel (fio_b) used in Sintering ($Q_{fio,b}$)	Low, ±1.8%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-15	Emission factor of each fuel in Sintering (fio_b) $EF_{fio,b}$	Low, ±2%,	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable Ukrainian conversion factors will be utilized in order to calculate EF.
B-17	Electricity Consumed in Sintering ($ECIO_b$)	Low, ±2%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-18	Emissions Factor for Electricity Consumption in Sintering ($EFECIO_b$)	See B-11	Pls. refer to B-11
B-19	Total CO2 from Reducing Agents in Pig Iron Production ($TCRAPI_b$)	Low, ±500kg	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available. IPCC default will be used for emission factor
B-20	Total CO2 from limestone in Pig Iron Production ($TCLPI_b$)	Low, ±0.5%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available. IPCC default will be used for emission factor
B-22	Quantity of each fuel ($fspi_b$) used in steam production in Pig Iron Production ($Q_{fspi,b}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline.
B-23	Emission factor of each fuel in steam production ($fspi_b$) $EF_{fspi,b}$	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline.

B-26	Quantity of each fuel (ffp_b) used in furnace process ($Q_{ffp,b}$)	Low, ±0.7%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-27	Emission factor of each fuel in furnace process (ffp_b) $EF_{ffp,b}$	Low	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable Ukrainian conversion factors will be utilized in order to calculate EF.
B-29	Electricity Consumed in furnace process ($ECFP_b$)	Low, ±2.0%	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards.
B-30	Emissions Factor for Electricity Consumption in furnace process ($EFECFP_b$)	See B-11	Pls. refer to B-11
B-34	Quantity of each fuel (fsp_b) used in steam production in furnace process ($Q_{fsp,b}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline.
B-35	Emission factor of each fuel used in steam production in furnace process (fsp_b) $EF_{fsp,b}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in baseline
B-37	Quantity of each fuel (fca_b) used in compressed air production in furnace process ($Q_{fca,b}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline
B-38	Emission factor of each fuel in furnace process (fca_b) $EF_{fca,b}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in baseline
B-39	Electricity Consumed in making compressed air for the furnace process ($ECCA_b$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline
B-40	Emissions Factor for Electricity Consumption in compressed air production ($EFECCA_b$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline
B-42	Quantity of each fuel (fop_b) used in oxygen production ($Q_{fop,b}$)	N/A	Metering and measuring devices will be calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Not applicable in baseline
B-43	Emission factor of each fuel in oxygen production (fop_b) $EF_{fop,b}$	N/A	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF. Not applicable in baseline

B-44	Electricity Consumed in making oxygen ($ECOP_b$)	Low, ±0.5%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-45	Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_b$)	See B-11	Pls. refer to B-11
B-46	Total CO2 from limestone for furnace process ($TCLFP_b$)	Medium	Estimated. In line with AISW's Guiding Metrological Instructions. Impact of the use of lime on ERs is well below 1% .
B-49	Quantity of each fuel (fbm_b) used in casting/blooming ($Q_{fbm,b}$)	Low, ±0.7%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-50	Emission factor of each fuel in casting/blooming (fbm_b) $EF_{fbm,b}$	Low	Caloric value will be provided by fuel supplier for natural gas and coke oven gas and cross checked by AISW laboratory as applicable. Ukrainian conversion factors will be utilized in order to calculate EF.
B-52	Electricity Consumed in casting/blooming ($ECBM_b$)	Low, ±2.0%	Metering and measuring devices are calibrated as per manufacture's instructions and in line with AISW's Guiding Metrological Instructions and national standards. Detailed monitoring device listing is available.
B-53	Emissions Factor for Electricity Consumption in casting/blooming ($EFECBM_b$)	See B-11	Pls. refer to B-11

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, processes that differ in baseline and project (OHF vs. Converters and Blooming vs. Continuous Casting) 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 AISW therefore monitoring is integral part of routine monitoring. All data will be collected into electronic database of AISW. Data is compiled in (i) day-to-day records, (ii) quarterly records, and (iii) annual records. All records are finally stored in Planning Department. The 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 AISW under supervision of Chief Energy Specialist and managed by Director General 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 Chief Energy Specialist. The World Bank will also supervise the implementation of the Monitoring Plan for the project at regular intervals. See also Annex 3 for additional information.

Table 4. Responsible specialists for monitoring.

Responsibility	Responsible specialist	Data variables	
		Baseline	**Project**
Overall Project Responsibility	Chief Engineer		
Overall Responsibility for Monitoring report	Chief Energy Specialist	B-8, B-11, B-15, B-18, B-23, B-30, B-35, B-38, B-40, B-43, B-45, B-50, B-53	P-8, P-11, P-15, P-18, P-23, P-30, P-35, P-38, P-40, P-43, P-45, P-50, P-53
Data for Converters and Continuous Casting	Deputy Chief Engineer for continuous casting and staff	N/A	P-1, P-5, P-29, P-37, P-39, P-46, P-49, P-52
Data for OHFs and Blooming	Deputy Chief Engineer for steel production and staff	B-1, B-5, B-29, B-37, B-39, B-46, B-49, B-52	N/A
Data for Blast Furnaces	Deputy Chief Engineer for blast-furnace production and staff	B-6, B-7, B-10, B-22	P-6, P-7, P-10, P-22
Data for Sinter Plant	Deputy Head of Sinter Shop and staff	B-14, B-17, B-19, B-20, B-34,	P-14, P-17, P-19, P-20, P-34,
Data for Oxygen Plants	Chief of Oxygen-Compressor Shop and staff	B-42, B-44	P-42, P-44
Data for CHP	Chief of CHP and staff	N/A	P-11 (measurement of the amount of electricity produced by CHP)

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

Kevin James
Quality tonnes
Pokrovsky Hills, WL #55, Beregovaya Street, 3
Moscow, Russia 125367
+ (7 495) 737-5073, kjames@qualitytonnes.com
Mr. James is not a project participant.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Estimate of *ex-ante* project data is based on (i) historical data for pig iron production (Sinter Plant and Blast Furnace) and technical specifications of the project for (ii) Converters and (iii) Continuous Casting. Detailed calculation is included in Annex 3.

Table 5. Estimate of Project Data.

Project Emissions (PE)		2007	2008	2009	2010	2011	2012
Pig Iron	t CO2/y	6,013,667	8,669,854	8,993,265	9,579,018	9,564,491	9,549,965
Converters	t CO2/y	649,541	924,436	946,433	994,735	979,865	964,995
Casting	t CO2/y	24,515	34,779	35,490	37,175	36,491	35,807
Total	t CO2/y	6,687,723	9,629,068	9,975,187	10,610,927	10,580,847	10,550,766
Total 2008-2012	t CO2/y		51,346,796				

E.2. Estimated leakage:

Not applicable.

