INITIAL AND FIRST JI MONITORING REPORT

Version 3.6
14 February 2012

CONTENTS

ANNEXES

SECTION A. General Project activity information

A.1 Title of the project activity:

"Implementation of energy efficient measures at "Donetsksteel" – metallurgical plant"

Sectoral scope 4: Manufacturing Industries
Sectoral scope 9: Metal Production

A.2. ITL project ID:

UA2000037

A.3. Short description of the project activity:

Project purpose

The aim of this project is to reduce GHG due to modern technologies usage in iron and steel production processes. To meet the aims mentioned above, it was envisaged to implement two energy efficient subprojects:

1. Implementation of Pulverized Coal Injection (PCI) for Blast Furnace 1 (BF 1);
2. Implementation of automatic process control system (APCS) for Open Hearth Furnaces (OHF).

The project consists of two subprojects:

1. *Implementation of Pulverized Coal Injection (PCI) for Blast Furnace 1 (BF 1)*. As the result of implementation of this measure due to injection of pulverized coal into the furnace a significant saving of coke was achieved: about 20% reduction in specific consumption of coke per tonne of pig iron. Coke production requires much more energy than PC production. Therefore, positive ecological effect is achieved due to the substitution of coke with pulverized coal.

2. *Implementation of automatic process control system (APCS) for Open Hearth Furnaces (OHF)*. In the result of implementation of this measure, significant saving of fuel, electricity and other resources was achieved due to technological processes optimization and exclusion of human factor. Implementation of APCS for Open Hearth Furnaces is a unique project which has no analogues in Ukraine. This can be confirmed by relevant patents (No 35552, 26512, 20930), which are owned by PJSC "Donetsksteel" – metallurgical plant".

Current status

Both subprojects have already been implemented. All the necessary documentation was developed and approved by relevant authorities, as well as all permits and licenses were obtained. Due to the project implementation harm to environment was significantly reduced, including reduction of GHG emissions.

Implementation of PCI technology was finished in January 2007.
Implementation of APCS was finished in November 2006.

A.4. Monitoring period:

- Monitoring period starting date: 01.01.2008 at 00:00;
- Monitoring period closing date: 31.10.2011 at 24:00.

A.5. Methodology applied to the project activity:

A.5.1. Baseline methodology:

The baseline for the JI project was set in accordance with Appendix B to decision 9/CMP.1 (JI guidelines)[1], and with *Guidance on Criteria for Baseline Setting and Monitoring* developed by the Joint Implementation Supervisory Committee (JISC). Project participants have chosen the following approach regarding baseline setting, defined in the Guidance (Paragraph 9):

a) An approach for baseline setting and monitoring developed in accordance with appendix B of the JI guidelines (JI specific approach).

A.5.2. Monitoring methodology:

The monitoring methodology for the JI project was developed in accordance with Appendix B to decision 9/CMP.1 (JI guidelines)[2], and with *Guidance on Criteria for Baseline Setting and Monitoring* developed by the Joint Implementation Supervisory Committee (JISC). Project participants have chosen the following approach regarding monitoring methodology, defined in the Guidance (Paragraph 9):

a) An approach for baseline setting and monitoring developed in accordance with appendix B of the JI guidelines (JI specific approach).

A.6. Status of implementation including time table for major project parts:

All subprojects have been implemented according to the following time schedule:

Activities	Start of activities	Commissioning/Implementation date
BF1 project designing	January 1, 2002	June 1, 2002
Decision making for PCI	January 15, 2003	February 14, 2003
Preparation works for PCI	February 14, 2003	May 1, 2005
BF1 shutdown	May 1, 2005	May 31, 2005
BF1 Construction works	May 1, 2005	February 1, 2007
Start and setup works for BF1	October 1, 2006	December 10, 2006
Commissioning of BF1	December 10, 2006	January 9, 2007
APCS project designing	January 15, 2004	September 11, 2004
Decision making for APCS	September 11, 2004	October 11, 2004
OHF5 shutdown	November 29, 2004	December 31, 2004
APCS implementation	December 31, 2004	February 9, 2005
Start and setup works for APCS at OHF5	February 9, 2005	March 16, 2006
APCS implementation for other OHFs	March 16, 2006	November 23, 2006

Table 1: Schedule of subprojects' implementation

The project was approved by the Host Party: Letter of Approval of State Environmental Investment Agency of Ukraine No. 3187/23/7 was issued on 01/11/2011. Letter of Approval No. 2010JI30 was issued by NL Agency, Ministry of Foreign Affairs of Netherlands on 07/10/2010.

---

[1] http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=2

[2] http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=2

A.7. Intended deviations or revisions to the determined PDD:

There were no intended deviations or revisions to the determined PDD.

A.8. Intended deviations or revisions to the determined monitoring plan:

In accordance with paragraph 41 of Guidance on Criteria for Baseline Setting and Monitoring, Version 03, the monitoring process and its results were improved in the following way:

- Carbon dioxide emission factors for consumption of electricity from Ukrainian power grid in 2008 - 2011 were changed from 0.896 tCO_2e/MWh (Standardised baseline emission factor for Ukrainian power grid (see Annex 2)to the new emission factors approved for obligatory use in ERUs calculations for JI projects in Ukraine by the Orders of Ukrainian DFP. New estimations of emission factors for 2008-2011 rely on the latest available data across entire Ukrainian power grid and represent the best knowledge on emissions of GHGs. For future monitoring periods emission factors approved by the Orders of Ukrainian DFP will be used.
- Text representation of calculation formulae of "carbon dioxide emission factor for limestone, dolomite and magnesite powder consumption" were detailed to reflect more accurately the calculation method applied. The changes didn't influence the calculation method itself.
- Text representation of calculation formulae of "carbon dioxide emission factor for pig iron production process under the project"; "carbon dioxide emission factor for steel production process under the project"; "carbon dioxide emission factor for pig iron production process under the baseline" and "carbon dioxide emission factor for steel production process under the baseline" was corrected to reflect more accurately the calculation method applied. The changes didn't influence the calculation method itself.

All the revisions to the determined monitoring plan are illustrated in Table 2. The proposed revisions improve the accuracy of information compared to the original monitoring plan without changing conformity with the relevant rules and regulations for the establishment of monitoring plans.

PDD version 3.4 dated 3 November 2011	Monitoring report
Carbon dioxide emission factors for consumption of electricity from Ukrainian power grid in 2008-2011	

Baseline	$EF_{CO2,el}$	tCO_2e/ MWh	0.896	“Standardised baseline emission factor for Ukrainian power grid” developed by Global Carbon B.V. and positively determined by TUV SUD (Annex 2)

2008	$EF_{CO2,el}$	tCO_2/ MWh	1.219	Ukrainian National Environment Investment Agency Order No 62 from 15.04.2011[3]
2009	$EF_{CO2,el}$	tCO_2/ MWh	1.237	Ukrainian National Environment Investment Agency Order No 63 from 15.04.2011[4]
2010	$EF_{CO2,el}$	tCO_2/ MWh	1.225	Ukrainian National Environment Investment Agency Order No 43 from 28.03.2011[5]
2011	$EF_{CO2,el}$	tCO_2/ MWh	1.227	Ukrainian National Environment Investment Agency Order No 75 from 12.05.2011[6]

Carbon dioxide emission factor for limestone, dolomite and magnesite powder consumption

PDD version 3.4:

$EF_{CO2,lmst}$	tCO_2/t	0.4400	IPCC, Volume 3, Chapter 4, Table 4.3
$EF_{CO2,dlmt}$	tCO_2/t	0.4800	IPCC, Volume 3, Chapter 4, Table 4.3
$EF_{CO2,mgst}$	tCO_2/t	0.5200	Default value, Webmineral http://www.webmineral.com/data/Magnesite.shtml

Monitoring report:

$$EF_{CO2,lmst} = C_{lmst} \times 44/12$$ ***(Formula 8)***

$$EF_{CO2,dlmt} = C_{dlmt} \times 44/12$$ ***(Formula 9)***

$$EF_{CO2,mgst} = C_{mgst} \times 44/12$$ ***(Formula 10)***

C_{lmst}	tC/t	0.1200	IPCC, Volume 3, Chapter 4, p. 4.27, Table 4.3
C_{dlmt}	tC/t	0.1300	IPCC, Volume 3, Chapter 4, p. 4.27, Table 4.3
C_{mgst}	tC/t	0.1425	Default value, Webmineral http://www.webmineral.com/data/Magnesite.shtml

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

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

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

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

PDD version 3.4 dated 3 November 2011	Monitoring report
Carbon dioxide emission factor for pig iron production process under the project	
$EF^{BF}_{CO2,PJ,y} = \Big(\big(FC^{BF}_{coke,PJ,y} \times (EF_{CO2,coke} + C_{coke,y} \times 44/12)\big) + \big(FC^{BF}_{n.gas,PJ,y} \times EF_{CO2,n.gas}\big) + \big(FC^{BF}_{lmst,PJ,y} \times EF_{CO2,lmst}\big) + \big(FC^{BF}_{el,PJ,y} \times EF_{CO2,el}\big) + \big(FC^{BF}_{sinter,PJ,y} \times EF_{CO2,sinter}\big) + \big(FC^{BF}_{pellets,PJ,y} \times EF_{CO2,pellets}\big) + \big(FC^{BF}_{PC,PJ,y} \times EF_{CO2,PC}\big) + \big(FC^{OX\ BF}_{el,PJ,y} \times EF_{CO2,el}\big)\Big) / P^{BF}_{iron,PJ,y}$ ***(Formula 3)***	$EF^{BF}_{CO2,PJ,y} = \Big(\big(FC^{BF}_{coke,PJ,y} \times (EF_{CO2,coke} + C_{coke,y} \times 44/12)\big) + \big(FC^{BF}_{n.gas,PJ,y} \times \mathbf{NCV_{n.gas,y}} \times EF_{CO2,n.gas}\big) + \big(FC^{BF}_{lmst,PJ,y} \times EF_{CO2,lmst}\big) + \big(FC^{BF}_{el,PJ,y} \times EF_{CO2,el}\big) + \big(FC^{BF}_{sinter,PJ,y} \times EF_{CO2,sinter}\big) + \big(FC^{BF}_{pellets,PJ,y} \times EF_{CO2,pellets}\big) + \big(FC^{BF}_{PC,PJ,y} \times \mathbf{EF^{PCI}_{CO2,PJ,y}}\big) + \big(\mathbf{FC^{BF}_{PC,PJ,y} \times NCV_{coal} \times EF_{CO2,coal}}\big) + \big(FC^{OX\ BF}_{el,PJ,y} \times EF_{CO2,el}\big)\Big) / P^{BF}_{iron,PJ,y}$ ***(Formula 3)***
Carbon dioxide emission factor for steel production process under the project	
$EF^{OHF}_{CO2,PJ,y} = \Big(\big(FC^{OHF}_{iron,PJ,y} \times EF_{CO2,iron}\big) + \big(FC^{OHF}_{lmst,PJ,y} \times EF_{CO2,lmst}\big) + \big(FC^{OHF}_{lime,PJ,y} \times EF_{CO2,lime}\big) + \big(FC^{OHF}_{coke,PJ,y} \times EF_{CO2,coke}\big) + \big(FC^{OHF}_{dlmt,PJ,y} \times EF_{CO2,dlmt}\big) + \big(FC^{OHF}_{mgst,PJ,y} \times EF_{CO2,mgst}\big) + \big(FC^{OHF}_{sinter,PJ,y} \times EF_{CO2,sinter}\big) + \big(FC^{OHF}_{coal,PJ,y} \times EF_{CO2,coal}\big) + \big(FC^{OHF}_{n.gas,PJ,y} \times EF_{CO2,n.gas}\big) + \big(FC^{OHF}_{COG,PJ,y} \times EF_{CO2,COG}\big) + \big(FC^{OHF}_{el,PJ,y} \times EF_{CO2,el}\big)\Big) / P^{OHF}_{steel,PJ,y}$ ***(Formula 7)***	$EF^{OHF}_{CO2,PJ,y} = \Big(\big(FC^{OHF}_{iron,PJ,y} \times \mathbf{EF^{BF}_{CO2,PJ,y}}\big) + \big(FC^{OHF}_{lmst,PJ,y} \times EF_{CO2,lmst}\big) + \big(FC^{OHF}_{lime,PJ,y} \times EF_{CO2,lime}\big) + \big(FC^{OHF}_{coke,PJ,y} \times (EF_{CO2,coke} + \mathbf{C_{coke,y} \times 44/12})\big) + \big(FC^{OHF}_{dlmt,PJ,y} \times EF_{CO2,dlmt}\big) + \big(FC^{OHF}_{mgst,PJ,y} \times EF_{CO2,mgst}\big) + \big(FC^{OHF}_{sinter,PJ,y} \times EF_{CO2,sinter}\big) + \big(FC^{OHF}_{coal,PJ,y} \times \mathbf{NCV_{coal}} \times EF_{CO2,coal}\big) + \big(FC^{OHF}_{n.gas,PJ,y} \times \mathbf{NCV_{n.gas,y}} \times EF_{CO2,n.gas}\big) + \big(FC^{OHF}_{COG,PJ,y} \times \mathbf{NCV_{COG}} \times EF_{CO2,COG}\big) + \big(FC^{OHF}_{el,PJ,y} \times EF_{CO2,el}\big)\Big) / P^{OHF}_{steel,PJ,y}$ ***(Formula 7)***

PDD version 3.4 dated 3 November 2011	Monitoring report
Carbon dioxide emission factor for pig iron production process under the baseline	
$EF^{BF}_{CO2,BL,y} = \Big(\big(FC^{BF}_{coke,BL,y} \times (EF_{CO2,coke} + C_{coke,y} \times 44/12)\big) + (FC^{BF}_{n.gas,BL,y} \times EF_{CO2,n.gas}) + (FC^{BF}_{lmst,BL,y} \times EF_{CO2,lmst}) + (FC^{BF}_{el,BLy} \times EF_{CO2,el}) + (FC^{BF}_{sinter,BL,y} \times EF_{CO2,sinter}) + (FC^{BF}_{pellets,BL,y} \times EF_{CO2,pellets})\Big) / P^{BF}_{iron,BL,y}$ ***(Formula 11)***	$EF^{BF}_{CO2,BL,y} = \Big(\big(FC^{BF}_{coke,BL,y} \times (EF_{CO2,coke} + C_{coke,y} \times 44/12)\big) + (FC^{BF}_{n.gas,BL,y} \times \boldsymbol{NCV_{n.gas,y}} \times EF_{CO2,n.gas}) + (FC^{BF}_{lmst,BL,y} \times EF_{CO2,lmst}) + (FC^{BF}_{el,BL,y} \times EF_{CO2,el}) + (FC^{BF}_{sinter,BL,y} \times EF_{CO2,sinter}) + (FC^{BF}_{pellets,BL,y} \times EF_{CO2,pellets})\Big) / P^{BF}_{iron,BL,y}$ ***(Formula 14)***
Carbon dioxide emission factor for steel production process under the baseline	
$EF^{OHF}_{CO2,BL,y} = \Big((FC^{OHF}_{iron,BL,y} \times EF_{CO2,iron}) + (FC^{OHF}_{lmst,BLy} \times EF_{CO2,lmst}) + (FC^{OHF}_{lime,BL,y} \times EF_{CO2,lime}) + (FC^{OHF}_{coke,BL,y} \times EF_{CO2,coke}) + (FC^{OHF}_{coal,BL,y} \times EF_{CO2,coal}) + (FC^{OHF}_{n.gas,BL,y} \times EF_{CO2,n.gas}) + (FC^{OHF}_{COG,BL,y} \times EF_{CO2,COG}) + (FC^{OHF}_{el,BL,y} \times EF_{CO2,el})\Big) / P^{OHF}_{steel,BL,y}$ ***(Formula 14)***	$EF^{OHF}_{CO2,BL,y} = \Big((FC^{OHF}_{iron,BL,y} \times \boldsymbol{EF^{BF}_{CO2,BL,y}}) + (FC^{OHF}_{lmst,BL,y} \times EF_{CO2,lmst}) + (FC^{OHF}_{lime,BL,y} \times EF_{CO2,lime}) + \big(FC^{OHF}_{coke,BL,y} \times (EF_{CO2,coke} + \boldsymbol{C_{coke,y} \times 44/12})\big) + \boldsymbol{(FC^{OHF}_{dlmt,BL,y} \times EF_{CO2,dlmt})} + \boldsymbol{(FC^{OHF}_{mgst,BL,y} \times EF_{CO2,mgst})} + \boldsymbol{(FC^{OHF}_{sinter,BL,y} \times EF_{CO2,sinter})} + (FC^{OHF}_{coal,BL,y} \times \boldsymbol{NCV_{coal}} \times EF_{CO2,coal}) + (FC^{OHF}_{n.gas,BL,y} \times \boldsymbol{NCV_{n.gas,y}} \times EF_{CO2,n.gas}) + (FC^{OHF}_{COG,BL,y} \times \boldsymbol{NCV_{COG}} \times EF_{CO2,COG}) + (FC^{OHF}_{el,BL,y} \times EF_{CO2,el})\Big) / P^{OHF}_{steel,BL,y}$ ***(Formula 17)***

Table 2: Revisions to the determined monitoring plan.

