FOURTH PERIODIC ANNUAL JI MONITORING REPORT

VERSION 3.1

DATED 3RD MAY 2012

CONTENTS

SECTION A. General project activity and monitoring information

A.1 Title of the project activity:

Usage of alternative raw materials at Kryvyi Rih Cement, Ukraine

A.2. JI registration number:

Reference number: JI0194
ITL project ID: UA2000021

A.3. Short description of the project activity:

The project is aimed at significant decrease of carbon dioxide emissions originating from calcination of raw materials in the clinker kiln at PJSC Heidelbergcement Ukraine (formerly Kryvyi Rih Cement plant). Emissions from calcination can be decreased by addition of alternative raw materials[1] (AMC) which do not contain carbonates. Such alternative materials are metallurgical slag of different types, ashes generated at power plants that use coal fuel.

Kryvyi Rih Cement is the major cement producer in Central Ukraine. The plant is owned by HeidelbergCement, one of the world's leading producers of construction materials. Kryvyi Rih Cement was built in 1952 and fully modernized in 1983. Since the modernization the plant applies dry production process – one rotary kiln with calciner and multistage cyclone system capable of producing approximately 1.0 million tonnes of clinker annually.

It was planned to increase step by step over 2 to 3 years the share of AMC in the raw material mix to approximately 20% by mass from the level of about 4% which was achieved before the project start in 2004. This level is taken as the baseline. To adopt such high proportion of AMC the composition of raw materials had been adjusted by increasing the number of components to keep the clinker chemical composition and quality within the required limits.

Conventional raw materials for clinker manufacturing are limestone and clay with addition of small amounts of correcting additives (ferrous oxide).

As stated in the project design, from 2004 blast furnace slag was being added into raw material mix, thus partially replacing the natural raw materials. The actual annual amount of slag added since the beginning of the project is presented in Table 1. The slag is being added into the raw mix, prior to raw mills, and mixed/milled together with other raw materials (limestone, clay, additives) prior to entering the clinker kiln. The slag being originated from blast furnace process had already passed the treatment at high temperature and does not contain calcium and magnesium carbonates. Therefore, during thermal processing in clinker kiln at high temperature it does not decarbonize with emissions of CO_2 like natural raw materials do. The more slag in the raw meal, the less CO_2 is emitted during burning of materials in the kiln (emissions from calcination).

A.4. Monitoring period:

- Monitoring period starting date: 01.01.2011 at 00:00;
- Monitoring period closing date: 31.12.2011 at 24:00

[1] AMC is defined as de-carbonated materials, see ACM0015/version02

A.5. Methodology applied to the project activity (incl. version number):

A.5.1. Baseline methodology:

JI-specific approach based on the PDD ver. 2.0 dated 20th of August 2010.

A.5.2. Monitoring methodology:

A JI-specific monitoring approach was developed for this project based on the PDD ver. 2.0 dated 20th of August 2010.

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

The project implementation started within planned time schedule. The actually achieved proportion of slag addition is presented in a table below:

Table 1: Status of project implementation over 2004-2011

Year	Slag addition percentage achieved by the Project
2004	11.51
2005	18.03
2006	20.62
2007	16.67
2008	18.4
2009	20.4
2010	21.7
2011	**7.6**

In 2011 the economic situation in the region caused increase of the alternative components cost. This resulted in significant decrease of the share of AMC proportion in the raw meal.

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

Monitored amount of emission reductions differs from the one expected in PDD for the respective period stated in A.4. as shown in a table 2 below:

Table 2: Monitored amount of ER and expected in PDD for 2011

Year	2011
Achieved ERs in the reported monitoring period, tonnes of CO_2 equivalent	61 852
Estimated ERs in the determined PDD, tonnes of CO_2 equivalent	123 199

The difference can be explained by:

1) Changes in clinker production volume: actual ones versus estimates in PDD;
2) Changes in the share of AMC in raw meal composition versus those estimated in PDD: during the monitoring period high prices for AMC caused significant decrease in the share of blast furnace slag and fly ash addition;
3) Changes in kiln calorific consumption per tonne of clinker: actual one is higher than that estimated in PDD.