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

Table 6. Estimate of Project Data.

Project Emissions		2007	2008	2009	2010	2011	2012
Pig Iron	t CO2/y	6,013,667	8,669,854	8,993,265	9,579,018	9,564,491	9,549,965
Converters	t CO2/y	649,541	924,436	946,433	994,735	979,865	964,995
Casting	t CO2/y	24,515	34,779	35,490	37,175	36,491	35,807
Total	t CO2/y	6,687,723	9,629,068	9,975,187	10,610,927	10,580,847	10,550,766
Total 2008-2012	t CO2/y		51,346,796				

E.4. Estimated baseline emissions:

Estimate of *ex-ante* the baseline is based on historical data. Detailed calculation is included in Annex 3.

Baseline Emissions		2007	2008	2009	2010	2011	2012
Pig Iron	t CO2/y	6,379,439	9,196,012	9,537,829	10,157,745	10,141,033	10,124,322
Open Hearth Furnaces	t CO2/y	776,194	1,111,213	1,144,530	1,210,384	1,199,844	1,189,304
Blooming	t CO2/y	116,781	166,269	170,294	179,058	176,454	173,852
Total	t CO2/y	7,272,415	10,473,493	10,852,653	11,547,187	11,517,331	11,487,477
Total 2008-2012	t CO2/y		55,878,141				

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

Table 7. Estimate of Emission Reductions.

Emission reductions		2007	2008	2009	2010	2011	2012
Pig Iron	t CO2/y	365,772	526,158	544,564	578,727	576,542	574,357
Converters/ Open Hearth Furnaces	t CO2/y	126,653	186,777	198,097	215,649	219,979	224,309
Casting/Blooming	t CO2/y	92,266	131,490	134,804	141,883	139,963	138,045
Total	t CO2/y	584,692	844,425	877,465	936,260	936,484	936,711
Total 200-2012	t CO2/y		4,531,345				

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2007	6,687,723	0	7,272,415	584,692
Total tonnes of CO_2 equivalent	6,687,723	0	7,272,415	584,692

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2008	9,629,068	0	10,473,493	844,425
2009	9,975,187	0	10,852,653	877,465
2010	10,610,927	0	11,547,187	936,260
2011	10,580,847	0	11,517,331	936,484
2012	10,550,766	0	11,487,477	936,711
Total tonnes of CO_2 equivalent	51,346,796		55,878,141	4,531,345

SECTION F. Environmental impacts

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

The project has been subject to a formal environmental impact assessments or OVOS undertaken in accordance with the applicable legislation and regulations of Ukraine. These include: the Laws of Ukraine “On Protection of Environment”, “On Ecological Expertise”, “On Protection of Atmospheric Air”, “On Wastes”, “On Ensuring Sanitary and Epidemic Welfare of the Population”, and “On Local Councils and Local Government”, as well as the applicable Water Code, Land Code, and Forest Code.

The EIA documents provide a baseline reference of 2004 against which the environmental performance of the proposed developments were assessed. This indicates that the primary current concern is ground level air pollutant concentrations as measured at the facility boundary. Currently the level of ground-level concentration of emissions at the boundary of AISW exceeds MPC for NO_2 by 5%, and for CO by 77%. The total emissions recorded within one monitored group of pollutants exceed MPC by 122% and for another group by 207%. These levels are primarily attributable to the Sinter Plant and Blast Furnaces that are not involved in the current project and considered outside the scope of the EIA.

Recognizing the incremental nature of the overall project's implementation covering the installation of Converters and Continuous Slab Casters, the EIA was undertaken for each part as the design and engineering documents were approved for the required technical approvals, one step in which was the formal State Environmental Expertise. As a result, the EIAs were presented in books prepared by Lugansk branch of the Ukrainian Scientific Center of Technical Ecology (UkrNTEC).

The first book covered the installation of 2 Slab Casters, a Twin Ladle-Furnace and transitional re-construction of old Open Hearth Furnaces prior to replacement by Converters (subsequently covered in second Book) to give a capacity of 5 million tonnes of steel per year. The book was prepared in 2004 and is marked as TM-103172 (available on request). The EIA concluded that the project would decrease the total emissions of pollutants within the steel making part of the process from 15,829 tonnes per year to 4,980 tonnes per year with the percentage of emissions from steel production section being only 6.5% of overall emissions at the AISW.

Furthermore, after project implementation, the concentration of air pollutants will not exceed the maximum one-time permissible level of pollutant concentration in the atmosphere measured in mg/m^3 (MPC) as approved by the Ministry of Health of Ukraine and considered a national standard. More specifically, the concentration of pollutants in the air as a result of the project activity is expected to be the following:

Table 8. Concentrations of pollutants

Substance	Project Concentration (% of MPC)
CO	0.64
NO_2	0.43
SO_2	0.17
Particulate	0.92
Total Emissions	0.69

It was also concluded that concentration of pollutants in the ambient air due to the Slab Casters and Ladle Furnace would not exceed the allowable norms and would be even lower than for existing facilities. Similarly, water use while increasing for the Slab Casters, would not have a significant influence on the aggregate consumption for AISW. The EIA also envisaged the greening (planting trees, bushes etc) of the industrial area where new facilities were planned to be installed and in areas between AISW and adjacent residential areas. In total 178.2 ha or 54% of the site area of land will be vegetated.

Formal approval by the State Environmental Expertise authorities has been received for the developments covered by the Book 1 EIA on. The hard copy of the 115 page EIA in Russian is available at the Institute for Environment and Energy Conservation.

A subsequent Book covered the installation two Converters which would replace the three old Open Hearth Furnaces (leaving new Open Hearth Furnace operational). It was prepared in 2006 and is marked as 23218-3A. Its' primary conclusion was that the closure of the three Open Hearth Furnaces and would have a major positive environmental effect by reducing atmospheric emissions by 55,000 tonnes/year in comparison to 2004. This is a consequence of the higher environmental performance achievable from Converter versus open hearth steel making, improved process control using modern control systems, desulphurization of iron, off gas capture as fuel, inclusion of modern high efficiency dust capture systems on the Converters, and improved materials handling and process temperature practices. It also concluded that the contribution of the Converters to the maximum ground-level concentrations at the plant boundary would be insignificant. Of the high overall levels at the boundary noted in the base line quoted above, the contribution of the Converters is estimated as follows: NO_2 - 8.5%; SO_2 - 2.3%; and CO - 0.6%. It was also noted that the installation of the Converters would decrease the consumption of technical water by 17-18% in comparison with OHFs. The quantity of water discharge will be decreased by 7 times.