A.9. Changes since last verification:

Not applicable.

A.10. Person(s) responsible for the preparation and submission of the monitoring report:

PJSC "Donetsksteel" – Iron and Steel Works"
- Dorofeev Alexandr, Deputy Head Energy Efficiency Engineer
- Komkov Dmitriy, Head of Group of Energy Control

Global Carbon B.V.
- Lennard de Klerk, Director
- Denis Rzhanov, Team Leader JI Consultants
- Anna Vilde, Senior JI Consultant

SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period stated in A.4.

Key monitoring activities for the project could be described as follows.

Pig iron production by BF 1. Liquid pig iron from BF1is weighted by scales. Results of weighting are automatically submitted to the Automatic Process Control System of BF1 (APCS BF1) from where they are automatically inputted into SAP R/3 system. Then liquid iron is transported to OHF workshop where its weight can be cross-checked at mixer unit. Part of liquid iron is directed to casting machine where pig iron is cooled down. Cold pig iron is transported to Storage place where it is weighed at wagon weighbridge. Data are filled in daily Weighting reports, signed by responsible people and delivered to BFW accounting office. Accountants cross-check the data with measurement data from other workshops and input them into SAP R/3 system where they are aggregated. Based on the daily aggregated data WEB technical reports are generated. Information is stored till the end of the crediting period plus two years.

Consumption of coke, pellets, sinter and limestone by BF 1.Upon delivery to the Plant raw materials are weighted at wagon weighbridge at sorting station. Then they are loaded to storage hoppers with weighers from where they are portion by portion are supplied to BF1. Information from hopper weigher after every charging session is automatically submitted to the APCS BF1. Data from APCS BF1 is stored in electronic format and filled in to registration log of melting and daily Charging Report which is signed by responsible people. Daily Charging Reports are delivered to Deputy Head on Charging Materials, who checks it and inputs into SAPR/3 system, where it is aggregated. Information is stored till the end of the crediting period plus two years.

Consumption of pulverised coal by BF 1.From PCI production unit PCI gets into pneumatic pipeline leading to two injection points where PCI is weighted by strain-gage weighers. Information from weigher is automatically submitted to the APCS BF1.Data from APCS BF1 is stored in electronic format and filled in to registration log of melting and daily Charging Report which is signed by responsible people. Daily Charging Reports are delivered to Deputy Head on Charging Materials, who checks it and inputs into SAP R/3 system, where it is aggregated. Information is stored till the end of the crediting period plus two years.

Oxygen consumption by BF 1. Oxygen consumption is monitored by flow meter, data of which are automatically transferred to APSC BF1. On daily basis the recorded data in electronic format is transferred to Accounting Office of Process Control and Instrumentation Division in Department of Head Energy Engineer (PCI Division), where it is downloaded into Excel based computer system, where data are accumulated and inputted in monthly reports “Balance of Oxygen”. The report is signed by responsible person at Accounting Office of PCI Division and Head of PCI Division. Information is stored till the end of the crediting period plus two years.

Natural gas and coke oven gas (COG) consumption at BFW, OHFW. Fuel consumption is monitored by flow meters, data from which are automatically transferred to APSC BF1 or APCSs of OHFs respectively. On daily basis the recorded data in electronic format is transferred to Accounting Office of Process Control and Instrumentation Division in Department of Head Energy Engineer (PCI Division), where it is downloaded into Excel based computer system, where data are accumulated and inputted in monthly reports “Balance of Natural Gas”. The report is signed by responsible person at Accounting Office of PCI Division, Head of PCI Division and Head Energy Engineer. Information is stored till the end of the crediting period plus two years.

Natural gas net calorific value (NCV). Monthly certificates with data provided by natural gas supplier Naftogaz Ukraine Affiliate Company “Ukrtransgas” are used as primary data for natural gas NCV. Data are accumulated in the Technical Bureau in Department of Head Energy Engineer. Annual average value is calculated based on monthly average data. Information is stored till the end of the crediting period plus two years.

Electricity consumption at BFW, OHFW, Oxygen workshop. Electricity consumption is monitored by power meters, data from which are automatically transferred to APSC BF1, APCSs of OHFs and recorded to operational logs in oxygen workshop. Figures are then filled in daily reports “Daily Electricity Consumption” reflecting the readings of the power meters for each 24 hours, the daily reports are then submitted to Accounting Bureau of Department of Head Energy Engineer(Department of HEE) where they are accumulated and summed up. In the same way the data are collected in Electric Network and Substation Shop. In the end of the month data are cross-checked and common monthly “Report on Electricity Distribution” is formed. The report is signed by the responsible people from Accounting Bureau of Department and Electric Network and Substation Shop and stamped. Information is stored till the end of the crediting period plus two years.

Steel production by OHF workshop. Liquid steel from each of the OHFs is directed to continuous casting machine (CCM) which forms slabs of standard dimensions and mass of a running metre. For accuracy reasons a sample of slabs is weighted each month with slab dimensions measured; then monthly average mass of a running metre is calculated by dividing total measured mass of a sample of slabs by its total length. Length of the produced slabs is measured by contact rollers. Steel production is calculated by multiplying length of rolled metal by mass of a running metre. Each slab is registered at Production log, data from which is filled in passport of melting data, from which are inputted in SAP R/3 system by Accountant of OHF workshop. Data on steel production are cross-checked at Rolling Mill workshop where slabs are weighted before being processed. Based on the daily aggregated data WEB technical reports are generated. Final data are accumulated in SAP R/3 system where they are aggregated. Information is stored till the end of the crediting period plus two years.

Pig iron consumption by OHF workshop. Liquid pig iron from BF1 is weighted by wagon scales and transported to OFH workshop. Data on each ladle is registered in the log. Data are filled in daily Weighting reports, signed by responsible people and delivered to OHF workshop accounting office. Accountants cross-check the data with measurement data from BF workshop and input them into SAP R/3 system where they are aggregated. Based on the daily aggregated data WEB technical reports are generated. Information is stored till the end of the crediting period plus two years.

Consumption of lime, limestone, dolomite, magnesite powder, sinter, coke, coal by OHF workshop.
Charging materials arrive to Sorting Station where they are weighted and transported to OHF workshop in molds with standard dimensions (1 m^3). Consumption of each of material is calculated by multiplying number of molds with each of material loaded to the OHF by standard weight factor. Steelmaker registers quantity of materials used for each melting and transfers data to production Accountant who checks it and fills in passport of melting, data from where are inputted in SAP R/3 system by Accountant of OHF workshop. Final data are accumulated in SAP R/3 system where they can be aggregated. Information is stored till the end of the crediting period plus two years.

Monitoring points and flow of materials are presented in the figures 1 and 2.

The control and monitoring system can be divided into the following parts:

Scales
For the purpose of the emission reductions monitoring the following parameters are measured:

- Pig iron production at BF 1
- Coke consumption at BF 1
- Limestone consumption at BF 1
- Sinter consumption at BF 1
- Pellets consumption at BF 1
- Pulverized coal (PC) production
- Pulverized coal (PC) consumption by BF 1
- Pig iron consumption at OHFs
- Limestone consumption at OHFs
- Lime consumption at OHFs
- Dolomite consumption at OHFs
- Magnesite powder consumption at OHFs
- Sinter consumption at OHFs
- Coke consumption at OHFs
- Coal consumption at OHFs

Flow meters

For the purpose of the emission reductions monitoring the following parameters are measured:

- Natural gas consumption at BF 1
- Natural gas consumption for PC production
- Oxygen consumption by BF 1
- Total production of oxygen
- Natural gas consumption at OHFs
- COG consumption at OHFs

Power meters

For the purpose of the emission reductions monitoring the following parameters are measured:

- Electricity consumption at BF 1
- Electricity consumption for PC production
- Electricity consumption for oxygen production
- Electricity consumption at OHFs

Length meters

- Steel production at OHFs

B.1. Monitoring equipment types

1. Scales weight bridge VIK-VV2/4;
2. Scales VV-250-50-2;
3. Scales VV-250-50-2M;
4. Scales VV-200-50-2M;
5. Scales TP250×9;
6. Scales VTB-2
7. Scales VA-60-15-2
8. Scales VTV-25 D
9. Electricity meter A2R-4-OL-C25-T;
10. Electricity meter SA3U-I670;
11. Electricity meter SA3U-I670M;
12. Electricity meter SA3U-I670D;
13. Electricity meter SA3U-I 689;
14. Electricity meter SA3U-5009I;
15. Electricity meter SA4U-I 672M;
16. Electricity meter SA3U-IT;
17. Flow meter Metran-22-DD 2440;
18. Flow meter Metran-100-DD 1411;
19. Flow meter Metran-100-DD 1430;
20. Flow meter Metran-100-DD 1440;
21. Flow meter Safir M 5410
22. Flow meter Safir M 5415
23. Flow meter Safir M 5420
24. Flow meter Safir M 5420I
25. Flow meter Safir M 5430
26. Flow meter Safir M 5440K
27. Flow meter Sapfir M 22DD 2420
28. Flow meter Sapfir 22DD 2420
29. Flow meter Sapfir 22DD 2430
30. Flow meter Sapfir 22DI 2430
31. Slab length meter.

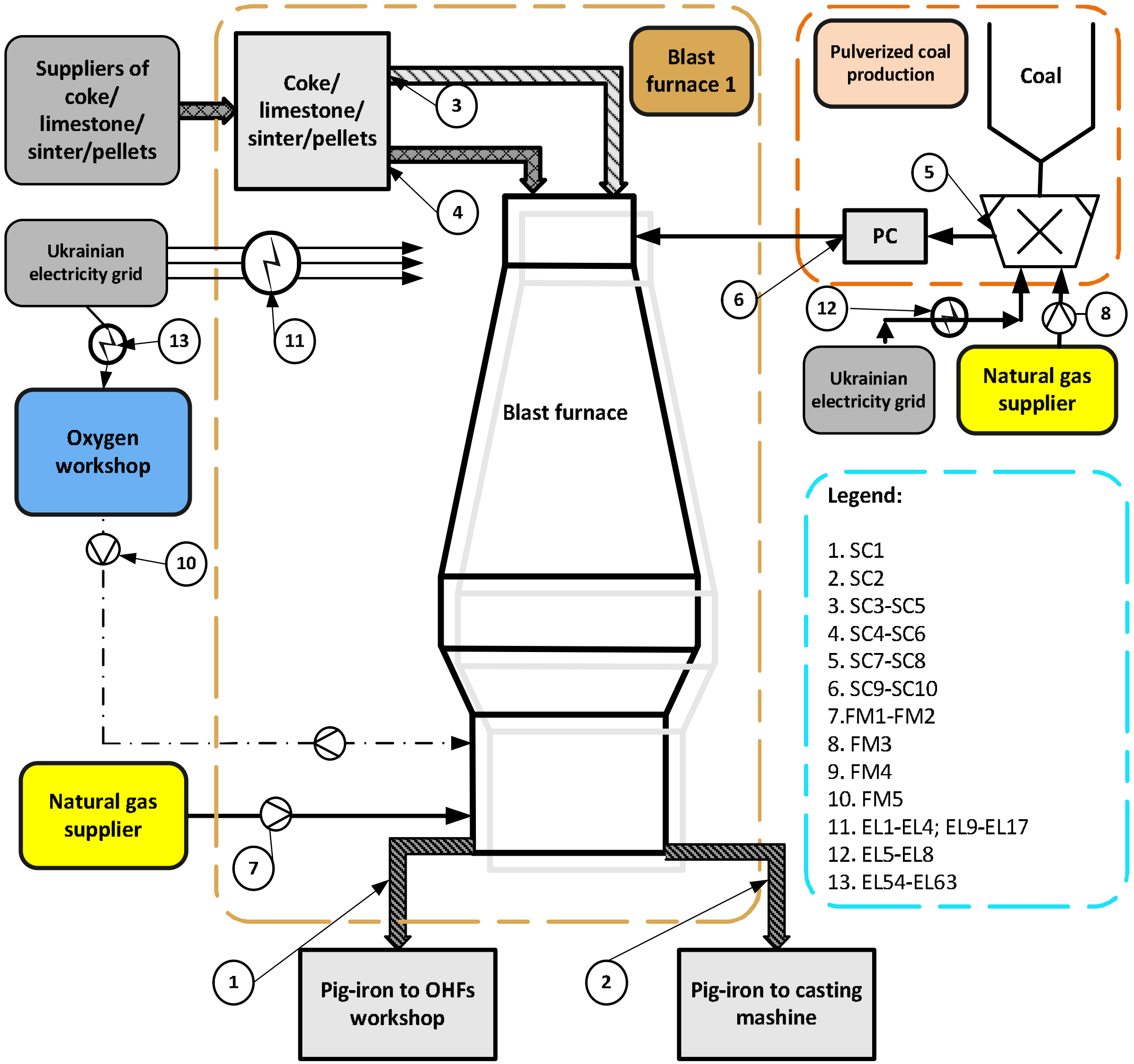

Figure 1.Indication of monitoring points at Blast furnace No 1.

