# Monitoring report of GHGs emission reduction

JI PROJECT:

## « IMPLEMENTATION OF ARC-FURNACE STEELMAKING AT MAGNITOGORSK IRON AND STEEL WORKS »

**Monitoring period: 01.01.2010 – 31.12.2010**

Version 1.4. (Final after verification)

Data of development of this version: 29 March 2011.

**CONTENTS**

# A. General information on the project

## *A.1. Introduction*

The aim of report is representation of the monitoring results and results of calculation of Emission Reduction Units (ERUs) generated by the JI project “Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works” for the period from January 01, 2010 to December 31, 2010.

The considered project has been approved in Russian Federation (RF) as host Party by the Order of Ministry of Economic Development of RF # 709 of December 30, 2010.

The Declaration of Approval from State of the Netherlands, acting through the Ministry of Economic Affairs, Agriculture and Innovation and its implementing agency “NL Agency”, being the Designated Focal Point for Joint Implementation (JI) in The Netherlands has been received for the project by 8$^{th}$ March 2011.

Thereby the project has been approved both by host Party and Party involved in the JI project, other than the host Party. Technical implementation of the project took place in 2003-2006.

## *A.2. Brief description of the project*

The proposed Joint Implementation project envisages a complex resource-saving effect from the transition to the technology of production of profiled steel in the electric arc furnaces (EAF) and its teeming in the continuous casting machines (CCM) instead of production of the same steel and profiled billet in the open-hearth plant and blooming mill plant.

Electric steelmaking process in EAFP and further teeming in CCM is a resource-saving technology, which allows at the same output rate to save the carbon-containing materials and fuels – coking coal, coke, pig iron, natural gas compared to the conventional OHFP process with ingots teeming. It is assumed that production of profiled steel billet in the project and the baseline is equivalent and corresponds to the actual steel production according to the monitoring data.

## *A.3. Emission reduction during monitoring period*

Current report takes into account $CO_2$ emission reduction generated during 2010. Detailed calculations are in the section D.

**The actual generation of ERUs for the period of 1$^{st}$ January 2010 to 31$^{st}$ December 2010 is 758 323 tonnes $CO_{2eq}$.**

In accordance with PDD, version 1.5 of January 31, 2011 the expected volume of ERUs for the period of 1$^{st}$ January 2010 to 31$^{st}$ December 2010 is 1 097 296 tonnes $CO_{2eq}$.

The volume of actually generated ERUs in 2010 turned out to be less than calculated in the PDD because of lesser output of profiled steel billet than it was planned. As well the specific $CO_2$ emissions from production of pig iron have decreased.

### *A.4. Contact information on project participants*

Contact person of project owner:

| | |
|---|---|
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Contact person of consultant of project owner and developer of this monitoring report:

| | |
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| Department: | - |

# B. Monitoring system of GHGs emission reduction

## *B.1 Information on the collection and archiving of information on the environmental impacts of the project*

In accordance with requirements of Articles 14, 22 the Federal Law on environmental protection # 7-FZ OJSC "MMK" has the approved Maximum Permissible Emissions (MPE) document. This document is approved by Chelyabinsk Regional Department of Technological and Environmental Surveillance of Rostechnadzor. This decision is valid for one year. Under this decision the harmful emission permit is issued. This permit quantified impacts to atmosphere by OJSC "MMK".

For confirmation of MPE the air emissions were estimated by OJSC "Magnitogorsk GIPROMEZ" in accordance with Russian "Guidelines for calculation of industrial emissions of air pollutants" (OND-86)[1]. These estimations were based on OJSC "MMK" Emission Inventory and Emission Sources Report done by Federal State Unitary Enterprise "All-Russian Institute for Carbon Chemistry" in Yekaterinburg (2008). This report was approved according to the established procedure.

Laboratory for Control of Air Quality of OJSC "MMK" performs environmental monitoring according to the monitoring schedule.

According to the provisions of Russian environmental law (Federal Law №7-FZ of 10.01.2002 "On Environmental Protection"), environmental experts and managers of polluting enterprises must have qualifications in environmental protection and environmental safety. Functions of the Department of environmental protection are ensuring compliance with environmental quality standards, obtaining government permits for emissions and discharges of hazardous substances, disposal of waste.

In accordance with referred above Federal Law OJSC "MMK" has the approved Maximum Permissible Discharge of Sewage document (MPDS) and Permissible Norm of Producing and Placement of Wastes document (PNPPW). In these documents procedure of collecting and archiving of information on the environmental impacts is defined.

There is a monitoring plan in MPDS document, which is defined the monitoring parameters, frequency of measurement for each parameter and responsible personnel. Monitoring plan is approved by OJSC "MMK". In PNPPW document list and quantity of produced wastes, frequency of producing, places of storage and responsible personnel are defined. This document is approved by OJSC "MMK".

Considering the above we can conclude that OJSC "MMK" conduct the periodic monitoring of the environment impacts. The enterprise also has an environmental management system certified by ISO 14001.

According to the information from Environmental department of OJSC "MMK" confirmed during the visit in January 2011:

The project was fully put into operation is 2006 and environmental protection equipment designed for it (gas purification units at EAFs, etc) operates normally. The total environmental impact for the section steel production has been radically reduced in comparison with the open-hearth/ingots casting technology.

Emissions of polluting substances are normalized in the permission to emission of the polluting substances, given out by Rostehnadzor in the Chelyabinsk area. Results of inventory of emissions prepares annually.

[1] http://www.vsestroi.ru/snip_kat/ad977f56010639c6e1ba95802d182677.php

According to the valid permission the emissions of pollutant substances do not create maximum concentration above limit, except a number of substances (nitrogen (IV) a dioxide, sulfur a dioxide, hydrogen sulfide, carbon oxide, phenol) for which the temporarily permission is established.

The polluted water is treated at local treatment facilities. The enterprise has several closed loop water turnover systems. The water which is subject to the discharge is released in the river Sukhaya (inflow of the river Ural).

Placing of a waste occurs in conformity to the project of specifications of formation of a waste and limits on their placing, confirmed by Rostehnadzor in the Chelyabinsk area.

### *B.2 Methodological approach applied (summary from PDD, version 1.5 of January, 31 2011)*

Monitoring of the baseline and project emissions during 2010 has been performed in accordance to the PDD, version 1.5 of January, 31 2011 except adjustments and deviations given in the Section C.

JI specific approach is applied for the monitoring of GHGs emission in accordance with paragraph 9 (a) of the “Guidance on criteria for baseline setting and monitoring” (Version 02).

Methodological approach applied for calculation of the $CO_2$ emissions by carbon balance method is in line with Tier 3 approach described in Section 4.2.2 of Chapter 4 of “2006 IPCC Guidelines for National Greenhouse Gas Inventories” (IPCC Guidelines 2006). This approach was complemented with monitoring of $CO_2$ emission factor for generation of electricity at MMK own power plants, $CO_2$ emissions due to consumption of electricity in EAFP, $CO_2$ emissions from generation and consumption of air blast in blast furnace plant.

Since MMK is a full-cycle iron and steel works, the production of coke and pig iron meets apart from EAFP the demand of basic oxygen furnace plant, even though the latter lies outside the project boundaries. EAFP produces profiled steel billet and slab steel billet, the latter is outside the project boundaries. To calculate $CO_2$ emissions within the project boundaries the specific $CO_2$ emissions per ton of coke, pig iron and steel billet are defined. Then specific emissions are multiplied by the output of these products within the project boundaries.

The project boundaries include (Diagram B.2.1, B.2.2 below):

- Metallurgical conversion production works: by-product coke plant, blast-furnace plant, EAFP (or OHFP and BMP in the baseline scenario)
- Own power generation capacities of MMK: Combined heat power plant (CHPP), Central power plant (CPP), Steam-air blowing power plant (SABPP), turbine section in the steam plant, gas recovery section in the steam plant
- Unified energy system of Urals.

Diagram B.2.1. Project boundaries. Project scenario

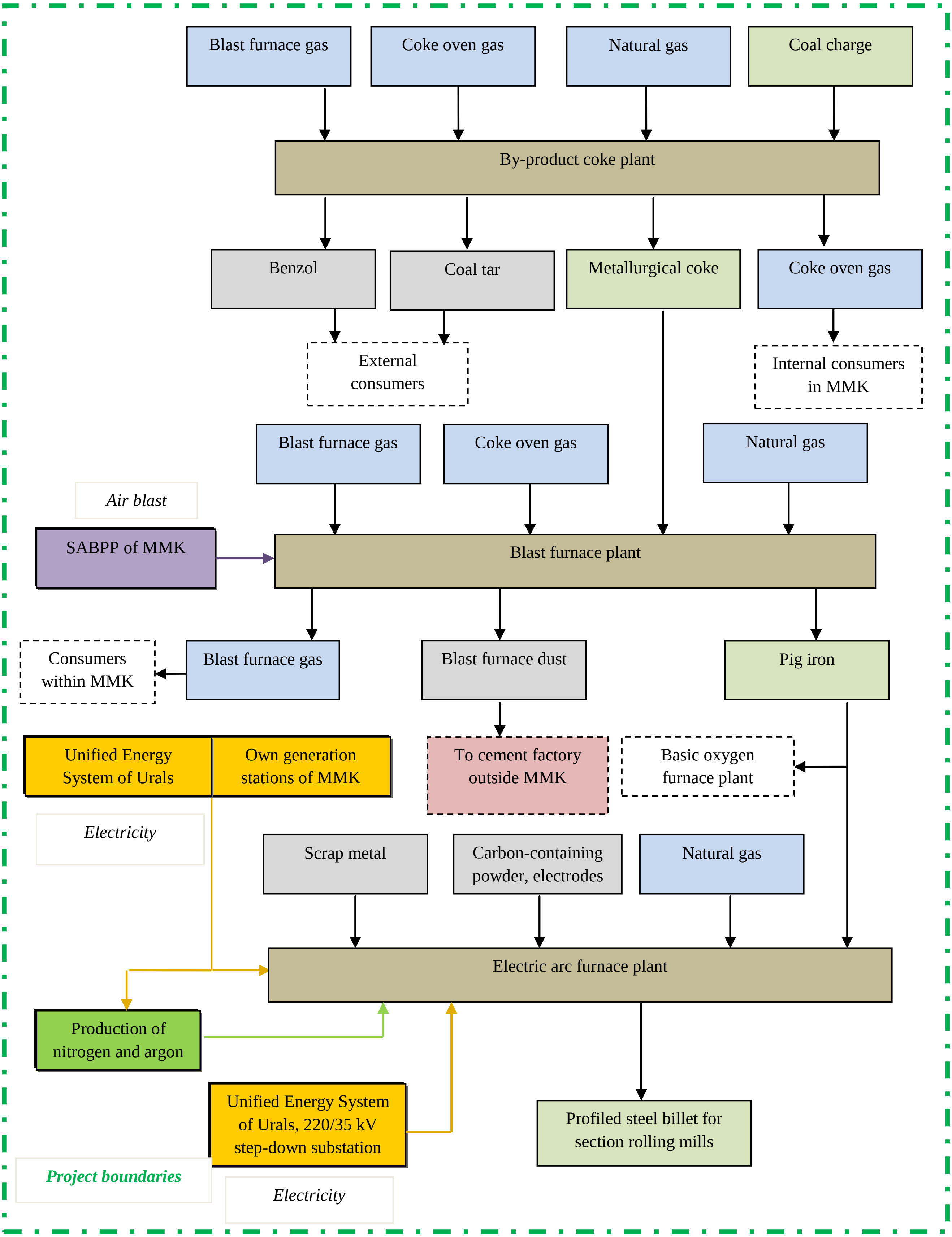
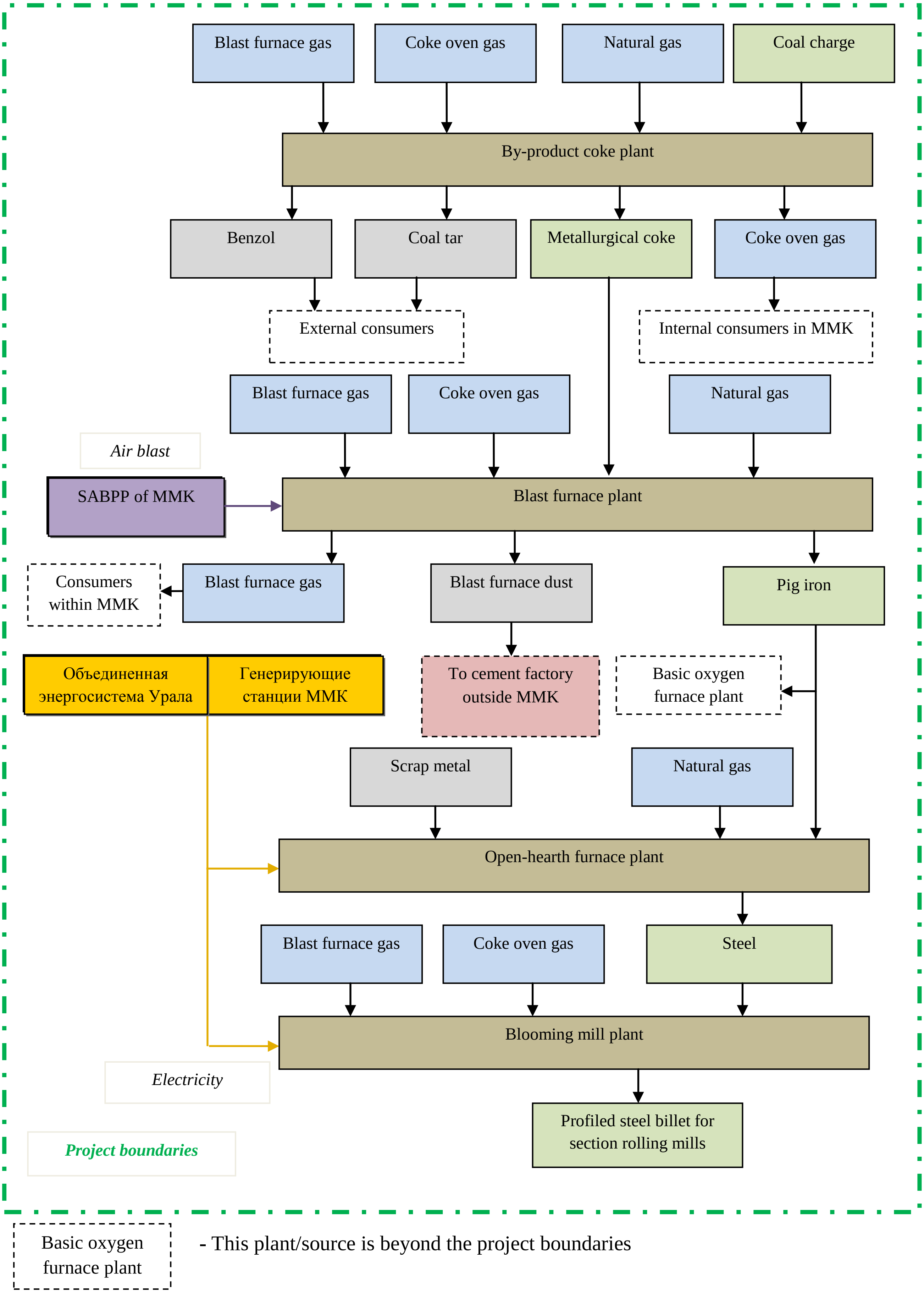


Diagram B.2.2. Project boundaries. Baseline scenario



To calculate the project $CO_2$ emissions we estimated the following parameters:

1. $CO_2$ emission from metallurgical conversions within the project boundaries (using carbon balance method)
2. Specific $CO_2$ emission per ton of coke, pig iron and steel billet (profiled and slab all together).
3. Specific consumption of pig iron and scrap metal for production of one ton of steel billet and specific consumption of metallurgical coke per one ton of pig iron.
4. Project $CO_2$ emission from metallurgical conversions during production of profiled steel billet using defined specific values and coefficients
5. $CO_2$ emission coefficients from generation of electricity and air blast at MMK, and accordingly the project emissions from consumption of electricity in EAFP and consumption of air blast in BFP required for production of the profiled steel billet.
6. Total project $CO_2$ emissions associated with production of profiled steel billet are summarized.

Blast furnace dust and scrubber sludge are particular kinds of industrial waste generated in blast furnace process. They originate in the system of dry cleaning of blast furnace gas and contain significant amounts of carbon. These materials are transported to agglomeration plant and consumed during production of fluxed agglomerate. The carbon from blast furnace dust and scrubber sludge is fully released as $CO_2$. Therefore, these emissions are included in emissions from production of pig iron in blast furnace plant. A small fraction of blast furnace dust comes to the cement plant. By conservative approach this fraction is considered as leakage emission outside OJSC “MMK” and included in the corresponding chapter of monitoring plan.

The consumption of production inputs, raw materials, energy resources, and the output of commercial products are routinely monitored by MMK applying the system of factory monitoring and reporting. These parameters are measured in accordance with applicable standards and rules in the iron and steel industry of Russia as well as international standards (OJSC “MMK” is certified by ISO 9001 standard). All required parameters are available within the production monitoring and reporting system of Magnitogorsk Metallurgical Works and thus associated procedure for monitoring of $CO_2$ emissions does not require any additional changes or improvements in the existing system.

The majority of carbon content parameters included in the monitoring plan are regularly determined by direct analyses in Central Laboratory of OJSC “MMK” or calculated on the basis of chemical composition of carbon-containing substances. The samples of blast furnace gas and coke oven gas are analyzed in CEST laboratory and the data on chemical composition of natural gas are taken from its technical passport issued and provided by the supplier.

Table B.2.1. contains the values of carbon content of raw materials, fuels and produced substances that are used in calculation formulae but fixed ex-ante as per PDD.

