



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

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**SECTION A. General description of the project****A.1. Title of the project:**

Revamping and Modernization of the Alchevsk Steel Mill - Using Higher Efficiency Technology to replace Open Hearth Furnaces (OHF), Ingot Casting and Blooming Mills.

PDD version 3
09/03/2007

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 commissioned in 2005. The plant has high energy intensity. AISW has a Sinter Plant, Lime Kilns, four Blast Furnaces, three 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 AIWS has been on steel production with the replacement of the three old OHF 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 planned 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 natural 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 2000 - 2001. 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 based on OHFs. Blooming Mill and Ingot Casting. According to the International Iron and Steel Institute, the crude steel production of Ukraine was 38.6 million metric tonnes in



2005 and 40.2% was produced using the OHF based process. The remaining part is produced predominately using decades old Basic-Oxygen Furnaces (49%) and Electric Arc Furnaces (around 7%).

However, as documented in minutes of Meeting of the Technical Council of the Plant, 26th May, 2003, (document is available on request) 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 fuel and material inputs will be needed after implementation of the project compared to the baseline case and therefore carbon dioxide emissions are reduced.

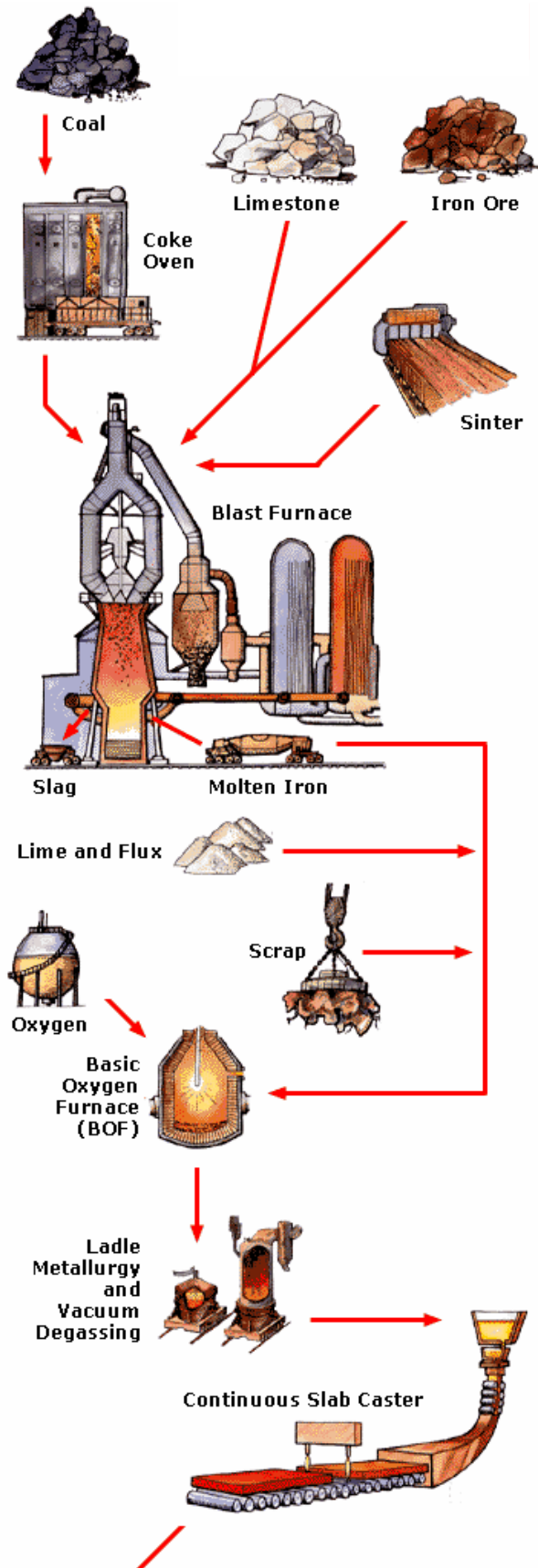
Steel making process

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.



<http://www.ltvsteel.com/ntmfiles/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	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 blooming/casting 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 thousand 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.

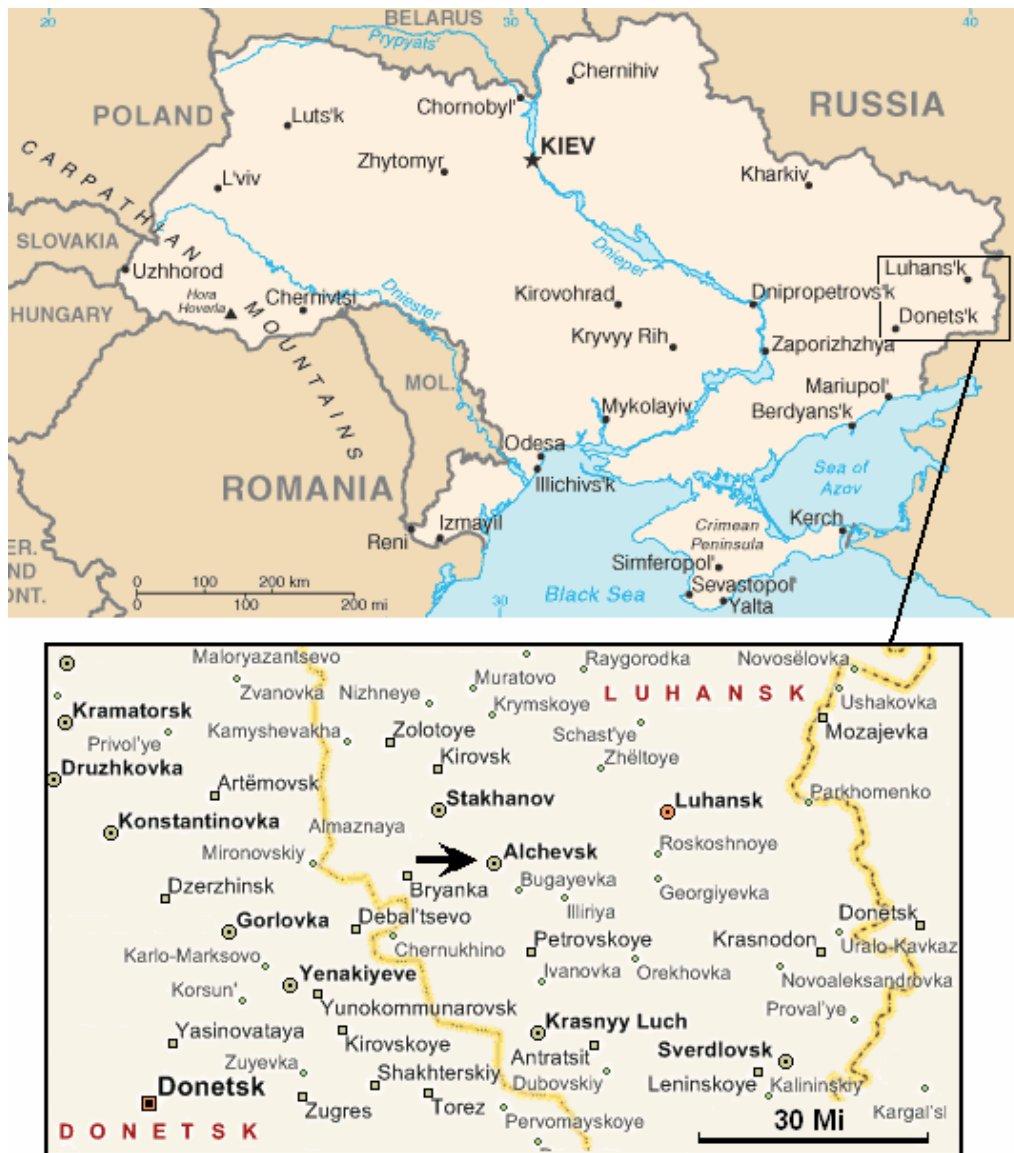


Fig. A.1 Location of proposed JI Project site, Alchevsk Iron & Steel Works.



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:

	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	Installation of Stripper Shop			█				
4	Construction of Oxygen-Converter Shop, installation of LD Converter 1 with first furnace "Polisium"			█				
5	Installation of LD Converter 2 with second furnace "Polisium"				█			
6	Reconstruction of Oxygen Plant #4		█					
7	Installation of Oxygen Plant KAAP-60 #7			█				
8	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 old 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 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%.

The decision to install 2x300 t LD Converters was made in May 2005, when Industrial Union of Donbass, the majority owner of the steel works, signed a contract with VAI, VOEST-ALPINE Industrieanlagenbau (now part of Siemens). According to the contract, the first Converter will be put into operation in July 2007 and the second in August 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 Section E. for detailed information on production, energy and material consumption.

It is important to note that the OHF requires approximately 70% of pig iron and 30% of scrap per tonne of liquid steel. This ratio is different for the LD Converter which requires 80% pig iron and 20% of scrap. In practice these proportions can slightly fluctuate with regard to available material resources at the Plant. This also allows the project result to be 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, the AISW is planning to reconstruct all the existing Blast Furnaces (#1,3,4,5) and build a new one (#6).

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 Blooming Mill with a new OHF and Blooming Mill.

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 shorten the period of credit repayment as discussed in details in section B.2. The rules governing the administration were under development in Ukraine for several years. AISW proceeded with its plans based on the Government of Ukraine's promise to finalize the JI rules. After the situation was resolved, AISW was well prepared to use the potential additional financial means from JI to enable energy efficiency measures in connection with the planned expansion of the production capacity.

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.

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

¹ http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/LD_BOF.pdf
http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/Secondary_%20Metallurgy_Solutions.pdf
http://www.industry.siemens.com/broschueren/pdf/metals/siemens_vai/en/Slab_Caster.pdf



Length of the crediting period before 1 January 2008	1 Years
Year	Estimate of annual emission reductions in tonnes of CO ₂ equivalent
2007	509,398
Total estimated emission reductions over the crediting period (tonnes of CO ₂ equivalent)	509,398

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.

Length of the crediting period starting 1 January 2008	5 Years
Year	Estimate of annual emission reductions in tonnes of CO ₂ equivalent
2008	791,713
2009	923,289
2010	985,129
2011	985,354
2012	985,580
Total estimated emission reductions over the crediting period (tonnes of CO ₂ equivalent)	4,671,065
Annual average of estimated emission reductions over the crediting period (tonnes of CO ₂ equivalent)	934,213

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 organized to get the LoA of Dutch Government.

SECTION B. Baseline

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

The baseline quantification employed for this project is a new approach as allowed by JI rules and not based on an existing CDM methodology as no suitable approved methodologies are currently available. The baseline approach will capture the CO₂ emissions per tonne of steel slab produced in the baseline case and use this figure to calculate the annual baseline emissions based on the actual steel produced in the project case (actual tonnes of steel produced in project case x tonnes of CO₂ per tonne of steel produced in baseline case).

Procedure for selection of the most plausible baseline scenario:

In order to select the most plausible scenarios, two feasible alternatives were identified (see also section B.2.):

- Alternative #1: Undertaking the project anyway without JI involvement (in other words, the project itself is the baseline scenario)



- This is clearly not the case. The project developers had confronted this earlier and chose to invest in the baseline technology of new Open Hearth Furnace and Blooming Mill commissioned in 2005. The project developers have used OHF technology in the past and the management feels more comfortable with it. Staff is well trained in OHF technology. Only with the potential financial incentives of the JI project, the management convinced that the risks of a new technology, retraining staff, and dealing with unknown operations and maintenance problems were worth taking. In addition, this is supported by the investment and barrier analysis in section B.2.
- Alternative #2: Continuation of the current practice in which steel production and blooming would continue and be expanded based on current technology.
 - This was the original plan of the steel mill as they demonstrated in 2005 with replacement of the old OHF and Blooming Mill with the exact same technology. This could be only altered with the potential of JI revenues. Therefore, **this is the most plausible baseline scenario.**

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:

Investment analysis

Total investment costs for project is \$944 million (VAT exclusive). The same slab output could be secured in the baseline scenario with investment costs only around \$200 million, or around 21% of the investment costs of the proposed project. Baseline investments could be implemented much faster, in 1.5 years only. This is the time needed to build three new open-hearth furnaces (OHFs) and reach the planned output. Project activities would require three more years to implement before the planned output can be reached. Projected costs have been based on the estimates made by a producer of equipment – Austrian Voest-Alpine Industries – and local contractors and company staff. It is worth mentioning that when decision to go ahead with the project was made in 2003 much lower investment costs were expected.

Main revenues are those resulting from sales of slabs. Output of the JI projected to reach 5,274 tonnes per year by 2007, and in the baseline scenario and by 2010 in the project scenario. Slab sales prices are anticipated to fall from recent high levels reaching US\$380-400 to US\$293 per ton by 2008. The slabs produced in continuous casting (project case) are of slightly better quality as made in ingot casting (baseline) therefore their market value and price is projected to be a bit higher (US\$322 per ton).

The project will reduce 4.67 million tonnes of CO₂ emissions in the period 2008-2012, or 0.93 million tonnes annually on average. This is less than 8.6 million originally estimated when the decision to go ahead with the project was made and still expected in 2005 when the PIN was prepared. Sale of ERUs is currently expected to generate an additional stream of payments averaging \$14 Million per year, which will be received by IUD from 2008 through 2012 (US\$70 Million total). Undiscounted, this is roughly around 7.4% of the total investment costs of the project scenario. The ERUs purchases and prices will be negotiated with the buyers. Weighted average sale price of ERU is assumed to be US\$15.

Operational cost estimates are based on historical experience and projected estimates, where applicable.

The period chosen for the financial analysis has been conservatively set equal to 2004 – 2018, until the loan repayment is completed, although the project is expected to be technically able to operate beyond that date. The same was done for the baseline in order to have equal terms of comparison despite the fact that loans could be repaid much earlier. The financial projections show results both with and without sale of emission reductions. All financial flows are expressed in real terms indexed to the year 2004. The analysis is prepared in US\$.

Financial analysis includes corporate income tax (CIT) into calculation as the project entity is a normal payer of CIT. Current rate of CIT is 25% in Ukraine. It is not expected to change during the project period. All sales and raw materials are presented without VAT as most of sales of the company are directed to export markets



and thus are not taxable with VAT.

In 2003, when the decision to implement the project was taken by the AIWS, attracting large and long-term investment finance posed enormous challenge. In 2004 the EUR 140 million trade finance package was arranged to purchase new production equipment by the Swiss trader Dufferco with participation of European banks and Export credit agencies.