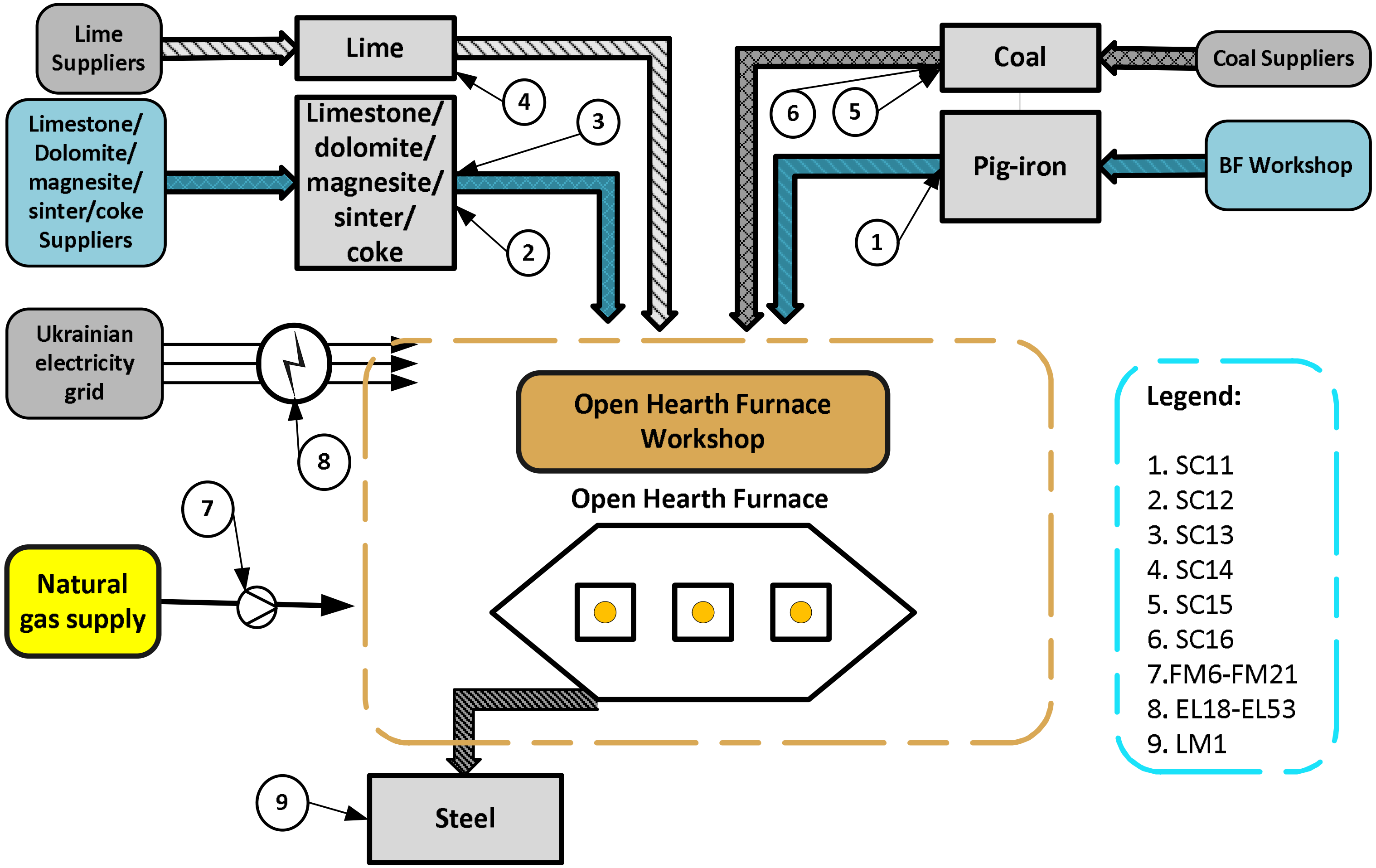

Figure 2.Indication of monitoring points at Open Hearth Furnaces workshop.

B.1.2. Table providing information on the equipment used (incl. type, serial number, uncertainty level, date of last calibration, required calibration intervals):

The control and monitoring system can be divided into the following parts:

Scales
For the purpose of the emission reductions monitoring the following parameters are measured:

- Pig iron production at BF 1
- Coke consumption at BF 1
- Limestone consumption at BF 1
- Sinter consumption at BF 1
- Pellets consumption at BF 1
- Pulverized coal (PC) production
- Pulverized coal (PC) consumption by BF 1
- Pig iron consumption at OHFs
- Limestone consumption at OHFs
- Lime consumption at OHFs
- Dolomite consumption at OHFs
- Magnesite powder consumption at OHFs
- Sinter consumption at OHFs
- Coke consumption at OHFs
- Coal consumption at OHFs

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
SC1	Pig iron production at BF 1	t	VV-250-50-2M	020906324/ 020906325	GOST 29329	01.06.2011	2 times a year
SC2	Pig iron production at BF 1	t	VV-250-50-2M	020805258/ 030100798	GOST 29329	18.06.2011	2 times a year
SC3	Coke, limestone, sinter, pellets consumption at BF 1	t	VIK-VV2/4	2*	GOST 29329	16.12.2009	2 years
SC4	Coke, limestone, sinter, pellets consumption at BF 1	t	VIK-VV2/4	3*	GOST 29329	16.12.2009	2 years
SC5	Coke, limestone, sinter, pellets consumption at BF 1	t	VIK-VV2/4	5	GOST 29329	25.12.2009	2 years
SC6	Coke, limestone, sinter, pellets consumption at BF 1	t	VIK-VV2/4	7	GOST 29329	25.12.2009	2 years
SC7	Pulverized coal (PC) production	t	VTB-2	01	GOST 29329	17.03.2010	2 years
SC8	Pulverized coal (PC) production	t	VTB-2	02	GOST 29329	17.03.2010	2 years
SC9	Pulverized coal (PC) production and consumption by BF 1	t	VTB-2	03	GOST 29329	14.02.2011	2 years
SC10	Pulverized coal (PC) production and consumption by BF 1	t	VTB-2	04	GOST 29329	14.02.2011	2 years
SC11	Pig iron consumption at OHFs	t	TP250×9	2	GOST 29329	06.09.2011	2 years
SC12	Limestone, dolomite, magnesite powder, sinter, coke consumption at OHFs	t	VV-200-50-2M	050200979/ 050200985	GOST 29329	10.08.2011	2 times a year
SC13	Limestone, dolomite, magnesite powder, sinter, coke consumption at OHFs	t	VTV-25 D	23	GOST 29329	18.08.2011	2 times a year

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
SC14	Lime consumption at OHFs	t	VTV-25 D	33	GOST 29329	27.07.2011	2 times a year
SC15	Coal consumption at OHFs	t	VV-200-50-2M	020805240/ 020906077	GOST 29329	18.05.2011	2 times a year
SC16	Coal consumption at OHFs	t	VA-60-15-2	011206127	GOST 29329	09.06.2011	2 times a year

***- Scales marked with star (*) are in reserve.**

Table 3: List of flow meters

Flow meters

For the purpose of the emission reductions monitoring the following parameters are measured:

- Natural gas consumption at BF 1
- Natural gas consumption for PC production
- Oxygen consumption by BF 1
- Total production of oxygen
- Natural gas consumption at OHFs
- COG consumption at OHFs

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
FM1	Natural gas consumption at BF 1	m^3	Metran 100-DD 1430	151632	0.5%	14.04.2011	2 years
FM2	Natural gas consumption at BF 1	m^3	Metran 100-DD 1411	154013	1%	11.10.2010	2 years
FM3	Natural gas consumption for PC production	m^3	Metran 22-DD 2440	56194	0.5%	13.07.2011	2 years
FM4	Oxygen consumption by BF 1	m^3	Metran 100-DD 1440	155135	0.5%	18.04.2011	2 years

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
FM5	Total production of oxygen	m^3	Safir M 5440K	10741216	0.25%	18.11.2010	2 years
FM6	Natural gas consumption at OHFs	m^3	Safir M 5410	07390014	0.25%	03.02.2011	2 years
FM7	Natural gas consumption at OHFs	m^3	Safir M 5415	08537694	0.25%	18.11.2010	2 years
FM8	Natural gas consumption at OHFs	m^3	Safir M 5420I	10234183	0.25%	08.02.2010	2 years
FM9	Natural gas consumption at OHFs	m^3	Sapfir 22DD 2420	205978	0.25%	21.04.2010	2 years
FM10	Natural gas consumption at OHFs	m^3	Safir M 5420	11604896	0.25%	21.07.2010	2 years
FM11	Natural gas consumption at OHFs	m^3	Safir M 5420	11526821	0.25%	21.07.2010	2 years
FM12	Natural gas consumption at OHFs	m^3	Sapfir 22DI 2430	672001	0.25%	20.09.2010	2 years
FM13	Natural gas consumption at OHFs	m^3	Safir M 5410	09813045	0.25%	20.09.2010	2 years
FM14	Natural gas consumption at OHFs	m^3	Safir M 5420	09457065	0.25%	21.09.2010	2 years
FM15	Natural gas consumption at OHFs	m^3	Safir M 5420	09480066	0.25%	22.09.2010	2 years
FM16	Natural gas consumption at OHFs	m^3	Safir M 5420	07102486	0.25%	19.08.2010	2 years
FM17	Natural gas consumption at OHFs	m^3	Safir M 5430	07033467	0.25%	19.08.2010	2 years
FM18	Natural gas consumption at OHFs	m^3	Sapfir 22DD 2420	205608	0.5%	15.07.2010	2 years
FM19	Natural gas consumption at OHFs	m^3	Sapfir M-22DD 2420	672059	0.25%	29.03.2010	2 years
FM20	Natural gas consumption at OHFs	m^3	Sapfir 22DD 2430	902160	0.25%	29.03.2010	2 years
FM21	Natural gas consumption at OHFs	m^3	Safir M 5410	09113231	0.25%	19.05.2010	2 years

Table 4: List of flow meters

Power meters

For the purpose of the emission reductions monitoring the following parameters are measured:

- Electricity consumption at BF 1
- Electricity consumption for PC production
- Electricity consumption for oxygen production
- Electricity consumption at OHFs

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
EL1	Electricity consumption at BF 1	kWh	SA3U-5009I	0026353	2%	20.11.2008	4 years
EL2	Electricity consumption at BF 1	kWh	SA3U-5009I	0026358	2%	20.11.2008	4 years
EL3	Electricity consumption at BF 1	kWh	SA3U-5009I	0004436	2%	20.11.2008	4 years
EL4	Electricity consumption at BF 1	kWh	SA3U-5009I	0017187	2%	20.11.2008	4 years
EL5	Electricity consumption for PC production	kWh	SA3U-5009I	0026356	2%	18.12.2009	4 years
EL6	Electricity consumption for PC production	kWh	SA3U-5009I	0026365	2%	18.12.2009	4 years
EL7	Electricity consumption for PC production	kWh	SA3U-5009I	0004423	2%	18.12.2009	4 years
EL8	Electricity consumption for PC production	kWh	Energia-9	33867	0,5%	08.2006*	6 years
EL9	Electricity consumption at BF 1	kWh	SA3U-5009I	0005884	2%	20.11.2008	4 years
EL10	Electricity consumption at BF 1	kWh	SA3U-5009I	0026345	2%	20.11.2008	4 years
EL11	Electricity consumption at BF 1	kWh	SA3U-5009I	0003909	2%	18.12.2009	4 years
EL12	Electricity consumption at BF 1	kWh	SA3U-5009I	1180499	2%	18.12.2009	4 years
EL13	Electricity consumption at BF 1	kWh	SA3U-5009I	0051005	2%	04.12.2009	4 years
EL14	Electricity consumption at BF 1	kWh	SA3U-I670	742038	2%	16.12.2009	4 years
EL15	Electricity consumption at BF 1	kWh	SA3U-I670M	904964	2%	30.09.2010	4 years
EL16	Electricity consumption at BF 1	kWh	SA3U-I670	680190	2%	21.12.2009	4 years
EL17	Electricity consumption at BF 1	kWh	SA3U-I670	226900	2%	21.12.2009	4 years
EL18	Electricity consumption at OHFs	kWh	SA3U-I670	112275	2%	23.12.2009	4 years
EL19	Electricity consumption at OHFs	kWh	SA3U-I670D	167599	2%	23.12.2009	4 years
EL20	Electricity consumption at OHFs	kWh	SA3U-I670D	167630	2%	23.12.2009	4 years

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
EL21	Electricity consumption at OHFs	kWh	SA3U-I670D	167405	2%	23.12.2009	4 years
EL22	Electricity consumption at OHFs	kWh	SA3U-I670D	438516	2%	23.12.2009	4 years
EL23	Electricity consumption at OHFs	kWh	SA4U-I672M	037858507	2%	15.04.2008	4 years
EL24	Electricity consumption at OHFs	kWh	SA3U-I670M	999378	2%	09.06.2010	4 years
EL25	Electricity consumption at OHFs	kWh	SA3U-I670M	050645	2%	05.06.2008	4 years
EL26	Electricity consumption at OHFs	kWh	SA3U-I670M	773411	2%	09.04.2010	4 years
EL27	Electricity consumption at OHFs	kWh	SA3U-I670	098848	2%	09.04.2010	4 years
EL28	Electricity consumption at OHFs	kWh	SA3U-I670D	365322	2%	12.11.2008	4 years
EL29	Electricity consumption at OHFs	kWh	SA4U-I672M	200652	2%	16.03.2009	4 years
EL30	Electricity consumption at OHFs	kWh	SA3U-I670M	197141	2%	09.04.2010	4 years
EL31	Electricity consumption at OHFs	kWh	SA3U-I670M	960577	2%	23.12.2009	4 years
EL32	Electricity consumption at OHFs	kWh	SA3U-I670M	786366	2%	24.03.2009	4 years
EL33	Electricity consumption at OHFs	kWh	SA3U-I670M	679769	2%	11.01.2011	4 years
EL34	Electricity consumption at OHFs	kWh	SA3U-I670D	445293	2%	23.12.2009	4 years
EL35	Electricity consumption at OHFs	kWh	SA3U-I670	944863	2%	23.12.2009	4 years
EL36	Electricity consumption at OHFs	kWh	SA3U-I670M	376138	2%	18.12.2009	4 years
EL37	Electricity consumption at OHFs	kWh	SA3U-I670	079822	2%	21.12.2009	4 years
EL38	Electricity consumption at OHFs	kWh	SA3U-I670	135490	2%	21.12.2009	4 years
EL39	Electricity consumption at OHFs	kWh	SA3U-I670M	602127	2%	21.12.2009	4 years
EL40	Electricity consumption at OHFs	kWh	SA3U-I670M	988905	2%	18.12.2009	4 years
EL41	Electricity consumption at OHFs	kWh	SA3U-I670	645142	2%	21.10.2010	4 years
EL42	Electricity consumption at OHFs	kWh	SA3U-I670M	185259	2%	08.04.2009	4 years
EL43	Electricity consumption at OHFs	kWh	SA3U-I672M	174833	2%	20.11.2008	4 years
EL44	Electricity consumption at OHFs	kWh	SA3U-I672M	879066	2%	20.11.2008	4 years
EL45	Electricity consumption at OHFs	kWh	EA 05RL-P2B-3	01079585	0.5%	06.05.2010	6 years
EL46	Electricity consumption at OHFs	kWh	SA3U-I670M	666489	2%	18.12.2009	4 years
EL47	Electricity consumption at OHFs	kWh	SA3U-I670M	666427	2%	18.12.2009	4 years
EL48	Electricity consumption at OHFs	kWh	SA3U-I670M	376795	2%	21.12.2009	4 years
EL49	Electricity consumption at OHFs	kWh	SA3U-5009I	0026346	2%	20.11.2008	4 years

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
EL50	Electricity consumption at OHFs	kWh	SA3U-5009I	0026359	2%	20.11.2008	4 years
EL51	Electricity consumption at OHFs	kWh	SA3U-IT	291725	2%	18.12.2009	4 years
EL52	Electricity consumption at OHFs	kWh	SA3U-I670D	168234	2%	21.12.2009	4 years
EL53	Electricity consumption at OHFs	kWh	SA3U-I670M	214605	2%	06.08.2010	4 years
EL54	Electricity consumption for oxygen production	kWh	Merkuriy 230AR00R	01844566	1%	26.03.2008	10 years
EL55	Electricity consumption for oxygen production	kWh	SA3U-I670M	202417	2%	23.09.2010	4 years
EL56	Electricity consumption for oxygen production	kWh	SA3U-I670M	387898	2%	06.01.2011	4 years
EL57	Electricity consumption for oxygen production	kWh	SA3U-I670	574941	2%	30.07.2010	4 years
EL58	Electricity consumption for oxygen production	kWh	SA3U-I670M	307132	2%	06.01.2011	4 years
EL59	Electricity consumption for oxygen production	kWh	SA3U-I670M	572791	2%	10.03.2011	4 years
EL60	Electricity consumption for oxygen production	kWh	SA3U-I670	680795	2%	27.03.2008	4 years
EL61	Electricity consumption for oxygen production	kWh	SA3U-I670M	227733	2%	27.03.2008	4 years
EL62**	Electricity consumption for oxygen production	kWh	SA3U-I670M	018025	2%	2nd quarter 2009	4 years
EL63**	Electricity consumption for oxygen production	kWh	Merkuriy 230AR00	01070793	1%	1st quarter 2007	10 years

*- more precise date of calibration is not available. It is date of primary calibration made by producer of the meter.