There are no other deviations to the determined PDD

A.8. Intended deviations or revisions to the registered monitoring plan

According to the paragraph 41 of the "Guidance on criteria for baseline setting and monitoring" version 03[2]:
The project participants are encouraged to improve the monitoring process and its results. Revisions, if any, to the monitoring plan to improve the accuracy and/or applicability of information collected shall be justified by project participants and shall be submitted for the determination referred to in paragraph 37 of the JI guidelines[3] by the AIE.

1) In order to improve transparency, fix inaccuracies and adjust the parameters and equations into accordance with one another, the description of some parameters and formulae in the determined monitoring plan has been amended.

Table 3: Variable deviations to the determined MP

ID number from the PDD	Determined monitoring plan		Revised monitoring plan	
	Parameter	Method of monitoring	Parameter	Method of monitoring
B9	$CaO_{clnk,Bsl}$	Description: Non-carbonate CaO content in clinker in baseline Source of data (to be) used: Plant records Data unit: %, t of CaO/ t of clinker Value and data unit applied: 65.67 % Time of determination/verification: Daily	CaO_{CLNK_Bsl}	Description: Non-carbonate CaO content in clinker in baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25 Value and data unit applied: 0.6567 t of CaO/ t of clinker Time of determination/verification: Fixed ex-ante
B10	$CaO_{RM,Bsl}$	Description: Non-carbonate CaO content in raw meal in baseline Source of data (to be) used: Plant records Data unit: %, t of CaO/ t of raw meal	CaO_{RM_Bsl}	Description: Non-carbonate CaO content in raw meal in baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25 Value and data unit applied: 0.0161 t of CaO/ t of raw meal

[2] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

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

		Value and data unit applied: 1.61 % Time of determination/verification: Daily		Time of determination/verification: Fixed ex-ante
B11	$MgO_{clnk,Bsl}$	Description: Non-carbonate MgO content in clinker in baseline Source of data (to be) used: Plant records Data unit: %, t of MgO/ t of clinker Value and data unit applied: 1.80 % Time of determination/verification: Daily	MgO_{CLNK_Bsl}	Description: Non-carbonate MgO content in clinker in baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25 Value and data unit applied: 0.0180 t of MgO/ t of clinker Time of determination/verification: Fixed ex-ante
B12	$MgO_{RM,Bsl}$	Description: Non-carbonate MgO content in raw meal in baseline Source of data (to be) used: Plant records Data unit: %, t of MgO/ t of raw meal Value and data unit applied: 0.212 % Time of determination/verification: Daily	MgO_{RM_Bsl}	Description: Non-carbonate MgO content in raw meal in baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25 Value and data unit applied: 0.00212 t of MgO/ t of raw meal Time of determination/verification: Fixed ex-ante

B14	$FC_{i,y}$	Description: Fuel of type i consumed by the kiln in year y Source of data (to be) used: Plant records Data unit: t or 1000 m^3 Time of determination/verification: Annually	$FC_{kiln,i,y}$	Description: Fuel of type *i* consumed by the kiln in year y Source of data (to be) used: Technical reports of the plant Data unit: t or 1000 m^3 Time of determination/verification: Annually Comment: The fuels used by the kiln are anthracite coal and natural gas
B15	NCV_i	Description: Net calorific value of fuel of type i in year y Source of data (to be) used: Plant records Data unit: GJ/t or GJ/1000 m^3 Time of determination/verification: Per shipment	$NCV_{i,y}$	Description: Net calorific value of fuel of type i in year y Source of data (to be) used: Certificates from natural gas supplier; Coal NCV laboratory tests. Data unit: GJ/t or GJ/1000 m^3 Time of determination/verification: Annually Comment: The fuels used within the project are anthracite coal and natural gas
B18	CKD_{Bsl}	Description: Baseline amount of cement kiln dust (CKD) leaving kiln systems Source of data (to be) used: Plant records Data unit: t Time of determination/verification: Annually	CKD_{Bsl}	Description: Baseline amount of cement kiln dust (CKD) leaving kiln systems Source of data (to be) used: Calculated as an average of amount of dust leaving kiln for 2001, 2002, 2003 (3 years preceding the project implementation). Value and data unit applied: 656.791 t Time of determination/verification: Fixed ex-ante
B19	$FC_{dry, i}$	Description: Baseline consumption of fuel of type i for raw	$HC_{dry,Bsl}$	Description: Baseline heat consumption for raw meal drying and kiln fuel