In 2005 EUR 350 million 3-years trade finance facility was syndicated by ABN-Amro and Societe Generale with participation of 20 commercial Banks. Part of this facility can be used for local expenditures under CAPEX and for working capital. A year later IFC followed with the long term US\$100 million direct loan and 250 million syndicated lending facility for the purpose of implementing CAPEX by IUD in AISW and another plant. Last year additional USD 200 million was raised from a number of Ukrainian commercial banks. Also last year IUD has increased its share capital in AISW by US\$ 200 million and is now planning to issue Eurobonds for the next phase of CAPEX. Average cost of financing is estimated at 9% as majority of lines have floating rates arrangement and tied to LIBOR. Normally structured finance lines used offer 1 year grace period and equal installments repayment. Under current assumptions, the debt service coverage is maintained at comfortable levels of 2 to 6 throughout project implementation and operation. The evolution of the debt structure raised se far reflects a growing confidence of financial institutions in AIWS and its shareholder IUD.

Alchevsk ISW financial indicators	FIRR Project
Project without carbon revenue	21.53%
Project with carbon revenue	22.41%
Baseline scenario	29.48%

FIRR for baseline scenario (29.48%) is noticeably higher than for project scenario, with carbon revenues (22.41%) or without them (21.53%). However NPV of the project is higher than in the baseline. Project scenario returns less cash flow on each dollar invested, but in absolute terms it generates more free cash flow than baseline scenario (higher NPV) due to greater project scale. Without the project, only three OHFs together with Oxygen blocks would need to be built and the remaining part of the process would remain the same. At the same time the downstream production facilities of the AISW (existing ingot casting facilities) are in good state and could secure production of slabs in long-term perspective with relatively small investments. The project activity not only involves construction of expensive new converters and Oxygen blocks, but also requires building two new continuous slab casters. The supporting operations needed for baseline would be less expensive than for project case because they are already in place.

The Project is expected to be profitable from the start of operations. Simulations of both baseline and project scenarios show relatively high financial rates of return (FIRR). The main reason for this is that prices for steel products are very favorable at the moment and the long-term forecasts suggest that they will continue to be high during the project activity. Historically steel market saw great price volatility especially for semi-finished products like slabs. And correlation between prices offered by steel producers and prices charged by raw materials suppliers has never been linear. The sensitivity analysis shows that possible decrease in slab prices may have significant impact on financial performance of the project. In the times of dramatic negative product price shifts steel producers usually find ways to renegotiate raw material prices. However, slight steel price changes seldom result in more favorable raw materials prices. Therefore despite the fact that adverse effect of slab prices instability may partly be mitigated by renegotiating prices of key raw materials (primarily iron ore and coking coal) steel price volatility poses significant risk to the project. It may pose a constraint on the planned output increase, and hence lower the generation of ERUs below estimated 0.93 million tonnes a year. The prospect of a demand for AIWS steel products looks solid. AISW's relies on external export markets where it faces competition of other steel producers, such as China, India and Brazil, but cost advantages give solid foundations for its solid competitive position. Historically Ukraine has been a low cost producer of steel and Alchevsk Steel Mill is among the most cost-competitive producers of semi-finished steel products in Ukraine. This is determined by relatively cheap, locally available resources (mainly iron ore and coke),



relatively low prices for energy resources and their low share in production costs (e.g. 6-7 percent share of natural gas) and low labor costs. Slabs from AISW are supplied to European Union, to US and to the Middle East.

Another reason for relatively high financial viability of both scenarios is that the project boundaries are located in a high value added part of the production chain. Furthermore, investment costs in certain fixed asset used in the production process, such as land, buildings, internal transportation infrastructure; power, heat and water supply systems, office facilities are treated as sunk costs, and therefore not included in financial analysis. This is because both baseline and project scenario are implemented in existing industrial site, using already existing buildings and infrastructure facilities. Comparable green field project would have exhibited much less attractive financial performance indicators not just due to increased direct investment costs but also because the time needed to reproduce supporting infrastructure would have decreased volume of production output within project horizon.

The role of carbon finance in the Project cash-flow is important. The FIRR would slide from 22.41% to 21.53% in the absence of ERUs. However, the sensitivity analysis shows that if market prices for steel fall the role of carbon credits will be critical for the AISW, widening the wedge between FIRR with and without carbon finance. At the time when AISW took decision to construct new LD-Converters and Slab Casters (2003) it was very difficult to envisage and expect high market prices in the long run (until 2018). Therefore AISW decision not to proceed with the business as usual but instead realize more costly and risky project relied heavily on possible carbon revenues within the Kyoto framework. The significance of carbon finance for project's financial viability has decreased since the time the decision to implement the project was made in 2003. Even at the stage of the PIN, the investment costs were expected to be lower and the volume of CO₂ emissions reductions times higher.

Other barriers

There are significant other barriers that make this project risky and suggest that it would not happen without significant financial incentives beyond the traditional returns. Above all, securing financing since 2003 has been a significant challenge for the project. With a total investment of \$ 944 million, the project ranks among the largest investments made by private investors in Ukraine today.

Financial system in Ukraine is still too underdeveloped to secure such a financing, therefore local financial institutions are capable of providing only a small portion of financing offering relatively short-term funds. Thus to secure financing described above for this project the IUD needed to approach a number of foreign financial institutions, including International Finance Corporation. Foreign finance of Ukrainian corporate entity on such a scale is relatively uncommon for Ukraine as foreign creditors are still very cautious about Ukraine country risk and its and business environment. A number of facilities were used for financing of the project. Price of funding for the IUD is higher than for competitors with full metallurgical cycle in other countries, or foreign owned plants in Ukraine due to relatively short track record of the IUD and a high sovereign risk profile of Ukraine among international investors. This has negative influence on competitive position of its plants and discourages long-term and large investments. Carbon finance revenue provide not only additional cash flow less dependent on commercial risks, but also additional comfort for lenders through due diligence by the carbon investors and the World Bank. In this way JI was crucial in making this project financeable.

Baseline scenario is not only financially more viable and less risky; it is also fully technically and environmentally feasible. Open-heart furnaces (OHFs) represent obsolete technology by international standards, but are still a common business practice in Ukraine.

The management team and technical staff of AISW have had many years of experience operating OHF, Ingot Casting and Blooming Mill technology. This is the technology they feel most comfortable with operating, repairing, and managing. AISW recently (2005) had a successful experience with the installation of a new



OHF, Ingot Caster, and Blooming Mill in a very similar project.

This track record of success with the OHF package of technologies combined with the training requirements, new technical and managerial expertise, and uncertainty of the new technology represented in the JI project, make the most plausible management decision to repeat the choice of 2005 and rely on traditional technologies. It obtained environmental permit and according to project sponsor there were no legal or regulatory changes since that time that would prevent commissioning of new OHFs if they were built now. Indeed environmental authorities endorsed the baseline that includes OHFs by issuing letter of endorsement in October 2006.

Realization of the project implies more risks than the baseline. This is mainly because such a large-scale project has not been implemented in the steel sector of Ukraine before. So the project is not a common practice. The risks such as construction risks and operational risks were difficult to estimate before its launching. With this regard the project implementation had to be ensured in close coordination and collaboration with the supplier of the equipment - Austrian Voest-Alpine Industries. The project required development of proper management capacity and experience in working with new equipment. Intensive training of AISW specialists is needed. Technical experts of VAI presented in Alchevsk continuously supervise the project. To ensure prompt implementation a special Project's Staff has been hired and reports directly to Director-General of the AISW. The Project Staff is responsible for full operation and communication of the project related issues. All these activities are connected with higher expenses in comparison with baseline scenario but undertaken to manage higher risks of proper further operation of newly installed facilities.

Protection against technical risks relies mostly on the experience and reputation of the designers and developers of the Project as well as suppliers of the equipment. IUD has good track records with industrial operations in Ukraine and EU (the company owns one steel plant in Poland and one in Hungary). Austrian Voest-Alpine Industries (VAI) is a worldwide leader in production heavy machinery equipment for ferrous metal producers.

Implementation of the project is financially attractive to AISW, but the use of less environmentally friendly technologies (OHFs and ingot casters) is financially more attractive and less risky. As shown in the financial analysis, the FIRR in baseline scenario is higher, financing is easier, and therefore this scenario would have been chosen under common practice. Moreover, the identified barriers, discussed in financial analysis, would prevent project owner from carrying out the proposed project activity without considering carbon finance. In this context carbon finance has triggered the emission reduction that otherwise would not have taken place.

Notwithstanding lower FIRR and higher risks the AISW and IUD decided to go ahead with the project. Impatient and risk-averse investor would have chosen baseline scenario. AISW and IUD, however, have chosen a long term perspective on investment that is still uncommon practice in a relatively risky business environment in Ukraine. Incremental early cash flow from carbon finance has been an important risk cushion. Though hard to quantify, but improved environmental performance which the project would bring to the company was also an important factor while choosing between different project options as the authorities in the country pay more and more attention to major pollutants inducing them to invest into greening projects.

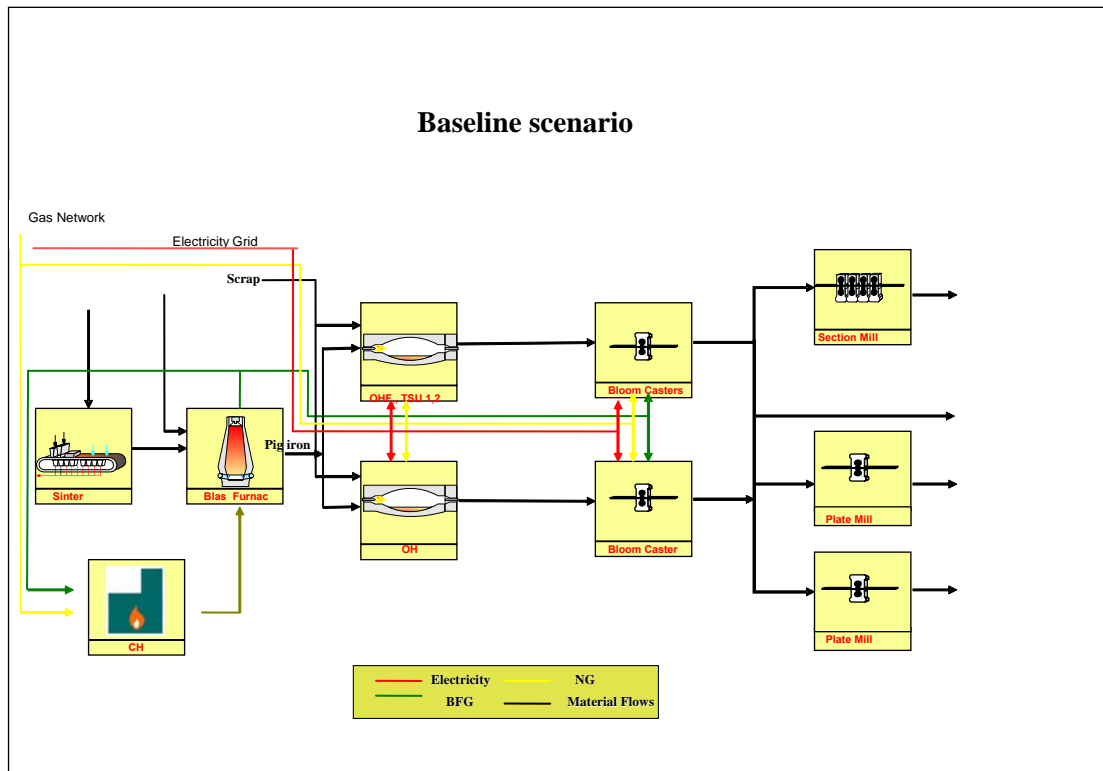
It can be therefore concluded that the proposed JI project is additional to what would occur otherwise.

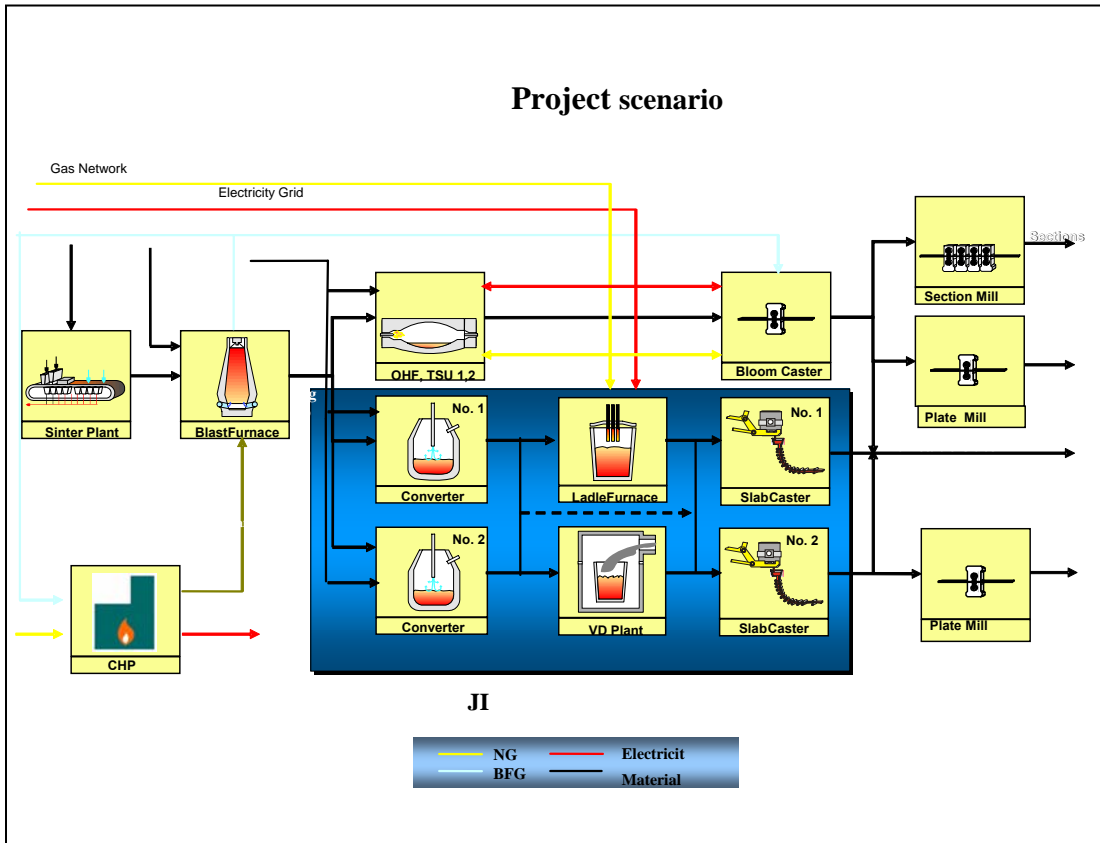
B.3. Description of how the definition of the project boundary is applied to the project:

The project boundary will encompass all of the technological changes resulting from the proposed project. In order to capture all CO₂ emissions associated with the material flows into project including fuels and electricity, Sinter Plant and Blast Furnaces, CHP and electricity grid are included in the project boundary.