**- monitoring pointsEL62 and EL63 are located in military forces base which is a sub-consumer of Oxygen workshop. No precise calibration dates are available, meters are calibrated by power supplier "Servis Invest" LLC.

Table 5: List of electricity meters

Length meter

- Steel production at OHFs

ID of monitoring point	Measured parameter	Work parameter	Type	Serial number	level of accuracy	Date of last calibration	Required calibration interval
LM1	Steel production at OHFs	mm	Siemens	n/n	1%	16.05.2011	1 year

Table 6: List of length meters

B.1.3. Calibration procedures

For scales

QA/QC procedures	Body responsible for calibration and certification
All scales are regularly calibrated in accordance with State Standard requirements and internal rules of the Plant. Calibration intervals of scales are indicated in the table 3.	Donetsksteel Metrological Department

For flow meters

QA/QC procedures	Body responsible for calibration and certification
All flow meters are regularly calibrated in accordance with State Standard requirements and internal rules of the Plant. Calibration intervals of flow meters are indicated in the table 4.	Donetsksteel Metrological Department

For power meters

QA/QC procedures	Body responsible for calibration and certification
All power meters are regularly calibrated or replaced by duly calibrated meters of similar type (usually in monitoring points where power can be switched off only for short time) at least once in 4 years in accordance with State Standard requirements. However, internal rules of the Plant set shorter calibration interval of 3 years and by decision of Department of HEE meters can be calibrated even more often. Calibration intervals of power meters in accordance with State Standard requirements are indicated in the table 5.	Donetsksteel Metrological Department The power supplier “Servis Invest” LLC is responsible for monitoring points EL62 and EL63.

For length meter

QA/QC procedures	Body responsible for calibration and certification
Length meter is regularly calibrated in accordance with State Standard requirements and internal rules of the Plant. Calibration interval of length meter is indicated in the table 6.	Donetsksteel Metrological Department

B.1.4. Involvement of Third Parties:

Naftogaz Ukraine Affiliate Company “Ukrtransgas”
The power supplier PJSC “Servis Invest” is responsible for monitoring points EL62 and EL63.

B.2. Data collection (accumulated data for the whole monitoring period):

Data flow from the meters to the ER calculations is presented on the following figures 3 (BF1) and 4 (OHF).

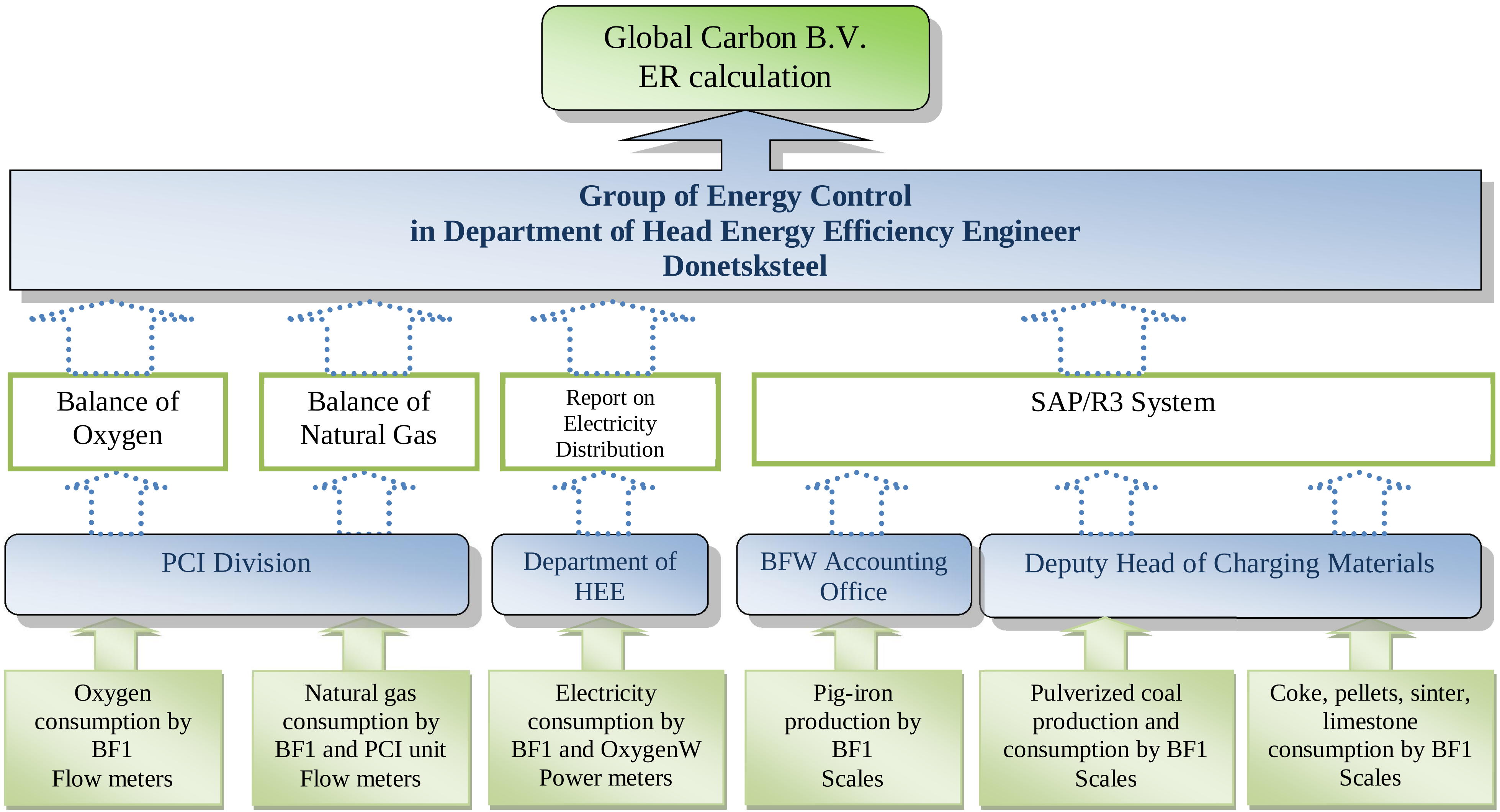

Figure 3:The operational and management structure

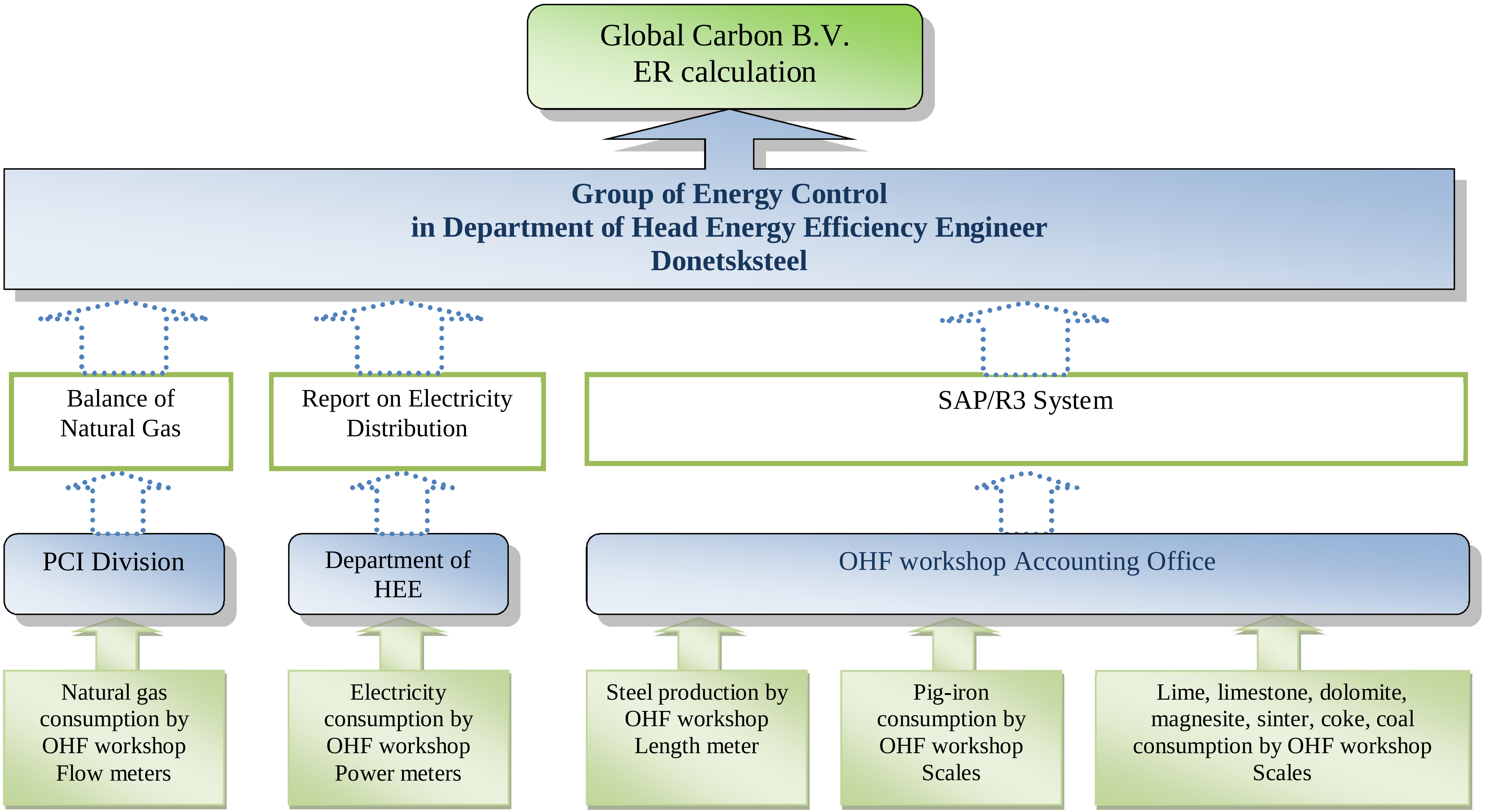

Figure 4:The operational and management structure

B.2.1. List of fixed default values and ex-ante baseline factors:

No	Fixed parameter	Variable	Unit	Value	Information source
1.	Natural gas combustion	$EF_{CO2,n.gas}$	tCO_2/GJ	0.0561	IPCC[7], Volume 2, Chapter 1, p. 1.24, Table 1.4
2.	COG combustion	$EF_{CO2,COG}$	tCO_2/GJ	0.0444	IPCC, Volume 2, Chapter 1, p. 1.23, Table 1.4
3.	Coke production	$EF_{CO2,coke}$	tCO_2/t	0.5600	IPCC, Volume 3, Chapter 4, p. 4.25, Table 4.1 (value for Coke oven)
4.	Coal combustion	$EF_{CO2,coal}$	tCO_2/GJ	0.0983	IPCC, Volume 2, Chapter 1, p. 1.23, Table 1.4
5.	Sinter production	$EF_{CO2,sinter}$	tCO_2/t	0.2000	IPCC, Volume 3, Chapter 4, p. 4.25, Table 4.1
6.	Pellets production	$EF_{CO2,pellets}$	tCO_2/t	0.0300	IPCC, Volume 3, Chapter 4, p. 4.25, Table 4.1
7.	Lime production	$EF_{CO2,lime}$	tCO_2/t	0.7700	IPCC, Volume 3, Chapter 2, p. 2.22, Table 2.4 (value for dolomitic lime for developing countries)
8.	Limestone carbon content	C_{lmst}	tC/t	0.1200	IPCC, Volume 3, Chapter 4, p. 4.27, Table 4.3
9.	Dolomite carbon content	C_{dlmt}	tC/t	0.1300	IPCC, Volume 3, Chapter 4, p. 4.27, Table 4.3
10.	Magnesite powder carbon content	C_{mgst}	tC/t	0.1425	Default value, Webmineral http://www.webmineral.com/data/Magnesite.shtml
11.	Grid electricity consumption in baseline	$EF_{CO2,el}$	tCO_2/ MWh	0.8960	Value for reducing projects. "Standardised baseline emission factor for Ukrainian power grid" developed by Global Carbon B.V. and positively determined by TUV SUD (Annex 2)
12.	Net calorific value of coal	NCV_{coal}	GJ/t	26.7000	IPCC, Volume 2, Chapter 1, p. 1.18, Table 1.2 (value for anthracite)
13.	Net calorific value of COG	NCV_{COG}	GJ/1000 m^3	16.7500	Donetsksteel data. In accordance with internal instruction for monitoring consumption of gases value of the COG consumed is adjusted to calorific value of 16.75 GJ/1000 m^3 (default value).