		meal drying and kiln fuel preparation Source of data (to be) used: Plant records Data unit: GJ, t or 1000 m^3 Time of determination/verification: Annually		preparation Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 26 Value and data unit applied: 169 084 GJ Time of determination/verification: Fixed ex-ante Comment: The fuel used for raw meal drying in the baseline and project scenario is natural gas. The coal drying is performed using kiln flue gases without additional fossil fuel combustion.
B20	$EL_{RM,kiln,Bsl}$	Description: Specific grid electricity consumption for clinker production, including consumption of electricity for raw mill preparation, kiln electricity consumption, fuel preparation and feeding in the baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 27 Data unit: MWh, kWh/t clinker Value and data unit applied: 101.06 kWh/t clinker Time of determination/verification: Annually	$EC_{RM,kiln,Bsl}$	Description: Specific grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in the baseline Source of data (to be) used: PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 27 Value and data unit applied: 101.06 kWh/t Time of determination/verification: Fixed ex-ante
P7	$CaO_{clnk,y}$	Description: Non-carbonate CaO content in clinker in year *y* Source of data (to be) used: Plant records Data unit: %, t of CaO/ t of clinker Time of determination/verification: Daily	$CaO_{CLNK,y}$	Description: Non-carbonate CaO content in clinker in year *y* Source of data (to be) used: Data from the plant laboratory Data unit: t of CaO/ t of clinker Time of determination/verification: Annually

P9	$CaO_{RM,y}$	Description: Non-carbonate CaO content in raw meal in year *y* Source of data (to be) used: Plant records Data unit: %, t of CaO/ t of raw meal Time of determination/verification: Daily	$CaO_{RM,y}$	Description: Non-carbonate CaO content in raw meal in year *y* Source of data (to be) used: Plant laboratory measurements Data unit: t of CaO/ t of raw meal Time of determination/verification: Annually
P11	$MgO_{CLNK,y}$	Description: Non-carbonate MgO content in clinker in year *y* Source of data (to be) used: Plant records Data unit: %, t of MgO/ t of clinker Time of determination/verification: Daily	$MgO_{CLNK,y}$	Description: Non-carbonate MgO content in clinker in year *y* Source of data (to be) used: Plant laboratory measurements Data unit: t of MgO/ t of clinker Time of determination/verification: Annually
P12	$MgO_{RM,y}$	Description: Non-carbonate MgO content in raw meal in year *y* Source of data (to be) used: Plant records Data unit: %, t of MgO/ t of raw meal Time of determination/verification: Daily	$MgO_{RM,y}$	Description: Non-carbonate MgO content in raw meal in year *y* Source of data (to be) used: Plant laboratory measurements Data unit: t of MgO/ t of raw meal Time of determination/verification: Annually
P24	$FC_{i,kiln,y}$	Description: Fuel of type *i* consumed by the kiln in year y Source of data (to be) used: Plant records Data unit: GJ, t or 1000 m^3 Time of determination/verification: Annually	$FC_{kiln,i,y}$	Description: Fuel of type *i* consumed by the kiln in year y Source of data (to be) used: Technical reports of the plant Data unit: t or 1000 m^3 Time of determination/verification: Annually Comment: The fuels used by the kiln are anthracite coal and natural gas
P29	$FC_{drums, y}$	Description:	$FC_{drums,i,y}$	Description:

		Fuel consumption for drying drums Source of data (to be) used: Plant records Data unit: GJ, t or 1000 m^3 Time of determination/verification: Annually		Fuel of type i consumed by the drying drums in year y Source of data (to be) used: Technical reports of the plant Data unit: 1000 m^3 Time of determination/verification: Annually Comment: The fuel used for raw meal drying in the baseline and project scenario is natural gas. The fuel preparation is performed using kiln flue gases without additional fossil fuel combustion.