Formal approval by the State Environmental Expertise authorities has been received for the developments covered by the Book 3 EIA. The hard copy of the 136 page EIA in Russian is available at the Institute for Environment and Energy Conservation.

The overall conclusion of the environmental assessment process undertaken in accordance with procedures as determined of the Government of Ukraine has concluded that the proposed development has significant positive environmental benefits and that any adverse impacts are not significant as well as being readily mitigated.

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 stated in F1, the EIA undertaken by the Government of Ukraine as the host Party found the project to have a positive environmental impact for the subject investments themselves.

However, other project participants, namely IBRD have undertaken a broader environmental assessment (EA) in accordance with the procedures set out in World Bank OP 4.01 applicable to a Category B project. This was undertaken in recognition that the replacement of Open Hearth Furnace and a Blooming Mill with Converters and Continuous slab casting that achieves both expanded capacity and improved environmental performance within the steel making part of the process, will also have potential environmental implications elsewhere in the overall facility. In particular, it was noted that the primary local air emissions come from the upstream processes, specifically from Sinter Plant operation and indirectly from the associated coke plant operated by Alchevsk Coke.

This EA concluded that the impacts on local air quality of the proposed project alone, where capacity is increased but in the absence of any upstream modernization specifically to the Sinter Plants, are essentially neutral. While water consumption increased, and there was a positive impact in terms of deceased waste water discharge and improved quality. There was an increase in solid waste generation and resulting landfill disposal, but this was related to waste not considered hazardous. However, the assessment also indicates that substantial air emission reductions are achievable through the longer term modernization program being undertaken by AISW which includes eliminating the existing Sinter Plants and either replacing them or out sourcing requirements, as well as further Blast Furnace upgrading. In addition it notes that these investments have been committed to by AISW as part of an Environmental Corrective Action Program which is incorporated into the partial financing provided by the International Finance Corporation.[33]

In summary, IBRD's EA[34] concludes that the improvement in environmental performance derived from replacement of major process elements with technology meeting World Bank Group Guidelines and

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[33] http://www.ifc.org/ifcext/spiwebsite1.nsf/2bc34f011b50ff6e85256a550073ff1c/c7c3ef9e3563d70d85257162007370c3?opendocument

[34] Documentation will be available at the World Bank InfoShop, www.worldbank.org, http://www.worldbank.org.in/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=295584&menuPK=228424&Projectid=P101615

approaching EU BAT more than offsets increases in mass pollutant generation from the increase in capacity assuming the long term modernization program is completed. The proposed project is a key step in achieving that ultimate goal.

SECTION G. Stakeholders' comments

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

The information on stakeholder comments is given as part of the EIAs prepared according to the Ukrainian legislation. In addition, a separate environmental study has been developed by the IFC. The study contains information on influence of the project activities on local communities. For more information, see:

http://www.ifc.org/ifcext/spiwebsite1.nsf/f451ebbe34a9a8ca85256a550073ff10/d0e27de2c9c30d2c85257168007098cc?OpenDocument and http://www.amk.lg.ua/eng/eko.html

The Mayor of the city of Alchevsk Mr. Chub has signed a letter supporting the realization of the project "Revamping and Modernization of the Alchevsk Steel Mill -Using Higher Efficiency Technology to replace Existing Open Hearth Furnaces (OHF), Ingot Casting and Blooming Mills". The letter was addressed to all relevant authorities (available on request).

IBRD has also conducted stakeholder consultation locally and disclosed the project information both locally in Alchevsk and in World Bank InfoShop in November 2007 based on World bank safeguard policies.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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URL:	
Represented by:	Mr. Shevchenko Taras Grygorovych
Title:	Director General of the AISW
Salutation:	Mr.
Last name:	Grygorovych
Middle name:	Taras
First name:	Shevchenko
Department:	
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Fax (direct):	
Mobile:	
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Represented by:	Mr. Serhiy Yermilov
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URL:	www.carbonfinance.org
Represented by:	
Title:	Manager
Salutation:	Mrs.
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Middle name:	
First name:	Joelle
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Mobile:	
Personal e-mail:	Jchassard@worldbank.org

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 exists in a recent (2005) upgrade of a separate steel line that installed a new OHF, Ingot Caster, and a Blooming Mill. This 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 major changes in operations in this production line, baseline calculations can be based on most recent historical data available as applicable.

The baseline tonnes CO2 emissions per tonne of Steel output will be measured using the actual efficiency of the recently (2005) installed OHF, Ingot Casting, and Blooming Mill. It 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 CO2 emissions per output figure will include both the material flows and energy flows into project. The material flows will include major raw inputs of pig iron, steel scrap, as well as process inputs such as oxygen and compressed air. Each material flow will be measured for it's per unit impact on the tonnes of CO2 emissions per tonne of steel slab output.

Table 9. Emission factors for reducing agents (Section 2.13.1 from IPCC Good Practice Guide http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2wb2.pdf

TABLE 2-11
EMISSION FACTORS FOR CO_2 FROM METAL PRODUCTION
(TONNE CO_2/TONNE REDUCING AGENT)

Reducing Agent	Emission Factor [a]
Coal[b]	2.5
Coke from coal [b]	3.1
Petrol coke	3.6
Prebaked anodes and coal electrodes	3.6

[a] If better information on actual carbon content is not available nationally or cannot be calculated from data in the Energy Chapter.
[b] Derived from data in the Energy Chapter

Table 10. Baseline emission factors for electricity, g/kWh (Dutch Ministry of Economic Affairs, Operational Guidelines for Project Design Documents of Joint Implementation Projects, version 2.3)

Year	2007	2008	2009	2010	2011	2012
EF	0.856	0.836	0.816	0.796	0.776	0.756

Table 11. Emission factors for fuels (Ministry Of Environmental Protection Of Ukraine, Ukraine's National Inventory Report of Greenhouse Gas Sources and Sinks 1990 To 2005, Kyiv 2007)

	TJ/1000000 m3	t CO2/TJ	Oxidizing factor	tCO2/m3	tCO2/1000m3
NG	33.82	56.1	0.995	0.00189	
COG	16.75	47.67	0.995	0.000794	0.794

List of supporting documents provided to the Determinator.