Since the demand of pig iron from the non-JI project steel line based on recently commissioned OHF will vary based on criteria outside the control of this project activity and is not attributable to the JI project, this line is excluded from project boundary. Emissions from upstream processes are proportionally taken into account based on pig iron consumption of the JI project.

The following schematics provide a picture of the project and baseline and different elements associated with emission reductions.





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

Date 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.

**SECTION D. Monitoring plan****D.1. Description of monitoring plan chosen:**

Reasonable and conservative quantification of the emission reduction results can be prepared for this project.

1. The most plausible 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. Without the JI involvement, this project would most plausibly use the same technology choice. This will allow the project developer to use actual annual efficiency data from the recently installed Open hearth furnace to inform the baseline. In effect, the baseline production and materials efficiency data can continuously be gathered from the existing new Open Hearth Furnace and Blooming Mills to more accurately inform the baseline case. Should there be major changes in operations in this production line, baseline calculations can be based on most recent historical data available as applicable.
2. This plant is an integrated steel mill, it has the oversight control and high level metering required to deliver accurate data on both the energy/material flows into the project boundary, but also the data required to determine the CO₂ impact of the materials.
3. All required material flows entering into the both the baseline production case and project cases are measured and can be quantified as per their CO₂ impact.
4. Pig iron increases in proportion to scrap from the baseline to the project. This will ensure a conservative result since the project developer has decided to calculate scrap at zero t CO₂/tonne. A higher proportion of pig iron to scrap as an input in the project versus the baseline year will ensure that these calculations will undercount the emission reductions.
5. The slabs produced in both the project and baseline case will be of at least of similar quality or better in the project case so the baseline and project case comparisons can be reasonably made. However, there is no major quality difference between the project and baseline cases.
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 CO₂ 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. 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 also as emission for project case) can be utilized elsewhere as CO₂ neutral fuel.

Key Variables/Parameters	Data Sources
Electricity & Fuel used	Measured
Emissions Factors for Fuel and Electricity	Measured for most fuels (except reducing agents), ERUPT defaults for electricity from the grid (to be replaced by national defaults once available) and IPCC Defaults for reducing agents
Tonnes of Steel produced	Measured
Quantities of materials used	Measured
Emissions factor of materials used	Measured (note more detailed explanations in data table)

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

1. Quantify all CO₂ contribution of all the material flows in the project scenario
2. Quantify the CO₂ 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 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 its' per unit impact on the tonnes of CO₂ emissions. Electricity consumed will be measured and converted to CO₂ 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 CO₂ emissions impact derived from local emissions factors based on the carbon content of the fuel. This will provide a very clear picture of the emissions of CO₂ from the project.

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 carbon 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 carbon 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/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 CO₂ 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 CO₂ per tonne of pig iron. The baseline consumption of pig iron will be the total output of steel in the project case multiplied by the tonnes of pig iron consumed per tonne of steel produced in the baseline technology case. The baseline calculations will include the CO₂ emissions per tonne of pig iron in the project year multiplied by the baseline consumption of pig iron calculated for the project year as CO₂ emissions from material input.

Data Quality Management

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

- Each new meter installed will be calibrated according to manufacturer's specifications and frequency.
- All new meters will be installed and calibrated before flows requiring monitoring commence
- All old meters that are used in new functions or are subject to some physical disruption in their use due to construction will be recalibrated according to manufacturer's specifications before measuring any flow.

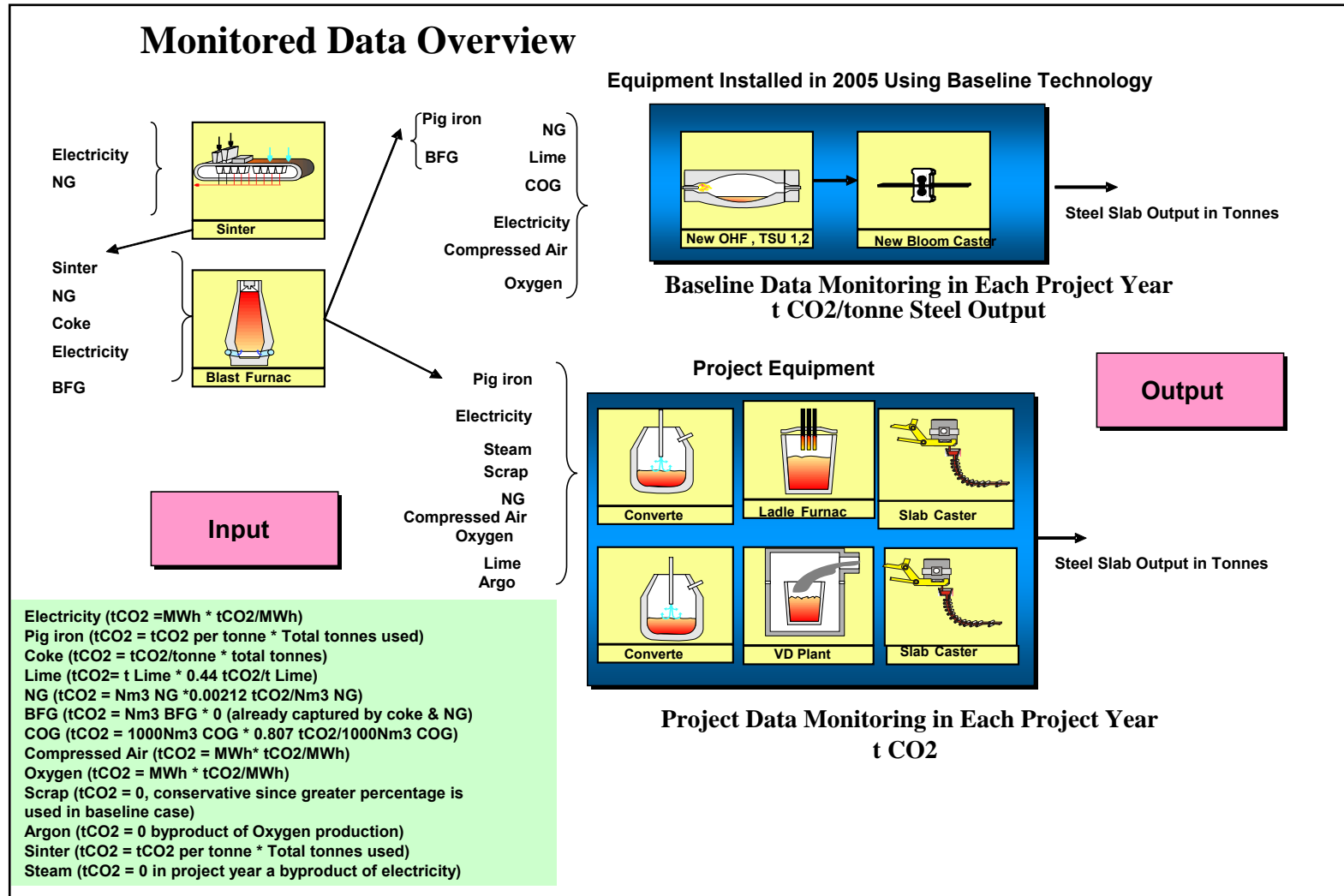
It is critical to note, that while there are numerous data points to collect, the data collected must be rigorously monitored regardless of the project to ensure the proper proportions of material flows are added to the steel making process at the correct time and that fuel and electricity bills can be prepared and paid. Data required for the monitoring plan will be closely tracked as 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 analyzed. Control over consumption of energy resources 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.

To help clarify any issues, the project developer has additional documentation, e.g.:



- the monitoring spreadsheet package currently including estimates that will be regularly updated with actual data to compile and calculate the emission reductions,
- the investment plan giving a schedule of construction activities, and
- summary of the people involved in the on-site monitoring team.

Monitoring 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)	Measured by Steel Producer	Tonnes	m	Continuous with annual tabulation	100%	electronic	
P-2	Total Carbon of Pig Iron (TCPI)	Calculated from other variables- TCFCPI, TCEPI, TCIPi and TSO	Tonnes CO2	c	annually	100%	electronic	In this case, pig iron produced in the Blast Furnaces will supply both the LD steel making and the recent addition of the new OHF. Since TCPI represents the total CO2 from all Pig Iron production (input for both lines) this result will be adjusted by
P-3	Total Carbon from Fuel Consumption for Pig Iron (TCFCPI)	Calculated from other variables – Q_{fpi} and EF_{fpi}	Tonnes CO2	c	Calculated once per year for each baseline and project year	100%	electronic	
P-4	Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PPI)	Calculated from other variables TPII, TSO, and TPIP	percent	c	annually	100%	electronic	Since all of the Pig Iron Produced will not be used for this project, the project developer will determine what percentage of the total emissions from the Blast Furnace are connected to the project.
P-5	Total Pig Iron Input into Steel Making Process (TPII)	Measured by project developer	Tonnes	m	Measured constantly-annual result	100%	electronic	
P-6	Total Pig Iron Produced	Measured by project developer	Tonnes	m	Measured constantly- annual result	100%	electronic	
P-7	Quantity of each fuel (fpi) used in making	Measured by Producer	Measured in appropriate SI	m	Continuous with annual tabulation	100%	electronic	For this project it is expected that the fuel will include:



	Pig Iron (Q_{fpi})		units for fuel(s)- liter, m ³ , joules, etc.					Blast Furnace Gas measured in 1000 Normal cubic meters (1000Nm ³), Coke Oven Gas (Nm ³)and Natural Gas (Nm ³)
P-8	Emission factor of each fuel (fpi) EF_{fpi}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO ₂ per SI unit(s) corresponding to units used in Q_{fpi}	M or estimated	annual average	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO ₂ /Nm ³ Coke Oven Gas is anticipated in 0.807 tonnes CO ₂ /1000m ³ Blast Furnace Gas would be 0.00 since the emissions associated with its creation are already counted in the emissions from pig iron (Natural Gas and Coke).
P-9	Total CO₂ from Electricity used in Pig Iron production (TCEPI)	Tabulated from other monitored variables EPCI and EFEC	Tonnes CO ₂	c	annual tabulation	100%	electronic	If both grid and self-generated electricity is used the totals will be combined to calculate TCEPI.
P-10	Electricity Consumed in producing Pig Iron (ECPI)	Measured in pig iron Production	MWh	m	Continuous with annual tabulation	100%	electronic	
P-11	Emissions Factor for Electricity Consumption (EFECPI)	Part generated on site (measured) part grid electricity using default factor from ERUTP which will be replaced by official Ukrainian data when it is	Tonnes CO ₂ /MWh	m	annual tabulation	100%	electronic	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 ERUTP default factor for the grid is currently (year 2006) 0.876

² 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.



		available						tonnes CO ₂ /MWh (2006) ²
P-12	Total CO₂ from inputs into Pig Iron (TCIPI)	Calculated from other data TTPI, TCFIO, TCEIO, TCRAPI, TCLPI	Tonnes CO ₂	C	annual	100%	electronic	
P-13	Total Carbon from Reducing Agents (TCLPI)	Measurement of tonnes of reducing agent multiplied by IPCC default factors	Tonnes CO ₂	m and C	annual	100%	electronic	For Coke used here- 3.1 tonnes CO ₂ per Tonne of Reducing agent (see references section for different types of reducing agents)
P-14	Total CO₂ from inputs into Pig Iron (TCIPI)	Calculated from other data TTPI, TCFIO, TCEIO, TCRAPI, TCLPI	Tonnes CO ₂	C	Calculated once per year for the baseline and prior two years	100%	electronic	
P-15	Total Carbon from Fuel Consumption in Iron Ore Preparation Process (Sintering) (TCFIO)	Calculated from other variables – Q _{fpi} and EF _{fpi}	Tonnes CO ₂	c	Calculated once per year for the baseline and prior two years	100%	electronic	
P-16	Quantity of each fuel (fio) used Iron Ore Preparation Process (Sintering) (Q_{fio})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m ³ , joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas in normal cubic meters(Nm ³)
P-17	Emission factor of each fuel (fio) EF_{fio}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO ₂ per SI unit(s) corresponding to units used in Q _{fpi}	M or estimated	Annually throughout project years	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO ₂ /Nm ³
P-18	Total CO₂ from Electricity used in Iron Ore	Tabulated from other monitored variables EPCI	Tonnes CO ₂	c	Calculated once per year for the baseline and prior	100%	electronic	