Table 7: Fixed parameters

[7] http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC for further)

B.2.2. List of variables:

ID (from PDD)	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Data aggregation frequency	Proportion of data to be monitored	How the data is archived? (electronic/ paper)	Meters used (as per B.1.2)/Third party involvement
P.1.	$P^{BF}_{iron,PJ,y}$ Amount of pig iron produced in the BF 1 under the project	t	m	Continuously	100%	Electronic and paper	SC1 – SC2
P.2.	$FC^{BF}_{coke,PJ,y}$ Coke consumption in the BF 1	t	m	Continuously	100%	Electronic and paper	SC3 – SC6
P.3.	$FC^{BF}_{n.gas,PJ,y}$ Natural gas consumption in the BF 1	1000 m^3	m	Continuously	100%	Electronic and paper	FM1-FM2
P.4.	$FC^{BF}_{el,PJ,y}$ Electricity consumption in the BF 1	MWh	m	Continuously	100%	Electronic and paper	EL1-EL4 EL9-EL17
P.5.	$FC^{BF}_{lmst,PJ,y}$ Limestone consumption in the BF 1	t	m	Continuously	100%	Electronic and paper	SC3 – SC6
P.6.	$FC^{BF}_{sinter,PJ,y}$ Sinter consumption in the BF 1	t	m	Continuously	100%	Electronic and paper	SC3 – SC6
P.7.	$FC^{BF}_{pellets,PJ,y}$ Pellets consumption in the BF 1	t	m	Continuously	100%	Electronic and paper	SC3 – SC6
P.8.	$P^{PCI}_{PC,PJ,y}$ Pulverized coal production	t	m	Continuously	100%	Electronic and paper	SC7 – SC10
P.9.	$FC^{BF}_{PC,PJ,y}$ Pulverized coal consumption in the BF 1	t	m	Continuously	100%	Electronic and paper	SC9 – SC10
P.10.	$FC^{PCI}_{n.gas,PJ,y}$ Natural gas consumption for PC preparation	1000 m^3	m	Continuously	100%	Electronic and paper	FM3
P.11.	$FC^{PCI}_{el,PJ,y}$ Electricity consumption for PC preparation	MWh	m	Continuously	100%	Electronic and paper	EL5- EL7
P.12.	$OX^{BF}_{PJ,y}$ Oxygen consumption by BF 1	1000 m^3	m	Continuously	100%	Electronic and paper	FM4
P.13.	$FC^{OX}_{el,PJ,y}$ Electricity consumption for oxygen production	MWh	m	Continuously	100%	Electronic and paper	EL54-EL63 The power supplier “Servis Invest” LLC is responsible for

ID (from PDD)	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Data aggregation frequency	Proportion of data to be monitored	How the data is archived? (electronic/ paper)	Meters used (as per B.1.2)/Third party involvement
							monitoring points EL62 and EL63.
P.14.	$OX_{PJ,y}$ Total oxygen produced under the project	1000 m^3	m	Continuously	100%	Electronic and paper	FM5
P.15.	$C_{coke,y}$ Coke carbon content	tC/t	m	Continuously	100 %	Electronic and paper	Coke supplier
P.16.	$P^{OHF}_{steel,PJ,y}$ Amount of steel produced in the OHF under the project	t	m	Continuously	100%	Electronic and paper	LM1
P.17.	$FC^{OHF}_{iron,PJ,y}$ Pig iron consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC11
P.18.	$FC^{OHF}_{lmst,PJ,y}$ Limestone consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC12-SC13
P.19.	$FC^{OHF}_{lime,PJ,y}$ Lime consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC14
P.20.	$FC^{OHF}_{dlmt,PJ,y}$ Dolomite consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC12-SC13
P.21.	$FC^{OHF}_{mgst,PJ,y}$ Magnesite powder consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC12-SC13
P.22.	$FC^{OHF}_{sinter,PJ,y}$ Sinter consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC12-SC13
P.23.	$FC^{OHF}_{coke,PJ,y}$ Coke consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC12-SC13
P.24.	$FC^{OHF}_{coal,PJ,y}$ Coal consumption in the OHFs	t	m	Continuously	100%	Electronic and paper	SC15-SC16
P.25.	$FC^{OHF}_{n.gas,PJ,y}$ Natural gas consumption in the OHFs	1000 m^3	m	Continuously	100%	Electronic and paper	FM6-FM21
P.26.	$FC^{OHF}_{el,PJ,y}$ Electricity consumption in the OHFs	MWh	m	Continuously	100%	Electronic and paper	EL18-EL53

ID (from PDD)	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Data aggregation frequency	Proportion of data to be monitored	How the data is archived? (electronic/ paper)	Meters used (as per B.1.2)/Third party involvement
P.27.	$FC_{COG,PJ,y}^{OHF}$ COG consumption at OHFs	1000 m^3	m	Continuously	100%	Electronic and paper	FM17
P.28.	$EF_{CO2,el}$ Carbon dioxide emission factor for consumption of electricity from Ukrainian power grid	t CO_2/MWh	c	Upon issue of the Order of Ukrainian DFP	100%	Electronic and paper	The parameter is not monitored by Project Participants, but is determined by the Host Party.
P.29.	$NCV_{n.gas,y}$ Net calorific value of natural gas	GJ/1000m^3	m	Monthly	100%	Electronic and paper	The parameter is not monitored by Project Participants, but is measured on sampling basis by natural gas supplier.

Table 8: Monitored project emissions variables

ID (from PDD)	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Data aggregation frequency	Proportion of data to be monitored	How the data is archived? (electronic/ paper)	Meters used (as per B.1.2)/Third party involvement
B.1	$P_{iron,BL,y}^{BF}$ Amount of pig iron produced in the BF 1 under the baseline	t	m	Monthly	100%	Electronic and paper	SC1– SC2
B.2	$P_{steel,BL,y}^{OHF}$ Amount of steel produced in the OHFs under the baseline	t	m	Monthly	100%	Electronic and paper	LM1

Table 9: Monitored baseline emissions variables

B.2.3. Data concerning GHG emissions by sources of the project activity:

Variable	Description	Unit	Value			
			2008	2009	2010	2011 (01.01-31.10)
$P^{BF}_{iron,PJ,y}$	Amount of pig iron produced in the BF 1 under the project	t	614 823	699 804	673 055	456 552
$FC^{BF}_{coke,PJ,y}$	Coke consumption in the BF 1	t	268 950	344 714	310 716	221 435
$FC^{BF}_{n.gas,PJ,y}$	Natural gas consumption in the BF 1	1000 m^3**	43 588	3 480	11 410	0
$FC^{BF}_{el,PJ,y}$	Electricity consumption in the BF 1	MWh	9 069*	9 563	9 351	6 589
$FC^{BF}_{lmst,PJ,y}$	Limestone consumption in the BF 1	t	945534*	104 680*	97 976	96 408
$FC^{BF}_{sinter,PJ,y}$	Sinter consumption in the BF 1	t	306 238	140 809	0	0
$FC^{BF}_{pellets,PJ,y}$	Pellets consumption in the BF 1	t	605 578	959 807	1 046 489	713 221
$P^{PCI}_{PC,PJ,y}$	Pulverized coal production	t	124 803	181 048	179 245	139 420
$FC^{BF}_{PC,PJ,y}$	Pulverized coal consumption in the BF 1	t	82 601	91 651	91 139	60 563
$FC^{PCI}_{n.gas,PJ,y}$	Natural gas consumption for PC preparation	1000 m^3**	1 334	2 070	2 117	1 649
$FC^{PCI}_{el,PJ,y}$	Electricity consumption for PC preparation	MWh	5 632	7 886*	7 849	6 377
$OX^{BF}_{PJ,y}$	Oxygen consumption by BF 1	1000 m^3**	37 408	24 024	29 952	21 468
$FC^{OX}_{el,PJ,y}$	Electricity consumption for oxygen production	MWh	142873	131156	127277	88 269
$OX_{PJ,y}$	Total oxygen produced under the project	1000 m^3**	146166	130848	130539	89 591
$C_{coke,y}$	Coke carbon content	tC/t	0.820	0.816	0.817	0.816
$P^{OHF}_{steel,PJ,y}$	Amount of steel produced in the OHF under the project	t	869494	527623	528719	338 121
$FC^{OHF}_{iron,PJ,y}$	Pig iron consumption in the OHFs	t	422103	231588	177407	116 437
$FC^{OHF}_{lmst,PJ,y}$	Limestone consumption in the OHFs	t	32623*	13228*	15472*	9 569*
$FC^{OHF}_{lime,PJ,y}$	Lime consumption in the OHFs	t	13690*	13913*	14956*	9 137*
$FC^{OHF}_{dlmt,PJ,y}$	Dolomite consumption in the OHFs	t	31169*	23319*	25168*	14 379*
$FC^{OHF}_{mgst,PJ,y}$	Magnesite powder consumption in the OHFs	t	4117*	2051*	1199*	357*
$FC^{OHF}_{sinter,PJ,y}$	Sinter consumption in the OHFs	t	24015	10953	0	0
$FC^{OHF}_{coke,PJ,y}$	Coke consumption in the OHFs	t	534	617	443	335
$FC^{OHF}_{coal,PJ,y}$	Coal consumption in the OHFs	t	2099	2381	4875	2 146
$FC^{OHF}_{n.gas,PJ,y}$	Natural gas consumption in the OHFs	1000 m^3**	112837	73207	78277	47 324

Variable	Description	Unit	Value			
			2008	2009	2010	2011 (01.01-31.10)
$FC_{el,PJ,y}^{OHF}$	Electricity consumption in the OHFs	MWh	69615	60246	62388	44 614
$FC_{COG,PJ,y}^{OHF}$	COG consumption at OHFs	1000 m^3**	0	0	0	0
$EF_{CO2,el}$	Carbon dioxide emission factor for consumption of electricity from Ukrainian power grid[8]	tCO_2/MWh	1.219[9]	1.237[10]	1.225[11]	1.227[12]
$NCV_{n.gas,y}$	Net calorific value of natural gas	GJ/1000m^3	33.88	33.70	33.74	33.92
$EF_{CO2,PJ,y}^{PCI}$	Carbon dioxide emission factor for PCI production	tCO_2/t	0.075	0.075	0.076	0.079
$EF_{CO2,PJ,y}^{BF}$	Carbon dioxide emission factor for pig-iron production process under the project	tCO_2/t	2.345	2.319	2.220	2.296
$EF_{CO2,PJ,y}^{OHF}$	Carbon dioxide emission factor for steel production process under the project	tCO_2/t	1.545	1.496	1.255	1.293

***- Some data were adjusted during monitoring compared to the values used for evaluation of emission reductions in the determined PDD (version 3.4.)**

**** - Data adjusted to standard conditions t=20 ˚C; p=1 atm.**

Table 10: Data collected in the project scenario

[8] "Emission factor of specific indirect carbon dioxide emissions from electricity consumption by 2nd class electricity consumers in accordance with Procedure for determining the class of consumers, adopted by Resolution of National Electricity Regulatory Commission of Ukraine on 13 of August 1998 No.1052".

[9] Ukrainian National Environment Investment Agency Order No 62 from 15.04.2011 http://www.neia.gov.ua/nature/doccatalog/document?id=127171

[10] Ukrainian National Environment Investment Agency Order No 63 from 15.04.2011 http://www.neia.gov.ua/nature/doccatalog/document?id=127172

[11] Ukrainian National Environment Investment Agency Order No 43 from 28.03.2011 http://www.neia.gov.ua/nature/doccatalog/document?id=126006

[12] Ukrainian National Environment Investment Agency Order No 75 from 12.05.2011http://www.neia.gov.ua/nature/doccatalog/document?id=127498

B.2.4.Data concerning GHG emissions by sources of the baseline:

Variable	Description	Unit	Value			
			2002	2003	2004	2005
$P^{BF}_{iron,BL,y}$	Amount of pig iron produced in the BF 1	t	n/a	452 075	488 593	162 459
$FC^{BF}_{coke,BL,y}$	Coke consumption in the BF 1	t	n/a	275 342	282 768	94 464
$FC^{BF}_{n.gas,BL,y}$	Natural gas consumption in the BF 1	1000 m^3*	n/a	36 625	45 216	14 281
$FC^{BF}_{el,BL,y}$	Electricity consumption in the BF 1	MWh	n/a	4 147	3 577	965
$FC^{BF}_{lmst,BL,y}$	Limestone consumption in the BF 1	t	n/a	68 852	38 888	20 228
$FC^{BF}_{sinter,BL,y}$	Sinter consumption in the BF 1	t	n/a	474 618	578 523	123 558
$FC^{BF}_{pellets,BL,y}$	Pellets consumption in the BF 1	t	n/a	291 294	265 830	151 540
$C_{coke,y}$	Coke carbon content	tC/t	0.812	0.815	0.820	0.816
$P^{OHF}_{steel,BL,y}$	Amount of steel produced in the OHF	t	887 850	898 887	991 386	n/a
$FC^{OHF}_{iron,BL,y}$	Pig iron consumption in the OHFs	t	465 548	473 117	513 343	n/a
$FC^{OHF}_{lmst,BL,y}$	Limestone consumption in the OHFs	t	69 021	58 187	56 392	n/a
$FC^{OHF}_{lime,BL,y}$	Lime consumption in the OHFs	t	9 189	10 664	13 423	n/a
$FC^{OHF}_{dlmt,BL,y}$	Dolomite consumption in the OHFs	t	29 938	29 419	36 950	n/a
$FC^{OHF}_{mgst,BL,y}$	Magnesite powder consumption in the OHFs	t	6 774	6 326	6 274	n/a
$FC^{OHF}_{sinter,BL,y}$	Sinter consumption in the OHFs	t	0	0	4 935	n/a
$FC^{OHF}_{coke,BL,y}$	Coke consumption in the OHFs	t	0	57	363	n/a
$FC^{OHF}_{coal,BL,y}$	Coal consumption in the OHFs	t	994	918	1 192	n/a
$FC^{OHF}_{n.gas,BL,y}$	Natural gas consumption in the OHFs	1000 m^3*	116 004	118 815	116 486	n/a
$FC^{OHF}_{el,BL,y}$	Electricity consumption in the OHFs	MWh	33 167	37 629	81 016	n/a
$FC^{OHF}_{COG,BL,y}$	COG consumption at OHFs	1000 m^3*	74 471	68 414	72 169	n/a
$EF_{CO2,el}$	Carbon dioxide emission factor for consumption of electricity from Ukrainian power grid	tCO_2e/MWh	0.896	0.896	0.896	0.896
$NCV_{n.gas,y}$	Net calorific value of natural gas	$GJ/1000m^3$	33.70	33.63	33.82	33.64

Variable	Description	Unit	Value			
			2008	2009	2010	2011 (01.01-31.10)
$P^{BF}_{iron,BL,y}$	Amount of pig iron produced in the BF 1 under the baseline	t	614 823	699 804	673 055	456 552
$P^{OHF}_{steel,BL,y}$	Amount of steel produced in the OHFs under the baseline	t	869494	527623	528719	338 121

*** - Data adjusted to standard conditions t=20 ˚C; p=1 atm.**

Table 11: Data collected in the baseline scenario

B.2.5.Data concerning leakage:

PDD did not identify any leakages, therefore, this section is not applicable.

B.2.6.Data concerning environmental impacts:

The Host Party for this project is Ukraine. Environmental Impact Assessment (EIA) is the part of the Ukrainian project planning and permitting procedures. Implementation regulations for EIA are included in the Ukrainian State Construction Standard DBN A.2.2.-1-2003[13] (Title: "Structure and Contents of the Environmental Impact Assessment Report (EIR) for Designing and Construction of Production Facilities, Buildings and Structures"). Environmental impact assessment of the project was undertaken at the project development stage. All the necessary permissions were obtained in compliance with the existing Ukrainian legislation, namely: the Laws of Ukraine “On Protection of Environment”, “On Ecological Expertise”, “On Protection of Atmospheric Air”, “On Ensuring Sanitary and Epidemic Welfare of the Population”, and “On Local Councils and Local Government”, as well as the applicable Water Code, Land Code, and Forest Code.

According to the EIA, implementation of the proposed technologies will not increase negative impacts on the environment because of the following:

- Equipment installed under the project activity is modern and efficient;
- The general effect from the implementation of the proposed technology envisages reduction of raw material (APCS project) and energy-intensive feedstock (coke in the subproject concerning the PCI technology) use;
- All project emissions will not exceed MPEs (maximum permit emissions).

Emission sources from Blast Furnace and Open Hearth Furnace Workshops are listed in Permit on emissions from stationary sources No 1 410 137 700-43 from 03.06.2009 effective till 03.06.2014. Emissions of pollutants by sources are monitored and reported through official statistical forms in line with Ukrainian regulations. All documents related to this activity are available to the AIE by request.

B.3.Data processing and archiving (incl. software used):

Pig iron production by BF 1. Liquid pig iron from BF1 is weighted by scales. Results of weighting are automatically submitted to the Automatic Process Control System of BF1 (APCS BF1) from where they are automatically inputted into SAP R/3 system. Then liquid iron is transported to OHF workshop where its weight can be cross-checked at mixer unit. Part of liquid iron is directed to casting machine where pig iron is cooled down. Cold pig iron is transported to Storage place where it is weighed at wagon weighbridge. Data are filled in daily Weighting reports, signed by responsible people and delivered to BFW accounting office. Accountants cross-check the data with measurement data from other workshops and input them into SAP R/3 system where they are aggregated. Based on the daily aggregated data WEB technical reports are generated. Information is stored till the end of the crediting period plus two years.