- Supporting Letter from the Ministry of Industrial Policy of Ukraine (1)
- Supporting Letter from Societe Generale (2)
- Minutes of the Meeting of the Technical Council of the Plant, 26 May, 2003 (3)
- Protocol # 11 of the Technical Council of the AISW, 22 November 22, 2002 (4)
- Training program (5)
- Annual Monitoring Database (6)
- Emission Reduction Calculation Spreadsheet (including a Listing of Monitoring Devices) (7)
- Financial Calculations for Baseline and Project Cases (8-9)
- Guiding Metrological Instructions
    - RMI-I-19.0.1-07, "Metrological product quality assurance." (10)
    - RMI-I-19.0.2-07, "Metrological expertise of documentation." (11)
    - RMI-I-19.1.1-07, "Management of measurement technique". (12)
- Main literature Referenced in Section B (13 -)

Annex 3

MONITORING PLAN

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

The monitoring procedure will center on the collection of baseline data from the recently installed OHF, Ingot Casting and Blooming Mill slab producing line and 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.
- CO2 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 CO2 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 using the new OHF technology package already installed in 2005 and measuring the CO2 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 CO2 emissions. This is then compared to the total CO2 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 exclusively from the grid. In the project case since Blast Furnace gas will no longer be needed in the Blooming Mill, the project developers plan to use the Blast Furnace Gas to generate electricity in an existing combined heat and power plant that does not generate electricity in the baseline case. This situation will be dealt with by calculating the emissions factor for electricity using a weighted average in the project case of grid electricity and electricity generated using Blast Furnace gas. If saved Blast Furnace gas is used to replace fossil fuels in other processes, it will be captured by the Monitoring Plan.

Data Quality Management

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 AISW's Guiding Metrological Instructions.
- 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 AISW's Guiding Metrological Instructions and manufacturer's specifications before measuring any flow.

Three set of instructions at the AISW regulate the monitoring procedures and responsibilities. They are called Guiding Metrological Instructions:

1) “Metrological product quality assurance” (RMI-I-19.0.1-07)
2) “Metrological expertise of documentation” (RMI-I-19.0.2-07)
3) “Management of measurement technique” (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

The instructions have been developed in accordance with ISO 9001 requirements. They secure required accuracy of all the measurements done using monitoring equipment. According to national legislative requirements the instructions should be revised every 3 years

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

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

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

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

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

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% with as all parameters are or will be monitored. All the equipment used for monitoring purposes are in line with national legislative requirements and standards and also in line with ISO 9001 standards. Details are given in Guiding Metrological Instructions. The data will be cross checked as well as internal audits and corrective actions are taken as defined in Guiding Metrological Instructions. For the project case, similar procedures will 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 6.

No major emergencies are expected having a 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 4. Detailed device listing for Converters and Continuous Casting will be available by initial verification (see figure 5 and table 14). Monitoring Database will be available for monitoring purposes.

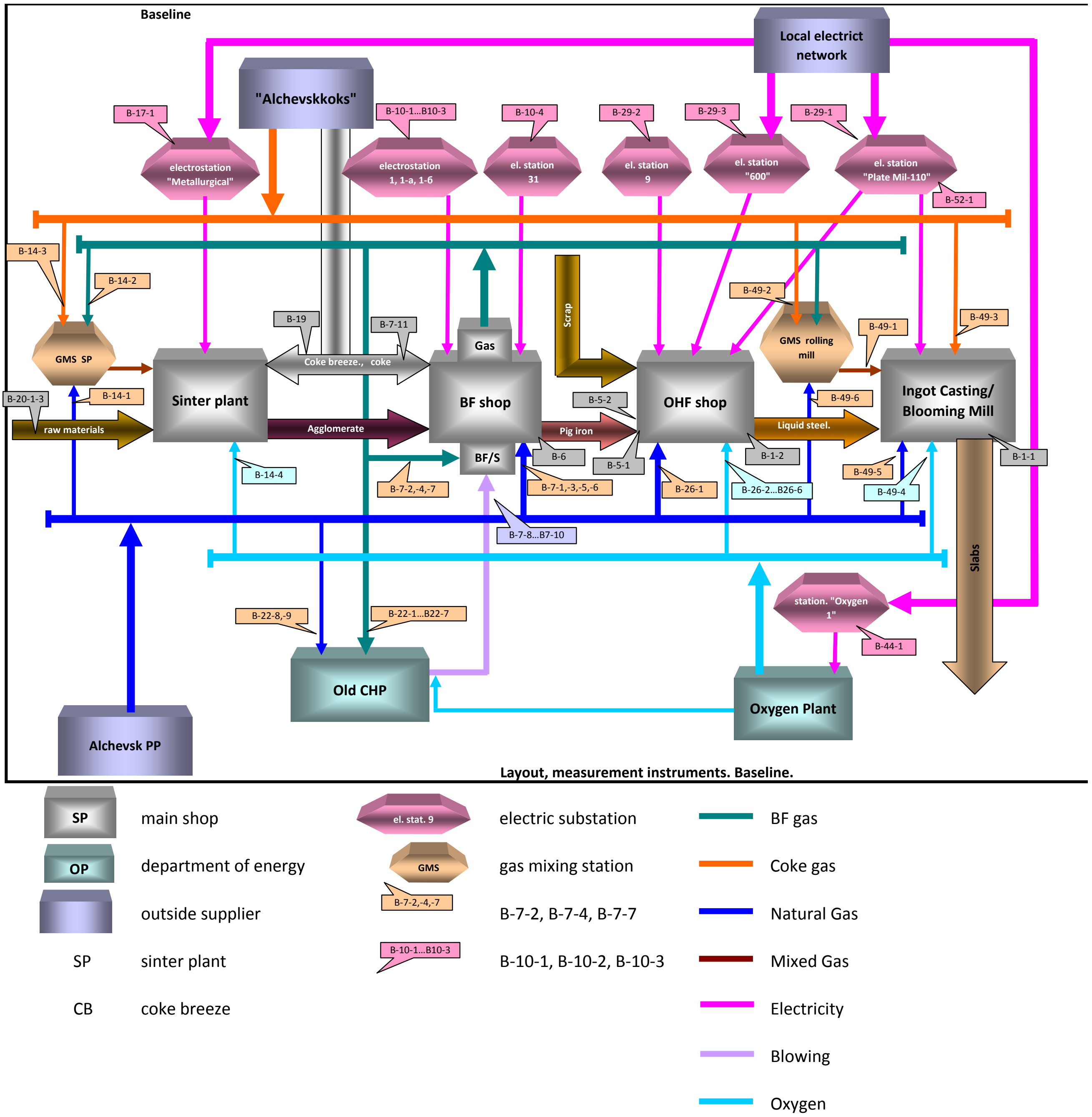
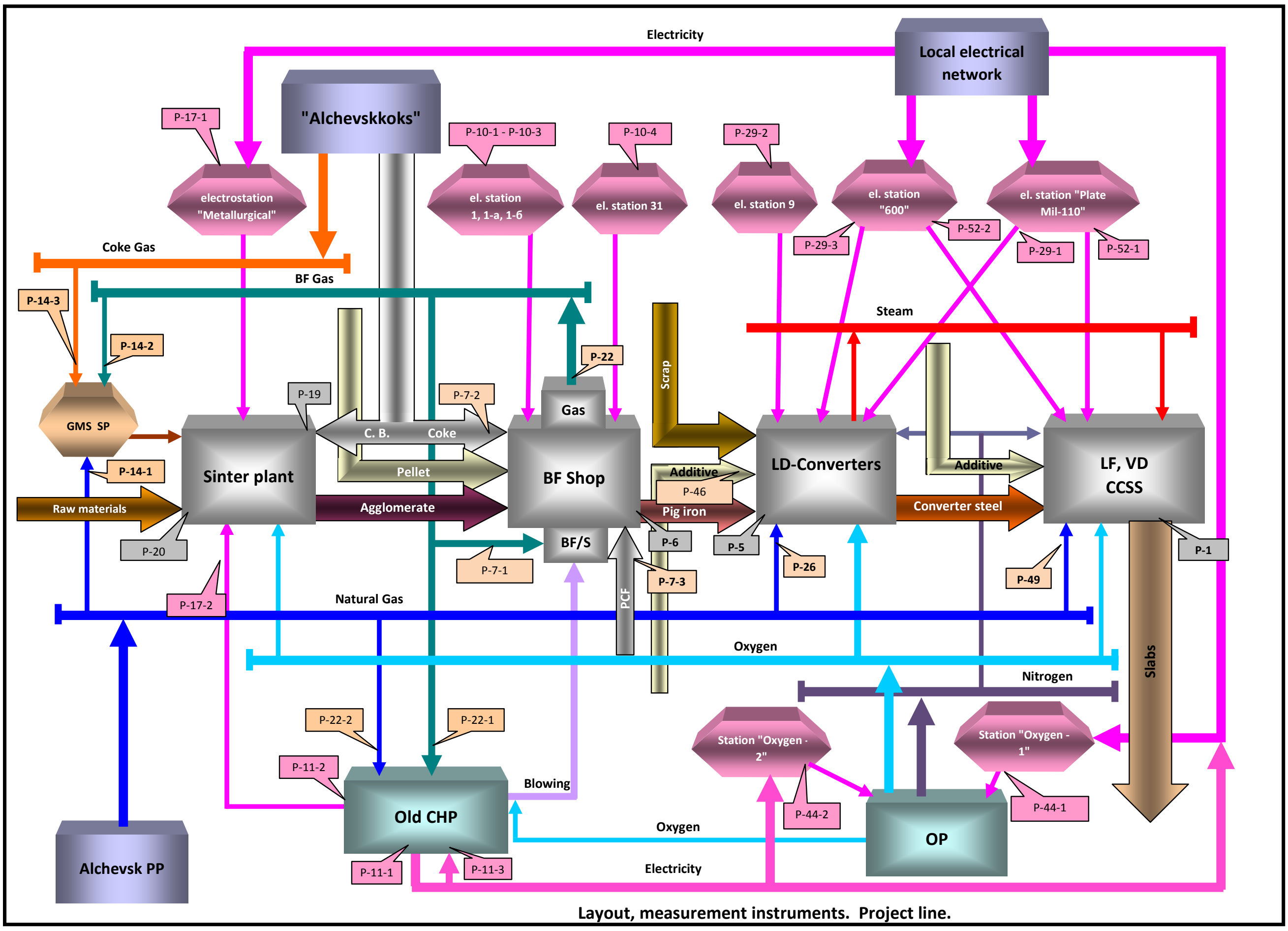