Table B.2.1. Carbon content of raw materials, fuels and produced substances fixed ex ante for the project and baseline[2]

| № | Parameter and measurement units | Variable | Value | Source of data |
|---|---|---|---|---|
| 1. | Carbon content in crude benzol, % by mass | **$\%C_{benzol}$** | 90.0 | The Central Lab of MMK performs a test of chemical composition of crude benzol once a month. The carbon content in |

[2] The data confirming the appropriateness of values of these parameters as a ground for their fixing ex-ante has been provided during determination of the PDD and available at OJSC “MMK” by request.

| | | | | |
|---|---|---|---|---|
| | | | | crude benzol therefore can be determined by known carbon content in each component and its % mass fraction.<br>During development of the PDD the analysis of chemical composition of crude benzol has been taken (QMS reporting form SMK CLK (51)-22-2) and calculated carbon content of crude benzol was 87.8%. As a conservative assumption the value with a certain margin (2,2%) was applied and fixed ex-ante, i.e. 90%. |
| 2. | Carbon content in coal tar, % by mass | **%C** $_{coal-tar}$ | 86.0 | During development of the PDD OJSC "MMK" provided to CTF, LLC a Memo #BPCP-C296 of 02.06.2009 (in the PDD by mistake data was mentioned as 26.06.2009), signed by Director of BPCP. It stated that by measurements the carbon content in the coal tar was 83%. By information of BPCP during site visit similar measurements in several preceding years showed the maximum value of 84%. As a conservative assumption the maximum value with a certain margin (2%) was applied and fixed ex-ante, i.e. 86% |
| 3. | Carbon content in pig iron, % by mass | **%C** $_{pig\ iron}$ | 4.70 | This is an important technological indicator, which determines the end of blast furnace smelting. Final carbon content of pig iron is a technological standard and measurements of the carbon content are performed by MMK Central Lab constantly. The average value for 2002 and 2007 was 4.7 % and provided in the Letter of OJSC MMK to CTF, LLC by 16.02.2009. Due to stability of the value it was decided to fix ex-ante the carbon content in pig iron as 4.7 %. |
| 4. | Carbon content in scrap metal, % by mass | **%C** $_{scrap}$ | 0.18 | Electric Arc Furnaces consume scrap metal during steel smelting. The supplied scrap metal is a subject for incoming control by MMK. The carbon content in the scrap metal varies depending on its origin but does not exceed 0,2% by measurements, however usually is less (information from specialists of EAFP). As an assumption for simplicity the carbon content of steel produced at EAFP of MMK (i.e. 0,18%) was applied for scrap metal and fixed ex-ante. |
| 5. | Carbon content in carbon-containing | **%C** $_{carbon}$ | 95.0 | In accordance with standard specification |

| | | | | |
|---|---|---|---|---|
| | powder, % by mass | powder_EAFP | | 1971-003-13303593-2006, which is confirmed by quality certification. |
| 6. | Carbon content in electrodes, % by mass | **%C** electrodes_EAFP | 99.0 | In accordance with standard specification 1911-109-052-2003, which is confirmed by quality certification. |
| 7. | Carbon content in steel, % by mass | **%C** steel | 0.18 | This is an important technological indicator, which determines quality of steel and may vary only within very narrow bounds depending on type of steel. The average carbon content of steel product mix, produced by the EAFP within long period of time (one year), based on MMK Lab measurements is quite stable. For 2002 the measurements performed by MMK Lab has shown the average value of 0.19 % and for 2007 the average value of 0.18%. Due to stability of the value it was decided to fix ex-ante the carbon content in steel as 0.18 % (the least one as more conservative). |
| 8. | Carbon content in power station coal, % by mass | **%C** energy coal | 73.0 | IPCC Guidelines 2006 default value has been taken as no measurements of the carbon content in power station coal are performed at OJSC "MMK". |

To estimate project emission reduction it is necessary to calculate the difference in baseline and project $CO_2$ emissions. Project implementation involves major changes in production assets: the equipment of open-hearth furnace plant is replaced leaving in operation only one Double-bath steelmaking unit (DBSU), and blooming mill plant is shut down. In these circumstances we use fixed specific coefficients, which characterize consumption of energy and materials in the baseline (Table B.2.2).

The following parameters have been determined to calculate baseline $CO_2$ emissions:

1. Specific $CO_2$ emissions from metallurgical conversion during production of one ton of metallurgical coke and pig iron are the same in the project and baseline scenarios;
2. Specific $CO_2$ emissions from metallurgical conversions for steel smelting in open-hearth furnace plant (OHFP) and production of profiled steel billet in blooming mill plant (BMP) are calculated by carbon balance method based on historical consumption of carbon-containing materials and fuels, historical output of production under baseline technology, and actual carbon content in BFG, COG and NG;
3. $CO_2$ emissions from metallurgical conversion for production of profiled steel billet in the baseline in amount equal to the actual project one are calculated on the basis of historical specific consumption of pig iron and scrap metal per ton of profiled steel in OHFP-BMP process, actual specific consumption of metallurgical coke per ton of pig iron and actual output of profiled steel billet in the project;
4. $CO_2$ emissions from consumption of electricity in the baseline are calculated on the basis of historical electricity consumption in OHFP and BMP (they produced only profiled steel), actual $CO_2$ emission factors from electricity consumption and actual output of profiled steel billet in the project;

5. $CO_2$ emissions during generation of air blast were calculated using actual specific consumption of air blast per ton of pig iron, $CO_2$ emission factor from generation of air blast and demand for pig iron required for production of profiled steel billet in the baseline;
6. Total $CO_2$ emissions associated with production of profiled steel billet in the baseline are summarized.

Table B.2.2. Historical averages of parameters, which characterize OHFP-BMP process[3]

| № | Parameter and measurement units, source of data | Symbol | Value |
|---|---|---|---|
| 1. | Annual average consumption of pig iron in OHFP, ths. tons<br>Archives of Economic Department (calculation of production costs) | $\mathbf{M}_{\text{pig iron\_OHFP}}$ | 1941.1 |
| 2. | Annual average consumption of scrap metal in OHFP, ths. tons<br>Archives of Economic Department (calculation of production costs) | $\mathbf{M}_{\text{scrap\_OHFP}}$ | 715.3 |
| 3. | Annual average smelting of steel in OHFP, ths. tons<br>Archives of Economic Department (calculation of production costs) | $\mathbf{P}_{\text{steel\_OHFP}}$ | 2335.7 |
| 4. | Annual average specific consumption of pig iron in OHFP per ton of steel, ton per ton<br>Archives of Economic Department (calculation of production costs) | $\mathbf{SM}_{\text{pig iron\_OHFP}}$ | 0.831 |
| 5. | Annual average specific consumption of scrap metal in OHFP per ton of steel, ton per ton<br>Archives of Economic Department (calculation of production costs) | $\mathbf{SM}_{\text{scrap\_OHFP}}$ | 0.306 |
| 6. | Annual average production of profiled steel billet in BMP, ths. tons<br>Archives of Economic Department (calculation of production costs) | $\mathbf{P}_{\text{profiled steel\_BM}}$ | 2029.9 |
| 7. | Annual average specific consumption of steel in OHFP per ton of profiled steel billet in BMP<br>Archives of Economic Department (calculation of production costs) | $\mathbf{SC}_{\text{steel\_profiled steel\_BM}}$ | 1.151 |
| 8. | Annual average specific consumption of natural gas in OHFP, $m^3$ per ton of steel<br>Data has been stored in CEST technical reports. Historical data on steel production is stored in archives of Economic Department (calculation of production costs) | $\mathbf{SC}_{\text{NG\_OHFP}}$ | 23.3 |
| 9. | Annual average specific consumption of blast furnace gas in BMP, $m^3$ per ton of steel | $\mathbf{SC}_{\text{BFG\_BM}}$ | 267.1 |

[3] The data confirming the appropriateness of values of these parameters as a ground for their fixing ex-ante has been provided during determination of the PDD and available at OJSC “MMK” by request.

| | | | |
|---|---|---|---|
| | Data has been stored in CEST technical reports. Historical data on steel production is stored in archives of Economic Department (calculation of production costs) | | |
| 10. | Annual average consumption of blast furnace gas in BMP, mln. $m^3$<br>CEST technical reports | **C** $_{BFG\_BM}$ | 542.0 |
| 11. | Annual average specific consumption of coke oven gas in BMP, $m^3$ per ton of steel<br>Data has been stored in CEST technical reports. Historical data on steel production is stored in archives of Economic Department (calculation of production costs) | **SC** $_{COG\_BM}$ | 7.7 |
| 12. | Annual average consumption of coke oven gas in BMP, mln. $m^3$<br>CEST technical reports | **C** $_{COG\_BM}$ | 16.0 |
| 13. | Annual average consumption of electricity in OHFP, GWh<br>CEST technical reports | **EC** $_{OHFP}$ | 16.2 |
| 14. | Annual average consumption of electricity in BMP, GWh<br>CEST technical reports | **EC** $_{BM}$ | 83.8 |

### *B.3 Approach for organization and implementation of monitoring*

The system of monitoring for the project has functioned during the year in accordance with internal procedure PD MMK 3-SSGO-01-2010 “Regulation on monitoring of GHG emissions reduction, created as a result of the realization of the project: “Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works”.

Monitoring of greenhouse gases emission reduction is carried out at OJSC “MMK” based on continuous monitoring of the monitoring parameters (Table B.3.1) specified in the PDD. Monitoring report is subject for verification. A reference about monitoring of each parameter is presented as informational matrix of the approved form. The data relating to the monitoring of the project is posted on a dedicated server of OJSC “MMK”.

Departments responsible for monitoring of each parameter of the JI project carry a responsibility for the treatment of primary reporting documents, processing, preparation, verification and transfer to the Department for relations with state authorities and markets protection (JI project implementation coordinator) of the reporting documents containing the information about monitored parameters. In each department of OJSC “MMK” involved in monitoring under the JI project the head of the department assigns a person responsible for provision of the reporting documents and tracking of the parameters change.

Picture B.3.1. Management structure of monitoring process

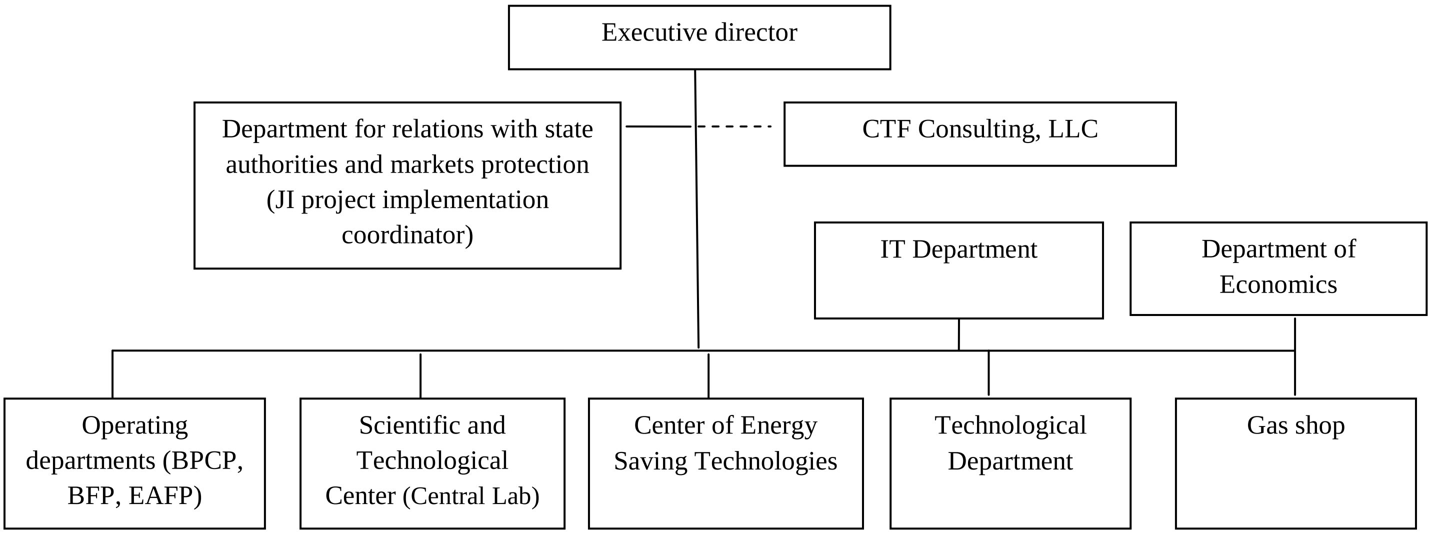



Table B.3.1. Responsibility of departments for monitoring parameters

| # | Department | Monitoring parameter |
|---|---|---|
| 1 | By-product coke plant | 1. Consumption of dry coal charge<br>2. Production of dry metallurgical coke<br>3. Production of crude benzol<br>4. Output of dry coal tar |
| 2 | Blast-furnace plant | 5. Consumption of dry skip metallurgical coke<br>6. Production of pig iron<br>7. Supply of blast furnace dust to the cement factory outside MMK |
| 3 | Electric arc-furnace plant | 8. Consumption of pig iron in EAFP<br>9. Consumption of carbon-containing powder in EAFP<br>10. Consumption of scrap metal in EAFP<br>11. Consumption of electrodes in EAFP<br>12. Output of profiled steel billet in EAFP<br>13. Total production of slab and profiled steel billet in EAFP<br>14. Total smelting of steel in EAF-180 |
| 4 | Technological department | 15. Total electricity consumption by MMK<br>16. Electricity purchase from Unified Energy System of Urals grid<br>17. Total electricity consumption in EAFP<br>18. Consumption of grid electricity by EAF-180<br>19. Specific electricity consumption for nitrogen production at MMK<br>20. Specific electricity consumption for production of |

| | | |
|---|---|---|
| | | pure nitrogen at MMK<br>21. Specific electricity consumption for production of argon at MMK<br>22. Consumption of BFG in CPP<br>23. Consumption of NG in CPP<br>24. Consumption of NG in CHPP<br>25. Consumption of BFG in SABPP<br>26. Consumption of COG in SABPP<br>27. Consumption of NG in SABPP<br>28. Consumption of NG in turbine section of SP<br>29. Consumption of NG in recovery unit of SP<br>30. Consumption of power station coal by CHPP<br>31. Generation of air blast at MMK<br>32. Consumption of BFG in SABPP for generation of air blast<br>33. Consumption of COG in SABPP for generation of air blast<br>34. Consumption of NG in SABPP for generation of air blast |
| 5 | Center of Energy Saving Technologies | 35. Consumption of BFG in BPCP<br>36. Carbon content in BFG<br>37. Consumption of COG in BPCP<br>38. Carbon content in COG<br>39. Consumption of NG in BPCP<br>40. Output of COG in BPCP<br>41. Consumption of COG in BFP<br>42. Consumption of NG in BFP<br>43. Consumption of BFG in BFP<br>44. Output of BFG in BFP<br>45. Consumption of NG in EAFP<br>46. Consumption of nitrogen in EAFP<br>47. Consumption of pure nitrogen in EAFP<br>48. Consumption of argon in EAFP |
| 6 | Central Laboratory of Control in structure of Scientific and Technological Center | 49. Carbon content in dry coal charge<br>50. Carbon content in dry metallurgical coke<br>51. Carbon content in blast furnace dust |
| 7 | Gas shop | 52. Carbon content in NG |

The period of data transfer by structural departments of OJSC "MMK" is monthly within 5 working days after their preparation and approval of paper form. Submission of the reports to Department for relations with state authorities and markets protection is performed by responsible person in electronic form.

Responsible person from department prepares documents containing information about monitoring parameters in electronic format *.doc, *.xls, *.pdf, *.jpeg (depending the type of the document, see Table B.3.2). From e-mail address assigned for each department these files are sent to the e-mail address of

Department of informational technologies that is registered as a resource for the monitoring of the project "Implementation of arc-furnace steelmaking at OJSC "MMK". Then received files are placed on the server of OJSC "MMK". Read access to this server is provided to users on the basis of an application for access to information resource. Editing rights of the electronic documents are restricted. Approved reported documents in paper form are stored in accordance with procedure existing in each department.

Storage of all records on monitoring for JI project (describing the period from January 1, 2008 to December 31, 2012) in electronic form is provided until January 1, 2015 by Department for relations with state authorities and markets protection.

Department for relations with state authorities and markets protection controls the completeness of the data and the term of data transfer. Every quarter all the relevant data are transferred to CTF Consulting, LLC. (consultant for the project) by e-mail. Similarly the information matrix of parameters, which were changed and other important information is sent to CTF Consulting, LLC in order that relevant definitions are made during a preparation of the monitoring report.

Within 10 working days after receipt of the complete set of reporting forms the specialists of CTF Consulting, LLC calculate $CO_2$ emission reduction achieved by JI project for each quarter. The results of calculation are reported to the Department for relations with state authorities and markets protection.

CTF Consulting, LLC develops for OJSC "MMK" the annual monitoring report on $CO_2$ emission reduction based on quarterly reporting upon receipt of the reporting for $4^{th}$ quarter. The monitoring report is sent then to Department for relations with state authorities and markets protection, which submits it for consideration of relevant departments. Department of Economics of MMK has to compare the figures contained in the monitoring report on consumption of raw materials and manufacture of products with Calculation of prime costs and confirm their compliance. Annual monitoring report is approved by Executive Director of MMK.

Table B.3.2. List of reporting documents prepared by departments of OJSC "MMK", which are used in project monitoring

| № | Organization department | Name of the reporting document in the Quality Management System (QMS) | Format of electronic copy |
|---|---|---|---|
| 1 | By-product coke plant | Technical report on coking<br>Report on recovery of main products from coke oven gas | .XLS<br>.XLS |
| 2 | Blast-furnace plant | Monthly technical report of BFP | .XLS |
| 3 | Electric arc-furnace plant | Technical report of EAFP | .XLS |
| 4 | Electric arc-furnace plant | Reference on consumption of pig iron, metallurgical scrap, carbon-containing powders, electrodes | .XLS |
| 5 | Technological department | Summary of energy consumption by departments of OJSC "MMK" | .XLS |
| 6 | Technological department | Analysis of energy resources consumption by OJSC "MMK"<br>(form QMS (2) -32-0) | .XLS |

| | | | |
|---|---|---|---|
| 7 | Technological department | Fuel consumption by type of product of power plants | .XLS |
| 8 | Central Laboratory of Control in structure of Scientific and Technological Center | Carbon content in dry coal charge and metallurgical coke of BPCP of OJSC "MMK". | .JPEG (scan of the table with signature laboratory head) |
| 10 | Central Laboratory of Control in structure of Scientific and Technological Center | Monthly average data of agglomerates, iron-ore raw materials and flux | .XLS |
| 11 | Center of Energy Saving Technologies | Report on balance of blast furnace gas consumption in workshops | .XLS |
| 12 | Center of Energy Saving Technologies | Report on balance of coke over gas consumption in workshops | .XLS |
| 13 | Center of Energy Saving Technologies | Report on balance of natural gas consumption in workshops | .XLS |
| 14 | Center of Energy Saving Technologies | Products distribution of the oxygen plant, delivered by pipeline to consumers | .XLS |
| 15 | Center of Energy Saving Technologies | Results of analysis of coke over gas | .XLS |
| 16 | Center of Energy Saving Technologies | Results of analysis of blast furnace gas | .XLS |
| 17 | Chief powerman department, Gas shop | Natural gas quality passport (provided by supplier) | .PDF/.JPEG (scan of the passport) |