	Preparation Process (Sintering) (TCEIO)	and EFEC			two years			
P-19	Electricity Consumed in Iron Ore Preparation Process (Sintering) (ECIO)	Measured in pig iron Production	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	
P-20	Total CO2 from limestone (TCLPI)	Pig iron producer	Tonnes CO2	C	Continuous with annual tabulation	100%	electronic	Total limestone used in tonnes multiplied by IPCC Good practice default of 0.44 tonnes of CO2 / tonne of limestone
P-21	Total CO2 from steam production in Pig Iron Production (TCSPI)	Measured from other variables	Tonnes CO2	C	annual	100%	electronic	Not expected in this project but will be monitored if changes are made in project years
P-22	Quantity of each fuel (fspi) used in steam production (Q_{fspi})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Continuous with annual tabulation	100%	electronic	Steam is not expected to be used in the Pig Iron production.
P-23	Emission factor of each fuel (fspi) EF_{fspi}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q _{fspi}	C	annual average	100%	electronic	
P-24	Total CO2 emissions from the furnace process (TCFP)	Calculated from other data TCFCFP, TCEFP, and TCIFP	Tonnes CO2	C	annual	100%	electronic	
P-25	Total CO2 emissions from fuel consumption in the furnace process (TCFCFP)	Calculated from other data Q _{ffp} and EF _{ffp}	Tonnes CO2	C	annual	100%	electronic	
P-26	Quantity of each fuel (ffp) used in furnace process (Q_{ffp})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter,	C	Continuous with annual tabulation	100%	electronic	Natural Gas in normal cubic meters(Nm3)



			m3, joules, etc.					
P-27	Emission factor of each fuel (ffp) EF_{ffp}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{ffp}	C	annual average	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO2/Nm3
P-28	Total CO2 emissions from electricity consumption in the furnace process (TCFCFP)	Calculated from other data ECFP and EFECFP	Tonnes CO2	C	annual	100%	electronic	
P-29	Electricity Consumed in the furnace process in steel making (ECFP)	Measured by project developer	MWh	C	Continuous with annual tabulation	100%	electronic	
P-30	Emissions Factor for Electricity Consumption (EFECFP)	Part generated on site (measured) part grid electricity using default factor from ERUTP which will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	m	annual tabulation	100%	electronic	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 ERUTP default factor for the grid is currently 0.876tonnes CO2 /MWh
P-31	Total CO2 emissions from inputs to the furnace process (TCIFP)	Calculated from other variables TCAFP, TCSFP, TCCAFP, TCOFP, TCLFP	Tonnes CO2	c	annual	100%	electronic	
P-32	Total CO2 from Argon entering the furnace (TCAFP)	Measured by Steel Producer or supplier	Tonnes CO2	m	Continuous	100%	electronic	Argon may be a by-product of oxygen product in which case TCAFP would equal zero with all the emissions being covered by TCOFP



P-33	Total CO2 from steam production (TCSFP)	Measured from other variables	Tonnes CO2	C	Annual tabulation	100%	electronic	Steam is produced as a by-product of electricity generation on site, so therefore TCSFP will equal zero with the emissions being covered by another variable
P-34	Quantity of each fuel (fsp) used in stream production (Q_{fsp})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Continuous with annual tabulation	100%	electronic	This parameter is collected for all fuels directly combusted in the steam production for the steel making process, electricity or fuels indirectly combusted for other inputs are dealt with in other variables.
P-35	Emission factor of each fuel (fsp) EF_{fsp}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fsp}	m	annual average	100%	electronic	
P-36	Total CO2 from compressed air production (TCCAFP)	Measured from other variables	Tonnes CO2	m	annual	100%	electronic	
P-37	Quantity of each fuel (fca) used in compressed air production (Q_{fca})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Continuous with annual tabulation	100%	electronic	Not expected in this project but will be monitored if changes are made in project years
P-38	Emission factor of each fuel (fca) EF_{fca}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fca}	M or e	annual average	100%	electronic	If no-local data exists the project developer can use IPCC defaults.



P-39	Electricity Consumed in making compressed air for the furnace process in steel making (ECCA)	Measured by project developer	MWh	m	Continuous with annual tabulation	100%	electronic	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.
P-40	Emissions Factor for Electricity Consumption (EFECCA)	Part generated on site (measured) part grid electricity using default factor from ERUTP which will be replaced by official Ukrainian data when it is available	Tonnes CO ₂ /MWh	m	annual tabulation	100%	electronic	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 ERUTP default factor for the grid is currently 0.876 tonnes CO ₂ /MWh
P-41	Total CO₂ from oxygen production (TCOP)	Measured from other variables	Tonnes CO ₂	c	annual	100%	electronic	
P-42	Quantity of each fuel (fop) used in oxygen production (Q_{fop})	Measured by Producer	Measured in appropriate SI units for fuel(s).	m	Continuous with annual tabulation	100%	electronic	Not expected in this project but will be monitored if changes are made in project years
P-43	Emission factor of each fuel (fop) EF_{fop}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO ₂ per SI unit(s) corresponding to units used in Q _{fop}	M or e	annual average	100%	electronic	If no-local data exists the project developer can use IPCC defaults.
P-44	Electricity Consumed in making oxygen for the furnace process in steel making (ECOP)	Measured by project developer	MWh	m	Continuous with annual tabulation	100%	electronic	In cases of more than one source of electricity, this should be measured separately by source (on site CHP plant and additional grid electricity)



P-45	Emissions Factor for Electricity Consumption (EFECOP)	Part generated on site (measured) part grid electricity using default factor from ERUTP which will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	m	annual tabulation	100%	electronic	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 ERUTP default factor for the grid is currently 0.876 tonnes CO2 /MWh
P-46	Total CO2 from limestone for furnace process (TCOFP)	Steel producer	Tonnes CO2	M and/or c	Continuous with annual tabulation	100%	electronic	Total limestone used in tonnes multiplied by IPCC Good practice default of 0.44 tonnes of CO2 / tonne of limestone
P-47	Total CO2 from blooming/casting (TCBM)	Measured from other variables TCFCBM and TCECBM	Tonnes CO2	c	Continuous with annual tabulation	100%	electronic	
P-48	Total CO2 from fuel consumption in blooming/casting (TCFCBM)	Measured from other variables Q_{fbm} and EF_{fbm}	Tonnes CO2	c	Continuous with annual tabulation	100%	electronic	
P-49	Quantity of each fuel (fbm) used in blooming/ casting (Q_{fbm})	Measured by Producer	Measured in appropriate SI units for fuel(s)	m	Continuous with annual tabulation	100%	electronic	For this project it is expected that the fuel will include: Blast Furnace Gas 1000 Normal cubic meters (1000Nm ³), Coke Oven Gas (Nm ³)



P-50	Emission factor of each fuel (fbm) EF_{fbm}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fbm}	M and/or e	annual	100%	electronic	Coke Oven Gas is anticipated in 0.807 tonnes CO2/1000m3 Blast Furnace Gas would be 0.00 since the emissions associated with its creation are already counted in the emissions from pig iron (Natural Gas and Coke).
P-51	Total CO2 from electricity consumption in blooming/ casting (TCECBM)	Measured from other variables ECBM and EFECBM	Tonnes CO2	c	annual	100%	electronic	
P-52	Electricity Consumed in blooming/ casting (ECBM)	Measured by project developer	MWh	m	Continuous with annual tabulation	100%	electronic	In cases of more than one source of electricity, this should be measured separately by source (on site CHP plant and additional grid electricity)
P-53	Emissions Factor for Electricity Consumption (EFECBM)	Part generated on site (measured) part grid electricity using default factor from ERUTP which will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	m	annual tabulation	100%	electronic	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 ERUTP default factor for the grid is currently 0.876 tonnes CO2 /MWh

**D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO₂ equivalent):**

$$PE_y = TSO_y \times \left(\frac{TCPI_y + TCFP_y + TCBM_y}{TSO_y} \right) =$$

$$(TCPI_y + TCFP_y + TCBM_y)$$

Where

PE_y= Project emissions

TSO= Total steel output measured in tonnes

TCPI= Total embodied CO₂ of Pig Iron entering into project measured in tonnes CO₂

TCFP= Total CO₂ in the furnace process measured in tonnes CO₂

TCBM=Total CO₂ in the blooming/casting/milling measured in tonnes CO₂

Y= project year

The formula for determining TCPI, TCFP, TCBM are exactly the same as those outlined in the baseline section using year y data in every case.³

³ 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.



D.1.1.3. Relevant data necessary for determining the <u>baseline</u> 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)	Measured by Steel Producer	Tonnes	m	Annually through entire course of the project including baseline year and prior two years	100%	electronic	
B-2	Total Carbon of Pig Iron (TCPI)	Calculated from other variables- TCF CPI, TCEPI, TCPI and TSO	Tonnes CO ₂	c	annually	100%	electronic	
B-3	Total Carbon from Fuel Consumption in Pig Iron production (TCFCPI)	Calculated from other variables – Q_{fpi} and EF_{fpi}	Tonnes CO ₂	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B-4	Percentage of Total amount of Pig Iron Produced Used in project Steel Making Activity (PPI)	Calculated from other variables TPII, TSO, and TPIP	percent	c	annually	100%	electronic	Since all of the Pig Iron Produced will not be used for this project, the project developer will determine what percentage of the total emissions from the Blast Furnace are connected to the project.
B-5	Total Pig Iron Input into Steel Making Process (TPII)	Measured by project developer	Tonnes	m	Measured constantly-annual result	100%	electronic	
B-6	Total Pig Iron Produced	Measured by project developer	Tonnes	m	Measured constantly- annual result	100%	electronic	



B-7	Quantity of each fuel (fpi) used in making Pig Iron (Q_{fpi})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m ³ , joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas in normal cubic meters(Nm ³)
B-8	Emission factor of each fuel (fpi) EF_{fpi}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO ₂ per SI unit(s) corresponding to units used in Q_{fpi}	M or estimated	Annually throughout project years	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO ₂ /Nm ³
B-9	Total CO₂ from Electricity used in Pig Iron production (TCEPI)	Tabulated from other monitored variables EPCI and EFEC	Tonnes CO ₂	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B-10	Electricity Consumed in producing Pig Iron (ECPI)	Measured in pig iron Production	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	
B-11	Emissions Factor for Electricity Consumption (EFECPI)	Grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO ₂ /MWh	m	annual tabulation through project years	100%	electronic	
B-12	Total CO₂ from inputs into Pig Iron (TCIPI)	Calculated from other data TTPI, TCFIO, TCEIO, TCRAPI, TCLPI	Tonnes CO ₂	C	Calculated once per year for the baseline and prior two years	100%	electronic	
B-13	Total Carbon from Fuel Consumption in Iron Ore Preparation Process (Sintering) (TCFIO)	Calculated from other variables – Q_{fpi} and EF_{fpi}	Tonnes CO ₂	c	Calculated once per year for the baseline and prior two years	100%	electronic	



B-14	Quantity of each fuel (fio) used Iron Ore Preparation Process (Sintering) (Q_{fio})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas in normal cubic meters(Nm3)
B -15	Emission factor of each fuel (fio) EF_{fio}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fio}	M or estimated	Annually throughout project years	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO2/Nm3
B-16	Total CO2 from Electricity used in Iron Ore Preparation Process (Sintering) (TCEIO)	Tabulated from other monitored variables EPCI and EFEC	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B -17	Electricity Consumed in Iron Ore Preparation Process (Sintering) (ECIO)	Measured in pig iron Production	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	
B -18	Emissions Factor for Electricity Consumption (EFECIO)	grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	m	annual tabulation through project years	100%	electronic	
B -19	Total Carbon from Reducing Agents (TCLPI)	Measurement of tonnes of reducing agent multiplied by IPCC default factor	Tonnes CO2	M and C	Calculated once per year for the baseline and prior two years	100%	electronic	For Coke used here- 3.1 tonnes CO2 per Tonne of Reducing agent (see references section for different types of reducing agents)



B -20	Total CO2 from limestone (TCLPI)	Pig iron producer	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	electronic	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)	Measured from other variables	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	electronic	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 -22	Quantity of each fuel (fspi) used in stream production (Q_{fspi})	Measured by Producer	Measured in appropriate SI units for fuel(s)	m	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO2/Nm3
B -23	Emission factor of each fuel (fspi) EF_{fspi}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q _{fspi}	C	annual average for each project year	100%	electronic	
B -24	Total CO2 emissions from the furnace process (TCFP)	Calculated from other data TCFCFP, TCEFP, and TCIFP	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	electronic	
B -25	Total CO2 emissions from fuel consumption in the furnace process (TCFCFP)	Calculated from other data Q _{ffp} and EF _{ffp}	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	electronic	
B -26	Quantity of each fuel (ffp) used in furnace process (Q_{ffp})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	C	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas in normal cubic meters(Nm3)



B -27	Emission factor of each fuel (ffp) EF_{ffp}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{ffp}	C	annual average for each project year	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO2/Nm3
B -28	Total CO2 emissions from electricity consumption in the furnace process (TCFCFP)	Calculated from other data ECFP and EFECFP	Tonnes CO2	C	Calculated once per year for the baseline and prior two years	100%	electronic	
B -29	Electricity Consumed in the furnace process in steel making (ECFP)	Measured by project developer	MWh	C	Calculated once per year for the baseline and prior two years	100%	electronic	
B -30	Emissions Factor for Electricity Consumption (EFECFP)	Grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	C and/or measured	Annual for each project year	100%	electronic	
B -31	Total CO2 emissions from inputs to the furnace process (TCIFP)	Calculated from other variables TCAFP, TCSFP, TCCAFP, TCOFP, TCLFP	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B -32	Total CO2 from Argon entering the furnace (TCAFP)	Measured by Steel Producer or supplier	Tonnes CO2	m	Calculated once per year for the baseline and prior two years	100%	electronic	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 (TCSFP)	Measured from other variables	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	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) used in stream production (Q_{fsp})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	
B -35	Emission factor of each fuel (fsp) EF_{fsp}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q _{fsp}	m	annual average for each project year	100%	electronic	
B -36	Total CO2 from compressed air production (TCCAFP)	Measured from other variables	Tonnes CO2	m	Calculated once per year for the baseline and prior two years	100%	electronic	
B -37	Quantity of each fuel (fca) used in compressed air production (Q_{fca})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Not expected in this project but will be monitored if changes are made in project years
B -38	Emission factor of each fuel (fca) EF_{fca}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q _{fca}	M or e	annual average for each project year	100%	electronic	
B -39	Electricity Consumed in making compressed air for the furnace process in steel making (ECCA)	Measured by project developer	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	



B -40	Emissions Factor for Electricity Consumption (EFECCA)	Grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	M and/or c	Continuous with annual tabulation for each project year	100%	electronic	
B -41	Total CO2 from oxygen production (TCOP)	Measured from other variables	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B -42	Quantity of each fuel (fop) used in oxygen production (Q_{fop})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Not expected in this project but will be monitored if changes are made in project years
B -43	Emission factor of each fuel (fop) EF_{fop}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q _{fop}	M or e	annual average for each project year	100%	electronic	
B -44	Electricity Consumed in making oxygen for the furnace process in steel making (ECOP)	Measured by project developer	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	