Figure 4. Baseline monitoring outline for GHG monitoring



SP	sinter plant		Blowing
OP	oxygen plant		Oxygen
	outside supplier		Nitrogen
el. station. 9	electric substation		Steam
	gas mixing station	G/C	blast furnace gas cleaning
	BF Gas	BF/S	blast furnace stove
	Coke Gas	C.B.	coke breeze, coal
	Natural Gas	PCF	powdered coal fuel BF shop (under consideration)
	Mixed Gas	BF Shop	blast furnace shop
	Electricity	**GDS**	gas-distribution station
		SP	sinter plant
		OCP	oxygen-converter plant
		CCSS	Continuous casting steel shop
		Old CHP	heat and power plant
		OP	oxygen plant

Figure 5. Project monitoring outline for GHG monitoring.

Table 12. Outline for monitoring methods for project line.

Continuous casting		
P-1	Slab production volume, t	weighting machine
P-49	Fuel for casting, 1000 m3, NG.	flow meter
P-52	electricity for casting, MWh.	supply meter
Converters		
P-5	Volume of pig iron, t	weighting machine
P-26	Fuel for converters, 1000 m3	flow meter
P-29	electricity for converter steel production, MWh	supply meter
P-46	Lime, t.	t.b.d.
Blast Furnace		
P-6	pig iron, total, t.	weighting machine
P-7	fuel for pig iron production, t, coke; m3, NG	weighting machine; flow meter
P-10	electricity for pig iron production, MWh	supply meter
Sinter Plant		
P-19	fuel for agglomerate production, t, coke.	weighting machine
P-20	volume of raw materials for agglomerate production, t, lime	
P-14	fuel for agglomerate production, m3, NG	flow meter
P-17	electricity for agglomerate production, MWh.	supply meter
Old CHP		
P-22	Fuel CHP, 1000 m3, BFG; m3 NG	flow meter
P-11	Output of electricity CHP, MWh	supply meter
Oxygen Plant		
P-44	Electricity for oxygen and nitrogen production, MWh.	supply meter

All devices will be in compliance with the relevant Ukrainian requirements and Guiding Metrological Instructions of AISW.

Detailed calculation for project and baseline emissions are included in table 15 and table 16.

Table 13. Detailed estimate of Project data.