### *B.4 Technical means of measurements and its accuracy*

| *№* | *Monitoring parameter* | *Measuring device* | *Inaccuracy of measurements,* |
|---|---|---|---|
| 1 | Consumption of coal charge in BPCP (on dry mass) | Consumption of coal charge is calculated based on gross coke production that is calculated as a sum of weighed amounts of metallurgical coke and coke breeze/coke nut after quenching and sifting of every shipment of the gross coke from the coke batteries. Besides humidity is measured to recalculate all material flows on dry mass. | 1% |
| 2 | Production of dry metallurgical coke | Railway scales | 1% |
| 3 | Production of crude benzol | Fluid level gauge | 0,1% |
| 4 | Output of dry coal tar | Reverse calculation via sum of products of tar distillation measured by fluid level gauge | 0,1% |
| 5 | Consumption of skip metallurgical coke in BFP | Weighting funnels with strain sensor VDD6-0.5. Besides humidity is measured to recalculate on dry mass | 1% |
| 6 | Production of pig iron in BFP | Railway scales | 0,3-1% depending on the scales type |
| 7 | Supply of blast furnace dust to the cement factory outside MMK | Railway scales | 0,3-1% depending on the scales type |
| 8 | Consumption of pig iron in EAFP | Railway scales | 0,3-1% depending on the scales type |
| 9 | Consumption of scrap metal in EAFP | | |
| 10 | Consumption of carbon-containing powder in EAFP | Strain-gauge weight-hopper | 1% |
| 11 | Consumption of electrodes in EAFP | Visual control | - |
| 12 | Output of profiled steel billet in EAFP | Calculation through geometric size of production output | - |
| 13 | Total production of slab and profiled steel billet in EAFP | | |

| | | | |
|---|---|---|---|
| 14 | Total smelting of steel in EAF-180 | | |
| 15 | Total electricity consumption by MMK | Electricity meters | Accuracy rating 0,5; 2,0; 2,5 depending on the type of meter |
| 16 | Electricity purchase from Unified Energy System of Urals grid | Electricity meters | Accuracy rating 0,5 |
| 17 | Total electricity consumption in EAFP | Electricity meters | Accuracy rating 0,5; 2,0; 2,5 depending on the type of meter |
| 18 | Consumption of grid electricity by EAF-180 | Electricity meters | Accuracy rating 0,5 |
| 19 | Specific electricity consumption for nitrogen production at MMK | - | - |
| 20 | Specific electricity consumption for production of pure nitrogen at MMK | | |
| 21 | Specific electricity consumption for production of argon at MMK | | |
| 22 | Consumption of BFG in CPP | Pressure differential flow meters Metran-100-DD-1411, Metran-22-DD-1420 and Sapphire-22-DD-2410 measure flows of COG, BFG and NG. Then the consumption of these gases is calculated by SPG-762 calculator.<br><br>Pressure differential flow meters Yokogava Eja110a measure flows of NG in BFP, CHPP, CPP, SABPP and the turbine section of the steam plant. Then the consumption of natural gas is calculated by SPG-762 calculator. | 1% |
| 23 | Consumption of NG in CPP | | |
| 24 | Consumption of NG in CHPP | | |
| 25 | Consumption of BFG in SP | | |
| 26 | Consumption of COG in SP | | |
| 27 | Consumption of NG in SP | | |
| 28 | Consumption of NG in turbine section of SP | | |
| 29 | Consumption of NG in recovery unit of SP | | |
| 30 | Consumption of BFG in BPCP | | |
| 31 | Consumption of COG in BPCP | | |
| 32 | Consumption of NG in BPCP | | |
| 33 | Consumption of COG in BFP | | |

| | | | |
|---|---|---|---|
| 34 | Consumption of BFG in BFP | | |
| 35 | Consumption of nitrogen in EAFP | | |
| 36 | Consumption of BFG in SABPP for generation of air blast | | |
| 37 | Consumption of COG in SABPP for generation of air blast | | |
| 38 | Consumption of NG in SABPP for generation of air blast | | |
| 39 | Consumption of NG in BFP | | |
| 40 | Consumption of NG in EAFP | | |
| 41 | Output of COG in BPCP | | |
| 42 | Output of BFG in BFP | | |
| 43 | Generation of air blast at MMK | Air flow meter | 1% |
| 44 | Consumption of pure nitrogen in EAFP | Air flow meter | 1% |
| 45 | Consumption of argon in EAFP | | |
| 46 | Consumption of power station coal by CHPP | Railway scale | 1% |
| 47 | Carbon content in BFG | Calculation through gas composition which is measured by VTI-2 gas analyzer | 0,3% |
| 48 | Carbon content in COG | | |
| 49 | Carbon content in dry coal charge | Carbon analyzer LECO SC144DR | 0,25% |
| 50 | Carbon content in dry metallurgical coke | | |
| 51 | Carbon content in blast furnace dust | Express carbon analyzer AN-7529 | 0,5% |
| 52 | Carbon content in NG | Component composition of NG is specified in technical passport by the supplier. Carbon content is then estimated on the basis of that measured composition of gas | 0,5% |
| 53 | Power transmission and distribution losses in Unified energy Systems of Urals grid | Specified in Annual report of Urals Inter-regional Power Distribution Company | - |

## C. Adjustments and deviations from the monitoring plan presented in PDD

Present monitoring report contains some adjustments and deviations from the monitoring plan presented in section D of PDD, version 1.5 of January 31, 2011 (for this version of PDD the Bureau Veritas Certification Holding SAS has issues a determination report № Russia/0043-2/2009 version 2 of February 2, 2011). The changes have been made to adapt a monitoring plan and represent the actually existing situation. Other monitoring parameters and calculation formulae are in compliance with PDD. It should be noted that the version 1.5 of January 31, 2011 differs from the preceding version 1.4 of January 15, 2010 only by changes in section A.5, therefore the initial monitoring plan has been developed in 2009.

| Mentioned in PDD | Implemented in practice | Explanation |
|---|---|---|
| **Electricity consumption for production of pure nitrogen, which is used during production of profiled steel billet in EAFP**<br><br>$EC_{pure\_N2\_profiled\_steel} = SEC_{pure\_N2\_PJ} * V_{pure\_N2\_EAFP} * P_{profiled\_steel\_EAFP\_} / \sum P_{profiled\&slab\ steel\_EAFP}$ **(D.1.1.2.-20)**<br><br>Where:<br><br>$SEC_{pure\_N2\_PJ}$ – Specific electricity consumption for production of pure nitrogen at MMK, MWh/1000 $m^3$<br><br>$V_{pure\_N2\_EAFP}$ – Consumption of pure nitrogen in EAFP, million $m^3$<br><br>$P_{profiled\_steel\_EAFP}$ - Output of profiled steel billet in EAFP, thousand tons<br><br>$\sum P_{profiled\&slab\ steel\_EAFP}$ - Total production of slab and profiled steel billet in EAFP, thousand tons. | Since July 2010 the value of specific electricity consumption for production of nitrogen is not defined and fixed as **150 kWh/1000 $m^3$**. | In August 2010 the Oxygen shop of OJSC "MMK" provided a note that in July 2010 the nitrogen compressors which provide the EAFP with gaseous nitrogen were switched. As a result it became impossible to define a quantity of electricity used for compressing of the nitrogen.<br><br>In the letter # KC-1079-06 of 05.08.2010 sent by Oxygen shop to CEST it was proposed to revise an order of electricity consumption accounting for nitrogen generation and fix the value as 150 kWh/1000 $m^3$.<br><br>The value of parameter had been monitored until July 2010. The average value for January-June 2010 is 141 kWh/1000 $m^3$. Therefore the fixed ex-ante value of specific electricity consumption for production of nitrogen as 150 kWh/1000 $m^3$ can be considered as applicable.<br><br>It should be furthermore noted that according to the "Standard for applying the concept of materiality in verifications" adopted at twenty-second meeting of the JISC the materiality threshold (item B.4 (b)) is two percent with annual average emission reductions by sources amounting to 100.000 tones per year or more.<br><br>Thus for considered project the threshold of materiality is 15.166 tones CO2eq (which are 2% of emission reduction of 758.323 tones CO2eq for 2010). To assess the impact of the issue to the ERUs amount the |

| | | |
|---|---|---|
| | | analysis has been made:<br>- Annual average specific electricity consumption for production of nitrogen in 2008 was 212 kWh/1000 $m^3$.<br>- Annual average specific electricity consumption for production of nitrogen in 2008 was 204 kWh/1000 $m^3$.<br>Based on assumption that specific electricity consumption for production of nitrogen might be higher in 2010 the value 300 kWh/1000 $m^3$ (i.e. twice higher than proposed fixed ante value) has been taken for analysis for all 2010. With such assumption the ERUs would be 756.813 tones CO2eq for 2010, which is just 510 tones CO2eq less than normally estimated.<br>Therefore the impact of the fixing ante of specific electricity consumption for production of nitrogen as done by OJSC "MMK" is not material in the context of the project and can be considered applicable for monitoring. |
| **Electricity consumption for production of argon, which is used during production of profiled steel billet in EAFP**<br>$\mathbf{EC_{Ar\_profiled\_steel} = SEC_{Ar\_PJ} * V_{Ar\_EAFP} * P_{profiled\_steel\_EAFP} / \sum P_{profiled\&slab\ steel\_EAFP}}$ **(D.1.1.2.-21)**<br>Where:<br>$SEC_{Ar\_PJ}$ – Specific electricity consumption for production of argon at MMK, MWh/1000 $m^3$<br>$V_{Ar\_EAFP}$ – Consumption of argon in EAFP, million $m^3$<br>$P_{profiled\_steel\_EAFP}$ - Output of profiled steel billet in | In 2010 the value of:<br>- Specific electricity consumption for production of pure nitrogen is **826 kWh/1000 $m^3$**<br>- Specific electricity consumption for production of argon is **55 kWh/1000 $m^3$** | For information:<br>values of specific electricity consumption for production of pure nitrogen and argon are reported in the Summary of energy consumption by departments of OJSC "MMK". During the visit to the works in January 2011 it was revealed that in fact these values are not measured but determined only once because the technical ability for their instrumental measurements currently is absent. This practice takes place over the several years including the period from January 1, 2008, and in the reporting for 2008 and 2009 the mentioned values remained same.<br>Anyhow the values are still subject of monitoring and reporting at MMK and not fixed ex-ante.<br>The appropriate confirmation by the Technological department of MMK is provided in the e-mail from the Head of Section of regulation |

| | | |
|---|---|---|
| EAFP, thousand tons<br><br>$\sum P_{profiled\&slab\ steel\_EAFP}$ - Total production of slab and profiled steel billet in EAFP, thousand tons. | | and analysis of fuel and energy resources consumption, date 17/03/2011 mrs. Irina Kucherova:"The consumption rates were determined in 1994, consumption of electricity for nitrogen production was calculated through the known value of consumption of electricity for oxygen production in the ratio of the melting points of nitrogen and oxygen (at an estimated exergy). The consumption of electricity for argon production was determined as electricity consumption for purification and compressing of the crude argon (this is a by-product of oxygen production) – for that the additional equipment had been installed.<br><br>It should be furthermore noted that according to the "Standard for applying the concept of materiality in verifications" adopted at twenty-second meeting of the JISC the materiality threshold (item B.4 (b)) is two percent with annual average emission reductions by sources amounting to 100.000 tones per year or more.<br><br>Thus for considered project the threshold of materiality is 15.166 tones CO2eq (which are 2% of emission reduction of 758.323 tones CO2eq for 2010). To assess the impact of the issue to the ERUs amount the analysis has been made:<br>- Being increased 2 times the values of specific electricity consumption for production of pure nitrogen and argon give the change of ERUs of 672 tones CO2eq.<br>- Even increase of the mentioned values for 10 times (which is definitely unlikely) gives the change of ERUs of 5.864 tonnes CO2eq or 0,77% of the total ERUs for 2010.<br><br>Therefore the impact of the values of specific electricity consumption for production of pure nitrogen and argon is not material in the context of the project and no additional confirmation of the correctness of the fixed value is required. |
| **$CO_2$ emissions from consumption of electricity** | To the moment of preparation of | The value of technological losses during transportation and distribution |

| | | |
|---|---|---|
| TDL – Technological losses during transportation and distribution of grid electricity in Unified Energy System of Urals, % | present Monitoring report the OJSC "MRSK of Urals" has not yet published on their web-site the annual report for 2010. Therefore the value of technological losses has been defined for all the year 2010 by data of 9 months (http://www.mrsk-ural.ru/ru/440.news1434.html) as **7.24%**. | of grid electricity in Unified Energy System of Urals changes over the last years within 1%.<br>The impact of such change on ERUs is less than 1000 tonnes $CO_{2eq}$. |
| ***Specific consumption of air blast per ton of pig iron produced***<br>$$\mathbf{SC_{air\ blast\ generation\_PJ} = P_{air\ blast\ generation} / P_{pig\ iron\_BF\_PJ}} \quad \textbf{(D.1.1.2.-29)}$$<br>Where:<br>$SC_{air\ blast\ generation\_PJ}$ – Specific consumption of air blast in BFP per ton of produced pig iron, thousand $m^3$/ton<br>$P_{air\ blast\ generation}$ – Generation of air blast at MMK, $m^3$ of air blast<br>$P_{pig\ iron\_BF\_PJ}$ – Production of pig iron in BFP, thousand tons | There is a misprint in PDD. Generation of air blast at MMK is designated $\mathbf{OC_{air\ blast\ generation\_PJ}}$ which follows from the table D.1.1.1 and formula D.1.1.2.-27. | |

# D. Calculation of GHG emissions reduction

## *D.1 $CO_2$ emissions from metallurgical conversions calculated by carbon balance method*

**<u>Production of metallurgical coke</u>**

$$PE_{metallurgical\_coke} = [(M_{coking\ coal\_PJ} * \%C_{coking\ coal\_PJ}) + (FC_{BFG\_CP\_PJ} * C_{BFG\_PJ}) + (FC_{COG\_CP\_PJ} * C_{COG\_PJ}) + (FC_{NG\_CP\_PJ} * C_{NG\_PJ}) - (P_{metallurgical\ coke\_PJ} * \%C_{metallurgical\ coke\_PJ}) - (P_{COG\_CP\_PJ} * C_{COG\_PJ}) - (P_{benzol\_PJ} * \%C_{benzol}) - (P_{coal\text{-}tar\_PJ} * \%C_{coal\text{-}tar})] * 44/12$$

**(PDD formula D.1.1.2.-1)**

***Specific $CO_2$ emissions per ton of produced metallurgical coke***

$$SPE_{metallurgical\ coke} = PE_{metallurgical\ coke} / P_{metallurgical\ coke\_PJ}$$

**(PDD formula D.1.1.2.-2)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $M_{coking\ coal\_PJ}$ | Consumption of coal charge in BPCP (on dry mass) | ths. tons | $C_{COG\_PJ}$ | Carbon content in COG | kg C/m$^3$ | $P_{COG\_CP\_PJ}$ | Output of COG in BPCP | mln. m$^3$ |
| $\%C_{coking\ coal\_PJ}$ | Carbon content in dry coal charge | % by mass | $FC_{NG\_CP\_PJ}$ | Consumption of NG in BPCP | mln. m$^3$ | $P_{benzol\_PJ}$ | Production of crude benzol | ths. tons |
| $FC_{BFG\_CP\_PJ}$ | Consumption of BFG in BPCP | mln. m$^3$ | $C_{NG\_PJ}$ | Carbon content in NG | kg C/m3 | $P_{coal\text{-}tar\_PJ}$ | Output of dry coal tar | ths. tons |
| $C_{BFG\_PJ}$ | Carbon content in BFG | kg C/m$^3$ | $P_{metallurgical\ coke\_PJ}$ | Production of dry metallurgical coke | ths. tons | $PE_{metallurgical\_coke}$ | Project emissions from production of metallurgical coke in BPCP | ths. tons $CO_2$ |
| $FC_{COG\_CP\_PJ}$ | Consumption of COG in BPCP | mln. m$^3$ | $\%C_{metallurgical\ coke\_PJ}$ | Carbon content in dry metallurgical coke | % by mass | $SPE_{metallurgical\ coke}$ | Specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP | ton $CO_2$/ ton |

*Specific $CO_2$ emissions form metallurgical conversions same for project and baseline. Production of metallurgical coke*

## *12 months of 2010*

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of coal charge in BPCP (on dry mass) | ths. tons | 511,5 | 500,7 | 551,8 | 571,9 | 516,3 | 458,0 | 485,0 | 509,2 | 582,4 | 536,5 | 554,7 | 550,1 | **6328,1** |
| | Carbon content in dry coal charge | % by mass | 80,40 | 80,70 | 80,50 | 80,70 | 80,40 | 80,10 | 80,10 | 80,50 | 80,20 | 80,00 | 80,10 | 80,40 | **80,34** |
| | | ths. tons C | 411,2 | 404,1 | 444,2 | 461,5 | 415,1 | 366,8 | 388,5 | 409,9 | 467,1 | 429,2 | 444,3 | 442,3 | **5084,3** |
| 2 | Consumption of COG in BPCP | mln. m3 | 46,6 | 45,3 | 51,9 | 54,2 | 48,1 | 42,4 | 46,7 | 50,6 | 61,3 | 52,1 | 53,6 | 53,3 | **606,0** |
| | Carbon content in COG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | **0,18** |
| | | ths. tons C | 8,6 | 8,2 | 9,3 | 9,6 | 8,5 | 7,5 | 8,7 | 9,5 | 11,4 | 9,9 | 10,0 | 9,9 | **111,0** |
| | Consumption of BFG in BPCP | mln. m3 | 131,8 | 134,1 | 139,7 | 141,0 | 136,4 | 117,5 | 118,6 | 118,4 | 121,4 | 129,6 | 137,3 | 137,2 | **1562,9** |
| | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | **0,21** |
| | | ths. tons C | 27,9 | 28,1 | 29,4 | 29,8 | 28,9 | 25,0 | 25,1 | 25,0 | 25,8 | 27,9 | 30,1 | 30,2 | **333,3** |
| | Consumption of NG in BPCP | mln. m3 | 3,3 | 2,9 | 2,7 | 1,9 | 0,8 | 0,7 | 0,8 | 0,7 | 0,8 | 1,1 | 1,6 | 2,4 | **19** |
| | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 1,6 | 1,4 | 1,3 | 0,9 | 0,4 | 0,3 | 0,4 | 0,3 | 0,4 | 0,5 | 0,8 | 1,2 | **9,6** |
| 3 | **Total mass of carbon in the input flow for production of metallurgical coke** | **ths. tons C** | **449,3** | **441,8** | **484,2** | **501,8** | **452,9** | **399,6** | **422,7** | **444,8** | **504,7** | **467,5** | **485,2** | **483,5** | **5538,2** |

Output carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Production of dry metallurgical coke | ths. tons | 359,6 | 351,7 | 388,7 | 404,7 | 367,1 | 325,0 | 344,1 | 360,1 | 415,6 | 380,1 | 392,9 | 388,2 | **4477,7** |
| | Carbon content in dry metallurgical coke | % by mass | 83,10 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 83,00 | 82,90 | 82,80 | 82,90 | 82,90 | 83,00 | **83,02** |
| | | ths. tons C | 298,8 | 290,5 | 323,4 | 337,9 | 305,8 | 269,7 | 285,6 | 298,5 | 344,1 | 315,1 | 325,7 | 322,2 | **3717,4** |
| 2 | Output of COG in BPCP | mln. m3 | 165,6 | 161,6 | 181,3 | 188,7 | 168,0 | 144,7 | 154,0 | 165,9 | 189,8 | 180,7 | 189,3 | 189,5 | **2079,0** |
| | Carbon content in COG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | **0,18** |
| | | ths. tons C | 30,4 | 29,2 | 32,4 | 33,3 | 29,7 | 25,6 | 28,8 | 31,2 | 35,4 | 34,2 | 35,4 | 35,1 | **380,8** |
| 3 | Output of dry coal tar | ths. tons | 15,5 | 15,1 | 17,9 | 18,3 | 16,4 | 14,1 | 15,4 | 15,3 | 17,5 | 17,7 | 18,6 | 18,3 | **200,1** |
| | Carbon content in dry coal tar | % by mass | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | 86,00 | **86,00** |
| | | ths. tons C | 13,3 | 13,0 | 15,4 | 15,7 | 14,1 | 12,1 | 13,3 | 13,2 | 15,0 | 15,2 | 16,0 | 15,7 | **172,1** |
| 4 | Production of crude benzol | ths. tons | 4,8 | 4,7 | 5,2 | 5,4 | 4,6 | 4,4 | 4,5 | 4,7 | 4,7 | 5,1 | 5,1 | 5,4 | **58,5** |
| | Carbon content in crude benzol | % | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | 90,00 | **90,00** |