B-45	Emissions Factor for Electricity Consumption (EFECOP)	Grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	M and/or c	annual tabulation for each project year	100%	electronic	
B-46	Total CO2 from limestone for furnace process (TCOFP)	Steel producer	Tonnes CO2	M and/or c	Calculated once per year for the baseline and prior two years	100%	electronic	Total limestone used in tonnes multiplied by IPCC Good practice default of 0.44 tonnes of CO2 / tonne of limestone
B-47	Total CO2 from blooming/casting (TCBM)	Measured from other variables TCFCBM and TCECBM	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B-48	Total CO2 from fuel consumption in blooming/casting (TCFCBM)	Measured from other variables Q_{fbm} and EF_{fbm}	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	
B-49	Quantity of each fuel (fbm) used in blooming/ casting (Q_{fbm})	Measured by Producer	Measured in appropriate SI units for fuel(s)- liter, m3, joules, etc.	m	Calculated once per year for the baseline and prior two years	100%	electronic	Natural Gas in normal cubic meters(Nm3)
B -50	Emission factor of each fuel (fbm) EF_{fbm}	Measured by project developer in conjunction with local fuel distributor.	Tonnes CO2 per SI unit(s) corresponding to units used in Q_{fbm}	M and/or e	Annual for each project year	100%	electronic	Natural Gas is anticipated at 0.00212 tonnes of CO2/Nm3
B-51	Total CO2 from electricity consumption in blooming/ casting (TCECBM)	Measured from other variables ECBM and EFECBM	Tonnes CO2	c	Calculated once per year for the baseline and prior two years	100%	electronic	



B-52	Electricity Consumed in blooming/ casting (ECBM)	Measured by project developer	MWh	m	Calculated once per year for the baseline and prior two years	100%	electronic	
B-53	Emissions Factor for Electricity Consumption (EFECBM)	Grid electricity using default factor from ERUTP (0.876 tonnes /MWh) will be replaced by official Ukrainian data when it is available	Tonnes CO2/MWh	M and/or c	annual tabulation for each project year	100%	electronic	

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO₂ equivalent):

BE_y=

$$TSO_y \times \left(\frac{TCPI_b + TCFP_b + TCBM_b}{TSO_b} \right)$$

Where

BE_y = Baseline emissions

TSO= Total steel output measured in tonnes

TCPI= Total embodied CO2 of Pig Iron entering project boundary measured in tonnes CO2

TCFP= Total CO2 in the furnace process measured in tonnes CO2

TCBM=Total CO2 in the blooming/casting milling measured in tonnes CO2

Y= project year



b=baseline year⁴

where $TCPI_b =$

$$(TCFCPI_b + TCEPI_b + TCIPI_b) * PII_b$$

where

TCFCPI= Total CO2 from fuel consumption in producing Pig Iron measured in tonnes CO2

TCEPI= Total CO2 from electricity consumption in producing Pig Iron measured in tonnes CO2

TCIPI= Total CO2 from Inputs into Pig Iron measured in tonnes CO2

PII= the percentage of the total Pig Iron Produced that would be used as an input in the steel making process⁵

Where

$TCFCPI_b =$

$$\sum_1^{fpi} (Q_{fpi, b} \times EF_{fpi, y})$$

where

fpi= number of fuels used in making pig iron

Q= quantity of fuel fpi used (measured in typical SI units for fuel- liter, m3, joules, etc.)

EF= tonnes of CO2 per unit of fuel fpi in year y

⁴ In this project case, the recent 2005 installation of a new Open Hearth Furnace and Blooming Mill on site will mirror the most plausible baseline scenario in tonnes of CO2 per tonne of steel produced. This better data from what amounts to a 'control plant' will be used to better inform the annual baseline process; measuring exactly an accurate figure based on an actual installation of the baseline technology. Methodologically, this would simply mean that year b = project year data observed in the baseline technology installation. This data will better represent the baseline scenario than historical data. However, should there be changes for operations of the OHF line, baseline can be based on recent historical data from that line.

⁵ 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 connected to the project's steel making emissions. In the baseline case this will equal the Tonnes of Pig Iron input per Tonne of Steel output in the baseline technology multiplied by the Total Steel Output of the Project steel making line all divided by the Total Tonnes of Pig Iron Produced.



$$TCEPI_b =$$

$$ECPI_b * EFECPI_y$$

Where

ECPI = Electricity Consumed in producing pig iron in MWh⁶

EFECPI = Emissions factor for electricity in tonnes of CO₂/MWh in year y

Where

$$TCIPI_b = TTPI_b \times \frac{(TCFIO_y + TCEIO_y + TCRAPI_y + TCSPI + TCLPI_y)}{TTPI_y}$$

TCFIO = Total Carbon from fuel used to prepare Iron Ore in tonnes of CO₂

$$\sum_1^{fio} (Q_{fio, b} \times EF_{fio, y})$$

where

fio = number of fuels used in preparing iron ore (sinter, pellets, or lumps)

Q = quantity of fuel fio used (measured in typical SI units for fuel- liter, m³, joules, etc.)

EF = tonnes of CO₂ per unit of fuel fio in year y

TCEIO = Total Carbon from electricity consumption preparing iron Ore in tonnes of CO₂

$$ECIO_b * EFECIO_y$$

Where

ECIO = Electricity Consumed in preparing Iron Ore in MWh

EFECIO = Emissions factor for electricity in tonnes of CO₂/MWh in year y

⁶ 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 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 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 current monitoring plan and will be included in the final emission reduction results.



TCRAPI= Total Carbon from Reducing Agent in tonnes CO₂= tonnes Reducing agent × Reducing Agent Default Emission Factor⁷

TCLPI=Total Carbon from lime production entering Blast Furnace process measured in tonnes CO₂

Where

TCLPI= (Total lime used in tonnes × 0.440 tonnes of CO₂/tonnes of limestone⁸)

TCSPI =Total Carbon from steam production entering Furnace process measured in tonnes CO₂

Where

TCSPI=

$$\sum_1^{fsp} (Q_{fsp_i, b} \times EF_{fsp_i, y})$$

where

fsp= number of fuels used in steam production for the pig iron Process

Q= quantity of fuel fspi used (measured in typical SI units for fuel- liter, m³, joules, etc.)

EF= tonnes of CO₂ per unit of fuel fspi in year y

PII=

$$\frac{((TPII_b) \times TSO_y)}{TSO_b} \div TPIP_y$$

Where

TPII= Total Pig Iron Input in the steel process (in tonnes)

⁷ For default factors for various reducing agents see the reference section which documents IPCC Good Practice Guideline defaults. If 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.

⁸ Taken from IPCC Good Practice 2.5.1 - <http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2wb1.pdf>



TSO= Total Steel output
 TPIP= Total Pig Iron Produced (in tonnes)

Where
 $TCFP_b =$
 $(TCFCFP_b + TCEFP_b + TCIFP_b)$

where

TCFCFP= Total CO2 from fuel consumption in Furnace Process measured in tonnes CO2
 TCECFP= Total CO2 from electricity consumption in Furnace Process measured in tonnes CO2
 TCIFP= Total CO2 from Inputs into Furnace Process measured in tonnes CO2

Where
 $TCEFP_b =$
 $\sum_1^{ffp} (Q_{ffp, b} \times EF_{ffp, y})$

where
 ffp= number of fuels used in Furnace Process
 Q= quantity of fuel ffp used (measured in typical SI units for fuel- liter, m3, joules, etc.)
 EF= tonnes of CO2 per unit of fuel ffp in year y

$TCECFP_b =$
 $ECFP_b * EFECFP_y$

Where
 ECFP =Electricity Consumed in Furnace Process in MWh
 EFECFP= Emissions factor for electricity in tonnes of CO2/MWh in year y



Where

$$TCIFP_b = (TCAFP_b + TCSFP_b + TCCAFP_b + TCOFP_b + TCLFP_b)$$

where

TCAFP = Total Carbon from Argon production entering Furnace process measured in tonnes CO₂.⁹

Where

$$TCAFP = (\text{Total argon used in m}^3 \times \text{MWh/m}^3 \text{ argon}) \times EFEC_y$$

TCSFP = Total Carbon from steam production entering Furnace process measured in tonnes CO₂

Where

TCSFP =

$_{fsp}$

$$\sum_1 (Q_{fsp, b} \times EF_{fsp, y})$$

where

$_{fsp}$ = number of fuels used in steam production for the Furnace Process

Q = quantity of fuel $_{fsp}$ used (measured in typical SI units for fuel- liter, m³, joules, etc.)

EF = tonnes of CO₂ per unit of fuel $_{fsp}$ in year y

TCCAFP = Total Carbon from compressed air production entering Furnace process measured in tonnes CO₂

Where

$$TCCAFP = (\text{Total Compressed Air used in m}^3 \times \text{MWh/m}^3 \text{ compressed air}) \times EFECCA_y$$

$$ECCA_b * EFECCA_y$$

Where

ECCA = Electricity Consumed in producing compressed air for the Furnace Process in MWh

EFECCA = Emissions factor for electricity in tonnes of CO₂/MWh in year y

Or

TCCAFP =

⁹ Argon production is a byproduct of Oxygen production and therefore will not double counted.



$$\sum_1^{fca} (Q_{fca, b} \times EF_{fca, y})$$

where

fca= number of fuels used in compressed air production for the Furnace Process

Q= quantity of fuel fca used (measured in typical SI units for fuel- liter, m3, joules, etc.)

EF= tonnes of CO2 per unit of fuel fca in year y

TCOFP=Total Carbon from oxygen production entering Furnace process measured in tonnes CO2

Where

$$TCCA_{FP} = (\text{Total Oxygen used in m3} \times \text{MWh/m3 oxygen}) \times EF_{E_{COP, y}}$$

$$E_{COP, b} * EF_{E_{CCA, y}}$$

Where

ECCA =Electricity Consumed in producing oxygenfor the Furnace Process in MWh

EF_{ECCA}= Emissions factor for electricity in tonnes of CO2/MWh in year y

Or

$$TCCA_{FP} =$$

$$\sum_1^{fop} (Q_{fop, b} \times EF_{fop, y})$$

where

fop= number of fuels used in oxygen production for the Furnace Process

Q= quantity of fuel fop used (measured in typical SI units for fuel- liter, m3, joules, etc.)

EF= tonnes of CO2 per unit of fuel fop in year y



TCLFP=Total Carbon from lime entering Furnace process measured in tonnes CO₂

Where

$$TCLFP = (\text{Total lime used in tonnes} \times 0.440 \text{ tonnes of CO}_2/\text{tonnes of limestone}^{10})$$

Where

$$TCBM = (TCFCBM_b + TCEBM_b)$$

where

TCFCBM= Total CO₂ from fuel consumption in the blooming/casting milling measured in tonnes CO₂

TCECBM= Total CO₂ from electricity consumption in the blooming/casting milling measured in tonnes CO₂

Where

$$TCEPBM_b =$$

$$\sum_{fbm} (Q_{fbm} \times EF_{fbm})$$

where

fbm= number of fuels used in the blooming/casting milling

Q= quantity of fuel fbm used (measured in typical SI units for fuel- liter, m³, joules, etc.)

EF= tonnes of CO₂ per unit of fuel fbm in year y

$$TCECBM =$$

$$ECBM_y * EFECBM_y$$

Where

¹⁰ Taken from IPCC Good Practice 2.5.1 - <http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2wb1.pdf>



ECBM =Electricity Consumed in the blooming/casting milling in MWh
EFEC= Emissions factor for electricity in tonnes of 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 <u>project</u>, and how these data will be archived:								
ID number <i>(Please use numbers to ease cross-referencing to D.2.)</i>	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 CO₂ equivalent):



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 <i>(Please use numbers to ease cross-referencing to D.2.)</i>	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 CO₂ equivalent):

As the approach indicates in most project such as the one described in this PDD, there should be no leakage 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 are not large to begin with and 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 CO₂ equivalent):

$$ER_y = BE_y - PE_y$$

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)	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
B&P -1	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -2	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -3	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -4	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -5	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -6	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -7	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -8	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AEI will look to determine is the source of information credible and independent of the project.</i>
B&P -9	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -10	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -11	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -12	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -13	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -14	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -15	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine is the source of information credible and independent of the project.</i>
B&P -16	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -17	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -18	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -19	Medium	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -20	Medium	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>



B&P -21	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -22	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -23	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AEI will look to determine is the source of information credible and independent of the project.</i>
B&P -24	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -25	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -26	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -27	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine is the source of information credible and independent of the project.</i>
B&P 28	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -29	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -30	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -31	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -32	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -33	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -34	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -35	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine is the source of information credible and independent of the project.</i>
B&P 36	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -37	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -38	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine is the source of information credible and independent of the project.</i>
B&P -39	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -40	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -41	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -42	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -43	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine is the source of information credible and independent of the project.</i>
B&P -44	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -45	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -46	Medium	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -47	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -48	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P -49	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>



B&P-50	Low	<i>The project developer will document the source(s) of data and provide a clear indication of their expertise. The AIE will look to determine if the source of information is credible and independent of the project.</i>
B&P-51	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P-52	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>
B&P-53	Low	<i>Metering and measuring devices will be calibrated as per manufacture's instructions</i>

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

The steel sector around the world is already quite well monitored. The data required to determine this approach is routinely collected within the normal operations of the steel mill. The appropriate data collection needs will be codified in a collection template which will be fed into the monitoring database. The management team of the steel works will deputize several staff of its data management unit to ensure this collection occurs and will have a staff person responsible for data entry. Supervision of the monitoring will be performed by relevant Manager. The World Bank will serve an oversight function reviewing documentation at regular intervals and addressing any problems that arise. See also Annex 3 for details.

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
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Mr. James is not a project participant.