ID number	Data variable	Units	2007	2008	2009	2010	2011	2012
	Project Emissions (PE)	Tonnes CO2	6,687,723	9,629,068	9,975,187	10,610,927	10,580,847	10,550,766
P-1	Total Steel Output (TSO_p)	Tonnes	3,296,000	4,759,000	4,944,000	5,274,000	5,274,000	5,274,000
P-2	Total CO2 of Pig Iron ($TCPI_p$)	Tonnes CO2	6,013,667	8,669,854	8,993,265	9,579,018	9,564,491	9,549,965
P-3	Total CO2 from Fuel Consumption for Pig Iron ($TCFCPI_p$)	Tonnes CO2	623,758	900,626	935,637	998,089	998,089	998,089
P-4	Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PII_p)	share	1.00	1.00	1.00	1.00	1.00	1.00
P-5	Total Pig Iron Input into Steel Making Process ($TPII_p$)	Tonnes	2,964,884	4,280,911	4,447,326	4,744,174	4,744,174	4,744,174
P-6	Total Pig Iron Produced ($TPIP_p$)[35]	Tonnes	2,964,884	4,280,911	4,447,326	4,744,174	4,744,174	4,744,174
P-7	Quantity of each fuel (fpi_p) used in making Pig Iron ($Q_{fpi,p}$)							
	NG	m3	287,593,753	415,248,367	431,390,587	460,184,898	460,184,905	460,184,905
	COG	1000 m3	101,745	146,906	152,617	162,804	162,804	162,804
P-8	Emission factor of each fuel in Pig Iron Production (fpi_p) $EF_{fpi,\ p}$							
	NG	Tonnes CO2 per m3	0.00189	0.00189	0.00189	0.00189	0.00189	0.00189
	COG	Tonnes per 1000 Nm3	0.794	0.794	0.794	0.794	0.794	0.794
P-9	Total CO2 from Electricity used in Pig Iron production ($TCEPI_p$)	Tonnes CO2	388,556	547,917	555,599	578,157	563,631	549,104
P-10	Electricity Consumed in producing Pig Iron ($ECPI_p$)	MWh	495,136	714,912	742,703	792,277	792,277	792,277
P-11	Emissions Factor for Electricity Consumption in Pig Iron Production ($EFECPI_p$)	Tonnes CO2/MWh	0.785	0.766	0.748	0.730	0.711	0.693
	Total Electricity Used in Steel Making Process		1,025,288	1,480,384	1,537,931	1,640,585	1,640,585	1,640,585
	Grid Emission Factor	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756

[35] Total Pig iron output will be measured in the project case

	CHP Plant Emission Factor	Tonnes CO2/MWh	0.00	0.00	0.00	0.00	0.00	0.00
	Total Electricity Produced by CHP	MWh	85,345	123,227	128,017	136,562	136,562	136,562
	Blast Furnace Gas	1000 m3	398,275	575,058	597,412	637,288	637,288	637,288
	NG	m3	0	0	0	0	0	0
	Emission factor for BFG	Tonnes CO2 per 1000 m3	0	0	0	0	0	0
	Emission factor for NG	Tonnes CO2 per m3	0.00189	0.00189	0.00189	0.00189	0.00189	0.00189
P-12	**Total CO2 from inputs into Pig Iron ($TCIPI_p$)**	Tonnes CO2	5,001,353	7,221,310	7,502,029	8,002,772	8,002,772	8,002,772
P-13	**Total CO2 from Fuel Consumption in Sintering ($TCFIO_p$)[36]**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
P-14	**Quantity of each fuel (fio_p) used in Sintering ($Q_{fio,\ p}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-15	**Emission factor of each fuel in Sintering (fio_p) $EF_{fio.\ p}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-16	**Total CO2 from Electricity used in Sintering ($TCEIO_p$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
P-17	**Electricity Consumed in Sintering ($ECIO_p$)**	MWh	N/A	N/A	N/A	N/A	N/A	N/A
P-18	**Emissions Factor for Electricity Consumption ($EFECIO_p$)**	Tonnes CO2/MWh	0.785	0.766	0.748	0.730	0.711	0.693
P-19	**Total CO2 from Reducing Agents in Pig Iron Production ($TCRAPI_p$)**	Tonnes CO2	4,947,867	7,144,083	7,421,799	7,917,187	7,917,187	7,917,187
	Total Reducing Agent	Tonnes	1,596,086	2,304,543	2,394,129	2,553,931	2,553,931	2,553,931
	Default Emission Factor	Tonnes CO2/Tonne	3.10	3.10	3.10	3.10	3.10	3.10
P-20	Total CO2 from limestone in Pig Iron Production ($TCLPI_p$)	Tonnes CO2	53,487	77,228	80,230	85,585	85,585	85,585
	Total Limestone	Tonnes	121,560	175,517	182,340	194,511	194,511	194,511

[36] The data for Iron Ore is currently aggregated into the Pig Iron Process. The project will separate the data.

	Default Emission Factor	Tonnes CO2/Tonne	0.44	0.44	0.44	0.44	0.44	0.44
P-21	**Total CO2 from steam production in Pig Iron Production ($TCSPI_p$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
P-22	**Quantity of each fuel ($fspi_p$) used in steam production in Pig Iron Production ($Q_{fspi, p}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-23	**Emission factor of each fuel in Steam Production ($fspi_p$) $EF_{fspi, p}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-24	**Total CO2 emissions from the furnace process ($TCFP_p$)**	Tonnes CO2	649,541	924,436	946,433	994,735	979,865	964,995
P-25	**Total CO2 emissions from fuel consumption in the furnace process ($TCFCFP_p$)**	Tonnes CO2	116,284	167,900	174,427	186,069	186,069	186,069
P-26	**Quantity of each fuel (ffp_p) used in furnace process ($Q_{ffp,p}$)**							
	NG	m3	61,597,314	88,938,594	92,395,962	98,563,176	98,563,177	98,563,177
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-27	**Emission factor of each fuel in the furnace process (ffp_p) $EF_{ffp,p}$**							
	NG	Tonnes CO2 per m3	0.00189	0.00189	0.00189	0.00189	0.00189	0.00189
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-28	**Total CO2 emissions from electricity consumption in the furnace process ($TCECFP_p$)**	Tonnes CO2	241,969	341,209	345,993	360,041	350,995	341,949
P-29	**Electricity Consumed in the furnace process ($ECFP_p$)**	MWh	308,340	445,204	462,510	493,382	493,382	493,382
P-30	**Emissions Factor for Electricity Consumption in the furnace process ($EFECFP_p$)**	Tonnes CO2/MWh	0.785	0.766	0.748	0.730	0.711	0.693
P-31	**Total CO2 emissions from inputs to the furnace process ($TCIFP_p$)**	Tonnes CO2	291,288	415,327	426,013	448,625	442,801	436,977
P-32	**Total CO2 from Argon entering the furnace ($TCAFP_p$)[37]**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
P-33	**Total CO2 from steam production in the furnace process ($TCSFP_p$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A

[37] Currently made as a byproduct of oxygen production.