*Specific $CO_2$ emissions form metallurgical conversions same for project and baseline. Production of metallurgical coke*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ths. tons C | 4,3 | 4,2 | 4,7 | 4,9 | 4,1 | 4,0 | 4,0 | 4,2 | 4,2 | 4,5 | 4,6 | 5 | **52,7** |
| 5 | **Total mass of carbon in the output flow from production of metallurgical coke** | **ths. tons C** | **346,8** | **336,9** | **376,0** | **391,9** | **353,7** | **311,4** | **331,7** | **347,1** | **398,7** | **369,1** | **381,7** | **377,9** | **4322,9** |

CO2 emissions from production of metallurgical coke

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | **Total for year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Burning of carbon during production of metallurgical coke | ths. tons C | 102,5 | 104,9 | 108,3 | 110,0 | 99,2 | 88,2 | 91,1 | 97,6 | 106,0 | 98,4 | 103,5 | 105,6 | **1215,3** |
| 2 | CO2 emissions from production of metallurgical coke in BPCP | ths. tons CO2 | 375,9 | 384,8 | 397,0 | 403,2 | 363,7 | 323,4 | 333,9 | 357,9 | 388,6 | 361,0 | 379,5 | 387,1 | **4456,0** |
| 3 | **Specific CO2 emissions per ton of produced metallurgical coke** | **ton CO2/ton** | **1,045** | **1,094** | **1,021** | **0,996** | **0,991** | **0,995** | **0,970** | **0,994** | **0,935** | **0,950** | **0,966** | **0,997** | **0,995** |

*Specific $CO_2$ emissions form metallurgical conversions same for project and baseline. Production of metallurgical coke*

## Production of pig iron

$$PE_{pig\_iron} = [(M_{skip\_metallurgical\ coke\_BF\_PJ} * \%C_{metallurgical\ coke\_PJ}) + (FC_{COG\_BF\_PJ} * C_{COG\_PJ}) + (FC_{NG\_BF\_PJ} * C_{NG\_PJ}) + (FC_{BFG\_BF\_PJ} * C_{BFG\_.PJ}) - - (P_{pig\ iron\_BF\_PJ} * \%C_{pig\ iron}) - (P_{BFG\_BF\_PJ} * C_{BFG\_PJ})] * 44/12$$

**(PDD formula D1.1.2.-3)**

***Specific CO2 emissions per ton of pig iron produced***

$$SPE_{pig\ iron} = PE_{pig\_iron} / P_{pig\ iron\_BF\_PJ}$$

**(PDD formula D.1.1.2.-4)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $M_{skip\_metallurgical\ coke\_BF\_PJ}$ | Consumption of skip metallurgical coke in BFP | ths. tons | $P_{pig\ iron\_BF\_PJ}$ | Production of pig iron in BFP | ths. tons |
| $FC_{COG\_BF\_PJ}$ | Consumption of COG in BFP | mln. $m^3$ | $P_{BFG\_BF\_PJ}$ | Output of BFG in BFP | mln. $m^3$ |
| $FC_{NG\_BF\_PJ}$ | Consumption of NG in BFP | mln. $m^3$ | $C_{NG\_PJ}$ | carbon content in NG | kg $C/m^3$ |
| $FC_{BFG\_BF\_PJ}$ | Consumption of BFG in BFP | mln. $m^3$ | $C_{BFG\_.PJ}$ | Carbon content in BFG | kg $C/m^3$ |
| $C_{COG\_PJ}$ | Carbon content in COG | kg $C/m^3$ | $PE_{pig\ iron}$ | Project emissions from production of pig iron in the blast furnace plant | ths. tons $CO_2$ |
| $\%C_{pig\ iron}$ | Carbon content in pig iron | % by mass | $SPE_{pig\ iron}$ | Specific $CO_2$ emissions per ton of produced pig iron | ton $CO_2$/ton |
| $\%C_{metallurgical\ coke\_PJ}$ | Carbon content in metallurgical coke | % by mass | | | |

### *12 months of 2010*

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of skip metallurgical coke in BFP | ths. tons | 310,8 | 314,3 | 379,5 | 368,5 | 337,2 | 305,4 | 323,4 | 337,8 | 369,5 | 348,5 | 352,1 | 357,3 | 4104,3 |
| | Carbon content in dry metallurgical coke | %by mass | 83,10 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 83,00 | 82,90 | 82,80 | 82,90 | 82,90 | 83,00 | 83,02 |
| | | ths. tons C | 258,3 | 259,6 | 315,7 | 307,7 | 280,9 | 253,5 | 268,4 | 280,0 | 306,0 | 288,9 | 291,9 | 296,6 | 3407,4 |
| 2 | Consumption of COG in BFP | mln. m3 | 2,1 | 1,3 | 3,0 | 6,2 | 6,4 | 5,3 | 5,6 | 5,0 | 4,7 | 3,5 | 6,3 | 9,4 | 58,9 |
| | Carbon content in COG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,18 |

*Specific $CO_2$ emissions form metallurgical conversions same for project and baseline. Production of pig iron*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ths. tons C | 0,38 | 0,23 | 0,55 | 1,09 | 1,14 | 0,95 | 1,05 | 0,94 | 0,88 | 0,67 | 1,17 | 1,74 | **10,8** |
| | Consumption of NG in BFP | mln. m3 | 65,5 | 70,0 | 86,5 | 89,7 | 79,9 | 76,5 | 79,7 | 77,4 | 77,9 | 83,4 | 82,6 | 85,4 | **954,4** |
| | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 32,4 | 34,6 | 42,8 | 44,4 | 39,5 | 37,8 | 39,4 | 38,3 | 38,5 | 41,2 | 40,8 | 42,2 | **472,1** |
| | Consumption of BFG in BFP | mln. m3 | 345,9 | 340,5 | 435,0 | 414,0 | 367,4 | 313,5 | 337,0 | 343,1 | 353,8 | 368,3 | 364,9 | 357,9 | **4341,3** |
| | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | **0,21** |
| | | ths. tons C | 73,3 | 71,4 | 91,7 | 87,6 | 78,0 | 66,6 | 71,5 | 72,3 | 75,2 | 79,3 | 79,9 | 78,7 | **925,5** |
| 3 | **Total mass of carbon in the input flow for production of pig iron** | **ths. tons C** | **364,4** | **365,9** | **450,7** | **440,8** | **399,5** | **358,9** | **380,3** | **391,6** | **420,5** | **410,1** | **413,9** | **419,2** | **4815,9** |

Output carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | **Total for year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Production of pig iron in BFP | ths. tons | 686,3 | 700,0 | 849,3 | 842,4 | 769,6 | 708,4 | 754,5 | 761,4 | 799,0 | 781,0 | 786,9 | 795,1 | **9234,0** |
| | Carbon content in pig iron | % by mass | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | **4,70** |
| | | ths. tons C | 32 | 33 | 40 | 40 | 36 | 33 | 35 | 36 | 38 | 37 | 37 | 37 | **434** |
| 2 | Output of BFG in BFP | mln. m3 | 955,5 | 976,5 | 1199,3 | 1188,3 | 1068,8 | 974,1 | 1029,5 | 1024,5 | 1051,0 | 1071,1 | 1044,4 | 1083,8 | **12666,9** |
| | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | **0,21** |
| | | ths. tons C | 202,5 | 204,8 | 252,8 | 251,5 | 226,9 | 207,0 | 218,3 | 216,0 | 223,3 | 230,6 | 228,7 | 238,2 | **2700,7** |
| 3 | **Total mass of carbon in the output flow from production of pig iron** | **ths. tons C** | **234,8** | **237,7** | **292,7** | **291,1** | **263,1** | **240,3** | **253,8** | **251,8** | **260,9** | **267,3** | **265,7** | **275,6** | **3134,7** |

CO2 emissions from production of pig iron

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | **Total for year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Carbon burning during production of pig iron | ths. tons | 129,6 | 128,2 | 158,1 | 149,7 | 136,5 | 118,6 | 126,6 | 139,7 | 159,7 | 142,8 | 148,2 | 143,6 | **1681,2** |
| 2 | CO2 emissions from production of pig iron in the blast furnace plant | ths. tons CO2 | 475,2 | 470,2 | 579,6 | 548,8 | 500,4 | 434,8 | 464,1 | 512,4 | 585,5 | 523,5 | 543,3 | 526,6 | **6164,3** |
| 3 | **Specific CO2 emissions per ton of pig iron produced** | **ton CO2/ton** | **0,692** | **0,672** | **0,682** | **0,651** | **0,650** | **0,614** | **0,615** | **0,673** | **0,733** | **0,670** | **0,690** | **0,662** | **0,668** |

*Specific $CO_2$ emissions form metallurgical conversions same for project and baseline. Production of pig iron*

**<u>Production of profiled steel billet in EAFP (project only)</u>**

$$PE_{EAFP} = [(M_{pig\ iron\_EAFP} * \%C_{pig\ iron}) + (M_{carbon\ powder\_EAFP} * \%C_{carbon\ powder\_EAFP}) + (M_{scrap\_EAFP} * \%C_{scrap}) + (M_{electrodes\_EAFP} * \%C_{electrodes\_EAFP}) + (FC_{NG\_EAFP} * C_{NG\_PJ}) - (\sum P_{profiled\&slab\ steel\_EAFP} * \%C_{steel})] * 44/12$$

**(PDD formula D.1.1.2-5)**

***Specific CO2 emissions per ton of profiled steel billet produced in EAFP***

$$SPE_{EAFP} = PE_{EAFP} / \sum P_{profiled\&slab\ steel\_EAFP}$$

**(PDD formula D.1.1.2-6)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $M_{pig\ iron\_EAFP}$ | Consumption of pig iron in EAFP | ths. tons | $FC_{NG\_EAFP}$ | Consumption of NG in EAFP | mln. $m^3$ |
| $M_{carbon\ powder\_EAFP}$ | Consumption of carbon-containing powder in EAFP | ths. tons | $\sum P_{profiled\&slab\ steel\_EAFP}$ | Total production of slab and profiled steel billet in EAFP | ths. tons |
| $M_{scrap\_EAFP}$ | Consumption of scrap metal in EAFP | ths. tons | $PE_{EAFP}$ | Project $CO_2$ emissions from production of profiled steel billet in EAFP | ths.tons $CO_2$ |
| $M_{electrodes\_EAFP}$ | Consumption of electrodes in EAFP | ths. tons | $SPE_{EAFP}$ | Specific $CO_2$ emissions per ton of steel billet produced in EAFP | ton $CO_2$/ton |
| $\%C_{pig\ iron}$ | Carbon content in pig iron | % by mass | $\%C_{electrodes\_EAFP}$ | Carbon content in electrodes | % by mass |
| $\%C_{carbon\ powder\_EAFP}$ | Carbon content in carbon-containing powder | % by mass | $C_{NG\_PJ}$ | Carbon content in NG | kg C/$m^3$ |
| $\%C_{scrap}$ | Carbon content in scrap metal | % by mass | $\%C_{steel}$ | Carbon content in steel | % by mass |

*Specific $CO_2$ emissions from metallurgical conversions in the project only. Production of profiled steel billet in EAFP*

## *12 months of 2010*

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of pig iron in EAFP | ths. tons | 50,1 | 74,9 | 99,2 | 94,6 | 54,8 | 38,8 | 36,6 | 70,8 | 91,8 | 71,4 | 93,5 | 105,4 | **882,0** |
|  | Carbon content in pig iron | % by mass | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | 4,70 | **4,70** |
|  |  | ths. tons C | 2,4 | 3,5 | 4,7 | 4,4 | 2,6 | 1,8 | 1,7 | 3,3 | 4,3 | 3,4 | 4,4 | 5,0 | **41,5** |
| 2 | Consumption of carbon-containing powder in EAFP | ths. tons | 0,30 | 1,33 | 1,03 | 0,81 | 0,80 | 0,62 | 0,99 | 0,58 | 0,58 | 0,43 | 0,17 | 0,28 | **7,9** |
|  | Carbon content in carbon-containing powder | % by mass | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | 95,00 | **95,00** |
|  |  | ths. tons C | 0,3 | 1,3 | 1,0 | 0,8 | 0,8 | 0,6 | 0,9 | 0,5 | 0,6 | 0,4 | 0,2 | 0,3 | **7,5** |
| 3 | Consumption of scrap metal in EAFP | ths. tons | 38,7 | 116,4 | 125,8 | 112,6 | 162,5 | 131,9 | 146,8 | 135,2 | 135,7 | 75,9 | 33,7 | 37,9 | **1253,2** |
|  | Carbon content in scrap metal | % by mass | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | **0,18** |
|  |  | ths. tons C | 0,07 | 0,21 | 0,23 | 0,20 | 0,29 | 0,24 | 0,26 | 0,24 | 0,24 | 0,14 | 0,06 | 0,07 | **2,3** |
| 4 | Consumption of electrodes in EAFP | ths. tons | 0,07 | 0,22 | 0,23 | 0,20 | 0,36 | 0,31 | 0,32 | 0,25 | 0,24 | 0,15 | 0,05 | 0,05 | **2,4** |
|  | Carbon content in electrodes | % by mass | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | 99,00 | **99,00** |
|  |  | ths. tons C | 0,1 | 0,2 | 0,2 | 0,2 | 0,4 | 0,3 | 0,3 | 0,2 | 0,2 | 0,1 | 0,1 | 0,0 | **2,4** |
| 5 | Consumption of NG in EAFP | mln. m3 | 7,0 | 6,0 | 4,9 | 5,5 | 6,0 | 4,7 | 4,5 | 5,3 | 5,6 | 5,0 | 3,4 | 5,4 | **63,5** |
|  | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
|  |  | ths. tons C | 3,5 | 3,0 | 2,4 | 2,7 | 3,0 | 2,3 | 2,2 | 2,6 | 2,8 | 2,5 | 1,7 | 2,7 | **31,4** |
| **6** | **Total mass of carbon in the input flow in EAFP** | **ths. tons C** | **6,2** | **8,2** | **8,5** | **8,4** | **7,0** | **5,3** | **5,5** | **7,0** | **8,1** | **6,5** | **6,4** | **8,0** | **85,1** |

Output carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total production of slab and profiled steel billet in EAFP | ths. tons | 78,6 | 169,7 | 199,3 | 183,8 | 192,9 | 151,5 | 162,0 | 181,8 | 200,8 | 129,9 | 112,4 | 125,9 | **1888,4** |
|  | Carbon content in steel | % by mass | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | **0,18** |
|  |  | ths. tons C | 0,1 | 0,3 | 0,4 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,4 | 0,2 | 0,2 | 0,2 | **3,4** |
| **2** | **Total mass of carbon in the output flow from EAFP** | **ths. tons C** | **0,1** | **0,3** | **0,4** | **0,3** | **0,3** | **0,3** | **0,3** | **0,3** | **0,4** | **0,2** | **0,2** | **0,2** | **3,4** |

*Specific $CO_2$ emissions from metallurgical conversions in the project only. Production of profiled steel billet in EAFP*

CO2 emissions from production of steel

| № | Data variable | Unit | Янв. | Фев. | Март | Апр. | Май | Июнь | Июль | Авг. | Сент. | Окт. | Ноя. | Дек. | Итог по году |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Burning of carbon during production of profiled steel billet in EAFP | ths. tons C | 6,1 | 7,9 | 8,2 | 8,0 | 6,6 | 5,0 | 5,2 | 6,7 | 7,8 | 6,3 | 6,2 | 7,8 | **81,7** |
| 2 | CO2 emissions from production of profiled steel billet in EAFP | ths. tons CO2 | 22,3 | 28,9 | 30,0 | 29,4 | 24,3 | 18,4 | 19,0 | 24,5 | 28,4 | 23,1 | 22,6 | 28,5 | **299,4** |
| **3** | **Specific CO2 emissions per ton of profiled steel billet produced in EAFP** | **tons CO2/ton** | 0,284 | 0,170 | 0,151 | 0,160 | 0,126 | 0,122 | 0,117 | 0,135 | 0,141 | 0,178 | 0,201 | 0,227 | 0,159 |

*Specific $CO_2$ emissions from metallurgical conversions in the project only. Production of profiled steel billet in EAFP*

**Steel smelting in Open-Hearth Furnace Plant (baseline only)**

$$BE_{OHFP} = [(M_{pig\ iron\_OHFP} * \%C_{pig\ iron}) + (M_{scrap\_OHFP} * \%C_{scrap}) + (SC_{NG\_OHFP} * P_{steel\_OHFP} * C_{NG\_PJ}) - (P_{steel\_OHFP} * \%C_{steel})] *44/12$$

**(PDD formula D.1.1.4-1)**

***Specific CO2 emissions per ton of steel smelted in OHFP***

$$SBE_{OHFP} = BE_{OHFP} / P_{steel\_OHFP}$$

**(PDD formula D.1.1.4.-2)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $M_{pig\ iron\_OHFP}$ | Annual average consumption of pig iron in OHFP | ths. tons | $C_{NG\_PJ}$ | Carbon content in NG | kg C/$m^3$ |
| $\%C_{pig\ iron}$ | Carbon content in pig iron | % by mass | $P_{steel\_OHFP}$ | Annual average smelting of steel in OHFP | ths. tons |
| $M_{scrap\_OHFP}$ | Annual average consumption of scrap metal in OHFP | ths. tons | $\%C_{steel}$ | Carbon content in steel | % by mass |
| $\%C_{scrap}$ | Carbon content in scrap metal | % by mass | $BE_{OHFP}$ | $CO_2$ emissions from steel smelting in OHFP | ths. tons $CO_2$ |
| $SC_{NG\_OHFP}$ | Annual average consumption of NG in OHFP | mln. $m^3$ | $SBE_{OHFP}$ | Specific $CO_2$ emissions per ton of steel smelted in OHFP | ton $CO_2$/ton |

## *12 months of 2010*

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Annual average consumption of pig iron in OHFP | ths. tons | 1941,1 | | | | | | | | | | | | 1941,1 |
| | Carbon content in pig iron | % by mass | 4,70 | | | | | | | | | | | | 4,70 |
| | | ths. tons C | 91,2 | | | | | | | | | | | | 91,2 |
| 2 | Annual average consumption of scrap metal in OHFP | ths. tons | 715,3 | | | | | | | | | | | | 715,3 |
| | Carbon content in scrap metal | % by mass | 0,18 | | | | | | | | | | | | 0,18 |
| | | ths. tons C | 1,3 | | | | | | | | | | | | 1,3 |
| 3 | Annual average consumption of NG in OHFP | mln. m3 | 54,4 | | | | | | | | | | | | 54,4 |