**SECTION E. Estimation of greenhouse gas emission reductions****E.1. Estimated project emissions:**

Year 2007

Blast Furnace and Sinter Plant (Project)

output: 2,964,884 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
Lime	0.041	tonnes/t	121,560	tonnes	0.44	t CO ₂ / t Lime	53,487
Coke	538.33	Kg/t	1,596,086	tonnes	3.1	t CO ₂ / t	4,947,867
Fuels							
Natural Gas	97	Nm ³ /t	287,593,753	Nm ³	0.00212	t CO ₂ /Nm ³ t CO ₂ / 1000	609,699
BFG	1380.37	Nm ³ /t	4,092,636,992	Nm ³	0.000	Nm ³	0
COG	34.3166	Nm ³ /t	101,744,740	Nm ³	0.807	t CO ₂ /1000m ³	82,074
Electricity	167	kWh/t	495,136	MWh	0.785	t CO ₂ /MWh	388,556
total							6,028,196

2.033198 Tonnes CO₂/Tonne Pig Iron**Electricity Emission Factor for Project Case**

Total Electricity Consumed by Project	1,025,288	MWh
Grid Emission Factor	0.856	Tonnes CO ₂ /MWh
CHP Plant Emission Factor	0.00	Tonnes CO ₂ /MWh
Total Electricity Produced by CHP Plant	85,345	MWh
Emission Factor for Electricity in Project Case	0.78	Tonnes CO ₂ /MWh

Steam Project0 Tonnes CO₂/MWh**LD Process**

output: 3,422,073 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Material							
Pig iron	866.4	Kg/t	2,964,884	t	2.033	t CO ₂ /t	6,028,196
Scrap	216.6	Kg/t	741,221	t	18.47%	%	
Lime	90	Kg/t	307,987	t	0.44	t CO ₂ / t Lime	135,514
Compressed Air	0.06346	kWh/t	217	MWh	0.785	t CO ₂ /MWh	170
Oxygen	57.8	kWh/t	197,796	MWh	0.785	t CO ₂ /MWh	155,220
Argon	0	kWh/t	0	MWh	0.785	t CO ₂ /MWh	0
Fuels							
NG	18	Nm ³ /t	61,597,314	Nm ³	0.00212	t CO ₂ /Nm ³	130,586
Electricity	49	kWh/t	167,682	MWh	0.785	t CO ₂ /MWh	131,588
total							6,581,273

**Sec. Metallurgy (LF)**

output: 2,040,323 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	138,742	MWh	0.785	t CO2/MWh	108,877
Materials							
Argon Compressed	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
Air	0.001064	kWh/t	2	MWh	0.785	t CO2/MWh	2
total							108,879

Sec. Metallurgy (VDOH)

output: 678,976 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	1,697	MWh	0.785	t CO2/MWh	1,332
Materials							
Argon	0	kWh/t	0	MWh	0.785	t CO2/MWh	0
Steam	39.3	kg/t	0	t	0.000	t CO2/ t	0
Oxygen	1.04	kWh/t	706	MWh	0.785	t CO2/MWh	554
total							1,886

CSC

output: 3,296,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	3,296,000	Nm ³	0.00212	t CO2/Nm3	6,988
Materials							
Compressed Air	0.01216	kWh/t	40	MWh	0.785	t CO2/MWh	31
Oxygen	3.06	kWh/t	10,086	MWh	0.785	t CO2/MWh	7,915
Electricity	4	kWh/t	13,184	MWh	0.785	t CO2/MWh	10,346
total							25,280

6,717,318 Total Tonnes of CO2



Year 2008

Blast Furnace and Sinter Plant (Project)

output: 4,280,911 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Lime	0.041	tonnes/t	175,517	tonnes	0.44	t CO2/ t	77,228
Coke	538.33	Kg/t	2,304,543	tonnes	3.1	t CO2/ t	7,144,083
Fuels							
Natural Gas	97	Nm3/t	415,248,367	Nm3	0.00212	t CO2/Nm3 t CO2/ 1000	880,327
BFG	1380.37	Nm3/t	5,909,241,117	Nm3	0.000	Nm3	0
COG	34.3166	Nm3/t	146,906,310	Nm3	0.807	t CO2/1000m3	118,504
Electricity	167	kWh/t	714,912	MWh	0.766	t CO2/MWh	547,917
total							8,690,831

2.030136 Tonnes CO2/Tonne Pig Iron**Electricity Emission Factor for Project Case**

Total Electricity Consumed by Project	1,480,384	MWh
Grid Emission Factor	0.836	Tonnes CO2/MWh
CHP Plant Emission Factor	0.00	Tonnes CO2/MWh
Total Electricity Produced by CHP Plant	123,227	MWh
Emission Factor for Electricity in Project Case	0.766	Tonnes CO2/MWh

Steam Project

0 Tonnes CO2/MWh

LD Process

output: 4,941,033 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Material							
Pig iron	866.4	Kg/t	4,280,911	t	2.017888	t CO2/t	8,638,398
Scrap	216.6	Kg/t	1,070,228	t	18.47%	%	
Lime	90	Kg/t	444,693	t	0.44	t CO2/ t Lime	195,665
Compressed Air	0.06346	kWh/t	314	MWh	0.766	t CO2/MWh	240
Oxygen	57.8	kWh/t	285,592	MWh	0.766	t CO2/MWh	218,881
Argon	0	kWh/t	0	MWh	0.766	t CO2/MWh	0
Fuels							
NG	18	Nm3/t	88,938,594	Nm3	0.00212	t CO2/Nm3	188,550
Electricity	49	kWh/t	242,111	MWh	0.766	t CO2/MWh	185,556
total							9,427,290

**Sec. Metallurgy (LF)**

output: 2,945,964 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	200,326	MWh	0.766	t CO2/MWh	153,532
Materials							
Argon Compressed	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
Air	0.001064	kWh/t	3	MWh	0.766	t CO2/MWh	2
total							153,534

Sec. Metallurgy (VDOH)

output: 980,354 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	2,451	MWh	0.766	t CO2/MWh	1,878
Materials							
Argon	0	kWh/t	0	MWh	0.766	t CO2/MWh	0
Steam	39.3	kg/t	0	t	0.000	t CO2/ t	0
Oxygen	1.04	kWh/t	1,020	MWh	0.766	t CO2/MWh	781
total							2,660

CSC

output: 4,759,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	4,759,000	Nm ³	0.00212	t CO2/Nm3	10,089
Materials							
Compressed Air	0.01216	kWh/t	58	MWh	0.766	t CO2/MWh	44
Oxygen	3.06	kWh/t	14,563	MWh	0.766	t CO2/MWh	11,161
Electricity	4	kWh/t	19,036	MWh	0.766	t CO2/MWh	14,589
total							35,884

9,619,368 Total Tonnes of CO2



Year 2009

Blast Furnace (Project)

output: 4,447,326 t/ year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Lime	0.041	tonnes/t	182,340	tonnes	0.44	t CO2/ t	80,230
Coke	538.33	Kg/t	2,394,129	tonnes	3.1	t CO2/ t	7,421,799
Fuels							
Natural Gas	97	Nm3/t	431,390,587	Nm3	0.00212	t CO2/Nm3 t CO2/ 1000	914,548
BFG	1380.37	Nm3/t	6,138,954,890	Nm3	0.000	Nm3	0
COG	34.3166	Nm3/t	152,617,095	Nm3	0.807	t CO2/1000m3	123,111
Electricity	167	kWh/t	742,703	MWh	0.748	t CO2/MWh	555,599
total							9,015,057

2.027074 Tonnes CO2/Tonne Pig Iron**Electricity Project**

Total consumed	1,537,931	MWh
Grid EF	0.816	Tonnes CO2/MWh
CHP Plant EF	0.00	Tonnes CO2/MWh
Total Produced by CHP Plant	128,017	MWh
EF	0.748076381	Tonnes CO2/MWh

Steam Project

0 Tonnes CO2/MWh

LD Process

output: 5,133,109 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Material							
Pig iron	866.4	Kg/t	4,447,326	t	2.027074	t CO2/t	9,015,057
Scrap	216.6	Kg/t	1,111,831	t	18.47%	%	
Lime	90	Kg/t	461,980	t	0.44	t CO2/ t Lime	203,271
Compressed Air	0.06346	kWh/t	326	MWh	0.748	t CO2/MWh	244
Oxygen	57.8	kWh/t	296,694	MWh	0.748	t CO2/MWh	221,950
Argon	0	kWh/t	0	MWh	0.748	t CO2/MWh	0
Fuels							
NG	18	Nm ³ /t	92,395,962	Nm ³	0.00212	t CO2/Nm3	195,879
Electricity	49	kWh/t	251,522	MWh	0.748	t CO2/MWh	188,158
total							9,824,559

**Sec. Metallurgy (LF)**

output: 3,060,484 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	208,113	MWh	0.748	t CO2/MWh	155,684
Materials							
Argon Compressed	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
Air	0.001064	kWh/t	3	MWh	0.748	t CO2/MWh	2
total							155,687

Sec. Metallurgy (VDOH)

output: 1,018,464 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	2,546	MWh	0.748	t CO2/MWh	1,905
Materials							
Argon	0	kWh/t	0	MWh	0.748	t CO2/MWh	0
Steam	39.3	kg/t	0	tonnes	0.000	t CO2/ t	0
Oxygen	1.04	kWh/t	1,059	MWh	0.748	t CO2/MWh	792
total							2,697

CSC

output: 4,944,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	4,944,000	Nm ³	0.00212	t CO2/Nm3	10,481
Materials							
Compressed Air	0.01216	kWh/t	60	MWh	0.748	t CO2/MWh	45
Oxygen	3.06	kWh/t	15,129	MWh	0.748	t CO2/MWh	11,317
Electricity	4	kWh/t	19,776	MWh	0.748	t CO2/MWh	14,794
total							36,638

10,019,581 Total Tonnes of CO2



Year 2010

Blast Furnace (Project)

output: 4,744,174 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Lime	0.041	tonnes/t	194,511	tonnes	0.44	t CO2/ t	85,585
Coke	538.33	Kg/t	2,553,931	tonnes	3.1	t CO2/ t	7,917,187
Fuels							
Natural Gas	97	Nm3/t	460,184,898	Nm3	0.00212	t CO2/Nm3 t CO2/ 1000	975,592
BFG	1380.37	Nm3/t	6,548,715,747	Nm3	0.000	Nm3	0
COG	34.3166	Nm3/t	162,803,929	Nm3	0.807	t CO2/1000m3	131,329
Electricity	167	kWh/t	792,277	MWh	0.730	t CO2/MWh	578,157
total							9,602,265

2.024012 Tonnes CO2/Tonne Pig Iron**Electricity Project**

Total consumed	1,640,585	MWh
Grid EF	0.796	Tonnes CO2/MWh
CHP Plant EF	0	Tonnes CO2/MWh
Total Produced by CHP Plant	136562	MWh
EF	0.729741095	Tonnes CO2/MWh

Steam Project

0 Tonnes CO2/MWh

LD Process

output: 5,475,732 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Material							
Pig iron	866.4	Kg/t	4,744,174	t	2.024012	t CO2/t	9,602,265
Scrap	216.6	Kg/t	1,186,044	t	18.47%	%	
Lime	90	Kg/t	492,816	t	0.44	t CO2/ t	216,839
Compressed Air	0.06346	kWh/t	347	MWh	0.730	t CO2/MWh	254
Oxygen	57.8	kWh/t	316,497	MWh	0.730	t CO2/MWh	230,961
Argon	0	kWh/t	0	MWh	0.730	t CO2/MWh	0
Fuels							
NG	18	Nm ³ /t	98,563,176	Nm ³	0.00212	t CO2/Nm3	208,954
Electricity	49	kWh/t	268,311	MWh	0.730	t CO2/MWh	195,797
total							10,455,070

**Sec. Metallurgy (LF)**

output: 3,264,764 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	222,004	MWh	0.730	t CO2/MWh	162,005
Materials							
Argon Compressed	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
Air	0.001064	kWh/t	3	MWh	0.730	t CO2/MWh	3
total							162,008

Sec. Metallurgy (VDOH)

output: 1,086,444 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	2,716	MWh	0.730	t CO2/MWh	1,982
Materials							
Argon	0	kWh/t	0	MWh	0.730	t CO2/MWh	0
Steam	39.3	kg/t	0	tonnes	0.000	t CO2/ t	0
Oxygen	1.04	kWh/t	1,130	MWh	0.730	t CO2/MWh	825
total							2,807

CSC

output: 5,274,000 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	5,274,000	Nm ³	0.00212	t CO2/Nm3	11,181
Materials							
Compressed Air	0.01216	kWh/t	64	MWh	0.730	t CO2/MWh	47
Oxygen	3.06	kWh/t	16,138	MWh	0.730	t CO2/MWh	11,777
Electricity	4	kWh/t	21,096	MWh	0.730	t CO2/MWh	15,395
total							38,399

10,658,283 Total Tonnes of CO2



Year 2011

Blast Furnace (Project)

output: 4,744,174 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Lime	0.041	tonnes/t	194,511	tonnes	0.44	t CO2/ t	85,585
coke	538.33	Kg/t	2,553,931	tonnes	3.1	t CO2/ t	7,917,187
Fuels							
Natural Gas	97	Nm3/t	460,184,905	Nm3	0.00212	t CO2/Nm3 t CO2/ 1000	975,592
BFG	1380.37	Nm3/t	6,548,715,843	Nm3	0.000	Nm3	0
COG	34.3166	Nm3/t	162,803,931	Nm3	0.807	t CO2/1000m3	131,329
Electricity	167	kWh/t	792,277	MWh	0.711	t CO2/MWh	563,631
total							9,587,738

2.02095 Tonnes CO2/Tonne Pig Iron**Electricity Project**

Total consumed	1640584.789	MWh
Grid EF	0.776	Tonnes CO2/MWh
CHP Plant EF	0	Tonnes CO2/MWh
Total Produced by CHP Plant	136562	MWh
EF	0.711405891	Tonnes CO2/MWh

Steam Project

0 Tonnes CO2/MWh

LD Process

output: 5,475,732 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Material							
Pig iron	866.4	Kg/t	4,744,174	t	2.02095	t CO2/t	9,587,738
Scrap	216.6	Kg/t	1,186,044	t	18.47%	%	
Lime	90	Kg/t	492,816	t	0.44	t CO2/ t	216,839
Compressed Air	0.06346	kWh/t	347	MWh	0.711	t CO2/MWh	247
Oxygen	57.8	kWh/t	316,497	MWh	0.711	t CO2/MWh	225,158
Argon	0	kWh/t	0	MWh	0.711	t CO2/MWh	0
Fuels							
Natural Gas	18	Nm3/t	98,563,177	Nm3	0.00212	t CO2/Nm3	208,954
Electricity	49	kWh/t	268,311	MWh	0.711	t CO2/MWh	190,878
total							10,429,814

**Sec. Metallurgy (LF)**

output: 3,264,764 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	222,004	MWh	0.711	t CO2/MWh	157,935
Materials							
Argon Compressed Air	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
	0.001064	kWh/t	3	MWh	0.711	t CO2/MWh	2
total							157,937

Sec. Metallurgy (VDOH)

output: 1,086,444 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	2,716	MWh	0.711	t CO2/MWh	1,932
Materials							
Argon	0	kWh/t	0	MWh	0.711	t CO2/MWh	0
Steam	39.3	kg/t	0	tonnes	0.711	t CO2/ t	0
Oxygen	1.04	kWh/t	1,130	MWh	0.711	t CO2/MWh	804
total							2,736