P-34	**Quantity of each fuel (fsp_p) used in steam production in the furnace process ($Q_{fsp,p}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-35	**Emission factor of each fuel used in steam production (fsp_p) $EF_{fsp, p}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-36	**Total CO2 from compressed air production for the furnace process ($TCCAFP_p$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
P-37	**Quantity of each fuel (fca_p) used in compressed air production ($Q_{fca,p}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-38	**Emission factor of each fuel in compressed air production (fca_p) $EF_{fca, p}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-39	**Electricity Consumed in making compressed air for the furnace process ($ECCA_p$)** [38]	MWh	N/A	N/A	N/A	N/A	N/A	N/A
P-40	**Emissions Factor for Electricity Consumption in compressed air production ($EFECCA_p$)**	Tonnes CO2/MWh	N/A	N/A	N/A	N/A	N/A	N/A
P-41	**Total CO2 from oxygen production ($TCOFP_p$)**	Tonnes CO2	155,774	219,662	222,742	231,786	225,962	220,138
P-42	**Quantity of each fuel (fop_p) used in oxygen production ($Q_{fop, p}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-43	**Emission factor of each fuel in oxygen production (fop_p) $EF_{fop, p}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-44	**Electricity Consumed in making oxygen ($ECOP_p$)**	MWh	198,502	286,611	297,753	317,627	317,627	317,627
P-45	**Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_p$)**	Tonnes CO2/MWh	0.785	0.766	0.748	0.730	0.711	0.693

[38] Covered by B-29

P-46	**Total CO2 from limestone for furnace process ($TCLFP_p$)**	Tonnes CO2	135,514	195,665	203,271	216,839	216,839	216,839
	Total Limestone	Tonnes	307,987	444,693	461,980	492,816	492,816	492,816
	Default Emission Factor	Tonnes CO2/Tonne	0.44	0.44	0.44	0.44	0.44	0.44
P-47	**Total CO2 from casting ($TCBM_p$)**	Tonnes CO2	24,515	34,779	35,490	37,175	36,491	35,807
P-48	**Total CO2 from fuel consumption in casting ($TCFCBM_p$)**	Tonnes CO2	6,222	8,984	9,333	9,956	9,956	9,956
P-49	**Quantity of each fuel (fbm_p) used in casting ($Q_{fbm,\ p}$)**							
	NG	m3	3,296,000	4,759,000	4,944,000	5,274,000	5,274,000	5,274,000
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-50	**Emission factor of each fuel used in casting (fbm_p) $EF_{fbm,\ p}$**							
	NG	Tonnes CO2/m3	0.00189	0.00189	0.00189	0.00189	0.00189	0.00189
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
P-51	**Total CO2 from electricity consumption in casting ($TCECBM_p$)**	Tonnes CO2	18,292	25,795	26,156	27,218	26,534	25,851
P-52	**Electricity Consumed in casting ($ECBM_p$)**	MWh	23,310	33,656	34,965	37,299	37,299	37,299
P-53	**Emissions Factor for Electricity Consumption in casting ($EFECBM_p$)**	Tonnes CO2/MWh	0.785	0.766	0.748	0.730	0.711	0.693

Table 14. Detailed estimate of Baseline data.

ID Number	Data variable	Units	2007	2008	2009	2010	2011	2012
	Baseline Emissions (BE)	Tonnes CO2	7,272,415	10,473,494	10,852,653	11,547,187	11,517,331	11,487,477
B-1	**Total Steel Output (TSO_b)**	Tonnes	3,296,000	4,759,000	4,944,000	5,274,000	5,274,000	5,274,000
B-2	**Total CO2 of Pig Iron ($TCPI_b$)**	Tonnes CO2	6,379,439	9,196,012	9,537,829	10,157,745	10,141,033	10,124,322
B-3	**Total CO2 from Fuel Consumption in Pig Iron production ($TCFCPI_b$)**	Tonnes CO2	657,838	949,834	986,757	1,052,621	1,052,621	1,052,621
B-4	**Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PII_b)**	share	1.00	1.00	1.00	1.00	1.00	1.00

B-5	**Total Pig Iron Input into Steel Making Process ($TPII_b$)**	Tonnes	3,126,874	4,514,805	4,690,312	5,003,379	5,003,379	5,003,379
B-6	**Total Pig Iron Produced ($TPIP_b$)**[39]	Tonnes	3,126,874	4,514,805	4,690,312	5,003,379	5,003,379	5,003,379
B-7	**Quantity of each fuel (fpi_b) used in making Pig Iron ($Q_{fpi, b}$)**							
	NG	m3,	303,306,801	437,936,085	454,960,278	485,327,765	485,327,740	485,327,740
	COG	1000 m3	107,304	154,933	160,956	171,699	171,699	171,699
B-8	**Emission factor of each fuel (fpi_b) $EF_{fpi, b}$**							
	NG	Tonnes CO2 per m3	0.00189	0.00189	0.00189	0.00189	0.00189	0.00189
	COG	Tonnes per 1000 Nm3	0.794	**0.794**	**0.794**	**0.794**	**0.794**	**0.794**
B-9	**Total CO2 from Electricity used in Pig Iron production ($TCEPI_b$)**	Tonnes CO2	446,993	630,321	639,158	665,109	648,398	631,687
B-10	**Electricity Consumed in producing Pig Iron ($ECPI_b$)**	MWh	522,188	753,972	783,282	835,564	835,564	835,564
B-11	**Emissions Factor for Electricity Consumption in making Pig Iron ($EFECPI_b$)**	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756
B-12	**Total CO2 from inputs into Pig Iron ($TCIPI_b$)**	Tonnes CO2	5,274,608	7,615,858	7,911,914	8,440,015	8,440,015	8,440,015
B-13	**Total CO2 from Fuel Consumption in Sintering ($TCFIO_b$)**[40]	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
B-14	**Quantity of each fuel (fio_b) used in Sintering**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B-15	**Emission factor of each fuel in Sintering (fio_b) $EF_{fio, b}$**							
	Fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	Fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B-16	**Total CO2 from Electricity used in Sintering ($TCEIO_b$)**	Tonnes CO2	0	0	0	0	0	0
B-17	**Electricity Consumed in Sintering ($ECIO_b$)**	MWh	N/A	N/A	N/A	N/A	N/A	N/A
B-18	**Emissions Factor for Electricity Consumption in Sintering ($EFECIO_b$)**	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756

[39] Total Pig iron output will be measured in the project case

[40] The data for Iron Ore is currently aggregated into the Pig Iron Process. The project will separate the data.