Consumption of coke, pellets, sinter and limestone by BF 1.Upon delivery to the Plant raw materials are weighted at wagon weighbridge at sorting station. Then they are loaded to storage hoppers with weighers from where they are portion by portion are supplied to BF1. Information from hopper weigher after every charging session is automatically submitted to the APCS BF1. Data from APCS BF1 is stored in electronic format and filled in to registration log of melting and daily Charging Report which is signed by responsible people. Daily Charging Reports are delivered to Deputy Head on Charging Materials, who checks it and inputs into SAP R/3 system, where it is aggregated. Information is stored till the end of the crediting period plus two years.

[13] State Construction Standard DBN A.2.2.-1-2003 :"Structure and Contents of the Environmental Impact Assessment Report (EIR) for Designing and Construction of Production Facilities, Buildings and Structures", State Committee Of Ukraine On Construction And Architecture, 2004

Consumption of pulverised coal by BF 1.From PCI production unit PCI gets into pneumatic pipeline leading to two injection points where PCI is weighted by strain-gage weighers. Information from weigher is automatically submitted to the APCS BF1. Data from APCS BF1 is stored in electronic format and filled in to registration log of melting and daily Charging Report which is signed by responsible people. Daily Charging Reports are delivered to Deputy Head on Charging Materials, who checks it and inputs into SAP R/3 system, where it is aggregated. Information is stored till the end of the crediting period plus two years.

Oxygen consumption by BF 1. Oxygen consumption is monitored by flow meter, data of which are automatically transferred to APSC BF1. On daily basis the recorded data in electronic format is transferred to Accounting Office of Process Control and Instrumentation Division in Department of Head Energy Engineer (PCI Division), where it is downloaded into Excel based computer system, where data are accumulated and inputted in monthly reports “Balance of Oxygen”. The report is signed by responsible person at Accounting Office of PCI Division and Head of PCI Division. Information is stored till the end of the crediting period plus two years.

Natural gas and COG consumption at BFW, OHFW. Fuel consumption is monitored by flow meters, data from which are automatically transferred to APSC BF1 or APCSs of OHFs respectively. On daily basis the recorded data in electronic format is transferred to Accounting Office of Process Control and Instrumentation Division in Department of Head Energy Engineer (PCI Division), where it is downloaded into Excel based computer system, where data are accumulated and inputted in monthly reports “Balance of Natural Gas”. The report is signed by responsible person at Accounting Office of PCI Division, Head of PCI Division and Head Energy Engineer. Information is stored till the end of the crediting period plus two years.

Natural gas NCV. Monthly certificates with data provided by natural gas supplier Naftogaz Ukraine Affiliate Company “Ukrtransgas” are used as primary data for natural gas NCV. Data are accumulated in the Technical Bureau in Department of Head Energy Engineer. Annual average value is calculated based on monthly average data. Information is stored till the end of the crediting period plus two years.

Electricity consumption at BFW, OHFW, Oxygen workshop. Electricity consumption is monitored by power meters, data from which are automatically transferred to APSC BF1, APCSs of OHFs and recorded to operational logs in oxygen workshop. Figures are then filled in daily reports “Daily Electricity Consumption” reflecting the readings of the power meters for each 24 hours, the daily reports are then submitted to Accounting Bureau of Department of Head Energy Engineer where they are accumulated and summed up. In the same way the data are collected in Electric Network and Substation Shop. In the end of the month data are cross-checked and common monthly “Report on Electricity Distribution” is formed. The report is signed by the responsible people from Accounting Bureau of Department and Electric Network and Substation Shop and stamped. Information is stored till the end of the crediting period plus two years.

Steel production by OHF workshop. Liquid steel from each of the OHFs is directed to continuous casting machine (CCM) which forms slabs of standard dimensions and mass of a running metre. For accuracy reasons a sample of slabs is weighted each month with slab dimensions measured; then monthly average mass of a running metre is calculated by dividing total measured mass of a sample of slabs by its total length. Length of the produced slabs is measured by contact rollers. Steel production is calculated by multiplying length of rolled metal by mass of a running metre. Each slab is registered at Production log, data from which is filled in passport of melting data, from which are inputted in SAP R/3 system by Accountant of OHF workshop. Data on steel production are cross-checked at Rolling Mill workshop where slabs are weighted before being processed. Based on the daily aggregated data WEB technical reports are generated. Information is stored till the end of the crediting period plus two years. Final data are accumulated in SAP R/3 system where they are aggregated. Information is stored till the end of the crediting period plus two years.

Pig iron consumption by OHF workshop. Liquid pig iron from BF1 is weighted by wagon scales and transported to OFH workshop. Data on each ladle is registered in the log. Data are filled in daily Weighting reports, signed by responsible people and delivered to OHF workshop accounting office. Accountants cross-check the data with measurement data from BF workshop and input them into SAP R/3 system where they are aggregated. Based on the daily aggregated data WEB technical reports are generated. Information is stored till the end of the crediting period plus two years.

Consumption of lime, limestone, dolomite, magnesite powder, sinter, coke, coal by OHF workshop.
Charging materials arrive to Sorting Station where they are weighted and transported to OHF workshop in molds with standard dimensions (1 m^3). Consumption of each of material is calculated by multiplying number of molds with each of material loaded to the OHF by standard weight factor. Steelmaker registers quantity of materials used for each melting and transfers data to production Accountant who checks it and fills in passport of melting, data from where are inputted in SAP R/3 system by Accountant of OHF workshop. Final data are accumulated in SAP R/3 system where they can be aggregated. Information is stored till the end of the crediting period plus two years.

B.4. Special event log:

There are no special events recorded for the monitoring period.

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

The general management of the monitoring team is implemented by the Donetsksteel Group of Energy Control Supervised by Deputy Head Energy Efficiency Engineer. On-site day-to-day (operational) management is implemented by the heads of corresponding shops. The technological process data is logged into the servers continuously and to the logbooks on the daily basis.

Installation and maintenance of metering devices is performed in compliance to Plant Standard STP 54C-7.6-01-2006. According to this standard the responsibilities on installation, calibration and maintenance of metering devices are carried out by the Heads of the Department who assign responsible executors. In case with BF1 and OHFs these are Head of BF Workshop and Head of OHF Workshop respectively who organize execution of the relevant data collection procedures, periodic calibration according to the requirements of producers of the metering devises, maintaining them in working order and their repair.

All data necessary for the CO_2 emission reductions calculation is collected in the Group of Energy Control Supervised by Deputy Head Energy Efficiency Engineer. The general management of the monitoring system is executed by the Head of Group of Energy Control.

For this monitoring period the names of the personnel involved is as follows:
- Deputy Head Energy Efficiency Engineer: Alexander Dorofeev;
- Head of Group of Energy Control: Dmytro Komkov;

Copies of the monthly reports are provided to Global Carbon B.V. which performs emission reductions calculation and prepares Monitoring reports.

C.1.2. Trainings:

The employees responsible for operation and for the monitoring and control were dully trained.

Donetsksteel has a comprehensive system for education and training of staff. All of the staff members receive professional education which imply theoretical studies, practical supervised training at worksite and qualification exam. At worksite all the staff members are periodically instructed to refresh their knowledge of their responsibilities and safety rules. Training of monitoring personnel takes place in line with general professional training system working at the Plant. Job descriptions are available at each workplace.

Health and safety rules, as well as preparedness to emergency situations are covered by the above mentioned training program which ends with an exam. In addition, each month employees are instructed at the work places. The instruction registration logs are kept at each work place and were available to AIE during the site visit.

C.2. Involvement of Third Parties:

Naftogaz Ukraine Affiliate Company “Ukrtransgas” is the Third Party involved.
National Environmental Investment Agency approved carbon dioxide emission factors for electricity consumption from Ukrainian power grid.
The power supplier “Servis Invest” LLC is responsible for monitoring points EL62 and EL63.

C.3. Internal audits and control measures:

The accuracy of reported monitoring data is ensured on the stage of preparing the monthly reports used as a primary data for emission reductions calculation. Each parameter in the report is cross-checked with the readings of meters measuring the overall material and fuel consumption in workshops. The consumption of individual installations is determined by deducting the sum of readings of the individual consumers from the overall consumption in workshops. If the difference does not correspond to the readings being cross-checked, the reason for it is determined and data are adjusted accordingly taking into account accuracy class of the metering devise. Once the monthly report is prepared it is signed by the Head of the corresponding workshop and its data is used for official reporting, calculation of specific consumption norms and other purposes of the Plant.

Quality control of the emission reductions calculated by Global Carbon JI Consultant is usually carried out by Global Carbon Team Leader.

C.4. Troubleshooting procedures:

As the data for the CO_2 emission reductions calculations is used for the commercial activities of the plant, any meter failure, data discrepancy will be found within one day. The meter will be substituted by working one. In case of absence of the flow meters due to their calibration or repair the average readings for the previous three days are to be recorded. The maximum acceptable period for the flow meter absence is 3 days.

SECTION D. Calculation of GHG emission reductions

All calculations concerning emissions reduction for this project were done in separate Excel spreadsheets.

D.3.1. Project emissions:

$$PE_y = PE_y^{BF} + PE_y^{OHF} \quad (1)$$

Where:

PE_y Project emissions in period *y* (tCO_2e);

PE_y^{BF} Emissions in period *y* due to implementation of PCI for BF 1, (tCO_2e);

PE_y^{OHF} Emissions in period *y* due to implementation of APCS for OHFs, (tCO_2e).

Results of the emissions calculations are presented in metric tons of carbon dioxide equivalent (tCO_2e), 1 metric ton of carbon dioxide equivalent is equal to 1 metric ton of carbon dioxide (tCO_2), i.e. 1 tCO_2e = 1 tCO_2.

Calculation of PCI emissions

Project emissions for subproject “Implementation of Pulverized Coal Injection (PCI) for Blast Furnace 1” consist of emissions due to the fossil fuel combustions as well as using carbon containing raw materials.

The following sources of emissions during the pig iron production process are considered:

$FC_{coke,PJ,y}^{BF}$ Coke consumption at BF 1in period y, t;

$FC_{n.gas,PJ,y}^{BF}$ Natural gas consumption at BF 1in period y, 1000 m^3;

$FC_{el,PJ,y}^{BF}$ Electricity consumption at BF 1in period y, MWh;

$FC_{lmst,PJ,y}^{BF}$ Limestone consumption at BF 1in period y, t;

$FC_{sinter,PJ,y}^{BF}$ Sinter consumption at BF 1in period y, t;

$FC_{pellets,PJ,y}^{BF}$ Pellets consumption at BF 1in period y, t;

$P_{PC,PJ,y}^{PCI}$ Pulverized coal production in period y, t;

$FC_{PC,PJ,y}^{BF}$ Pulverized coal (PC) consumption at BF 1in period y, t;

$OX_{PJ,y}^{BF}$ Oxygen consumption at BF 1in period y, 1000 m^3.

Therefore, project emissions in period *y* due to implementation of PCI for BF 1 can be calculated the following way:

$$PE_y^{BF} = P_{iron,PJ,y}^{BF} \times EF_{CO2,PJ,y}^{BF}, \quad (2)$$

where:

$P_{iron,PJ,y}^{BF}$ - Pig iron production at BF 1 in period y, t pig iron;

$EF_{CO2,PJ,y}^{BF}$- Carbon dioxide emission factor for pig iron production process under the project, tCO_2/t pig iron.

$$\begin{aligned} EF_{CO2,PJ,y}^{BF} = & \Big(\Big(FC_{coke,PJ,y}^{BF} \times \big(EF_{CO2,coke} + C_{coke,y} \times 44/12\big)\Big) \\ & + \big(FC_{n.gas,PJ,y}^{BF} \times NCV_{n.gas,y} \times EF_{CO2,n.gas}\big) + \big(FC_{lmst,PJ,y}^{BF} \times EF_{CO2,lmst}\big) \\ & + \big(FC_{el,PJ,y}^{BF} \times EF_{CO2,el}\big) + \big(FC_{sinter,PJ,y}^{BF} \times EF_{CO2,sinter}\big) \\ & + \big(FC_{pellets,PJ,y}^{BF} \times EF_{CO2,pellets}\big) + \big(FC_{PC,PJ,y}^{BF} \times EF_{CO2,PJ,y}^{PCI}\big) + \big(FC_{PC,PJ,y}^{BF} \\ & \times NCV_{coal} \times EF_{CO2,coal}\big) + \big(FC_{el,PJ,y}^{OX\,BF} \times EF_{CO2,el}\big)\Big) / P_{iron,PJ,y}^{BF} \end{aligned} \quad (3)$$

where:

$EF_{CO2,PJ,y}^{PCI}$ - carbon dioxide emission factor for PC production process under the project in period y, tCO_2/t

PC;
$C_{coke,y}$ - carbon content in coke, tC/t coke;
$44/12$ - ratio between molecular weights of molecules CO_2 and C;
$NCV_{n.gas,y}$- net calorific value of natural gas in period y, GJ/1000 m^3.

Carbon dioxide emission factor for PC production process under the project can be found the following way:

$$EF^{PCI}_{CO2,PJ,y} = \frac{\left(FC^{PCI}_{n.gas,PJ,y} \times NCV_{n.gas,y} \times EF_{CO2,n.gas}\right) + \left(FC^{PCI}_{el,PJ,y} \times EF_{CO2,el}\right)}{P^{PCI}_{PC,PJ,y}} \quad (4)$$

where,
$FC^{PCI}_{n.gas,PJ,y}$ - Natural gas consumption for PC productionin period y, 1000 m^3;
$FC^{PCI}_{el,PJ,y}$ - Electricity consumption for PC productionin period y, MWh;
$P^{PCI}_{PC,PJ,y}$ – Pulverized coal production level at PCI unit in period y, t.
$NCV_{n.gas,y}$- net calorific value of natural gas in period y, GJ/1000 m^3.

$$FC^{OX\,BF}_{el,PJ,y} = OX^{BF}_{PJ,y} \times \left(FC^{OX}_{el,PJ,y} / OX_{PJ,y}\right) \quad (5)$$

where,
$FC^{OX\,BF}_{el,PJ,y}$ – Electricity consumption for production of oxygen supplied to BF1 under the project in period y, MWh;
$OX^{BF}_{PJ,y}$ – Amount of oxygen supplied to BF1 under the project in period y, 1000 m^3;
$OX_{PJ,y}$ – Total oxygen produced under the projectin period y, 1000 m^3;
$FC^{OX}_{el,PJ,y}$ – Total electricity consumed for oxygen production under the projectin period y, MWh.

Calculation of APCS emissions
Project emissions for subproject “Implementation of automatic process control system (APCS) for Open Hearth Furnaces” consist of emissions due to the fossil fuel combustions as well as using carbon containing raw materials.

The following sources of emissions during the steel production process in the OHFs are considered:

$P^{OHF}_{steel,PJ,y}$	Steel production at OHFs in period y, t;
$FC^{OHF}_{iron,PJ,y}$	Pig iron consumption at OHFs in period y, t;
$FC^{OHF}_{lmst,PJ,y}$	Limestone consumption at OHFs in period y, t;
$FC^{OHF}_{lime,PJ,y}$	Lime consumption at OHFs in period y, t;
$FC^{OHF}_{dlmt,PJ,y}$	Dolomite consumption in the OHFs in period y, t;
$FC^{OHF}_{mgst,PJ,y}$	Magnesite powder consumption in the OHFs in period y, t;
$FC^{OHF}_{sinter,PJ,y}$	Sinter consumption in the OHFs in period y, t;
$FC^{OHF}_{coke,PJ,y}$	Coke consumption at OHFs in period y, t;
$FC^{OHF}_{coal,PJ,y}$	Coal consumption at OHFs in period y, t;
$FC^{OHF}_{n.gas,PJ,y}$	Natural gas consumption at OHFs in period y, 1000 m^3;
$FC^{OHF}_{COG,PJ,y}$	COG consumption at OHFs in period y, 1000 m^3;
$FC^{OHF}_{el,PJ,y}$	Electricity consumption at OHFs in period y, MWh.