Table 4: Formulae deviations to the determined MP

Equation ID from the PDD	Equation in the determined MP	Equation in the revised MP
5	$PE_{dry,y} = FC_{drums,y} \times NCV_{fd,y} \times EF_{CO2}$	$PE_{dry,y} = \sum_i FC_{drums,i,y} \times NCV_{i,y} \times EF_{CO2,i}$
6	$PE_{El\_grid,y} = EL_{RM,kiln,y} \div 1000 \times EF_{el,y}$	$PE_{El\_grid,y} = EC_{RM,kiln,y} \times EF_{EL,y}$
7	$BE_y = BE_{Calcin} + BE_{FC} + BE_{Dust} + BE_{dry} + BE_{EL\_grid}$	$BE_y = BE_{Calc,y} + BE_{FC,y} + BE_{dust,y} + BE_{dry,y} + BE_{EL\_grid,y}$
8	$BE_{Calcin} = \frac{CLNK_y}{CLNK_{Bsl}} \times \left(0.785 \times \left(\begin{matrix} CaO_{CLNK\_Bsl} \times CLNK_{Bsl} - \\ - CaO_{RM\_Bsl} \times RM_{Bsl} \end{matrix} \right) + +1.092 \times \left(\begin{matrix} MgO_{CLNK\_Bsl} \times CLNK_{Bsl} - \\ - MgO_{RM\_Bsa} \times RM_{Bsl} \end{matrix} \right) \right)$	$BE_{Calc,y} = \frac{CLNK_y}{CLNK_{Bsl}} \times \left(0.785 \times \left(\begin{matrix} CaO_{CLNK\_Bsl} \times CLNK_{Bsl} - \\ - CaO_{RM\_Bsl} \times RM_{Bsl} \end{matrix} \right) + +1.092 \times \left(\begin{matrix} MgO_{CLNK\_Bsl} \times CLNK_{Bsl} - \\ - MgO_{RM\_Bsl} \times RM_{Bsl} \end{matrix} \right) \right)$
9	$BE_{FC} = KE_{BSL} \times \frac{\sum_i \left(FC_{i,y} \times NCV_i \times EF_{CO_2,y} \right)}{\sum_i \left(FC_{i,y} \times NCV_i \right)} \times CLNK_y$	$BE_{FC,y} = KE_{BSL} \times \frac{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y} \times EF_{CO_2,i} \right)}{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y} \right)} \times CLNK_y$

10	$BE_{dust} = \left(BE_{calc} \times ByPass + \frac{BE_{calc} \times d}{\left[BE_{calc}(1-d)+1\right]} \times CKD_{Bsl} \right) \times \frac{CLNK_y}{CLNK_{Bsl}}$	$BE_{dust,y} = \left(BE_{calc,y} \times ByPass + \frac{BE_{calc,y} \times d}{\left[BE_{calc,y}(1-d)+1\right]} \times CKD_{Bsl} \right) \times \frac{CLNK_y}{CLNK_{Bsl}}$
11	$BE_{dry} = \sum_i \left(FC_{dry,Bsl} \times EF_{CO2,i} \right) \times \frac{CLNK_y}{CLNK_{Bsl}}$	$BE_{dry,y} = \sum_i \left(HC_{dry,Bsl} \times EF_{CO2,i} \right) \times \frac{CLNK_y}{CLNK_{Bsl}}$
12	$BE_{El\_grid} = EL_{RM,kiln,Bsl} \div 1000 \times EF_{el,y} \times CLNK_y$	$BE_{El\_grid,y} = EC_{RM,kiln,Bsl} \div 1000 \times EF_{EL,y} \times CLNK_y$