B-19	**Total CO2 from Reducing Agents ($TCRAPI_b$)**	Tonnes CO2	4,947,867	7,144,083	7,421,799	7,917,187	7,917,187	7,917,187
	Total Reducing Agent	Tonnes	1,596,086	2,304,543	2,394,129	2,553,931	2,553,931	2,553,931
	Default Emission Factor	Tonnes CO2/Tonne	3.10	3.10	3.10	3.10	3.10	3.10
B-20	**Total CO2 from limestone in Pig Iron Production ($TCLPI_b$)**	Tonnes CO2	53,487	77,228	80,230	85,585	85,585	85,585
	Total Limestone	Tonnes	121,560	175,517	182,340	194,511	194,511	194,511
	Default Emission Factor	Tonnes CO2/Tonne	0.44	0.44	0.44	0.44	0.44	0.44
B-21	**Total CO2 from steam production in Pig Iron Production ($TCSPI_b$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
B-22	**Quantity of each fuel ($fspi_b$) used in steam production in Pig Iron Production ($Q_{fspi, b}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B-23	**Emission factor of each fuel in steam production ($fspi_b$) $EF_{fspi, b}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B-24	**Total CO2 emissions from the furnace process ($TCFP_b$)**	Tonnes CO2	776,194	1,111,213	1,144,530	1,210,384	1,199,844	1,189,304
B -25	**Total CO2 emissions from fuel consumption in the furnace process ($TCFCFP_b$)**	Tonnes CO2	353,877	510,952	530,815	566,245	566,245	566,245
B -26	**Quantity of each fuel (ffp_b) used in furnace process ($Q_{ffp,b}$)**							
	NG	m3	187,452,920	270,657,930	281,179,427	299,947,467	299,947,451	299,947,451
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -27	**Emission factor of each fuel in furnace process (ffp_b) $EF_{ffp,b}$**							
	NG	Tonnes CO2 per m3	**0.00189**	**0.00189**	**0.00189**	**0.00189**	**0.00189**	**0.00189**
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -28	**Total CO2 emissions from electricity consumption in the furnace process ($TCECFP_b$)**	Tonnes CO2	113,151	159,558	161,795	168,364	164,134	159,904
B -29	**Electricity Consumed in furnace process ($ECFP_b$)**	MWh	132,185	190,859	198,278	211,513	211,513	211,513

B -30	**Emissions Factor for Electricity Consumption in furnace process ($EFECFP_b$)**	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756
B -31	**Total CO2 emissions from inputs to the furnace process ($TCIFP_b$)**	Tonnes CO2	309,167	440,703	451,920	475,774	469,465	463,155
B -32	**Total CO2 from Argon entering the furnace ($TCAFP_b$)[41]**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
B -33	**Total CO2 from steam production in furnace process ($TCSFP_b$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
B -34	**Quantity of each fuel (fsp_b) used in steam production in furnace process ($Q_{fsp,b}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -35	**Emission factor of each fuel in used in steam production (fsp_b) $EF_{fsp, b}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -36	**Total CO2 from compressed air production in furnace process ($TCCAFP_b$)**	Tonnes CO2	N/A	N/A	N/A	N/A	N/A	N/A
B -37	**Quantity of each fuel (fca_b) used in compressed air production in furnace process ($Q_{fca, b}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -38	**Emission factor of each fuel in furnace process (fca_b) $EF_{fca, b}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -39	**Electricity Consumed in making compressed air for the furnace process in steel making ($ECCA_b$)[42]**	MWh	N/A	N/A	N/A	N/A	N/A	N/A
B -40	**Emissions Factor for Electricity Consumption ($EFECCA_b$)**	Tonnes CO2/MWh	N/A	N/A	N/A	N/A	N/A	N/A
B -41	**Total CO2 from oxygen production (TCOFP)**	Tonnes CO2	168,776	237,998	241,334	251,133	244,823	238,513
B -42	**Quantity of each fuel (fop_b) used in oxygen production ($Q_{fop, b}$)**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A

[41] Currently made as a byproduct of oxygen production.

[42] Covered by B-29

B -43	**Emission factor of each fuel in oxygen production (fop_b) $EF_{fop, b}$**							
	fuel 1		N/A	N/A	N/A	N/A	N/A	N/A
	fuel 2		N/A	N/A	N/A	N/A	N/A	N/A
B -44	**Electricity Consumed in making oxygen ($ECOP_b$)**	MWh	197,169	284,686	295,753	315,494	315,494	315,494
B-45	**Emissions Factor for Electricity Consumption in making oxygen ($EFECOP_b$)**	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756
B-46	**Total CO2 from limestone for furnace process ($TCLFP_b$)**	Tonnes CO2	140,390	202,706	210,585	224,642	224,641	224,641
	Total Limestone	Tonnes	319,069	460,694	478,603	510,549	510,549	510,549
	Default Emission Factor	Tonnes CO2/Tonne	0.44	0.44	0.44	0.44	0.44	0.44
B-47	**Total CO2 from casting/blooming (TCBM)**	Tonnes CO2	116,781	166,269	170,294	179,058	176,454	173,852
B-48	**Total CO2 from fuel consumption in casting/blooming ($TCFCBM_b$)**	Tonnes CO2	47,168	68,104	70,752	75,475	75,474	75,474
B-49	**Quantity of each fuel (fbm_b) used in casting/blooming ($Q_{fbm,b}$)**							
	NG	m3	2,791,712	4,030,873	4,187,779	4,467,303	4,467,078	4,467,078
	COG	1000 m3	52,736	76,144	79,104	84,384	84,384	84,384
B -50	**Emission factor of each fuel in casting/blooming (fbm_b) $EF_{fbm,b}$**							
	NG	Tonnes CO2 per m3	**0.00189**	**0.00189**	**0.00189**	**0.00189**	**0.00189**	**0.00189**
	COG	Tonnes CO2 per 1000 **m3**	**0.79448**	**0.79448**	**0.79448**	**0.79448**	**0.79448**	**0.79448**
B-51	**Total CO2 from electricity consumption in casting/blooming ($TCECBM_b$)**	Tonnes CO2	69,614	98,165	99,541	103,583	100,980	98,377
B-52	**Electricity Consumed in casting/blooming ($ECBM_b$)**	MWh	81,324	117,422	121,987	130,129	130,129	130,129
B-53	**Emissions Factor for Electricity Consumption in casting/blooming ($EFECBM_b$)**	Tonnes CO2/MWh	0.856	0.836	0.816	0.796	0.776	0.756

Table 15. Abbreviations[43]

AISW	Alchevsk Iron and Steel Works
BFG	Blast Furnace Gas
BF	Blast Furnace
BOF	Basic oxygen steelmaking furnace i.e. converter
CHP	Combined Heat and Power
COG	Coke Oven Gas
CSC	Continuous Casting
ER	Emission Reduction
ERU	Emission Reduction Unit
Furnace process	OHF for Baseline case, Converters for Project case
IUD	Industrial Union of Donbass
LD process	Basic oxygen steelmaking process (Linz-Donawitz), i.e.converter
LF	Ladle Furnace
N/A	Not applicable
NG	Natural Gas
OHF	Open-Hearth Furnace
TSU	Recently commissioned (tandem) Open-Hearth Furnaces
VDOH	Vacuum Tank Degassing Plant (Vacuumator)

[43] Pls. see tables D.1.1.1 and D.1.1.3 for detailed explanations for Data variables.