CSC

output: 5,274,000 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	5,274,000	Nm ³	0.00212	t CO2/Nm3	11,181
Materials							
Compressed Air	0.01216	kWh/t	64	MWh	0.711	t CO2/MWh	46
Oxygen	3.06	kWh/t	16,138	MWh	0.711	t CO2/MWh	11,481
Electricity	4	kWh/t	21,096	MWh	0.711	t CO2/MWh	15,008
total							37,715

10,628,203 Total Tonnes of CO2



Year 2012

Blast Furnace (Project)

output: 4,744,174 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
Lime	0.041	tonnes/t	194,511	tonnes	0.44	t CO ₂ / t Lime	85,585
coke	538.33	Kg/t	2,553,931	tonnes	3.1	t CO ₂ / t	7,917,187
Fuels							
Natural Gas	97	Nm ³ /t	460,184,905	Nm ³	0.00212	t CO ₂ /Nm ³ t CO ₂ / 1000	975,592
BFG	1380.37	Nm ³ /t	6,548,715,843	Nm ³	0.000	Nm ³	0
COG	34.3166	Nm ³ /t	162,803,931	Nm ³	0.807	t CO ₂ /1000m ³	131,329
Electricity	167	kWh/t	792,277	MWh	0.693	t CO ₂ /MWh	549,104
total							9,573,212

2.017888 Tonnes CO₂/Tonne Pig Iron**Electricity Project**

Total consumed	1640584.789	MWh
Grid EF	0.756	Tonnes CO ₂ /MWh
CHP Plant EF	0	Tonnes CO ₂ /MWh
Total Produced by CHP Plant	136562	MWh
EF	0.693070688	Tonnes CO ₂ /MWh

Steam Project0 Tonnes CO₂/MWh**LD Process**

output: 5,475,732 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Material							
Pig iron	866.4	Kg/t	4,744,174	t	2.017888	t CO ₂ /t	9,573,212
Scrap	216.6	Kg/t	1,186,044	t	18.47%	%	
Lime	90	Kg/t	492,816	t	0.44	t CO ₂ / t	216,839
Compressed Air	0.06346	kWh/t	347	MWh	0.693	t CO ₂ /MWh	241
Oxygen	57.8	kWh/t	316,497	MWh	0.693	t CO ₂ /MWh	219,355
Argon	0	kWh/t	0	MWh	0.693	t CO ₂ /MWh	0
Fuels							
Natural Gas	18	Nm ³ /t	98,563,177	Nm ³	0.00212	t CO ₂ /Nm ³	208,954
Electricity	49	kWh/t	268,311	MWh	0.693	t CO ₂ /MWh	185,958
total							10,404,559

**Sec. Metallurgy (LF)**

output: 3,264,764 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	68	kWh/t	222,004	MWh	0.693	t CO2/MWh	153,864
Materials							
Argon Compressed Air	0	kWh/t	0	MWh	0.000	t CO2/MWh	0
	0.001064	kWh/t	3	MWh	0.693	t CO2/MWh	2
total							153,867

Sec. Metallurgy (VDOH)

output: 1,086,444 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
Electricity	2.5	kWh/t	2,716	MWh	0.693	t CO2/MWh	1,882
Materials							
Argon	0	kWh/t	0	MWh	0.693	t CO2/MWh	0
Steam	39.3	kg/t	0	tonnes	0.693	t CO2/ t	0
Oxygen	1.04	kWh/t	1,130	MWh	0.693	t CO2/MWh	783
total							2,666

CSC

output: 5,274,000 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuel							
Natural Gas	1	Nm ³ /t	5,274,000	Nm ³	0.00212	t CO2/Nm3	11,181
Materials							
Compressed Air	0.01216	kWh/t	64	MWh	0.693	t CO2/MWh	44
Oxygen	3.06	kWh/t	16,138	MWh	0.693	t CO2/MWh	11,185
Electricity	4	kWh/t	21,096	MWh	0.693	t CO2/MWh	14,621
total							37,031

10,598,123 Total Tonnes of CO2**E.2. Estimated leakage:**

Not applicable.

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

Year	Project Emissions	Leakage	Total
2007	6,717,318	0	6,717,318

Year	Project Emissions	Leakage	Total
2008	9,619,368	0	9,619,368
2009	10,019,581	0	10,019,581
2010	10,658,283	0	10,658,283
2011	10,628,203	0	10,628,203
2012	10,598,123	0	10,598,123

E.4. Estimated baseline emissions:

Year 2007

Blast Furnace and Sinter Plant (Baseline)

output: 3,126,874 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
lime	0.041	tonnes/t	128,202	tonnes	0.44	t CO ₂ / t Lime	56,409
coke	538.33	Kg/t	1,683,290	tonnes	3.1	t CO ₂ / t	5,218,200
Fuels							
Natural Gas	97	Nm ³ /t	303,306,801	Nm ³	0.00212	t CO ₂ /Nm ³ t CO ₂ / 1000	643,010
BFG	1380.37	Nm ³ /t	4,316,243,395	Nm ³	0.000	Nm ³	0
COG	34.3166	Nm ³ /t	107,303,693	Nm ³	0.807	t CO ₂ /1000m ³	86,558
Electricity	167	kWh/t	522,188	MWh	0.856	t CO ₂ /MWh	446,993
total							6,394,761

2.045097 Tonnes CO₂/Tonne Pig Iron**OHF**

output: 3,988,360 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
Pig iron	784	Kg/t	3,126,874	t	2.045	t CO ₂ / t Pig Iron	6,394,761.31
Scrap	336	Kg/t	1,340,089	t	28.00%	%	
Lime	80	Kg/t	319,069	t	0.44	t CO ₂ / t Lime	140,390
Compressed Air	2.1428	kWh/t	8,546	MWh	0.856	t CO ₂ /MWh	7,316
Oxygen	49.436	kWh/t	197,169	MWh	0.856	t CO ₂ /MWh	168,776
Fuel							
Natural Gas	47	Nm ³ /t	187,452,920	Nm ³	0.00212	t CO ₂ /Nm ³	397,400
Electricity	31	kWh/t	123,639	MWh	0.856	t CO ₂ /MWh	105,835
total							7,108,644

**Ingot Casting**

Production: 3,988,160 t/year

Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	unit	CO ₂ ,t
Fuel							
Natural Gas	0.7	Nm ³ /t	2,791,712	Nm ³	0.00212	t CO ₂ /Nm ³	5,918
Electricity	0.9	kWh/t	3,589	MWh	0.856	t CO ₂ /MWh	3,072
Materials							
Compressed Air	0.0277	kWh/t	111	MWh	0.856	t CO ₂ /MWh	95
oxygen	1.224	kWh/t	4,882	MWh	0.856	t CO ₂ /MWh	4,179
total							13,264

Blooming Mill

output: 3,296,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO ₂ /Nm ³	0
BF Gas	195	Nm ³ /t	642,720	Nm ³	0.0000	t CO ₂ / 1000 Nm ³	0
Coke Gas	16	Nm ³ /t	52,736	Nm ³	0.807	t CO ₂ /1000 Nm ³	42,540
Electricity	19	kWh/t	62,624	MWh	0.856	t CO ₂ /MWh	53,606
Materials							
compressed air	0.01	kWh/t	33	MWh	0.856	t CO ₂ /MWh	28
oxygen	3.06	kWh/t	10085.76	MWh	0.856	t CO ₂ /MWh	8,633
total							104,808

7,226,716 Total Tonnes of CO₂**Year 2008****Blast Furnace and Sinter Plant (Baseline)**

output: 4,514,805 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
lime	0.041	tonnes/t	185,107	tonnes	0.44	t CO ₂ / t Lime	81,447
coke	538.33	Kg/t	2,430,455	tonnes	3.1	t CO ₂ / t	7,534,410
Fuels							
Natural Gas	97	Nm ³ /t	437,936,085	Nm ³	0.00212	t CO ₂ /Nm ³	928,425
BFG	1380.37	Nm ³ /t	6,232,101,378	Nm ³	0.000	t CO ₂ / 1000 Nm ³	0
COG	34.3166	Nm ³ /t	154,932,757	Nm ³	0.807	t CO ₂ /1000m ³	124,979
Electricity	167	kWh/t	753,972	MWh	0.836	t CO ₂ /MWh	630,321
total							9,218,135

2.041757 Tonnes CO₂/Tonne Pig Iron

**OHF**

output: 5,758,679 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Pig iron	784	Kg/t	4,514,805	T PI	2.042	t CO2/ t Pig Iron	9,218,134.19
Scrap	336	Kg/t	1,934,916	t scrap	28.00%	%	
Lime	80	Kg/t	460,694	t lime	0.44	t CO2/ t Lime	202,706
Compressed Air	2.1428	kWh/t	12,340	MWh	0.836	t CO2/MWh	10,316
Oxygen	49.436	kWh/t	284,686	MWh	0.836	t CO2/MWh	237,998
Fuel							
Natural Gas	47	Nm ³ /t	270,657,930	Nm ³	0.00212	t CO2/Nm ³	573,795
Electricity	31	kWh/t	178,519	MWh	0.836	t CO2/MWh	149,242
total							10,242,948

Ingot Casting

Production: 5,758,390 t/year

Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	unit	CO2,t
Fuel							
Natural Gas	0.7	Nm ³ /t	4,030,873	Nm ³	0.00212	t CO2/Nm ³	8,545
Electricity	0.9	kWh/t	5,183	MWh	0.836	t CO2/MWh	4,333
Materials							
Compressed Air	0.0277	kWh/t	160	MWh	0.836	t CO2/MWh	134
oxygen	1.224	kWh/t	7,048	MWh	0.836	t CO2/MWh	5,892
total							18,904

Blooming Mill

output: 4,759,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm ³	0
BF Gas	195	Nm ³ /t	928,005	Nm ³	0.0000	t CO2/ 1000 Nm ³	0
Coke Gas	16	Nm ³ /t	76,144	Nm ³	0.807	t CO2/1000 Nm ³	61,423
Electricity	19	kWh/t	90,421	MWh	0.836	t CO2/MWh	75,592
Materials							
compressed air	0.01	kWh/t	48	MWh	0.836	t CO2/MWh	40
oxygen	3.06	kWh/t	14562.54	MWh	0.836	t CO2/MWh	12,174
total							149,229

10,411,081 Total Tonnes of CO2



Year 2009

Blast Furnace (Baseline)

output: 4,690,312 t/ year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
lime	0.041	tonnes/t	192,303	tonnes	0.44	t CO ₂ / t	84,613
coke	538.33	Kg/t	2,524,936	tonnes	3.1	t CO ₂ / t	7,827,301
Fuels							
Natural Gas	97	Nm ³ /t	454,960,278	Nm ³	0.00212	t CO ₂ /Nm ³	964,516
BFG	1380.37	Nm ³ /t	6,474,366,174	Nm ³	0.000	t CO ₂ / 1000 Nm ³	0
COG	34.3166	Nm ³ /t	160,955,566	Nm ³	0.807	t CO ₂ /1000m ³	129,837
Electricity	167	kWh/t	783,282	MWh	0.816	t CO ₂ /MWh	639,158
total							9,560,812

2.038417 Tonnes CO₂/Tonne Pig Iron**OHF**

output: 5,982,541 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
Pig iron	784	Kg/t	4,690,312	t	2.03841706	t CO ₂ / t	9,560,812.28
Scrap	336	Kg/t	2,010,134	t	28.00%	%	
Lime	80	Kg/t	478,603	t	0.44	t CO ₂ / t	210,585
Compressed Air	2.1428	kWh/t	12,819	MWh	0.816	t CO ₂ /MWh	10,461
Oxygen	49.436	kWh/t	295,753	MWh	0.816	t CO ₂ /MWh	241,334
Fuel							
Natural Gas	47	Nm ³ /t	281,179,427	Nm ³	0.00212	t CO ₂ /Nm ³	596,100
Electricity	31	kWh/t	185,459	MWh	0.816	t CO ₂ /MWh	151,334
total							10,770,627

Ingot Casting

Production: 5,982,541 t/year

Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	unit	CO ₂ ,t
Fuel							
Natural Gas	0.7	Nm ³ /t	4,187,779	Nm ³	0.00212	t CO ₂ /Nm ³	8,878
Electricity	0.9	kWh/t	5,384	MWh	0.816	t CO ₂ /MWh	4,394
Materials							
Compressed Air	0.0277	kWh/t	166	MWh	0.816	t CO ₂ /MWh	135
oxygen	1.224	kWh/t	7,323	MWh	0.816	t CO ₂ /MWh	5,975
total							19,382

Blooming Mill

output: 4,944,400 t/year



Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm3	0
BF Gas	195	Nm ³ /t	964,158	Nm ³	0.0000	t CO2/ 1000 Nm3	0
Coke Gas	16	Nm ³ /t	79,110	Nm ³	0.807	t CO2/1000 Nm3	63,816
Electricity	19	kWh/t	93,944	MWh	0.816	t CO2/MWh	76,658
Materials							
compressed air	0.01	kWh/t	49	MWh	0.816	t CO2/MWh	40
oxygen	3.06	kWh/t	15129.864	MWh	0.816	t CO2/MWh	12,346
total							152,860

10,942,870 Total Tonnes of CO2

Year 2010

Blast Furnace (Baseline)

output: 5,003,379 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Materials							
Lime	0.041	tonnes/t	205,139	tonnes	0.44	t CO2/ t	90,261
coke	538.33	Kg/t	2,693,469	tonnes	3.1	t CO2/ t	8,349,754
Fuels							
Natural Gas	97	Nm ³ /t	485,327,765	Nm ³	0.00212	t CO2/Nm3	1,028,895
BFG	1380.37	Nm ³ /t	6,906,514,303	Nm ³	0.000	t CO2/ 1000 Nm3	0
COG	34.3166	Nm ³ /t	171,698,957	Nm ³	0.807	t CO2/1000m3	138,504
Electricity	167	kWh/t	835,564	MWh	0.796	t CO2/MWh	665,109
total							10,182,262