2) The more recent country-specific emission factor of carbon dioxide for electricity consumed from the Ukrainian grid is available, thus the value and the method of monitoring have been revised:

Table 5: Carbon dioxide emission factor for electricity consumption from the Ukrainian electricity grid

Determined monitoring plan		Revised monitoring plan	
Parameter	Method of monitoring	Parameter	Method of monitoring
$EF_{EL,y}$	Description: Carbon emission factor of electricity grid of Ukraine in year *y* Source of data (to be) used: Plant records; the study "Standardized emission factors for the Ukrainian electricity grid" version 5 dated 02/02/2007 Value and data unit applied : 0.896 tCO_2/MWh Time of determination/verification: Annually	$EF_{EL,y}$	Description: CO_2 emission factor for electricity consumed by the project activity in period y equal to the indirect specific carbon dioxide emissions from electricity consumption by the 1st class electricity consumers according to the Procedure for determining the class of consumers, approved by the National Electricity Regulatory Commission of Ukraine from August 13, 1998 # 1052 Source of data (to be) used: Provided by the DFP on the annual basis. If in a given year or part of the year the emission factor is not available for this year the value of the previous year will be used. Value and data unit applied : For 2011: 1.09 tCO_2/MWh The data units have been converted from $kgCO_2$/kWh into tCO_2/MWh Time of determination/verification: Ex-post according to the publicly available data, on an annual basis

The new carbon dioxide emission factor for electricity consumed from the grid has been issued by National Environmental Investment Agency of Ukraine (current name - State Environmental Investment Agency of Ukraine or SEIA), which is the Designated Focal Point (DFP) of Ukraine. For the monitoring purposes new emission factors for electricity consumed from the grid will be taken from the corresponding SEIA orders on an annual basis. If no new orders are issued, the latest emission factor will be applied for calculation of emissions in baseline and project scenario.

3) The CO_2 emission factors for fuel combustion have been revised in order to improve the accuracy of emission reduction calculations:

Table 6: Carbon dioxide emission factor for combustion of fuels used during the monitoring period

Determined monitoring plan		Revised monitoring plan	
Parameter	Method of monitoring	Parameter	Method of monitoring
$EF_{CO2,\ i}$	Description: Fuel of type *i* Emission Factor Source of data (to be) used: Plant records Data unit: tCO_2/GJ Time of determination/verification: Annually	$EF_{CO2,i}$	**When *i* refers to coal (*$EF_{CO2,Coal}$*):** Description: CO_2 emission factor for coal combustion Source of data (to be) used: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction, Table 1.4, Page 1.23, value for anthracite. Measurement units have been converted from $kgCO_2/TJ$ into tCO_2/GJ Value and data unit applied : 0.0983 tCO_2/GJ Time of determination/verification: Fixed ex-ante
		$EF_{CO2,i}$	**When *i* refers to natural gas (*$EF_{CO2,NG}$*):** Description: CO_2 emission factor for natural gas combustion Source of data (to be) used: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction, Table 1.4, Page 1.24, value for natural gas. Measurement units have been converted from $kgCO_2/TJ$ into tCO_2/GJ Value and data unit applied : 0.0561 tCO_2/GJ Time of determination/verification: Fixed ex-ante

The fuels used for kiln heating at the plant within the project are natural gas and coal:

- The parameter $FC_{kiln,i,y}$ (PDD ID is P24 and B14) is represented as $FC_{kiln,NG,y}$ (1000 m^3) and $FC_{kiln,Coal.y}$ (t)

The fuel used for raw material drying at the plant within the project is natural gas:

- The parameter $FC_{drums,i,y}$ (PDD ID is P29) is represented as $FC_{drums,NG,y}$ (1000 m^3)

The fuels used at the plant within the project are natural gas and coal:

- The parameter $EF_{CO2,\ i}$ (PDD ID is P25) is represented as $EF_{CO2,NG}$ (tCO_2/1000 m^3) and $EF_{CO2,Coal}$ (tCO_2/t)

- The parameter $NCV_{i,y}$ (PDD ID is B15) is represented as $NCV_{NG,y}$ (GJ/1000 m^3) and $NCV_{Coal,y}$ (GJ/t)

A.9. Changes since last verification:

Also please see Section A.8. above. No other changes occurred since the last verification.