Therefore, project emissions in year y due to implementation of APCS for OHFs can be calculated the following way:

$$PE_y^{OHF} = P_{steel,PJ,y}^{OHF} \times EF_{CO2,PJ,y}^{OHF}$$, where: (6)

$P_{steel,PJ,y}^{OHF}$ - Steel production at all OHFs in period y, t steel;
$EF_{CO2,PJ,y}^{OHF}$ - Carbon dioxide emission factor for steel production process under the project, tCO_2/t steel.

$$\begin{aligned} EF_{CO2,PJ,y}^{OHF} = \Big(& \big(FC_{iron,PJ,y}^{OHF} \times EF_{CO2,PJ,y}^{BF}\big) + \big(FC_{lmst,PJ,y}^{OHF} \times EF_{CO2,lmst}\big) \\ & + \big(FC_{lime,PJ,y}^{OHF} \times EF_{CO2,lime}\big) \\ & + \Big(FC_{coke,PJ,y}^{OHF} \times \big(EF_{CO2,coke} + C_{coke,y} \times 44/12\big)\Big) \\ & + \big(FC_{dlmt,PJ,y}^{OHF} \times EF_{CO2,dlmt}\big) + \big(FC_{mgst,PJ,y}^{OHF} \times EF_{CO2,mgst}\big) \\ & + \big(FC_{sinter,PJ,y}^{OHF} \times EF_{CO2,sinter}\big) + \big(FC_{coal,PJ,y}^{OHF} \times NCV_{coal} \times EF_{CO2,coal}\big) \\ & + \big(FC_{n.gas,PJ,y}^{OHF} \times NCV_{n.gas,y} \times EF_{CO2,n.gas}\big) \\ & + \big(FC_{COG,PJ,y}^{OHF} \times NCV_{COG} \times EF_{CO2,COG}\big) + \big(FC_{el,PJ,y}^{OHF} \times EF_{CO2,el}\big)\Big) \\ & / P_{steel,PJ,y}^{OHF} \end{aligned} \quad (7)$$

Calculation of carbon dioxide emission factors for limestone, dolomite and magnesite powder consumption

Carbon dioxide emission factors for limestone, dolomite and magnesite consumption consist of material specific carbon contents multiplied by carbon dioxide/carbon molecular weight ratio (44/12)

Therefore, carbon dioxide emission factors for limestone can be calculated the following way:

$$EF_{CO2,lmst} = C_{lmst} \times 44/12$$, where: (8)

$EF_{CO2,lmst}$ - carbon dioxide emission factor for limestone consumption, tCO_2/t limestone;
C_{lmst} - limestone carbon content, tC/t limestone;
$44/12$ - carbon dioxide/carbon molecular weight ratio.

Carbon dioxide emission factors for dolomite can be calculated the following way:

$$EF_{CO2,dlmt} = C_{dlmt} \times 44/12$$, where: (9)

$EF_{CO2,dlmt}$ - carbon dioxide emission factor for dolomite consumption, tCO_2/t dolomite;
C_{dlmt} - dolomite carbon content, tC/t dolomite;
$44/12$ - carbon dioxide/carbon molecular weight ratio.

Carbon dioxide emission factors for magnesite powder can be calculated the following way:

$$EF_{CO2,mgst} = C_{mgst} \times 44/12$$, where: (10)

$EF_{CO2,mgst}$ - carbon dioxide emission factor for magnesite powder consumption, tCO_2/t magnesite powder;
C_{mgst} - magnesite powder carbon content, tC/t magnesite powder;
$44/12$ - carbon dioxide/carbon molecular weight ratio.

All the other carbon dioxide emission factors used are constant and given in the table 7.

Project emissions	[tCO_2e]
2008	2 785 020
2009	2 412 524
2010	2 158 034
2011 (01.01-31.10)	1 485 317
Total for the monitoring period	**8 840 895**

Table 12: Project emissions

D.3.2. Baseline emissions:

Baseline emissions are calculated according to the following formulae:

$$BE_y = BE_y^{BF} + BE_y^{OHF} \quad (11)$$

where:

BE_y Baseline emissions in period *y*, (tCO_2e);
BE_y^{BF} Emissions in period *y* due to exploiting BF 1 without PCI, (tCO_2e);
BE_y^{OHF} Emissions in period *y* due to exploiting OHF without APCS, (tCO_2e).

Results of the emissions calculations are presented in metric tons of carbon dioxide equivalent (tCO_2e), 1 metric ton of carbon dioxide equivalent is equal to 1 metric ton of carbon dioxide (tCO_2), i.e. 1 tCO_2e = 1 tCO_2.

Calculation of BF emissions

Baseline emissions in period *y* due to realization of subproject “Implementation of Pulverized Coal Injection (PCI) for Blast Furnace 1” are calculated in the following way:

$$BE_y^{BF} = P_{iron,BL,y}^{BF} \times EF_{CO2,BL,y}^{BF}, \text{ where:} \quad (12)$$

$EF_{CO2,BL,y}^{BF}$ - Carbon dioxide emission factor for pig iron production process under the baseline, tCO_2/t iron;
$P_{iron,BL,y}^{BF}$ - Pig iron production at BF 1 in period y, t iron. This value is equal to project level of pig iron production at BF 1.
Therefore:

$$P_{iron,BL,y}^{BF} = P_{iron,PL,y}^{BF} \quad (13)$$

Carbon dioxide emission factor for pig iron production process under the baseline is based on actual data received during three years before the project implementation. The value considered is a weighted average between carbon dioxide emission factors for pig iron production process calculated for the period 2003-2005 (See Table 13). For each year in this period carbon dioxide emission factor was found by following formula:

$$EF^{BF}_{CO2,BL,y} = \Big(\Big(FC^{BF}_{coke,BL,y} \times \big(EF_{CO2,coke} + C_{coke,y} \times 44/12\big)\Big) + \big(FC^{BF}_{n.gas,BL,y} \times NCV_{n.gas,y} \times EF_{CO2,n.gas}\big) + \big(FC^{BF}_{lmst,BL,y} \times EF_{CO2,lmst}\big) + \big(FC^{BF}_{el,BL,y} \times EF_{CO2,el}\big) + \big(FC^{BF}_{sinter,BL,y} \times EF_{CO2,sinter}\big) + \big(FC^{BF}_{pellets,BL,y} \times EF_{CO2,pellets}\big)\Big) / P^{BF}_{iron,BL,y} \quad (14)$$

The following sources of emissions during the pig iron production process are considered:

$FC^{BF}_{coke,BL,y}$ Coke consumption at BF 1in period y, t;
$FC^{BF}_{n.gas,BL,y}$ Natural gas consumption at BF 1in period y, 1000 m^3;
$FC^{BF}_{el,BL,y}$ Electricity consumption at BF 1in period y, MWh;
$FC^{BF}_{lmst,BL,y}$ Limestone consumption at BF 1in period y, t;
$FC^{BF}_{sinter,BL,y}$ Sinter consumption at BF 1in period y, t;
$FC^{BF}_{pellets,BL,y}$ Pellets consumption at BF 1in period y, t;

The following results were obtained:

Parameter	Units	2003	2004	2005	Weighted average
Carbon dioxide emission factor for pig-iron production process under the baseline	tCO_2e/t iron	2.619	2.534	2.471	**2.560**

Table 13: Baseline carbon dioxide emission factor for pig-iron production process.

Calculation of APCS emissions

Baseline emissions for subproject "Implementation of automatic process control system (APCS) for Open Hearth Furnaces" are calculated in the following way:

$$BE^{OHF}_{y} = P^{OHF}_{steel,BL,y} \times EF^{OHF}_{CO2,BL,y} \quad (15)$$ where:

$EF^{OHF}_{CO2,BL,y}$ - Carbon dioxide emission factor for steel production process under the baseline, tCO_2/t steel;
$P^{OHF}_{steel,BL,y}$ - Steel production at all OHFs under the baseline in period *y*, t steel. This value is equal to project level of steel production.

Therefore:

$$P^{OHF}_{steel,BL,y} = P^{OHF}_{steel,PJ,y} \quad (16)$$

Carbon dioxide emission factor for steel production process under the baseline is based on actual data received during three years before the project implementation. This value considered is a weighted average between carbon dioxide emission factors for steel production process calculated for the period 2002-2004 (See Table 14). For each year in this period carbon dioxide emission factor was found by following formula:

$$EF^{OHF}_{CO2,BL,y} = \Big(\big(FC^{OHF}_{iron,BL,y} \times EF^{BF}_{CO2,BL,y}\big) + \big(FC^{OHF}_{lmst,BL,y} \times EF_{CO2,lmst}\big) + \big(FC^{OHF}_{lime,BL,y} \times EF_{CO2,lime}\big) + \big(FC^{OHF}_{coke,BL,y} \times (EF_{CO2,coke} + C_{coke,y} \times 44/12)\big) + \big(FC^{OHF}_{dlmt,BL,y} \times EF_{CO2,dlmt}\big) + \big(FC^{OHF}_{mgst,BL,y} \times EF_{CO2,mgst}\big) + \big(FC^{OHF}_{sinter,BL,y} \times EF_{CO2,sinter}\big) + \big(FC^{OHF}_{coal,BL,y} \times NCV_{coal} \times EF_{CO2,coal}\big) + \big(FC^{OHF}_{n.gas,BL,y} \times NCV_{n.gas,y} \times EF_{CO2,n.gas}\big) + \big(FC^{OHF}_{COG,BL,y} \times NCV_{COG} \times EF_{CO2,COG}\big) + \big(FC^{OHF}_{el,BL,y} \times EF_{CO2,el}\big)\Big) / P^{OHF}_{steel,BL,y} \quad (17)$$

The following sources of emissions during the steel production process in the OHFs were considered:

$P^{OHF}_{steel,BL,y}$	Steel production at OHFs in period y, t;
$FC^{OHF}_{iron,BL,y}$	Pig iron consumption at OHFs in period y, t;
$FC^{OHF}_{lmst,BL,y}$	Limestone consumption at OHFs in period y, t;
$FC^{OHF}_{lime,BL,y}$	Lime consumption at OHFs in period y, t;
$FC^{OHF}_{dlmt,BL,y}$	Dolomite consumption in the OHFs in period y, t;
$FC^{OHF}_{mgst,BL,y}$	Magnesite powder consumption in the OHFs in period y, t;
$FC^{OHF}_{sinter,BL,y}$	Sinter consumption in the OHFs in period y, t;
$FC^{OHF}_{coke,BL,y}$	Coke consumption at OHFs in period y, t;
$FC^{OHF}_{coal,BL,y}$	Coal consumption at OHFs in period y, t;
$FC^{OHF}_{n.gas,BL,y}$	Natural gas consumption at OHFs in period y, 1000 m^3;
$FC^{OHF}_{COG,BL,y}$	COG consumption at OHFs in period y, 1000 m^3;
$FC^{OHF}_{el,BL,y}$	Electricity consumption at OHFs in period y, MWh.

The following results were obtained:

Parameter	Units	2002	2003	2004	Weighted average
Carbon dioxide emission factor for steel production process under the baseline	tCO_2e/t steel	1.750	1.751	1.738	**1.746**[14]

Table 14: Baseline carbon dioxide emission factor for steel production process.

Calculation of carbon dioxide emission factors for limestone, dolomite and magnesite powder consumption

Carbon dioxide emission factors for limestone, dolomite and magnesite consumption consist of material specific carbon contents multiplied by carbon dioxide/carbon molecular weight ratio (44/12). Calculation formulae are same as for the calculation of project emissions. Please, refer to Section D.3.1.

[14] This value was adjusted compared to calculation result of the determined PDD (version 3.4.).

The obtained results are in the table below:

Baseline emissions	[tCO_2e]
2008	3 092 082
2009	2 712 727
2010	2 646 164
2011 (01.01-31.10)	1 759 133
Total for the monitoring	**10 210 106**

Table 15: Baseline emissions

D.3.3. Leakage:

Not Applicable

D.3.4. Summary of the emissions reductions during the monitoring period:

$$ERy = BEy - PEy\,,$$ where

ER_y is the total GHG emission reduction for the project in the monitoring period *y*, (tCO_2e);

BE_y is the total baseline GHG emissions in the monitoring period *y*, (tCO_2e);

PE_y is the total project GHG emissions in the monitoring period *y*, (tCO_2e).

Emission Reductions	[tCO_2e]
2008	307 062
2009	300 203
2010	488 130
2011 (01.01-31.10)	273 816
Total for the monitoring period	**1 369 211**

Table 16: Emission Reductions

Annex 1

Definitions and acronyms

Acronyms and Abbreviations

CH_4	METHANE
CO_2	CARBON DIOXIDE
GHG	GREENHOUSE GASES
GWP	GLOBAL WARMING POTENTIAL
IPCC	INTERGOVERMENTAL PANEL ON CLIMATE CHANGE
PDD	PROJECT DESIGN DOCUMENT
COG	COKE OVEN GAS
BF	BLAST FURNACE
APSC	AUTOMATIC PROCESS CONTROL SYSTEM
OHFS	OPEN HEARTH FURNACES

Definitions

Baseline	The scenario that reasonably represents what would have happened to greenhouse gases in the absence of the proposed project, and covers emissions from all gases, sectors and source categories listed in Annex A of the Protocol and anthropogenic Removals by sinks, within the project boundary.
Emissions reductions	Emissions reductions generated by a JI project that have not undergone a verification or determination process as specified under the JI guidelines, but are contracted for purchase.
Global Warming Potential (GWP)	An index that compares the ability of greenhouse gases to absorb heat in the atmosphere in comparison to carbon dioxide. The index was established by the Intergovernmental Panel of Climate Change.
Greenhouse gas (GHG)	A gas that contributes to climate change. The greenhouse gases included in the Kyoto Protocol are: carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorcarbons (HFCs), Perfluorcarbons (PFCs) and Sulphurhexafluoride (SF6).
Joint Implementation (JI)	Mechanism established under Article 6 of the Kyoto Protocol. JI provides Annex I countries or their companies the ability to jointly implement greenhouse gas emissions reduction or sequestration projects that generate Emissions Reduction Units.
Monitoring plan	Plan describing how monitoring of emission reductions will be undertaken. The monitoring plan forms a part of the Project Design Document (PDD).

Annex 2

Standardized emission factors for the Ukrainian electricity grid

Introduction

Many Joint Implementation (JI) projects have an impact on the CO_2 emissions of the regional or national electricity grid. Given the fact that in most Economies in Transition (IET) an integrated electricity grid exists, a standardized baseline can be used to estimate the amount of CO_2 emission reductions on the national grid in case of:

a) Additional electricity production and supply to the grid as a result of a JI project (= producing projects);

b) Reduction of electricity consumption due to the JI project resulting in less electricity generation in the grid (= reducing projects);

c) Efficient on-site electricity generation with on-site consumption. Such a JI project can either be a), b), or a combination of both (e.g. on-site cogeneration with partial on-site consumption and partial delivery to the grid).