2.035077 Tonnes CO2/Tonne Pig Iron

OHF

output: 6,381,861 t /year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	Unit	CO2, t
Materials							
Pig iron	784	Kg/t	5,003,379	t	2.03507706	t CO2/ t	10,182,261.86
Scrap	336	Kg/t	2,144,305	t	28.00%	%	
Lime	80	Kg/t	510,549	t	0.44	t CO2/ t	224,642
Compressed Air	2.1428	kWh/t	13,675	MWh	0.796	t CO2/MWh	10,885
Oxygen	49.436	kWh/t	315,494	MWh	0.796	t CO2/MWh	251,133
Fuel							
Natural Gas	47	Nm ³ /t	299,947,467	Nm ³	0.00212	t CO2/Nm3	635,889
Electricity	31	kWh/t	197,838	MWh	0.796	t CO2/MWh	157,479
total							11,462,289

Ingot Casting

Production: 6381861 t /year



Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	Unit	CO ₂ ,t
Fuel							
Natural Gas	0.7	Nm ³ /t	4,467,303	Nm ³	0.00212	t CO ₂ /Nm ³	9,471
Electricity	0.9	kWh/t	5,744	MWh	0.796	t CO ₂ /MWh	4,572
Materials							
Compressed Air	0.0277	kWh/t	177	MWh	0.796	t CO ₂ /MWh	141
oxygen	1.224	kWh/t	7,811	MWh	0.796	t CO ₂ /MWh	6,218
total							20,401

Blooming Mill

output: 5274000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	Unit	CO ₂ , t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO ₂ /Nm ³	0
BF Gas	195	Nm ³ /t	1,028,430	Nm ³	0.0000	t CO ₂ / 1000 Nm ³	0
Coke Gas	16	Nm ³ /t	84,384	Nm ³	0.807	t CO ₂ /1000 Nm ³	68,070
Electricity	19	kWh/t	100,206	MWh	0.796	t CO ₂ /MWh	79,764
Materials							
compressed air	0.01	kWh/t	53	MWh	0.796	t CO ₂ /MWh	42
oxygen	3.06	kWh/t	16138.44	MWh	0.796	t CO ₂ /MWh	12,846
total							160,722

11,643,412 Total Tonnes of CO₂

Year 2011

Blast Furnace (Baseline)

output: 5,003,379 t/year

Input:	Cons/t liq. steel	Unit	Input	Unit	EF	Unit	CO ₂ , t
Materials							
lime	0.041	tonnes/t	205,139	tonnes	0.44	t CO ₂ / t	90,261
coke	538.33	Kg/t	2,693,469	tonnes	3.1	t CO ₂ / t	8,349,754
Fuels							
Natural Gas	97	Nm ³ /t	485,327,740	Nm ³	0.00212	t CO ₂ /Nm ³	1,028,895
BFG	1380.37	Nm ³ /t	6,906,513,946	Nm ³	0.000	t CO ₂ / 1000 Nm ³	0
COG	34.3166	Nm ³ /t	171,698,948	Nm ³	0.807	t CO ₂ /1000m ³	138,504
Electricity	167	kWh/t	835,564	MWh	0.776	t CO ₂ /MWh	648,398
total							10,165,550

2.031737 Tonnes CO₂/Tonne Pig Iron

**OHF**

output: 6,381,861

Input:	Cons/t liq. steel	Unit	Input		EF	Unit	CO2, t
Materials							
Pig iron	784	Kg/t	5,003,379	t	2.03173706	t CO2/ t	10,165,550.05
Scrap	336	Kg/t	2,144,305	t	28.00%	%	
Lime	80	Kg/t	510,549	t	0.44	t CO2/ t	224,641
Compressed Air	2.1428	kWh/t	13,675	MWh	0.776	t CO2/MWh	10,612
Oxygen	49.436	kWh/t	315,494	MWh	0.776	t CO2/MWh	244,823
Fuel							
Natural Gas	47	Nm ³ /t	299,947,451	Nm ³	0.00212	t CO2/Nm ³	635,889
Electricity							
	31	kWh/t	197,838	MWh	0.776	t CO2/MWh	153,522
total							11,435,037

Ingot Casting

Production: 6,381,540 t/year

Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	Unit	CO2,t
Fuel							
Natural Gas	0.7	Nm ³ /t	4,467,078	Nm ³	0.00212	t CO2/Nm ³	9,470
Electricity							
	0.9	kWh/t	5,743	MWh	0.776	t CO2/MWh	4,457
Materials							
Compressed Air	0.0277	kWh/t	177	MWh	0.776	t CO2/MWh	137
oxygen	1.224	kWh/t	7,811	MWh	0.776	t CO2/MWh	6,061
total							20,126

Blooming Mill

output: 5,274,000 t/year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO2, t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³	0.00212	t CO2/Nm ³	0
BF Gas	195	Nm ³ /t	1,028,430	Nm ³	0.0000	t CO2/ 1000 Nm ³	0
Coke Gas	16	Nm ³ /t	84,384	Nm ³	0.807	t CO2/1000 Nm ³	68,070
Electricity							
	19	kWh/t	100,206	MWh	0.776	t CO2/MWh	77,760
Materials							
compressed air	0.01	kWh/t	53	MWh	0.776	t CO2/MWh	41
oxygen	3.06	kWh/t	16138.44	MWh	0.776	t CO2/MWh	12,523
total							158,394

11,613,557 Total Tonnes of CO2



Year 2012

Blast Furnace (Baseline)

output: 5,003,379 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
lime	0.041	tonnes/t	205,139	tonnes	0.44	t CO ₂ / t	90,261
coke	538.33	Kg/t	2,693,469	tonnes	3.1	t CO ₂ / t	8,349,754
Fuels							
Natural Gas	97	Nm ³ /t	485,327,740	Nm ³	0.00212	t CO ₂ /Nm ³ t CO ₂ / 1000 Nm ³	1,028,895
BFG	1380.37	Nm ³ /t	6,906,513,946	Nm ³	0.000	Nm ³	0
COG	34.3166	Nm ³ /t	171,698,948	Nm ³	0.807	t CO ₂ /1000m ³	138,504
Electricity	167	kWh/t	835,564	MWh	0.756	t CO ₂ /MWh	631,687
total							10,148,839

2.028397 Tonnes CO₂/Tonne Pig Iron**OHF**

output: 6,381,861 t / year

Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Materials							
Pig iron	784	Kg/t	5,003,379	t	2.02839706	t CO ₂ / t	10,148,838.76
Scrap	336	Kg/t	2,144,305	t	28.00%	%	
Lime	80	Kg/t	510,549	t	0.44	t CO ₂ / t	224,641
Compressed Air	2.1428	kWh/t	13,675	MWh	0.756	t CO ₂ /MWh	10,338
Oxygen	49.436	kWh/t	315,494	MWh	0.756	t CO ₂ /MWh	238,513
Fuel							
Natural Gas	47	Nm ³ /t	299,947,451	Nm ³	0.00212	t CO ₂ /Nm ³	635,889
Electricity	31	kWh/t	197,838	MWh	0.756	t CO ₂ /MWh	149,565
total							11,407,786

Ingot Casting

Production: 6,381,540 t/year

Input:	Consumption per t liq. steel	Unit	Input	Unit	EF	Unit	CO ₂ ,t
Fuel							
Natural Gas	0.7	Nm ³ /t	4,467,078	Nm ³	0.00212	t CO ₂ /Nm ³	9,470
Electricity	0.9	kWh/t	5,743	MWh	0.756	t CO ₂ /MWh	4,342
Materials							
oxygen	1.224	kWh/t	7,811	MWh	0.756	t CO ₂ /MWh	5,905
Compressed Air	0.0277	kWh/t	177	MWh	0.756	t CO ₂ /MWh	134
							19,851

Blooming Mill

output: 5,274,000 t / year



Input:	Cons/t liq. steel	Unit	Input	unit	EF	unit	CO ₂ , t
Fuels							
Natural Gas	0	Nm ³ /t	0	Nm ³ 1000	0.00212	t CO ₂ /Nm ³ t CO ₂ / 1000	0
BF Gas	195	Nm ³ /t	1,028,430	Nm ³	0.0000	Nm ³	0
Coke Gas	16	Nm ³ /t	84,384	Nm ³	0.807	t CO ₂ /1000 Nm ³	68,070
Electricity	19	kWh/t	100,206	MWh	0.756	t CO ₂ /MWh	75,756
Materials							
compressed air	0.01	kWh/t	53	MWh	0.756	t CO ₂ /MWh	40
oxygen	3.06	kWh/t	16138.44	MWh	0.756	t CO ₂ /MWh	12,201
total							156,066

11,583,703 Total Tonnes of CO₂

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

Year	Baseline Emissions	Project Emissions + Leakage	Emission Reduction
2007	7,226,716	6,717,318	509,398

Year	Baseline Emissions	Project Emissions + Leakage	Emission Reduction
2008	10,411,081	9,619,368	791,713
2009	10,942,870	10,019,581	923,289
2010	11,643,412	10,658,283	985,129
2011	11,613,557	10,628,203	985,354
2012	11,583,703	10,598,123	985,580

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	6,717,318	0	7,226,716	509,398
Total tonnes of CO ₂ equivalent)	6,717,318	0	7,226,716	509,398



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	9,619,368	0	10,411,081	791,713
2009	10,019,581	0	10,942,870	923,289
2010	10,658,283	0	11,643,412	985,129
2011	10,628,203	0	11,613,557	985,354
2012	10,598,123	0	11,583,703	985,580
Total tonnes of CO ₂ equivalent)	51,523,558	0	56,194,623	4,671,065

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 NO₂ 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 reconstruction 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/m³ (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:

Substance	Project
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	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: NO₂ - 8.5%; SO₂ - 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 JI 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 decreased 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 outsourcing 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.¹¹

In summary, IBRD's EA¹² concludes that the improvement in environmental performance derived from replacement of major process elements with technology meeting World Bank Group Guidelines and 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 JI 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/rus/eko.html>

The Mayor of the city of Alchevsk Mr. Chub has signed a letter supporting the realization of the JI 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).

¹¹

<http://www.ifc.org/ifcext/spiwebsite1.nsf/2bc34f011b50ff6e85256a550073ff1c/c7c3ef9e3563d70d85257162007370c3?opendocument>

¹² Documentation will be available at the World Bank InfoShop, www.worldbank.org

Annex 1**CONTACT INFORMATION ON PROJECT PARTICIPANTS**

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Annex 2**BASELINE INFORMATION****Baseline calculation**

1. Determine most plausible Baseline Scenario
2. Determine how the JI project reducing emissions beyond the most plausible baseline scenario (using JISC Guidance)
3. Establish the product boundaries to include all energy and material flows into the furnace and casting technology and outflow of raw steel slab products
4. Quantify all CO₂ contribution of all the material flows in the baseline scenario
5. Quantify the CO₂ contributions of all energy flows in the baseline scenario
6. Quantify the total annual production output in the baseline case
7. Determine the tonnes of CO₂ per tonne of output
8. Multiply tonnes of CO₂ per tonne of Output in baseline case by actual tonnes of Output in the project Case.

Monitoring procedures

1. Quantify all CO₂ contribution of all the material flows in the project scenario
2. Quantify the CO₂ contributions of all energy flows in the project scenario
3. Quantify the total annual production output in the project case

	Source	Gas	Included?	Justification / Explanation
Baseline	Fuel used in Furnace and bloom mill	CO ₂	yes	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Electricity Used in furnace	CO ₂	yes	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	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	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	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	Fuel used in Furnace and bloom mill	CO ₂	yes	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
	Electricity Used in furnace	CO ₂	yes	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	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	CO ₂ will be the major source of CO ₂ emissions produced and reduced.
		CH ₄	no	This amount is likely to be insignificant and will not typically change from baseline to project case.
		N ₂ O	no	This amount is likely to be insignificant and will not typically change from baseline to project case.

Explanation/justification:

The predominate source of greenhouse gas emissions from the production of steel is in the form of CO₂ from direct fuel consumption, electricity consumption, and the CO₂ emissions embedded in the input material such as oxygen, pig iron, and limestone. Several of the inputs such as limestone and the reducing agents required to create pig iron will involve both process related CO₂ emissions and CO₂ emissions from fuel and electricity consumption.

Baseline Calculations

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 JI 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 its per unit impact on the tonnes of CO₂ emissions per tonne of steel slab output.



Quantifying Project Emissions

The project emissions are calculated exactly the same manner as baseline emissions.

Leakage

There should be no leakage for this project as long as the old technology employed is decommissioned and not used again somewhere else. The project developer will need to document that the previous equipment is decommissioned. The emissions from installing the new equipment will not be significant. The emissions from transport of materials are not large to begin with and will not be significantly different in the two cases.

Quantifying Emission Reductions:

Emission reductions are the difference between baseline emissions and project emissions. Since the baseline will be adjusted every year to capture the emissions from the actual output, this comparison will continue to be relevant through the time period of the project activity.

Annex 3**MONITORING PLAN**

The monitoring procedures for the most part are straightforward in term of what steel plants already do- 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 JI project boundary including:

- The types and amounts of different fuels used at various stages of the process.
- The amount and source of electricity consumed at various points of the process.
- The data required to formulate the Electricity Emissions Factor using ERUPT calculations until the Ukrainian Government publishes official coefficients
- The quantities of material inputs entering into the project boundaries for the steel making process.
- The electricity and fuel used to produce the material inputs into the process.
- Natural 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.

1. Emission reductions from a decrease in the direct energy required to create the same tonne of steel end product
2. The emission reductions derived from using fewer material inputs to create the same tonne of steel end product.

The approached used does not seek any credit for fuel switches or decreases in production.

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 JI 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.

Data Quality Management

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

- Each new meter installed will be calibrated according to manufacturer's specifications and frequency.
- All new meters will be installed and calibrated before flows requiring monitoring commence



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

Monitoring database will be available for monitoring purposes.

Main responsible parties for monitoring the data:

Overall Project Responsibility -Mr. Dykovich, Chief engineer.

Data for Converters and slab Casters will be monitored by Mr. Akulov, Deputy Chief Engineer for continuous casting and staff

BFs - Mr. Tkach, Deputy Chief Engineer for aglo-blast-furnace production and staff

OBFs- Mr. Lukyanov, Deputy Chief Engineer for steel production and staff

Oxygen Plants - Mr. Shamrai, Chief of Oxygen-Compressor Shop and staff

CHP (old) - Mr. Ros, Chief of CHP (old) and staff

References

From 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 CO₂ FROM METAL PRODUCTION (TONNE CO₂/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	