*Specific $CO_2$ emissions for metallurgical conversions in the baseline only. Steel smelting in the OHFP*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 26,9 | | | | | | | | | | | | **26,9** |
| **4** | **Total mass of carbon in the input flow in the OHFP** | **ths. tons C** | **119,4** | | | | | | | | | | | | **119,4** |

Output carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | **Total for year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Annual average smelting of steel in OHFP | ths. tons | 2335,7 | | | | | | | | | | | | **2335,7** |
| | Carbon content in steel | % by mass | 0,18 | | | | | | | | | | | | **0,18** |
| | | ths. tons C | 4,2 | | | | | | | | | | | | **4,2** |
| **2** | **Total mass of carbon in the output flow from OHFP** | **ths. tons C** | **4,2** | | | | | | | | | | | | **4,2** |

CO2 emissions from steel smelting in OHFP

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | **Total for year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Burning of carbon during steel smelting in OHFP | ths. tons C | 115,2 | | | | | | | | | | | | **115,2** |
| 2 | CO2 emissions from steel smelting in OHFP | ths. tons CO2 | 422,6 | | | | | | | | | | | | **422,6** |
| **3** | **Specific CO2 emissions per ton of steel smelted in OHFP** | **tons CO2/ton** | **0,181** | | | | | | | | | | | | **0,181** |

*Specific $CO_2$ emissions for metallurgical conversions in the baseline only. Steel smelting in the OHFP*

**<u>Production of profiled steel billet in the Blooming Mill Plant (baseline only)</u>**

$$BE_{BM} = [(M_{steel\_BM} * \%C_{steel}) + (SC_{BFG\_BM} * P_{profiled\ steel\_BM} * C_{BFG\_PJ}) + (SC_{COG\_BM} * P_{profiled\ steel\_BM} * C_{COG\_PJ}) - (P_{profiled\ steel\_BM} * \%C_{steel})] * 44/12$$

**(PDD formula D.1.1.4-3)**

***Specific CO2 emissions per ton of profiled steel billet produced in BMP***

$$SBE_{BM} = BE_{BM} / P_{profiled\ steel\_BM}$$

**(PDD formula D.1.1.4.-4)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $M_{steel\_BM}$ | Annual average consumption of steel in BMP | ths. tons | $SC_{COG\_BM}$ | Annual average consumption of COG in BMP | mln. $m^3$ |
| $\%C_{steel}$ | Carbon content in steel | % by mass | $C_{COG\_PJ}$ | Carbon content in COG | kg $C/m^3$ |
| $SC_{BFG\_BM}$ | Annual average consumption of BFG in BMP | mln. $m^3$ | $P_{profiled\ steel\_BM}$ | Annual average production of profiled steel billet in BMP | ths. tons |
| $C_{BFG\_PJ}$ | Carbon content in BFG | kg $C/m^3$ | $BE_{BM}$ | $CO_2$ emissions from production of profiled steel billet in BMP | ths. tons $CO_2$ |
| | | | $SBE_{BM}$ | Specific $CO_2$ emissions per ton of profiled steel billet produced in BMP | ton $CO_2$/ton |

*Specific $CO_2$ emissions for metallurgical conversions in the baseline only. Production of profiled steel billet in the Blooming Mill Plant*

## *12 months of 2010*

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Annual average consumption of steel in BMP | ths. tons | 2335,7 | | | | | | | | | | | | **2335,7** |
| | Carbon content in steel | % by mass | 0,18 | | | | | | | | | | | | **0,18** |
| | | ths. tons C | 4,2 | | | | | | | | | | | | **4,2** |
| 2 | Annual average consumption of BFG in BMP | mln. m3 | 542,2 | | | | | | | | | | | | **542,2** |
| | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | **0,21** |
| | | ths. tons C | 114,7 | | | | | | | | | | | | **114,7** |
| 3 | Annual average consumption of COG in BMP | mln. m3 | 15,6 | | | | | | | | | | | | **15,6** |
| | Carbon content in COG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | **0,18** |
| | | ths. tons C | 2,8 | | | | | | | | | | | | **2,8** |
| **4** | **Total mass of carbon in the input flow in BMP** | **ths. tons C** | 121,7 | | | | | | | | | | | | **121,7** |

Output carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Annual average production of profiled steel billet in BMP | ths. tons | 2029,9 | | | | | | | | | | | | **2029,9** |
| | Carbon content in steel | % | 0,18 | | | | | | | | | | | | **0,18** |
| | | ths. tons C | 3,7 | | | | | | | | | | | | **3,7** |
| **2** | **Total mass of carbon in the output flow from BMP** | **ths. tons C** | 3,7 | | | | | | | | | | | | **3,7** |

CO2 emissions from production of profiled steel billet in BMP

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Carbon burning during production of profiled steel billet in BMP | ths. tons C | 118,0 | | | | | | | | | | | | **118,0** |
| 2 | CO2 emissions from production of profiled steel billet in BMP | **ths. tons CO2** | 432,7 | | | | | | | | | | | | **432,7** |
| 3 | **Specific CO2 emissions from production of profiled steel billet in BMP** | **tons CO2/ton** | **0,213** | | | | | | | | | | | | **0,213** |

*Specific $CO_2$ emissions for metallurgical conversions in the baseline only. Production of profiled steel billet in the Blooming Mill Plant*

### *D.2 Coefficients of consumption for metallurgical conversions*

**<u>Coefficients of consumption for metallurgical conversions in the project</u>**

**Specific consumption of pig iron per ton of steel billet produced in EAFP**

$$SC_{pig\ iron\_EAFP} = M_{pig\ iron\_EAFP} / \sum P_{profiled\&slab\ steel\_EAFP}$$ **(PDD formula D.1.1.2.-7)**

**Specific consumption of scrap metal per ton of steel billet produced in EAFP**

$$SC_{scrap\_EAFP} = M_{scrap\_EAFP} / \sum P_{profiled\&slab\ steel\_EAFP}$$ **(PDD formula D.1.1.2.-8)**

**Specific consumption of dry skip metallurgical coke per ton of produced pig iron**

$$SC_{skip\_metallurgical\_coke\_PJ} = M_{skip\_metallurgical\ coke\_BF\_PJ} / P_{pig\ iron\_BF\_PJ}$$ **(PDD formuila D.1.1.2.-9)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $SC_{pig\ iron\_EAFP}$ | Specific consumption of pig iron per ton of steel billet produced in EAFP | ton/ton | $M_{scrap\_EAFP}$ | Consumption of scrap metal in EAFP | ths. tons |
| $M_{pig\ iron\_EAFP}$ | Consumption of pig iron in EAFP | ths. tons | $SC_{skip\_metallurgical\_coke\_PJ}$ | Specific consumption of dry skip metallurgical coke per ton of pig iron produced in BFP | tons/ton |
| $\sum P_{profiled\&slab\ steel\_EAFP}$ | Total production of slab and profiled steel billet in EAFP | ths. tons | $M_{skip\_metallurgical\ coke\_BF\_PJ}$ | Consumption of dry skip metallurgical coke in BFP | ton/ton |
| $SC_{scrap\_EAFP}$ | Specific consumption of pig iron per ton of steel billet produced in EAFP | ton/ton | $P_{pig\ iron\_BF\_PJ}$ | Production of pig iron in BFP | ton/ton |

*Coefficients of consumption of materials for metallurgical conversions in the project*

## *12 months of 2010*

Project factors

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total production of slab and profiled steel billet in EAFP | ths. tons | 78,6 | 169,7 | 199,3 | 183,8 | 192,9 | 151,5 | 162,0 | 181,8 | 200,8 | 129,9 | 112,4 | 125,9 | 1888,4 |
| 2 | **Output of profiled steel billet in EAFP** | ths. tons | **35,2** | **91,0** | **99,0** | **88,2** | **64,5** | **58,9** | **63,4** | **130,9** | **157,4** | **96,0** | **101,7** | **121,3** | 1107,5 |
| 3 | Total smelting of steel in EAF-180 | ths. tons | 37,3 | 103,4 | 124,3 | 109,0 | 183,3 | 151,5 | 162,0 | 146,3 | 134,6 | 55,8 | 0,0 | 1,7 | 1209,1 |
| 4 | Consumption of pig iron in EAFP | ths. tons | 50,1 | 74,9 | 99,2 | 94,6 | 54,8 | 38,8 | 36,6 | 70,8 | 91,8 | 71,4 | 93,5 | 105,4 | **882,0** |
| 5 | Consumption of scrap metal in EAFP | ths. tons | 38,7 | 116,4 | 125,8 | 112,6 | 162,5 | 131,9 | 146,8 | 135,2 | 135,7 | 75,9 | 33,7 | 37,9 | **1253** |
| 6 | Specific consumption of pig iron per ton of steel billet produced in EAFP | ton/ton | 0,638 | 0,442 | 0,498 | 0,515 | 0,284 | 0,256 | 0,226 | 0,389 | 0,457 | 0,550 | 0,832 | 0,838 | 0,467 |
| 7 | Specific consumption of scrap metal per ton of steel billet produced in EAFP | ton/ton | 0,492 | 0,686 | 0,631 | 0,613 | 0,842 | 0,871 | 0,906 | 0,744 | 0,676 | 0,585 | 0,300 | 0,301 | **0,664** |
| 8 | Specific consumption of dry skip metallurgical coke per ton of produced pig iron | ton/ton | 0,453 | 0,449 | 0,447 | 0,437 | 0,438 | 0,431 | 0,429 | 0,444 | 0,462 | 0,446 | 0,448 | 0,449 | 0,444 |

Note: in this case, the calculation model operates with data including the data from cells previously submitted (*Specific consumption of coke per ton of iron*), and also contains indicators (*actual production of profiled steel billet in the EAFP* and *production of steel in EAF-180*), which will be used to calculate project emissions further.

*Coefficients of consumption of materials for metallurgical conversions in the project*

<u>**Coefficients of consumption of materials for metallurgical conversions in the baseline**</u>

**Consumption of pig iron per ton of smelted steel in the baseline**

$$SC_{pig\ iron\_OHFP} = M_{pig\ iron\_OHFP} / P_{steel\_OHFP}$$ **(PDD formula D.1.1.4.-5)**

**Consumption of scrap metal per ton of smelted steel in the baseline**

$$SC_{scrap\_OHFP} = M_{scrap\_OHFP} / P_{steel\_OHFP}$$ **(PDD formula D.1.1.4.-6)**

**Consumption of steel per ton of profiled steel billet produced in BMP**

$$SC_{steel\_profiled\_steel\_BM} = M_{steel\_BM} / P_{profiled\ steel\_BM}$$ **(PDD formula D.1.1.4.-7)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $SC_{pig\ iron\_OHFP}$ | Consumption of pig iron per ton of steel smelted in OHFP | ton/ton | $M_{scrap\_OHFP}$ | Consumption of scrap metal per ton of steel smelted in OHFP | ths. tons |
| $M_{pig\ iron\_OHFP}$ | Consumption of pig iron in OHFP | ths. tons | $SC_{steel\_profiled\_steel\_BM}$ | Specific consumption of steel per ton of profiled steel billet produced in BMP | ton/ton |
| $P_{steel\_OHFP}$ | Annual average output of steel in OHFP | ths. tons | $M_{steel\_BM}$ | Annual average consumption of steel in BMP | ths. tons |
| $SC_{scrap\_OHFP}$ | Specific consumption of scrap metal per ton of steel smelted in OHFP, | ton/ton | $P_{profiled\ steel\_BM}$ | Annual average output of profiled steel billet in BMP | ths. tons |

*Coefficients of consumption of materials for metallurgical conversions in the baseline*

## *12 months of 2010*

Baseline factors

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Annual average production of profiled steel billet in BMP | ths. tons | 2 029,9 | | | | | | | | | | | | **2 029,9** |
| 2 | **Output of profiled steel billet in EAFP** | **ths. tons** | **35,2** | **91,0** | **99,0** | **88,2** | **64,5** | **58,9** | **63,4** | **130,9** | **157,4** | **96,0** | **101,7** | **121,3** | **1107,5** |
| 3 | Annual average smelting of steel in OHFP | ths. tons | 2 335,7 | | | | | | | | | | | | **2 335,7** |
| 4 | Annual average consumption of pig iron in OHFP | ths. tons | 1 941,1 | | | | | | | | | | | | **1 941,1** |
| 5 | Annual average consumption of scrap metal in OHFP | ths. tons | 715,3 | | | | | | | | | | | | **715,3** |
| 6 | Specific consumption of pig iron per ton of steel smelted in OHFP | ton/ton | 0,831 | | | | | | | | | | | | **0,831** |
| 7 | Specific consumption of scrap metal per ton of steel smelted in OHFP | ton/ton | 0,306 | | | | | | | | | | | | **0,306** |
| 8 | Specific consumption of steel per ton of profiled steel billet produced in BMP | ton/ton | 1,151 | | | | | | | | | | | | **1,151** |
| 9 | Specific consumption of dry skip metallurgical coke per ton of produced pig iron | ton/ton | 0,453 | 0,449 | 0,447 | 0,437 | 0,438 | 0,431 | 0,429 | 0,444 | 0,462 | 0,446 | 0,448 | 0,449 | **0,444** |

Note: for this case the calculation mode in general operates with the values obtained from calculations in the PDD for the baseline (in figures, fixed ex-ante). Monitoring indicators are: *Actual production of profiled steel billet in the EAFP*, and *Specific consumption of metallurgical coke per ton of iron* (the same for the project and the baseline).

*Coefficients of consumption of materials for metallurgical conversions in the baseline*

## *D.3 Project $CO_2$ emissions from metallurgical conversions associated with production of profiled steel billet*

**Project $CO_2$ emissions from consumption of metallurgical coke for production of profiled steel billet**

$PE_{metallurgical\_coke\_profiled\_steel} = SC_{skip\_metallurgical\_coke\_PJ} * SC_{pig\ iron\_ EAFP} * P_{profiled\ steel\_EAFP} * SPE_{coke\ production}$ **(PDD formula D.1.1.2.-10)**

**Project $CO_2$ emissions from consumption of pig iron for production of profiled steel billet**

$PE_{pig\ iron\_profiled\_steel} = SC_{pig\ iron\_ EAFP} * P_{profiled\ steel\_EAFP} * SPE_{pig\ iron}$ **(PDD formula D.1.1.2.-11)**

**Project $CO_2$ emissions in EAFP from production of profiled steel billet**

$PE_{profiled\ steel\_ EAFP} = P_{profiled\ steel\_ EAFP} * SPE_{EAFP}$ **(PDD formula D.1.1.2.-12)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $PE_{metallurgical\_coke\_profiled\_steel}$ | Project $CO_2$ emissions from consumption of metallurgical coke for production of profiled steel billet | ths. tons $CO_2$ | $P_{profiled\ steel\_EAFP}$ | Output of profiled steel billet in EAFP | ths. tons |
| $SC_{skip\_metallurgical\_coke\_PJ}$ | Specific consumption of dry skip metallurgical coke per ton of pig iron smelted in BFP | ton/ton | $PE_{pig\ iron\_ profiled\_steel}$ | Project $CO_2$ emissions from consumption of pig iron for production of profiled steel billet | ths. tons $CO_2$ |
| $SC_{pig\ iron\_ EAFP}$ | Specific consumption of pig iron per ton of steel billet produced in EAFP | ton/ton | $SPE_{pig\ iron}$ | Specific $CO_2$ emissions per ton of produced pig iron | ton $CO_2$/ton |
| $SPE_{metallurgical\_coke}$ | Specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP | ton $CO_2$/ton | $SPE_{EAFP}$ | Specific $CO_2$ emissions per ton of profiled steel billet produced in EAFP | ton $CO_2$/ton |

*Project $CO_2$ emissions from metallurgical conversions associated with production of profiled steel billet*

## *12 months of 2010*

Project CO2 emissions from metallurgical conversions during production of profiled steel billet

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **CO2 emissions from consumption of metallurgical coke for production of profiled steel billet** | ths. tons CO2 | 10,630 | 19,745 | 22,489 | 19,788 | 7,959 | 6,463 | 5,962 | 22,484 | 31,129 | 22,363 | 36,577 | 45,535 | 251,124 |
| 2 | **CO2 emissions from consumption of pig iron for production of profiled steel billet** | ths. tons CO2 | 15,550 | 27,001 | 33,632 | 29,581 | 11,921 | 9,245 | 8,816 | 34,315 | 52,738 | 35,372 | 58,421 | 67,309 | 383,900 |
| 3 | **CO2 emissions in EAFP from production of profiled steel billet** | ths. tons CO2 | 10,009 | 15,485 | 14,916 | 14,113 | 8,117 | 7,156 | 7,436 | 17,629 | 22,272 | 17,072 | 20,448 | 27,498 | 182,151 |

*Project $CO_2$ emissions from metallurgical conversions associated with production of profiled steel billet*

### *D.4 $CO_2$ emissions from production of profiled steel billet in the baseline*

**$CO_2$ emissions from consumption of metallurgical coke for production of profiled steel billet in the baseline**

$$BE_{metallurgical\ coke\_profiled\_steel} = SC_{skip\_metallurgical\_coke\_PJ} * SC_{pig\ iron\_OHFP} * P_{profiled\ steel\_EAFP} * SC_{steel\_profiled\_steel\_BM} * SPE_{metallurgical\_coke}$$ **(PDD formula D.1.1.4.-8)**

**$CO_2$ emissions from consumption of pig iron in the baseline**

$$BE_{pig\ iron\_profiled\_steel} = SC_{pig\ iron\_OHFP} * P_{profiled\ steel\_EAFP} * SC_{steel\_profiled\_steel\_BM} * SPE_{pig\ iron}$$ **(PDD formula D.1.1.4.-9)**

**$CO_2$ emissions from steel smelting in OHFP**

$$BE_{steel\_OHFP} = SC_{steel\_profiled\_steel\_BM} * P_{profiled\ steel\_EAFP} * SBE_{OHFP}$$ **(PDD formula D.1.1.4.-10)**