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

PJSC Heidelbergcement
- Lyudmila Rudneva, Chief engineer for environment

Global Carbon B.V.
- Denis Prusakov, JI Team Leader
- Iurii Petruk, JI Consultant.

SECTION B. Key monitoring activities

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

The emission sources in the project are:

- Emissions due to fuel combustion (in the kiln and auxiliary combustion for material drying);
- Emissions from calcination of raw materials at high temperatures in the kiln;
- Indirect emissions due to consumption of grid electricity.

The following parameters are monitored in order to calculate the emissions:

Monitoring of kiln fuel consumption.
Cement plant has 1 kiln, which is in operation for the whole year except for overhaul/maintenance shutdowns. The fuels during monitoring period stated in A.4. were natural gas (NG) and anthracite coal. Gas consumption is constantly monitored by the two gas flow meters – one for the kiln burner and the second one for calciner of the kiln. Coal consumption is constantly monitored by the two Pfister weigh feeders.

Monitoring of fuel consumption for pre-drying of raw materials and components
Components of raw meal added into the kiln require drying prior to be mixed and put into the kiln. Such materials are lime, clay and slags used to partially substitute the natural raw materials. The drying of them is conducted in drying drums using NG as fuel. Gas consumption for drums is measured by gas meters.
Coal drying is performed using thermal energy of kiln flue gases, without additional combustion of natural gas or other fossil fuels.

Monitoring of the calorific values of fuels used
The fuels during monitoring period stated in A.4. were natural gas and anthracite coal. The NCV of NG was monitored by the fuel certificates issued by the natural gas supplier and regularly provided to the cement plant. NCV of coal was monitored by the plant laboratory, which has been carried out analysis of NCV of coal supplied to the kiln.

Monitoring of electricity consumption for raw materials preparation and handling to kiln, for kiln operation and for fuel preparation and handling. This consumption is measured by the group of electrical meters.

Monitoring of CaO and MgO content in the clinker produced
Monitoring of oxides content in clinker is made by conducting regular chemical analysis in the plant laboratory.

Monitoring of non-carbonated CaO and MgO content in raw meal
Monitoring of non-carbonated content of these oxides in the raw meal is made by performing the chemical analysis of CaO and MgO content in alternative raw materials (AMC) added into raw meal; quantity of AMC added; and further calculation to obtain the proportion of non-carbonated content of these oxides in the raw meal.

Monitoring of quantity of raw meal (RM) consumed by the kiln
The weigh feeders are used for monitoring of the RM quantity supplied to the kiln

Monitoring of quantity of clinker produced by the kiln
Clinker production is calculated based on constant metering of raw meal volume and chemical composition of RM (moisture and chemical composition measured by on-line x-ray spectrometer). Quantity of clinker is obtained by multiplying special transition coefficient by weight of raw meal supplied to the calciner and the kiln.

B.1. Monitoring equipment:

The monitoring equipment can be divided into four groups: electrical meters, gas flow meters, weigh feeders and laboratory chemical test equipment.

Gas meters

There are six gas meters used to measure the gas consumption as shown in Fig. 1 below. Gas meter 1 (GM1) and Gas meter 2 (GM2) measure the kiln fuel consumption, including consumption of the kiln calciner; and the four meters GM3 to GM6 measure the consumption for raw materials drying.