So far most JI projects in EIT, including Ukraine, have used the standardized Emission Factors (EFs) of the ERUPT programme. In the ERUPT programme for each EIT a baseline for producing projects and reducing projects was developed. The ERUPT approach is generic and does not take into account specific local circumstances. Therefore, in recent years new standardized baselines were developed for countries like Romania, Bulgaria, and Estonia. In Ukraine exist a similar need to develop a new standardized electricity baseline to take the specific circumstances of Ukraine into account. The following baseline study establishes a new electricity grid baseline for Ukraine for both producing JI projects and reducing JI projects.

This new baseline has been based on the following guidance and approaches:

- The "Guidance on criteria for baseline setting and monitoring" for JI projects, issued by the Joint Implementation Supervisory Committee[15];
- The "Operational Guidelines for the Project Design Document", further referred to as ERUPT approach or baseline [16];
- The approved CDM methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" [17];
- Specific circumstances for Ukraine as described below.

---

[15] Guidance on criteria for baseline setting and monitoring, version 01, Joint Implementation Supervisory Committee, ji.unfccc.int

[16] Operational Guidelines for Project Design Documents of Joint Implementation Projects. Ministry of Economic Affairs of the Netherlands, May 2004

[17] Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 06, 19 May 2006, cdm.unfccc.int

ERUPT

The ERUPT baseline was based on the following main principles:

- Based mainly on indirect data sources for electricity grids (i.e. IEA/OECD reports);
- Inclusion of grid losses for reducing JI projects;
- An assumption that all fossil fuel power plants are operating on the margin and in the period of 2000-2030 all fossil fuel power plants will gradually switch to natural gas.

The weak point of this approach is the fact that the date sources are not specific. For example, the Net Calorific Value (NCV) of coals was not determined on installation level but was taken from IPCC default values. Furthermore, the IEA data included electricity data until 2002 only. ERUPT assumes that Ukraine would switch all its fossil-fuel plant from coal to natural gas. In Ukraine such an assumption is unrealistic as the tendency is currently in the opposite direction.

ACM0002
The ACM0002 methodology was developed in the context of CDM projects. The methodology takes a combination of the Operating Margin (OM) and the Build Margin (BM) to estimate the emissions in absence of the CDM project activity. To calculate the OM four different methodologies can be used. The BM in the methodology assumes that recent built power plants are indicative for future additions to the grid in the baseline scenario and as a result of the CDM project activity construction of new power plants is avoided. This approach is valid in electricity grids in which the installed generating capacity is increasing, which is mostly the case in developing countries. However, the Ukrainian grid has a significant overcapacity and many power plants are either operating below capacity or have been moth-balled.

Nuclear is providing the base load in Ukraine
In Ukraine nuclear power plants are providing the base load of the electricity in Ukraine. To reduce the dependence on imported fuel the nuclear power plants are running at maximum capacity where possible. In the past five years nuclear power plants provide almost 50% of the total electricity:

Year	2001	2002	2003	2004	2005
Share of AES	44%	45%	45%	48%	48%

Table 17: Share of nuclear power plant in the annual electricity generation

All other power stations are operating on the margin. This includes hydro power plants which is showed in the table below.

	Minimum; 03:00	Maximum; 19:00
Consumption, MW	21.287	27.126
Generation, MW	22.464	28.354
Thermal power plants	*10.049*	*13.506*
Hydro power plants	*527*	*3.971*
Nuclear power plants	*11.888*	*10.877*
Balance imports/export, MW	-1.177	-1.228

Table 18: Electricity demand in Ukraine on 31 March 2005[18]

[18] Ukrenergo, http://www.ukrenergo.energy.gov.ua/ukrenergo/control/uk/publish/article?art_id=39047&cat_id=35061

Development of the Ukrainian electricity sector

The National Energy Strategy[19] sets the approach for the overall energy complex of Ukraine and the electricity sector in particular. The main priority of Ukraine is to reduce the dependence of imported fossil fuels. The strategy sets the following priorities[20]:

- increased use of local coal as a fuel;
- construction of the new nuclear power plants;
- energy efficiency and energy saving.

Due to the sharp increase of imported natural gas prices a gradual switch from natural gas to coal at the power plants is planned in the nearest future. Ukraine possesses a large overcapacity of the fossil-powered plants of which many are mothballed. These moth-balled plants might be connected to the grid in case of growing demand.

In the table below the installed capacity and load factor is given in Ukraine. As one can see the average load factor of thermal power plant is very low.

	Installed capacity (GW)	Average load factor, %
Thermal power plants	33.6	28.0
Hydro power plants	4.8	81.4
Nuclear power plants	13.8	26.0
Total	**52.2**	**39.0**

Table 19: Installed capacity[21] in Ukraine in 2004

According to IEA’s estimations, about 25% of thermal units might not be able to operate (though there is no official statistics). This means that still at least 45% of the installed thermal power capacity could be utilized, but is currently not used. In accordance with the IEA report the ‘current capacity will be sufficient to meet the demand in the next decade’[22].

In the table below the peak load of the years 2001- 2005 are given which is approximately 50% of the installed capacity.

	2001	2002	2003	2004	2005
Peak load (GW)	28.3	29.3	26.4	27.9	28.7

Table 20: Peak load in Ukraine in 2001 - 2005[23]

New nuclear power plants will take significant time to be constructed will not get on-line before the end of the second commitment period in 2012. There is no nuclear reactor construction site at such an advanced stage remaining in Ukraine, it is unlikely that Ukraine will have enough resources to commission any new nuclear units in the foreseeable future (before 2012)[24].

Latest nuclear additions (since 1991):

---

[19] http://mpe.kmu.gov.ua/fuel/control/uk/doccatalog/list?currDir=50505

[20] Energy Strategy of Ukraine for the Period until 2030, section 16.1, page 127.

[21] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 272, table 8.1

[22] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 269

[23] Ministry of Energy, letter dated 11 January 2007

[24] http://www.xaec.org.ua/index-ua.html

- Zaporizhzhya NPP unit 6, capacity 1 GW, commissioned in 1995;
- Rivne NPP unit 4, capacity 1 GW, commissioned in 2004;
- Khmelnitsky NPP unit 2, capacity 1 GW, commissioned in 2004.

Nuclear power plants under planning or at early stage of construction:

- South Ukraine NPP one additional unit, capacity 1 GW;
- Khmelnitsky NPP two additional units, capacity 1 GW each.

Approach chosen

In the selected approach of the new Ukrainian baseline the BM is not a valid parameter. Strictly applying BM in accordance with ACM0002 would result in a BM of zero as the latest additions to the Ukrainian grid were nuclear power plants. Therefore applying BM taking past additions to the Ukrainian grid would result in an unrealistic and distorted picture of the emission factor of the Ukrainian grid. Therefore the Operating Margin only will be used to develop the baseline in Ukraine.

The following assumptions from ACM0002 will be applied:

1) The grid must constitute of all the power plants connected to the grid. This assumption has been met as all power plants have been considered;

2) There should be no significant electricity imports. This assumption has been met in Ukraine as Ukraine is a net exporting country as shown in the table below;

3) Electricity exports are not accounted separately and are not excluded from the calculations.

	2001	2002	2003
Electricity produced, GWh	175.109	179.195	187.595
Exports, GWh	5.196	8.576	12.175
Imports, GWh	2.137	5.461	7.235

Table 21: Imports and exports balance in Ukraine[25]

ACM0002 offers several choices for calculating the OM. Dispatch data analyze cannot be applied, since the grid data is not available[26]. Simple adjusted OM approach is not applicable for the same reason. The average OM calculation would not present a realistic picture and distort the results, since nuclear power plants always work in the base load due to the technical limitations (and therefore cannot be displaced) and constitute up to 48% of the overall electricity generation during the past 5 years.

Therefore, the simple OM approach is used to calculate the grid emission factor. In Ukraine the low-cost must-run power plants are nuclear power stations. Their total contribution to the electricity production is below 50% of the total electricity production. The remaining power plants, all being the fossil-fuel plants and hydro power plants, are used to calculate the Simple OM.

%	2001	2002	2003	2004	2005
Nuclear power plants	44.23	45.08	45.32	47.99	47.92
Thermal power plants	38.81	38.32	37.24	32.50	33.22

[25] Source: State Committee of Statistics of Ukraine. Fuel and energy resources of Ukraine 2001-2003. Kyiv, 2004

[26] Ministry of Energy, letter dated 11 January 2007

Combined heat and power	9.92	11.02	12.28	13.04	12.21
Hydro power plants	7.04	5.58	5.15	6.47	6.65

Table 22: Share of power plants in the annual electricity generation of Ukraine[27]

The simple OM is calculated using the following formula:

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum GEN_{j,y}} \qquad \textbf{(Equation 1)}$$

where:

$F_{i,j,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y* (2001-2005);

j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid;

$COEF_{i,j,y}$ is the CO_2 emission coefficient of fuel *I* (tCO_2e / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources *j* and the percent oxidation of the fuel in year(s) *y*;

$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j*.

The CO_2 emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \qquad \textbf{(Equation 2)}$$

where:

NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel *i*;

$OXID_i$ is the oxidation factor of the fuel, fraction;

$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel *i*.

Individual data for power generation and fuel properties was obtained from the individual power plants[28]. The majority of the electricity (up to 95%) is generated centrally and therefore the data is comprehensive[29].
The Net Calorific Value (NCV) of fossil fuel can change considerably, in particular when using coal. Therefore the local NCV values of individual power plants for natural gas and coal were used. For heavy fuel oil, the IPCC[30] default NCV was used. Local CO_2 emission factors for all types of fuels were taken for the purposes of the calculations and Ukrainian oxidation factors were used. In the case of small-scale power plants some data regarding the fuel NCV is missing in the reports. For the purpose of simplicity, the NCV of similar fuel from a power plant from the same region of Ukraine was used.

[27] “Overview of data on electrical power plants in Ukraine 2001 - 2005“, Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[28] “Overview of data on electrical power plants in Ukraine 2001 - 2005“, Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[29] The data for small units (usually categorized in the Ukrainian statistics as ‘CHPs and others’) is scattered and was not always available. As it was rather unrealistic to collect the comprehensive data from each small-scale power plant, an average CO2 emission factor was calculated for the small-scale plants that provided the data. For the purpose of simplicity it was considered that all the electricity generated by the small power plants has the same average emission factor obtained.

[30] IPCC 1996. Revised guidelines for national greenhouse gas inventories.

Reducing JI projects

The Simple OM is applicable for additional electricity production delivered to the grid as a result of the project (producing JI projects). However, reducing JI projects also reduce grid losses. For example a JI project reduces on-site electricity *consumption* with 100,000 MWh and the losses in the grid are 10%. This means that the actual reduction in electricity *production* is 111.111 MWh. Therefore a reduction of these grid losses should be taken into account for reducing JI projects to calculate the actual emission reductions.

The losses in the Ukrainian grid are given in the table below and are based on the data obtained directly from the Ukrainian power plants through the Ministry of Energy.

Year	Technical losses %	Non-technical losses %	Total %
2001	14.2	7	21.2
2002	14.6	6.5	21.1
2003	14.2	5.4	19.6
2004	13.4	3.2	16.6
2005	13.1	1.6	14.7

Table 23: Grid losses in Ukraine[31]

As one can see grid losses are divided into technical losses and non-technical losses. For the purpose of estimating the EF only technical losses[32] are taken into account. As can been seen in the table the technical grid losses are decreasing. The average decrease of grid losses in this period was 0.275% per annum. Extrapolating these decreasing losses to 2012 results in technical grid losses of 12% by 2012. However, in order to be conservative the grid losses *over the full period 2006-2012* have been taken as 10%.

Further considerations

The "Guidance on criteria for baseline setting and monitoring" for JI projects requires baselines to be conservative. The following measures have been taken to adhere to this guidance and to be conservative:

- The grid emission factor is actually expected to grow due to the current tendency to switch from gas to coal;
- Hydro power plants have been included in the OM. This is conservative;
- With the growing electricity demand, out-dated mothballed fossil fired power plants are likely to come on-line as existing nuclear power plants are working on full load and new nuclear power plants are unlikely to come on-line before 2012. The emission factor of those moth-balled power plants is higher as all of them are coal of heavy fuel oil fired[33];
- The technical grid losses in Ukraine are high, though decreasing. With the current pace the grid losses in Ukraine will be around 12% in 2012. To be conservative the losses have been taken 10%;
- The emissions of methane and nitrous oxide have not taken into consideration, which is in line with ACM0002. This is conservative.

---

[31] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[32] Ukrainian electricity statistics gives two types of losses – the so-called 'technical' and 'non-technical'. 'Non-technical' losses describe the non-payments and other losses of unknown origin.

[33] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

Conclusion
An average CO_2 emission factor was calculated based on the years 2003-2005. The proposed baseline factors is based on the average constituting a fixed emission factor of the Ukrainian grid for the period of 2006-2012. Both baseline factors are calculated using the formulae below:

$$EF_{grid,produced,y} = EF_{OM,y} \quad \textbf{(Equation 3)}$$

and

$$EF_{grid,reduced,y} = \frac{EF_{grid,produced,y}}{1-loss_{grid}} \quad \textbf{(Equation 4)}$$

where:
$EF_{grid,produced,y}$ is the emission factor for JI projects supplying additional electricity to the grid (tCO_2e/MWh);
$EF_{grid,reduced,y}$ is the emission factor for JI projects reducing electricity consumptionfrom the grid (tCO_2e/MWh);
$EF_{OM,y}$ is the simple OM of the Ukrainian grid (tCO_2e/MWh);
$loss_{grid}$ is the technical losses in the grid (%).

The following result was obtained:

Type of project	Parameter	EF (tCO_2e/MWh)
JI project producing electricity	$EF_{grid,produced,y}$	0.807
JI projects reducing electricity	$EF_{grid,reduced,y}$	0.896

Table 24: Emission Factors for the Ukrainian grid 2006 - 2012

Monitoring
This baseline requires the monitoring of the following parameters:

- Electricity produced by the project and delivered to the grid in year y (in MWh);
- Electricity consumption reduced by the project in year (in MWh);
- Electricity produced by the project and consumed on-site in year y (in MWh).

The baseline emissions are calculated as follows:

$$BE_y = EF_{grid,produced,y} x EL_{produced,y} + EF_{grid,reduced,y} x \left(EL_{reduced,y} + EL_{consumed,y}\right) \quad \textbf{(Equation 5)}$$

where:
BE_y are the baseline emissions in year y (tCO_2e);
$EF_{grid,produced,y}$ is the emission factor of producing projects (tCO_2e /MWh);
$EL_{produced,y}$ is electricity produced and delivered to the grid by the project in year y (MWh);
$EF_{grid,reduced,y}$ is the emission factor of reducing projects (tCO_2e /MWh);
$EL_{produced,y}$ is electricity consumption reduced by the project in year y(MWh);
$EL_{consumed,y}$ is electricity produced by the project and consumed on-site in year y (MWh).

This baseline can be used as ex ante (fixed for the period 2006 – 2012) or ex post. In case an ex post baseline is chosen the data of the Ukrainian grid have to be obtained of the year in which the emission reductions are being claimed. Monitoring will have to be done in accordance with the monitoring plan of ACM0002 with the following exceptions:

- the Monitoring Plan should also include monitoring of the grid losses in year *y*;
- power plants at which JI projects take place should be excluded. Such a JI project should have been approved by Ukraine and have been determined by an Accredited Independent Entity.

Acknowledgements

The development of this new baseline has been made possible by funding of the EBRD and the Netherlands’ Ministry of Economic Affairs. The authors would further like to thank the Ukrainian Ministry of Energy for supplying the data and the Ministry of Environmental Protection for their support. This baseline study can be used freely in case of proper reference.

Global Carbon B.V.

Version 5, 2 February 2007