**$CO_2$ emissions from production of profiled steel billet in BMP**

$$BE_{profiled\ steel\_BM} = SBE_{BM} * P_{profiled\ steel\_EAFP}$$ **(PDD formula D.1.1.4.-11)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $BE_{metallurgical\ coke\_profiled\_steel}$ | $CO_2$ emissions from consumption of metallurgical coke in BFP for production of profiled steel billet in the baseline | ths. tons $CO_2$ | $BE_{steel\_OHFP}$ | $CO_2$ emissions from steel smelting in OHFP | ths. tons $CO_2$ |
| $BE_{pig\ iron\_profiled\_steel}$ | $CO_2$ emissions from consumption of pig iron in OHFP | ths. tons $CO_2$ | $BE_{profiled\ steel\_BM}$ | $CO_2$ emissions from production of profiled steel billet in BMP | ths. tons $CO_2$ |
| $SC_{skip\_metallurgical\_coke\_PJ}$ | Specific consumption of dry skip metallurgical coke per ton of pig iron smelted in BFP | ton/ton | $SBE_{OHFP}$ | Specific $CO_2$ emissions per ton of steel smelted in OHFP | tons $CO_2$/ton |
| $P_{profiled\ steel\_EAFP}$ | Output of profiled steel billet in EAFP | ths. tons | $SPE_{metallurgical\_coke}$ | Specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP | tons $CO_2$/ton |
| $SC_{steel\_profiled\_steel\_BM}$ | Consumption of steel per ton of profiled steel billet produced in BMP | ton/ton | $SBE_{BM}$ | Specific $CO_2$ emissions per ton of production of profiled steel billet in BMP | tons $CO_2$/ton |
| $SC_{pig\ iron\_OHFP}$ | Consumption of pig iron per ton of steel | ton/ton | $SPE_{pig\ iron}$ | Specific $CO_2$ emissions per ton of | tons $CO_2$/ton |

*$CO_2$ emissions from production of profiled steel billet in the baseline*

| | | | | | |
|---|---|---|---|---|---|
| | smelted in OHFP | | | produced pig iron | |

## *12 months of 2010*

CO2 emissions from  metallurgical conversions form steel making in OHFP and production of profilled steel billet in BMP

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **CO2 emissions from consumption of metallurgical coke in BFP for production of profiled steel billet (baseline)** | **ths.tons CO2** | 15,937 | 42,769 | 43,213 | 36,766 | 26,792 | 24,163 | 25,221 | 55,226 | 65,125 | 38,902 | 42,059 | 51,992 | 468,166 |
| 2 | **CO2 emissions from consumption of pig iron in BFP in the baseline** | **ths.tons CO2** | 23,314 | 58,485 | 64,625 | 54,962 | 40,127 | 34,564 | 37,297 | 84,285 | 110,331 | 61,534 | 67,177 | 76,853 | 713,555 |
| 3 | **CO2 emissions from steel smelting in OHFP** | **ths.tons CO2** | 7,330 | 18,955 | 20,617 | 18,366 | 13,435 | 12,258 | 13,200 | 27,264 | 32,776 | 19,987 | 21,180 | 25,259 | 230,627 |
| 4 | **CO2 emissions from production of profiled steel billet in BMP** | **ths.tons CO2** | 7,503 | 19,403 | 21,104 | 18,800 | 13,753 | 12,548 | 13,512 | 27,908 | 33,551 | 20,459 | 21,681 | 25,857 | 236,079 |

*$CO_2$ emissions from production of profiled steel billet in the baseline*

### *D.5 $CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

**$CO_2$ emissions from consumption of grid electricity by EAF-180 via 220/35 kV step-down substation during smelting of profiled steel grades**

$$PE_{EC\_grid\_profiled\_steel\_EAF} = SEC_{grid\_steel\_EAF} * P_{profiled\ steel\_EAFP} * \sum P_{steel\_EAF} / \sum P_{profiled\ \&slab\ steel\_EAFP} * EF_{grid} * (1+TDL)$$ **(PDD formula D.1.1.2.-14)**

**Specific consumption of grid electricity by EAF-180 via 220/35 kV step-down substation during smelting of profiled steel grades**

$$SEC_{grid\_steel\_EAF} = EC_{grid\_steel\_EAF} / \sum P_{steel\_EAF}$$ **(PDD formula D.1.1.2.-15)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$EC_{grid\_steel\_EAF}$** | Consumption of grid electricity by EAF-180 via 220/35 kV step-down substation | GW-h | **$SEC_{grid\_steel\_EAF}$** | Specific consumption of grid electricity by EAF-180 via 220/35 kV step-down substation per ton of all smelted steel | MW-h/ton |
| **$\sum P_{steel\_EAF}$** | Total smelting of steel in EAF-180 | ths. tons | **$EF_{grid}$** | $CO_2$ emission factor for grid electricity from Unified Energy Systems of Urals (EF grid = 0.541 t CO2/MW-h) | tons CO2/MW-h |
| **$P_{profiled\ steel\_EAFP}$** | Output of profiled steel billet in EAFP | ths. tons | **TDL** | Technological losses during transportation and distribution of grid electricity in Unified Energy System of Urals | % |
| **$\sum P_{profiled\&slab\ steel\_EAFP}$** | Total production of slab and profiled steel billet in EAFP | ths. tons | **$PE_{EC\_grid\_profiled\_steel\_EAF}$** | $CO_2$ emissions from consumption of grid electricity by EAF-180 via 220/35 kV step-down substation during smelting of profiled steel grades | ths. tons $CO_2$ |

**$CO_2$ emissions from consumption of electricity from corporate MMK grid by other equipment of EAFP (including DBSU) during production of profiled steel billet**

$$PE_{EC\_profiled\_steel\_other\ EAFP} = (SEC_{steel\ refinement\ and\ casting\ EAFP} * P_{profiled\ steel\_EAFP} + SEC_{steel\_OHFP} * P_{profiled\ steel\_EAFP} * (\sum P_{profiled\&slab\ steel\_EAFP} - \sum P_{steel\_EAF}) / \sum P_{profiled\&slab\ steel\_EAFP})) * ((EF_{own\ generation\_PJ} * (EC_{gross\_PJ} - EC_{import\_PJ}) + EF_{grid} * (EC_{import\_PJ} - EC_{grid\_steel\_EAF}) * (1+TDL)) / (EC_{gross\_PJ} - EC_{grid\_steel\_EAF}))$$

**(PDD formula D.1.1.2.-16)**

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

**Specific electricity consumption in EAFP for steel refining and casting**

$$SEC_{\text{steel refinement and casting EAFP}} = (EC_{EAFP} - EC_{\text{grid\_steel\_EAF}} - SEC_{\text{steel\_OHFP}} * (\sum P_{\text{profiled\&slab steel\_EAFP}} - \sum P_{\text{steel\_EAF}})) / \sum P_{\text{profiled\&slab steel\_EAFP}}$$

**(PDD formula D.1.1.2.-17)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$PE_{\text{EC\_other equipment\_EAFP\_PJ}}$** | CO2 emissions from consumption of electricity from corporate MMK grid by other equipment of EAFP (including DBSU) during production of profiled steel billet | ths. tons $CO_2$ | **$EF_{\text{own generation\_PJ}}$** | $CO_2$ emission factor for electricity produced by own generating capacities of MMK | tons $CO_2$/MW-h |
| **$SEC_{\text{steel refinement and casting EAFP}}$** | Specific electricity consumption in EAFP for steel refining and casting, | MW-h/ton | **$EC_{\text{gross\_PJ}}$** | Total electricity consumption by MMK | GW-h |
| **$P_{\text{profiled steel\_EAFP}}$** | Output of profiled steel billet in EAFP | ths. tons | **$EC_{\text{import\_PJ}}$** | Electricity purchases from Unified Energy Systems of Urals grid | GW-h |
| **$\sum P_{\text{profiled\&slab steel\_EAFP}}$** | Total production of slab and profiled steel billet in EAFP | ths. tons | **$EC_{\text{grid\_steel\_EAF}}$** | Consumption of grid electricity by EAF-180 via 220/35 kV step-down substation | GW-h |
| **$\sum P_{\text{steel\_EAF}}$** | Total smelting of steel in EAF-180 | ths. tons | **$EC_{EAFP}$** | Total electricity consumption in EAFP | GW-h |
| **$SEC_{\text{steel\_OHFP}}$** | Specific electricity consumption in OHFP per ton of steel | MW-h/ton | **TDL** | Technological losses during transportation and distribution of grid electricity in Unified Energy System of Urals[4] | % |
| **$EF_{grid}$** | CO2 emission factor for grid electricity from Unified Energy Systems of Urals (EF grid = 0.541 t CO2/MW-h) | tons $CO_2$/MW-h | | | |

[4] http://www.mrsk-ural.ru/ru/460

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

**$CO_2$ emissions from consumption of electricity from corporate grid of MMK, for production of nitrogen, pure nitrogen and argon needed for production of profiled steel billet**

$$PE_{EC\_Ar\_N2\_profiled\_steel} = (EC_{N2\_profiled\_steel} + EC_{pure\ N2\_profiled\_steel} + EC_{Ar\_profiled\_steel}) * ((EF_{own\ generation\_PJ} * (EC_{gross\_PJ} - EC_{import\_PJ}) + EF_{grid} * (EC_{import\_PJ} - EC_{grid\_steel\_EAF}) * (1+TDL))/(EC_{gross\_PJ} - EC_{grid\_steel\_EAF}) \quad \text{(PDD formula D.1.1.2.-18)}$$

**Electricity consumption for production of nitrogen, which is used during production of profiled steel billet in EAFP**

$$EC_{N2\_profiled\_steel} = SEC_{N2\_PJ} * V_{N2\_EAFP} * P_{profiled\_steel\_EAFP} / \sum P_{profiled\&slab\ steel\_EAFP} \quad \text{(PDD formula D.1.1.2.-19)}$$

**Electricity consumption for production of pure nitrogen, which is used during production of profiled steel billet in EAFP**

$$EC_{pure\_N2\_profiled\_steel} = SEC_{pure\_N2\_PJ} * V_{pure\_N2\_EAFP} * P_{profiled\_steel\_EAFP\_} / \sum P_{profiled\&slab\ steel\_EAFP} \quad \text{(PDD formulaD.1.1.2.-20)}$$

**Electricity consumption for production of argon, which is used during production of profiled steel billet in EAFP**

$$EC_{Ar\_profiled\_steel} = SEC_{Ar\_PJ} * V_{Ar\_EAFP} * P_{profiled\_steel\_EAFP} / \_\sum P_{profiled\&slab\ steel\_EAFP} \quad \text{(PDD formula D.1.1.2.-21)}$$

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$PE_{EC\_Ar\_N2\_profiled\_steel}$** | $CO_2$ emissions from consumption of electricity from corporate grid of MMK for production of nitrogen, pure nitrogen and argon needed for production of profiled steel billet | ths. tons $CO_2$ | **$EC_{gross\_PJ}$** | Total electricity consumption by MMK | GW-h |
| **$EC_{N2\_profiled\_steel}$** | Electricity consumption for production of nitrogen, which is used during production of profiled steel billet in EAFP | GW-h | **$EC_{import\_PJ}$** | Electricity purchases from Unified Energy Systems of Urals grid | GW-h |
| **$EC_{pure\ N2\_profiled\_steel}$** | Electricity consumption for production of pure nitrogen, which is used during production of profiled steel billet in EAFP | GW-h | **$EC_{grid\_steel\_EAF}$** | Consumption of grid electricity by EAFP-180, via 220/35 kV step-down substation | GW-h |
| **$EC_{Ar\_profiled\_steel}$** | Electricity consumption for production of argon, which is used during production of profiled steel billet in EAFP | GW-h | **$EF_{grid}$** | $CO_2$ emission factor for grid electricity from Unified Energy Systems of Urals (EF grid = 0.541 | tons $CO_2$/ MW-h |

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

| | | | | | |
|---|---|---|---|---|---|
| | | | | t CO2/MW-h) | |
| **EF** $_{own\ generation\_PJ}$ | CO2 emission factor for electricity produced by own generating capacities of MMK | tons $CO_2$/ MW-h | **TDL** | Technological losses during transportation and distribution of grid electricity in Unified Energy System of Urals | % |
| **SEC** $_{N2\_PJ}$ | Specific electricity consumption for production of nitrogen at MMK | MW-h/1000 $m^3$ | **V** $_{N2\_EAFP}$ | Consumption of nitrogen in EAFP | mln. $m^3$ |
| **SEC** $_{pure\_N2\_PJ}$ | Specific electricity consumption for production of pure nitrogen at MMK | MW-h/1000 $m^3$ | **V** $_{pure\_N2\_EAFP}$ | Consumption of pure nitrogen in EAFP | mln. $m^3$ |
| **SEC** $_{Ar\_PJ}$ | Specific electricity consumption for production of argon at MMK | MW-h/1000 $m^3$ | **V** $_{Ar\_EAFP}$ | Consumption of argon in EAFP | mln. $m^3$ |
| **P** $_{profiled\ steel\_EAFP}$ | Output of profiled steel billet in EAFP | ths. tons | **∑P** $_{profiled\&slab\ steel\_EAFP}$ | Total production of slab and profiled steel billet in EAFP | ths. tons |

## *12 months of 2010*

Electricity balance in project

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total electricity consumption in EAFP | GWh | 19,8 | 49,1 | 50,5 | 45,1 | 71,8 | 60,3 | 64,7 | 56,8 | 54,0 | 30,4 | 10,8 | 12,7 | **526,1** |
| 2 | Specific electricity consumption in EAFP for steel refining and casting | MWh/ton | *0,110* | *0,079* | *0,070* | *0,069* | *0,071* | *0,079* | *0,080* | *0,075* | *0,069* | *0,085* | *0,085* | *0,086* | **0,080** |
| 3 | Consumption of grid electricity by EAF-180 via 220/35 kV step-down substation | GWh | 10,9 | 35,2 | 36,2 | 31,9 | 57,9 | 48,4 | 51,8 | 42,9 | 39,8 | 18,9 | 0,5 | 1,0 | **375,3** |
| 4 | Specific consumption of grid electricity by EAF-180 via 220/35 kV step-down substation during smelting of profiled steel grades | MWh/ton | *0,292* | *0,340* | *0,291* | *0,293* | *0,316* | *0,320* | *0,320* | *0,293* | *0,295* | *0,339* | *0,000* | *0,621* | **0,310** |
| 5 | Total electricity consumption by MMK | GWh | 557,5 | 573,3 | 624,9 | 598,5 | 631,0 | 590,0 | 616,3 | 604,3 | 588,4 | 585,9 | 552,3 | 582,7 | **7105,1** |
| 6 | Electricity purchases from Unified Energy Systems of Urals grid | GWh | 85,8 | 148,8 | 165,6 | 184,2 | 192,7 | 185,3 | 224,6 | 196,0 | 182,8 | 127,0 | 97,8 | 107,0 | **1897,8** |

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | Electricity purchases from Unified Energy Systems of Urals grid except EAF-180 demand | GWh | 75,0 | 113,6 | 129,5 | 152,3 | 134,8 | 136,9 | 172,8 | 153,1 | 143,0 | 108,1 | 97,3 | 106,0 | **1522,4** |
| 8 | Electricity, generated by MMK | GWh | 471,7 | 424,4 | 459,3 | 414,3 | 438,3 | 404,7 | 391,7 | 408,3 | 405,6 | 458,8 | 454,5 | 475,7 | **5207,3** |

Electricity consumption for production of nitrogen, which is used during production of profiled steel billet in EAFP

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Consumption of nitrogen in EAFP* | mln. m3 | 0,3 | 1,1 | 1,2 | 1,4 | 2,0 | 2,5 | 2,4 | 2,6 | 2,2 | 1,2 | 1,0 | 1,0 | **19** |
| 2 | Specific electricity consumption for production of nitrogen at MMK | MWh/ths. m3 | *0,207* | *0,167* | *0,160* | *0,154* | *0,108* | *0,053* | *0,150* | *0,150* | *0,150* | *0,150* | *0,150* | *0,150* | **0,146** |
| 3 | Specific consumption of nitrogen for production of steel in EAFP | ths. m3/ton | 0,004 | 0,006 | 0,006 | 0,007 | 0,010 | 0,017 | 0,015 | 0,014 | 0,011 | 0,010 | 0,009 | 0,008 | **0,010** |
| 4 | Electricity consumption for production of nitrogen | GWh | 0,03 | 0,10 | 0,09 | 0,10 | 0,07 | 0,05 | 0,14 | 0,28 | 0,26 | 0,14 | 0,13 | 0,14 | **1,5** |
| 5 | *Consumption of pure nitrogen in EAFP* | mln. m3 | 0,14 | 0,21 | 0,09 | 0,12 | 0,275 | 0,08 | 0,06 | 0,18 | 0,13 | 0,08 | 0,08 | 0,09 | **1,5** |
| 6 | Specific electricity consumption for production of pure nitrogen at MMK | MWh/ths. m3 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | **0,826** |
| 7 | Specific consumption of pure nitrogen for production of steel in EAFP | ths. m3/ton | 0,0017 | 0,0012 | 0,0005 | 0,0006 | 0,0014 | 0,0005 | 0,0004 | 0,0010 | 0,0007 | 0,0006 | 0,0007 | 0,0007 | **0,0008** |
| 8 | Electricity consumption for production of pure nitrogen | GWh | 0,1 | 0,1 | 0,0 | 0,0 | 0,1 | 0,0 | 0,0 | 0,1 | 0,1 | 0,0 | 0,1 | 0,1 | **0,7** |
| 9 | *Consumption of argon in EAFP* | mln. m3 | 0,11 | 0,19 | 0,17 | 0,17 | 0,20 | 0,16 | 0,14 | 0,14 | 0,13 | 0,12 | 0,081 | 0,102 | **1,7** |
| 10 | Specific electricity consumption for production of argon at MMK | MWh/ths. m3 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | 0,055 | **0,055** |
| 11 | Specific consumption of argon for production of steel in EAFP | ths. m3/ton | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | **0,001** |
| 12 | Electricity consumption fo production of argon | GWh | 0,003 | 0,005 | 0,005 | 0,004 | 0,004 | 0,003 | 0,003 | 0,006 | 0,006 | 0,005 | 0,004 | 0,005 | **0,05** |

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

**Total $CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP**

$$PE_{electricity\_profiled\_steel\_EAFP} = PE_{EC\_grid\_profiled\_steel\_EAF} + PE_{EC\_profiled\_steel\_other\ EAFP} + PE_{EC\_Ar\_N2\_profiled\_steel}$$ **(PDD formula D.1.1.2.-13)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$PE_{electricity\_profiled\_steel\_EAFP}$** | Total $CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP | ths. tons $CO_2$ | **$PE_{EC\_profiled\_steel\_other\ EAFP}$** | $CO_2$ emissions from consumption of electricity from corporate MMK grid by other equipment of EAFP (including DBSU) during production of profiled steel billet | ths. tons $CO_2$ |
| **$PE_{EC\_grid\_profiled\_steel\_EAF}$** | $CO_2$ emissions from consumption of grid electricity by EAF-180 via 220/35 kV step-down substation during smelting of profiled steel grades in EAFP | ths. tons $CO_2$ | **$PE_{EC\_Ar\_N2\_profiled\_steel}$** | $CO_2$ emissions from consumption of electricity from corporate MMK grid for production of nitrogen, pure nitrogen, and argon needed for production of profiled steel billet in EAFP | ths. tons $CO_2$ |

## *12 months of 2010*

CO2 emissions from electricity consumption associated with production of profiled steel billet in EAFP

| № | Data variable | Unit | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emissions from consumption of grid electricity by EAF-180 via 220/35 kV step-down substation | ths. tons CO2 | 2,825 | 10,949 | 10,423 | 8,885 | 11,238 | 10,914 | 11,762 | 17,936 | 18,076 | 8,101 | 0,000 | 0,584 | **111,691** |
| 2 | CO2 emissions from consumption of electricity from corporate MMK grid in for production of nitrogen, pure nitrogen, and argon | ths. tons CO2 | 0,060 | 0,145 | 0,106 | 0,121 | 0,139 | 0,075 | 0,148 | 0,360 | 0,322 | 0,165 | 0,157 | 0,174 | **1,972** |
| 3 | CO2 emissions from consumption of electricity from corporate MMK grid by other equipment of EAFP (including DBSU) | ths. tons CO2 | 2,960 | 5,566 | 5,546 | 5,070 | 4,211 | 4,322 | 4,618 | 9,277 | 10,297 | 7,357 | 7,480 | 8,863 | **75,565** |
| 4 | **Total CO2 emissions from electricity consumption associated with production of profiled steel billet in EAFP** | **ths. tons CO2** | **5,844** | **16,659** | **16,075** | **14,076** | **15,588** | **15,311** | **16,528** | **27,572** | **28,695** | **15,623** | **7,637** | **9,621** | **189,229** |

*$CO_2$ emissions from electricity consumption associated with production of profiled steel billet in EAFP*

**<u>$CO_2$ emission factor for electricity produced at MMK</u>**

**$EF_{own\ generation\_PJ} = PE_{total\ electricity\ generation} / (EC_{gross\_PJ} - EC_{import\_PJ})$** **(PDD formula D.1.1.2.-22)**

**CO2 emissions from electricity generation at MMK**

**$PE_{total\ electricity\ generation} = PE_{combustion\ gases\_electricity} + PE_{combustion\ coal\_electricity}$** **(PDD formula D.1.1.2.-23)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$EF_{own\ generation\_PJ}$** | $CO_2$ emission factor for electricity produced at MMK | tons $CO_2$/MW-h | **$EC_{gross\_PJ}$** | Total electricity generation at MMK | GW-h |
| **$PE_{total\ electricity\ generation}$** | Total $CO_2$ emissions from electricity generation at MMK | ths. tons $CO_2$ | **$EC_{import\_PJ}$** | Electricity purchases from Unified Energy Systems of Urals grid | GW-h |
| **$PE_{combustion\ gases\_electricity}$** | $CO_2$ emissions from combustion of gases for electricity generation at MMK | ths. tons $CO_2$ | **$PE_{combustion\ coal\_electricity}$** | $CO_2$ emissions from combustion of power station coal | ths. tons $CO_2$ |

**$CO_2$ emissions from combustion of gases for electricity generation at MMK**

**$PE_{combustion\ gases\_electricity} = (FC_{BFG\_CPP\_PJ} * C_{BFG\_PJ} + FC_{NG\_CPP\_PJ} * C_{NG\_.PJ} + FC_{NG\_CHPP\_PJ} * C_{NG\_PJ} + FC_{BFG\_SABPP\_PJ} * C_{BFG\_PJ} + FC_{COG\_SABPP\_PJ} * C_{COG\_PJ} + FC_{NG\_SABPP\_PJ} * C_{NG\_PJ} + FC_{NG\_turbine\ section\ of\ SP\ \_PJ} * C_{NG\_.PJ} + FC_{NG\_gas\ recovery\ unit\text{-}2\ of\ SP\ \_PJ} * C_{NG\_PJ})/100 * 44/1$** **(PDD formula D.1.1.2.-24)**

**CO2 emissions from combustion of power station coal for electricity generation at MMK**

**$PE_{combustion\ coal\_electricity} = (FC_{energy\ coal\_CHPP\_PJ} * \%C_{energy\ coal})/100 * 44/12$** **(PDD formula D.1.1.2.-25)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$PE_{combustion\ gases\_electricity}$** | $CO_2$ emissions from combustion of gases for electricity generation at MMK | ths. tons $CO_2$ | **$PE_{combustion\ coal\_electricity}$** | $CO_2$ emissions from combustion of power station coal | ths. tons $CO_2$ |
| **$FC_{BFG\_CPP\_PJ}$** | Consumption of BFG in CPP | mln. $m^3$ | **$FC_{COG\_SABPP\_PJ}$** | Consumption of COG in SABPP | mln. $m^3$ |
| **$FC_{NG\_CPP\_PJ}$** | Consumption of NG in CPP | mln. $m^3$ | **$FC_{NG\_SABPP\_PJ}$** | Consumption of NG in SABPP | mln. $m^3$ |

*$CO_2$ emission factor for electricity produced at MMK*

| | | | | | |
|---|---|---|---|---|---|
| **FC** $_{NG\_CHPP\_PJ}$ | Consumption of NG in CHPP | mln. $m^3$ | **FC** $_{NG\_turbine\ section\ of\ SP\ \_PJ}$ | Consumption of NG in turbine section of SP | mln. $m^3$ |
| **FC** $_{BFG\_SABPP\_PJ}$ | Consumption of BFG in SABPP | mln. $m^3$ | **FC** $_{NG\_gas\ recovery\ unit\text{-}2\ of\ SP\ \_PJ}$ | Consumption of NG in gas recovery unit of SP | mln. $m^3$ |
| **C** $_{BFG\_PJ}$ | Carbon content in BFG | kg C/$m^3$ | **C** $_{NG\_PJ}$ | Carbon content in NG | kg C/$m^3$ |
| **C** $_{COG\_PJ}$ | Carbon content in COG | kg C/$m^3$ | **%C** $_{energy\ coal}$ | Carbon content in power station coal | % by mass |
| **FC** $_{energy\ coal\_CHPP\_PJ}$ | Consumption of power station coal by CHPP | ths. tons | | | |

## *12 months of 2010*

Input carbon flows, burning of gases

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of BFG in CPP | mln. m3 | 141,3 | 141,8 | 183,6 | 195,9 | 256,4 | 262,6 | 264,6 | 262,7 | 257,8 | 233,1 | 186,8 | 182,9 | 2569,5 |
| 2 | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | 0,21 |
| | | ths. tons C | 29,9 | 29,7 | 38,7 | 41,5 | 54,4 | 55,8 | 56,1 | 55,4 | 54,8 | 50,2 | 40,9 | 40,2 | 547,7 |
| 3 | Consumption of NG in CPP | mln. m3 | 31,6 | 25,7 | 23,2 | 20,8 | 27,3 | 26,3 | 25,7 | 26,1 | 19,6 | 26,1 | 25,0 | 26,2 | 303,6 |
| 4 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | ths. tons C | 15,6 | 12,7 | 11,5 | 10,3 | 13,5 | 13,0 | 12,7 | 12,9 | 9,7 | 12,9 | 12,4 | 13,0 | 150,2 |
| 5 | Consumption of NG in CHPP | mln. m3 | 54,5 | 49,9 | 56,9 | 55,7 | 69,3 | 67,6 | 63,6 | 67,9 | 65,9 | 63,7 | 57,1 | 58,2 | 730,4 |
| 6 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | ths. tons C | 27,0 | 24,7 | 28,2 | 27,6 | 34,3 | 33,4 | 31,5 | 33,5 | 32,6 | 31,5 | 28,3 | 28,8 | 361,3 |
| 7 | Consumption of COG in SABPP | mln. m3 | 55,6 | 58,4 | 71,8 | 73,2 | 61,8 | 46,8 | 44,3 | 53,1 | 60,2 | 59,8 | 57,8 | 65,3 | 708 |
| 8 | Carbon content in COG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | 0,21 |
| | | ths. tons C | 11,8 | 12,2 | 15,1 | 15,5 | 13,1 | 9,9 | 9,4 | 11,2 | 12,8 | 12,9 | 12,6 | 14,4 | 151,0 |
| 9 | Consumption of BFG in SABPP | mln. m3 | 12,9 | 10,1 | 10,9 | 12,9 | 11,5 | 7,6 | 7,0 | 8,7 | 11,5 | 12,9 | 12,3 | 11,5 | 129,8 |
| 10 | Carbon content in BFG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,18 |
| | | ths. tons C | 2,4 | 1,8 | 1,9 | 2,3 | 2,0 | 1,3 | 1,3 | 1,6 | 2,1 | 2,4 | 2,3 | 2,1 | 23,8 |

*$CO_2$ emission factor for electricity produced at MMK*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Consumption of NG in SABPP | mln. m3 | 9,7 | 8,4 | 7,8 | 5,3 | 6,4 | 5,1 | 4,8 | 5,3 | 5,9 | 6,2 | 5,9 | 8,1 | **79** |
| 12 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 4,8 | 4,2 | 3,9 | 2,6 | 3,2 | 2,5 | 2,4 | 2,6 | 2,9 | 3,1 | 2,9 | 4,0 | **39,1** |
| 13 | Consumption of NG in turbine section of SP | mln. m3 | 0,216 | 0,208 | 0,294 | 0,164 | 0,182 | 0,225 | 0,158 | 0,130 | 0,142 | 0,239 | 0,461 | 0,379 | **2,8** |
| 14 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 0,11 | 0,10 | 0,15 | 0,08 | 0,09 | 0,11 | 0,08 | 0,06 | 0,07 | 0,12 | 0,23 | 0,19 | **1,4** |
| 15 | Consumption of NG in gas recovery unit of SP | mln. m3 | 0,000 | 0,000 | 0,129 | 0,166 | 0,094 | 0,053 | 0,09 | 0,09 | 0,14 | 0,11 | 0,07 | 0,13 | **1,1** |
| 16 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 0,00 | 0,00 | 0,06 | 0,08 | 0,05 | 0,03 | 0,04 | 0,05 | 0,07 | 0,05 | 0,04 | 0,06 | **0,5** |
| 17 | **Total carbon input stream with gases** | **ths. tons C** | **91,6** | **85,5** | **99,5** | **99,9** | **120,7** | **116,2** | **113,5** | **117,4** | **115,0** | **113,2** | **99,7** | **102,7** | **1274,9** |

Input carbon flows, burning of coal

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of power station coal by CHPP | ths. tons | 9,1 | 8,4 | 6,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 4,1 | 7,6 | 7,9 | **43,4** |
| 2 | Carbon content in power station coal | % by mass | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 | 73,00 |
| | | ths. tons C | 6,6 | 6,1 | 4,7 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 3,0 | 5,5 | 5,8 | **31,7** |
| **3** | **Total ouput carbon flow** | **ths. tons C** | **6,6** | **6,1** | **4,7** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **3,0** | **5,5** | **5,8** | **31,7** |

$CO_2$ emissions from electricity generation

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Carbon burning in the gas-burning processes | ths. tons C | 91,6 | 85,5 | 99,5 | 99,9 | 120,7 | 116,2 | 113,5 | 117,4 | 115,0 | 113,2 | 99,7 | 102,7 | **1274,9** |
| 2 | CO2 emissions from burning of gases | ths. tons CO2 | 335,8 | 313,5 | 364,8 | 366,3 | 442,5 | 426,0 | 416,0 | 430,5 | 421,8 | 415,1 | 365,5 | 376,7 | **4674,5** |
| 3 | Carbon burning in the coal burning process | ths. tons C | 6,6 | 6,1 | 4,7 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 3,0 | 5,5 | 5,8 | **31,7** |
| 4 | CO2 emissions from coal burning | ths. tons CO2 | 24,3 | 22,5 | 17,1 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,9 | 20,2 | 21,2 | **116,3** |

*$CO_2$ emission factor for electricity produced at MMK*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | CO2 emission factor for electricity produced at MMK | ths. tons CO2 | 360,1 | 336,0 | 381,9 | 366,3 | 442,5 | 426,0 | 416,0 | 430,5 | 421,8 | 426,0 | 385,7 | 397,9 | 4790,8 |

Emission factors for electricity and power transmission/distribution losses

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emission factor for electricity generated at MMK | tons CO2/MWh | 0,763 | 0,792 | 0,831 | 0,884 | 1,010 | 1,053 | 1,062 | 1,054 | 1,040 | 0,928 | 0,849 | 0,837 | 0,920 |
| 2 | CO2 emissions factor for grid electricity purchased from Unified Energy System of Urals (fixed ex-ante, 2008-2012) | tons CO2/MWh | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 | 0,541 |
| 3 | Power transmission and distribution losses in Unified energy Systems of Urals grid* | %/100 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 | 0,0724 |

* http://www.mrsk-ural.ru/ru/440.news1434.html

## *D.6 $CO_2$ emissions from electricity consumption in the baseline*

**$CO_2$ emissions from electricity consumption in OHFP**

$$BE_{electricity\_OHFP} = SEC_{steel\_OHFP} * P_{profiled\ steel\_EAFP} * SC_{steel\_profiled\_steel\_BM} *((EF_{own\ generation\_PJ} * (EC_{gross\_PJ} - EC_{import\_PJ}) + EF_{grid} * (EC_{import\_PJ} - EC_{grid\_steel\_EAF}) * (1+TDL))/(EC_{gross\_PJ} - EC_{grid\_steel\_EAF})$$

**(PDD formula D.1.1.4.-12)**

**$CO_2$ emissions from consumption of electricity in BMP**

$$BE_{electricity\_BM} = SEC_{profiled\ steel\_BM\_} * P_{profiled\ steel\_EAFP} * ((EF_{own\ generation\_PJ} * (EC_{gross\_PJ} - EC_{import\_PJ}) + EF_{grid} * (EC_{import\_PJ} - EC_{grid\_steel\_EAF}) * (1+TDL))/ (EC_{gross\_PJ} - EC_{grid\_steel\_EAF})$$

**(PDD formula D.1.1.4.-14)**

**Total $CO_2$ emissions from electricity consumption**

$$BE_{total\ electricity\ consumption} = BE_{electricity\_OHFP} + BE_{electricity\_BM}$$

**(PDD formula D.1.1.4.-16)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$BE_{electricity\_OHFP}$** | $CO_2$ emissions from electricity consumption in OHFP | ths. tons $CO_2$ | **$EC_{gross\_PJ}$** | Total electricity consumption by MMK | GW-h |
| **$BE_{electricity\_BM}$** | $CO_2$ emissions from consumption of electricity in BMP | ths. tons $CO_2$ | **$EC_{import\_PJ}$** | Electricity purchases from Unified Energy Systems of Urals grid | GW-h |
| **$BE_{total\ electricity\ consumption}$** | Total $CO_2$ emissions from electricity consumption in the baseline | ths. tons $CO_2$ | **$EC_{grid\_steel\_EAF}$** | Consumption of grid electricity by EAF-180 via 220/35 kV step-down substation | GW-h |
| **$SEC_{steel\_OHFP}$** | Specific consumption of electricity in OHFP per ton of smelted steel | MW-h/ton | **$EF_{grid}$** | $CO_2$ emission factor for grid electricity from Unified Energy Systems of Urals (EF grid = 0.541 t CO2/MW-h) | tons $CO_2$/MW-h |
| **$SC_{steel\_profiled\_steel\_BM}$** | Specific consumption of steel per ton of profiled steel billet produced in BMP | tons $CO_2$/MW-h | **$EF_{own\ generation\_PJ}$** | $CO_2$ emission factor for electricity produced by own generating capacities of MMK | tons $CO_2$/MW-h |
| **$P_{profiled\ steel\_EAFP}$** | Output of profiled steel billet in EAFP | ths. tons | **TDL** | Technological losses during | % |

*$CO_2$ emissions from electricity consumption in the baseline*

| | | | | | |
|---|---|---|---|---|---|
| | | | | transportation and distribution of grid electricity in Unified Energy System of Urals | |
| **SEC** $_{profiled\ steel\_BM}$ | Specific consumption of electricity in BMP per ton of profiled steel billet | MW-h/ton | | | |

## *12 months of 2010*

Electricity balance in the baseline

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Specific consumption of electricity in OHFP per ton of smelted steel | MWh/ton | 0,007 | | | | | | | | | | | | **0,007** |
| 2 | Specific consumption of electricity in BMP per ton of profiled steel billet | MWh/ton | 0,041 | | | | | | | | | | | | **0,041** |
| 3 | Total electricity consumption by MMK | GWh | 557,5 | 573,3 | 624,9 | 598,5 | 631,0 | 590,0 | 616,3 | 604,3 | 588,4 | 585,9 | 552,3 | 582,7 | **7105,1** |
| 4 | Electricity purchases from Unified Energy Systems of Urals grid | GWh | 85,8 | 148,8 | 165,6 | 184,2 | 192,7 | 185,3 | 224,6 | 196,0 | 182,8 | 127,0 | 97,8 | 107,0 | **1897,8** |
| 5 | Electricity purchases from Unified Energy Systems of Urals grid except EAF-180 demand | GWh | 75,0 | 113,6 | 129,5 | 152,3 | 134,8 | 136,9 | 172,8 | 153,1 | 143,0 | 108,1 | 97,3 | 106,0 | **1522,4** |
| 6 | Electricity, generated by MMK | GWh | 471,7 | 424,4 | 459,3 | 414,3 | 438,3 | 404,7 | 391,7 | 408,3 | 405,6 | 458,8 | 454,5 | 475,7 | **5207,3** |

CO2 emissions from electricity demand in the baseline

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emissions from electricity demand in OHFP | ths. tons CO2 | 0,207 | 0,543 | 0,614 | 0,565 | 0,468 | 0,439 | 0,463 | 0,967 | 1,156 | 0,661 | 0,651 | 0,765 | **7,497** |
| 2 | CO2 emissions from electricity demand in BMP | ths. tons CO2 | 1,073 | 2,807 | 3,173 | 2,922 | 2,420 | 2,268 | 2,393 | 5,000 | 5,979 | 3,416 | 3,365 | 3,955 | **38,770** |
| 3 | **Total CO2 emissions from electricity denamd** | **ths. tons CO2** | **1,280** | **3,350** | **3,786** | **3,486** | **2,888** | **2,707** | **2,856** | **5,967** | **7,135** | **4,076** | **4,015** | **4,720** | **46,268** |

*$CO_2$ emissions from electricity consumption in the baseline*

### *D.6 $CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet*

**<u>$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the project</u>**

$$PE_{air\ blast\_for\_pig\_iron} = P_{profiled\ steel\_ EAFP} * SC_{pig\ iron\_ EAFP} * SC_{air\ blast\ generation\_PJ} * EF_{air\ blast\ generation\_PJ}$$ **(PDD formula D.1.1.2.-26)**

$$EF_{air\ blast\ generation\_PJ} = PE_{air\ blast\ generation} / OC_{air\ blast\ generation\_PJ}$$ **(PDD formula D.1.1.2.-27)**

$$PE_{air\ blast\ generation} = (FC_{BFG\_SABPP\_ air\ blast\ generation\ \_PJ} * C_{BFG\_PJ} + FC_{COG\_SABPP\_ air\ blast\ generation\ \_PJ} * C_{COG.PJ} + FC_{NG\_SABPP\_ air\ blast\ generation\_PJ} * C_{NG\_.PJ})/100 * 44/12$$

**(PDD formula D.1.1.2.-28)**

***Specific consumption of air blast per ton of pig iron produced***

$$SC_{air\ blast\ generation\_PJ} = OC_{air\ blast\ generation\_PJ} / P_{pig\ iron\_BF\_PJ}$$ **(PDD formula D.1.1.2.-29)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $PE_{air\ blast\_for\_pig\_iron}$ | $CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet | ths. tons $CO_2$ | $OC_{air\ blast\ generation\_PJ}$ | Generation of air blast at MMK | mln. $m^3$ |
| $P_{profiled\ steel\_ EAFP}$ | Output of profiled steel billet in EAFP | ths. tons | $FC_{BFG\_SABPP\_ air\ blast\ generation\ \_PJ}$ | Consumption of BFG in SABPP for generation of air blast | mln. $m^3$ |
| $SC_{pig\ iron\_ EAFP}$ | Specific consumption of pig iron per ton of profiled steel billet produced in EAFP | ton/ton | $C_{BFG\_PJ}$ | Carbon content in BFG | kg $C/m^3$ |
| $SC_{air\ blast\ generation}$ | Specific consumption of air blast per ton of pig iron produced | ths. $m^3$/ton | $FC_{COG\_SABPP\_ air\ blast\ generation\ \_PJ}$ | Consumption of COG in SABPP for generation of air blast | mln. $m^3$ |
| $EF_{air\ blast\ generation\_PJ}$ | $CO_2$ emission factor for air blast generation | ths. tons $CO_2$/ths. $m^3$ | $C_{COG.PJ}$ | Carbon content in COG | % by mass |
| $PE_{air\ blast\ generation}$ | $CO_2$ emissions from combustion of fuel for generation of air blast | ths. tons $CO_2$ | $FC_{NG\_SABPP\_ air\ blast\ generation\_PJ}$ | Consumption of NG in SABPP for generation of air blast | mln. $m^3$ |
| $P_{pig\ iron\_BF\_PJ}$ | Production of pig iron in BFP | ths. tons | $C_{NG\_.PJ}$ | Carbon content in NG | kg $C/m^3$ |

*$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the project*

## *12 months of 2010*

Generation of air blast at MMK

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Generation of air blast at MMK | mln. m3 | 1600,1 | 1589,6 | 2044,7 | 2049,8 | 2025,5 | 1887,5 | 1005,8 | 1106,4 | 1079,8 | 1043,8 | 1113,1 | 1924,4 | **18470,5** |
| 2 | **Specific consumption of air blast in BFP per ton of produced pig iron** | **ths. m3 of air blast/ton** | *2,331* | *2,271* | *2,407* | *2,433* | *2,632* | *2,664* | *1,333* | *1,453* | *1,351* | *1,336* | *1,415* | *2,420* | **2,004** |

Input carbon flows

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of BFG in SABPP for generation of air blast | mln. m3 | 68,5 | 87,9 | 113,4 | 121,0 | 104,0 | 100,2 | 106,5 | 113,4 | 101,4 | 90,1 | 96,5 | 95,5 | **1198,4** |
| 2 | Carbon content in BFG | kg C/m3 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,21 | 0,22 | 0,22 | 0,22 | **0,21** |
| | | ths. tons C | 14,5 | 18,4 | 23,9 | 25,6 | 22,1 | 21,3 | 22,6 | 23,9 | 21,5 | 19,4 | 21,1 | 21,0 | **255,4** |
| 3 | Consumption of COG in SABPP for generation of air blast | mln. m3 | 15,8 | 15,2 | 17,2 | 21,4 | 19,4 | 16,2 | 16,7 | 18,7 | 19,4 | 19,4 | 20,5 | 16,9 | **216,8** |
| 4 | Carbon content in COG | kg C/m3 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | **0,18** |
| | | ths. tons C | 2,9 | 2,7 | 3,1 | 3,8 | 3,4 | 2,9 | 3,1 | 3,5 | 3,6 | 3,7 | 3,8 | 3,1 | **39,7** |
| 5 | Consumption of NG in SABPP for generation of air blast | mln. m3 | 11,9 | 12,7 | 12,3 | 8,7 | 10,9 | 10,9 | 11,6 | 11,3 | 10,0 | 9,4 | 9,8 | 11,8 | **131,3** |
| 6 | Carbon content in NG | kg C/m3 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | **0,49** |
| | | ths. tons C | 5,9 | 6,3 | 6,1 | 4,3 | 5,4 | 5,4 | 5,7 | 5,6 | 4,9 | 4,6 | 4,8 | 5,9 | **65,0** |
| 7 | **Total carbon content in input gaseos flow** | **ths. tons C** | **23,3** | **27,5** | **33,1** | **33,7** | **30,9** | **29,6** | **31,5** | **33,0** | **30,1** | **27,7** | **29,8** | **30,0** | **360,1** |

CO2 emissions from generation of air blast

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **CO2 emissions from generation of air blast** | **ths. tons CO2** | **85,5** | **100,7** | **121,3** | **123,6** | **113,2** | **108,4** | **115,3** | **121,1** | **110,3** | **101,6** | **109,3** | **109,9** | **1320,2** |

*$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the project*

CO2 emission factor for generation of air blast

| № | Data variable | Unit | Янв. | Фев. | Март | Апр. | Май | Июнь | Июль | Авг. | Сент. | Окт. | Ноя. | Дек. | Итог по году |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emission factor for generation of air blast at MMK | tons CO2/ ths. m3 of air blast | 0,053 | 0,063 | 0,059 | 0,060 | 0,056 | 0,057 | 0,115 | 0,109 | 0,102 | 0,097 | 0,098 | 0,057 | 0,071 |

CO2 emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the project

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emissions from generation of air blast for production of pig iron | ths. tons CO2 | 2,798 | 5,782 | 7,037 | 6,660 | 2,697 | 2,305 | 2,191 | 8,108 | 9,937 | 6,867 | 11,757 | 14,051 | 80,189 |

*$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the project*

**<u>$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the baseline</u>**

$$BE_{air\ blast\_for\_pig\_iron} = SC_{air\ blast\ generation\_PJ} * SC_{pig\ iron\_OHFP} * P_{profiled\ steel\_EAFP} * SC_{steel\_profiled\_steel\_BM} * EF_{air\ blast\ generation\_PJ}$$ **(PDD formula D.1.1.4.-17)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| $BE_{air\ blast\_for\_pig\_iron}$ | $CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the baseline | ths. tons $CO_2$ | $P_{profiled\ steel\_EAFP}$ | Output of profiled steel billet in EAFP | ths. tons |
| $SC_{air\ blast\ generation\_PJ}$ | Specific consumption of air blast in BFP per ton of pig iron | ths. $m^3$/ton | $SC_{steel\_profiled\_steel\_BM}$ | Specific consumption of steel per ton of profiled steel billet produced in BMP | ton/ton |
| $SC_{pig\ iron\_OHFP}$ | Specific consumption of pig iron per ton of steel produced in OHFP | ton/ton | $EF_{air\ blast\ generation\_PJ}$ | $CO_2$ emission factor for air blast generation | ths. tons $CO_2$/ths. $m^3$ |

## *12 months of 2010*

CO2 emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the baseline

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO2 emissions from generation of air blast for production of pig iron | ths. tons CO2 | 4,195 | 12,525 | 13,522 | 12,374 | 9,079 | 8,616 | 9,268 | 19,916 | 20,790 | 11,946 | 13,519 | 16,043 | 151,792 |

*$CO_2$ emissions from generation of air blast for production of pig iron used for production of profiled steel billet in the baseline*

## *D.7 Emissions reduction calculation from project activity*

**Total project emissions from production of profiled steel billet**

$$PE = PE_{metallurgical\ coke\_profiled\_steel} + PE_{pig\ iron\_\ profiled\_steel} + PE_{profiled\ steel\_\ EAFP} + PE_{electricity\_profiled\_steel\_EAFP} + PE_{air\ blast\_for\_pig\_iron}$$

**(PDD formula D.1.1.2.-30)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **PE** | Total project $CO_2$ emissions from production of profiled steel billet | ths. tons $CO_2$ | **PE** **profiled steel_ EAFP** | $CO_2$ emissions in EAFP from production of profiled steel billet | ths. tons $CO_2$ |
| **PE** **metallurgical coke_profiled_steel** | $CO_2$ emissions from consumption of metallurgical coke for production of profiled steel billet | ths. tons $CO_2$ | **PE** **electricity_profiled_steel_EAFP** | $CO_2$ emissions from consumption of electricity for production of profiled steel billet in EAFP | ths. tons $CO_2$ |
| **PE** **pig iron_ profiled_steel** | $CO_2$ emissions from consumption of pig iron for production of profiled steel billet | ths. tons $CO_2$ | **PE** **air blast_for_pig_iron** | $CO_2$ emissions from consumption of air blast for production of pig iron for production of profiled steel billet | ths. tons $CO_2$ |

**Total $CO_2$ emissions in the baseline**

$$BE = BE_{metallurgical\ coke\_profiled\_steel} + BE_{pig\ iron\_profiled\_steel} + BE_{steel\_OHFP} + BE_{profiled\ steel\_BM} + BE_{total\ electricity\ consumption} + BE_{air\ blast\_for\_pig\_iron}$$

**(PDD formula D.1.1.4.-18)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **BE** | Total $CO_2$ emissions in the baseline | ths. tons $CO_2$ | **BE** **steel_OHFP** | $CO_2$ emissions from steel smelting in OHFP | ths. tons $CO_2$ |
| **BE** **metallurgical coke_profiled_steel** | $CO_2$ emissions from consumption of metallurgical coke in BFP for production of profiled steel billet in the baseline | ths. tons $CO_2$ | **BE** **profiled steel_BM** | $CO_2$ emissions from production of profiled steel billet in BMP | ths. tons $CO_2$ |
| **BE** **pig iron_profiled_steel** | $CO_2$ emissions from consumption of pig iron in BFP in the baseline | ths. tons $CO_2$ | **BE** **total electricity consumption** | Total $CO_2$ emissions from electricity consumption in the baseline | ths. tons $CO_2$ |
| | | | **BE** **air blast_for_pig_iron** | $CO_2$ emissions from generation of air blast in the baseline | ths. tons $CO_2$ |

**Utilization of blast furnace dust at the cement factory outside MMK**

$$LE_y = M_{dust\ utilization\_PJ} * \%\ C_{dust\_BF\_PJ} * 44/12$$ **(PDD formula D.1.3.2.-1)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$LE_y$** | $CO_2$ emissions from utilization of blast furnace dust at the cement factory outside MMK | ths. tons $CO_2$ | **$\%\ C_{dust\_BF\_PJ}$** | Carbon content in blast furnace dust, | % by mass |
| **$M_{dust\ utilization\_PJ}$** | Supply of blast furnace dust at the cement factory outside MMK | ths. tons | | | |

**GHG emission reduction from the project activity**

$$ER_y = BE_y - PE_y - LE_y$$ **(PDD formula D.1.4.-1)**

| Symbol | Data variable | Unit | Symbol | Data variable | Unit |
|---|---|---|---|---|---|
| **$ER_y$** | Emission reduction in the period y | tons $CO_{2eq}$ | **$PE_y$** | Project emissions in the period y | ths. tons $CO_2$ |
| **$BE_y$** | Baseline emissions in the period y | ths. tons $CO_2$ | **$LE_y$** | $CO_2$ emissions from utilization of blast furnace dust at the cement factory outside MMK | ths. tons $CO_2$ |

## *12 months of 2010*

Leakages - utilization of blast furnace dust outside MMK

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Supply of blast furnace dust to the cement factory outside MMK | ths. tons | 0,7 | 0,7 | 0,6 | 0,0 | 0,0 | 0,0 | 0,2 | 0,2 | 0,0 | 0,0 | 0,0 | 0,2 | 2,6 |
| | Carbon content in blast furnace dust | % by mass | 16,7 | 16,3 | 14,1 | 16,3 | 15,1 | 17,2 | 20,0 | 21,4 | 20,6 | 19,6 | 20,0 | 19,0 | 18,0 |
| | | ths. tons C | 0,12 | 0,11 | 0,08 | 0,00 | 0,00 | 0,00 | 0,04 | 0,03 | 0,00 | 0,00 | 0,00 | 0,04 | 0,4 |
| 2 | CO2 emissions from utilization of blast furnace dust at the cement factory outside MMK | ths. tons CO2 | 0,429 | 0,418 | 0,310 | 0,000 | 0,000 | 0,000 | 0,149 | 0,126 | 0,000 | 0,000 | 0,000 | 0,139 | 1,572 |

ERUs generated in 2010 in accordance with monitoring results

| № | Data variable | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total project CO2 emissions from production of profiled steel billet | ths. tons CO2 | 44,832 | 84,672 | 94,148 | 84,217 | 46,282 | 40,478 | 40,933 | 110,108 | 144,772 | 97,297 | 134,840 | 164,013 | 1086,593 |
| 2 | Total CO2 emissions in the baseline | ths. tons CO2 | 59,559 | 155,486 | 166,866 | 144,754 | 106,075 | 94,856 | 101,354 | 220,566 | 269,709 | 156,905 | 169,632 | 200,725 | 1846,487 |
| 3 | CO2 emissions from leakages | ths. tons CO2 | 0,429 | 0,418 | 0,310 | 0,000 | 0,000 | 0,000 | 0,149 | 0,126 | 0,000 | 0,000 | 0,000 | 0,139 | 1,572 |
| 4 | ERUs generated in 2010 | tons CO2eq | 14 299 | 70 396 | 72 408 | 60 537 | 59 792 | 54 377 | 60 273 | 110 332 | 124 937 | 59 608 | 34 792 | 36 573 | 758 323 |

# Appendix 1

| | Color legend for calculation tables |
|---|---|
| | carbon containing flow |
| | data input from MMK reports |
| | carbon mass |
| 0,19 | carbon conent |
| | specific CO2 emissions |
| | CO2 emissions, associated with production of profiled steel billet |
| | value fixed ex-ante |
| | value which requires a special note in the monitoring report (section C) |

# Appendix 2

## List of abbreviations

| | |
|---|---|
| BFG | Blast-Furnace Gas |
| BFP | Blast-Furnace Plant |
| BMP | Blooming Mill Plant |
| BOFP | Basic Oxygen Furnace Plant |
| BPCP | By-Product Coke Plant |
| CCM | Continuous Casting Machine |
| CEST | Center for Energy Saving Technologies |
| CHPP | Combined Heat Power Plant |
| CL | Central Lab |
| COG | Coke Oven Gas |
| CPP | Central Power Plant |
| DBSU | Double-Bath Steelmaking Unit |
| EAF | Electric Arc Furnace |
| EAFP | Electric Arc-Furnace Plant |
| EF | Emission Factor |
| EIA | Environmental Impact Assessment |
| ERU | Emission Reduction Unit |
| GHG | Greenhouse Gas |
| IMP and LDW | Integrated Mining-and-Processing, Limestone and Dolomite Works |
| IPCC | Intergovernmental Panel on Climate Change |
| JI | Joint Implementation |
| KP | The Kyoto Protocol |
| LFA | Ladle-Furnace Aggregate |
| MEC | Magnitogorsk Energy Company |
| MMK | Magnitogorsk iron and steel works |
| MNR | Ministry of Natural Resources |
| MPC | Maximum Permissible Concentration |
| MPE | Maximum Permissible Emissions |
| OHFP | Open-Hearth Furnace Plant |
| SABPP | Steam-Air Blowing Power Plant |
| SP | Steam Plant |
| SRA | Steel Refining Aggregate |
| TEE | Turbine Expansion Engine |
| QMS | Quality Management System |

# Appendix 3

### Response to the Further Action Request(s) in the Verification report issued for the previous monitoring period

In the Initial and First Verification report of Bureau Veritas No. Russia - ver /0048/2010 the verifier issued 6 Further Action Requests (FARs). Table 3.1. provides the response on these FARs in order to close them.

Table 3.1. Response to the FARs in the Initial and First Verification report of Bureau Veritas No. Russia - ver /0048/2010.

| | |
|---|---|
| **FAR 01.** Based on the first experience of monitoring, OJSC "MMK" may wish to issue a separate Manual of the Monitoring Management System though the present managerial set up is observed by the verifier as appropriate enough. | Indeed the specialized internal procedure PD MMK 3-SSGO-01-2010 "Regulation on monitoring of GHG emissions reduction, created as a result of the realization of the project: "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works" was approved at OJSC "MMK" by the Order of the Executive Director of MMK Y.A. Bodyaev № ID-173 of 03.03.2010. |
| **FAR 02.** Based on the first experience of monitoring, OJSC "MMK" may wish to issue a formal order to formalize the status of a JI working group responsible for the JI Project Monitoring Management System, in particular to appoint a JI coordinator to ensure the alignment with the existed managerial set up. | According to internal procedure PD MMK 3-SSGO-01-2010 (see above) the coordinator of JI project is a Department for relations with state authorities and markets protection.<br>Additionally the responsible persons for reporting on monitoring data and other related issues regarding JI projects were appointed in the related production departments according to the Order of First Vice-president on strategic development and metallurgy R.S. Takhutdinov # RT-4 of 21.01.2010 "On results of the external independent expertise (determination)". |
| **FAR 03**. Please develop a procedure, which provides emergency concepts in case of unexpected problems with data gathering and/or data quality. | The following measures should provide a protection and mitigate the consequences of unexpected problems with data access and/or data quality at OJSC "MMK":<br>1. According to specialized corporate procedure for the monitoring organization for the Joint Implementation project PD MMK 3-SSGO-01-2010:<br>- For ensuring of the secure storage and protection of electronic documents with data used for monitoring purposes the special folder is established on the server space of OJSC "MMK". Each responsible person from department that submit monitoring data has the own folder without editing rights from other persons.<br>- For prevention of unintended erasure of correct version of electronic document the reserve coping is ensured.<br><br>Electronic documents that are submitted to the server |

| | |
|---|---|
| | of MMK is accordance with PD MMK 3-SSGO-01-2010 are printed out and signed in the departments following the existing reporting procedures within certified QMS. Therefore in case of issues with electronic format the data may be restored from the official printed copies or local server space/local website of each relevant department or the Corporate Information System of MMK (CIS). |
| **FAR 04.** Based on the first experience of monitoring, OJSC "MMK" may wish to issue a formal procedure for data archiving as partially defined in the MR. | See response to FAR 01. |
| **FAR 05.** Based on the first experience of monitoring, OJSC "MMK" may wish to issue a formal procedure for the calculation of emission reductions and the preparation of the monitoring report in particular respect to internal verification and validation of data and responsibilities assigned for that. The extended and comprehensive Responsibility Structure of the MR is observed and discussed on the site visit. | See response to FAR 01. |
| **FAR 06.** Based on the first experience of monitoring, OJSC "MMK" may wish to issue a formal procedure for the internal control procedures (Internal audits and management review), which allow the identification and solution of problems at an early stage of calculation of emission reductions and the preparation of the monitoring report. | The internal verification of the monitoring data in the initial reporting forms submitted to Department for relations with state authorities and markets protection by the relevant departments of MMK is performed within each department according to existing procedures.<br>The internal audit of each production department is carried out by the group of internal audit at OJSC "MMK" as a part of certified QMS.<br>The management review of the activity of Department for relations with state authorities and markets protection including issues related to JI project is performed in form of periodic report of the department on the MMK's Board meeting. |