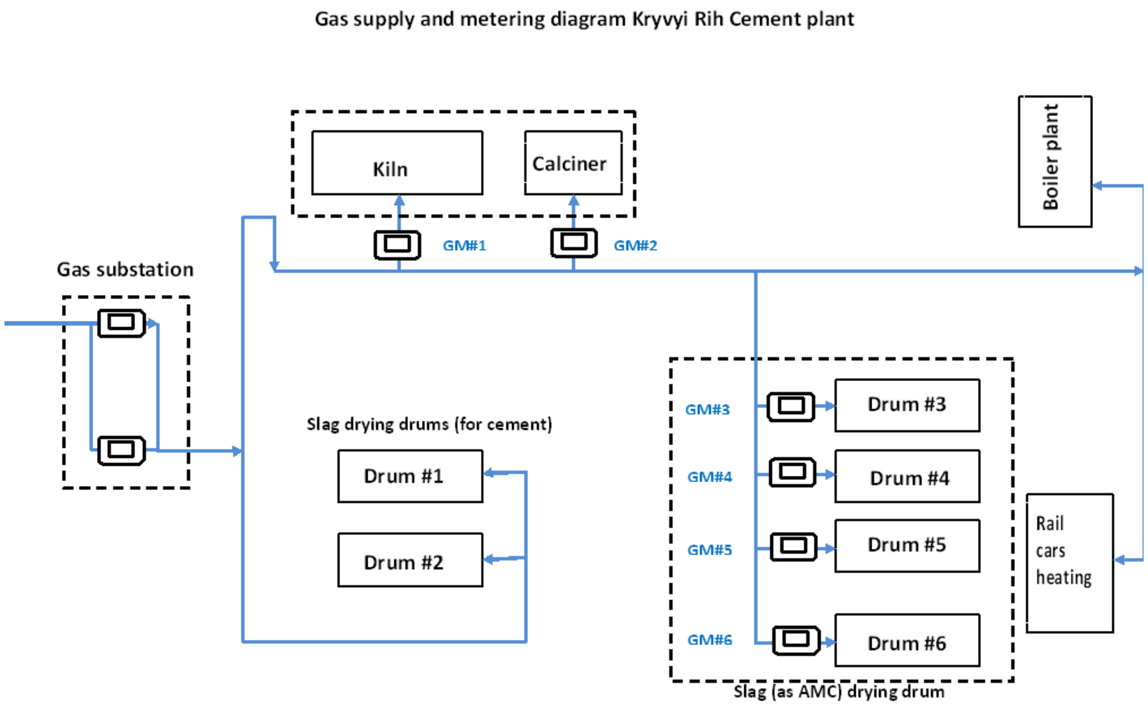

Figure 1: Gas supply and metering diagram

Meters are connected to the processing units allowing for monitoring and storage of data.
Gas meters GM3 to GM6 outputs (flow rate, pressure and temperature of the gas) are processed in electronic processors "UNIVERSAL" which converts the actual gas flow rate into the volume at standard measurement conditions[4]. The processors are connected to the PC allowing for monitoring and storage of data. The PC to which the data are logged and stored is installed in the department of chief power engineer.
During the period 2004-2006 the flows were recorded using paper circular diagrams which were processed daily and consumption recorded in a logbook. From 2007 until 2009 local electronic loggers were used instead of diagrams, data were processed daily and recorded in a logbook.
Since December 2009 the outputs of GM1 and GM2, including gas flow rate, pressure and temperature are logged in the server of kiln automation system where the conversion of gas flow rate to the m^3 at standard conditions is performed and data are stored. The daily consumption data is transferred to the department of chief power engineer.

Coal measurement equipment

The weight of coal combusted in the kiln and calciner is measured by weigh feeder Pfister DRW 4.10/1,6 and weigh feeder Pfister DRW 4.12/2 that are installed at the line of coal dosing and supply to the kiln and calciner.

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[4] Temperature 20 ºC (293 K) and pressure 101325 N/m^2 (760 mm Hg)

Power meters
To measure the total power consumption of raw material preparation chain (which includes mixing, milling grinding and handling to the kiln); kiln consumption and fuel preparation (if coal is used) 26 meters are used installed at distribution substations (DS) #6, 7, 8 and 9.

Raw meal measurement equipment
To monitor the consumption of raw meal fed into the kiln the weigh feeders are used as shown in the Figure 2 below. Each of weigh feeders consist of dosing device DCC-130, meter Multistream G-400 D and feeding unit P7-M.

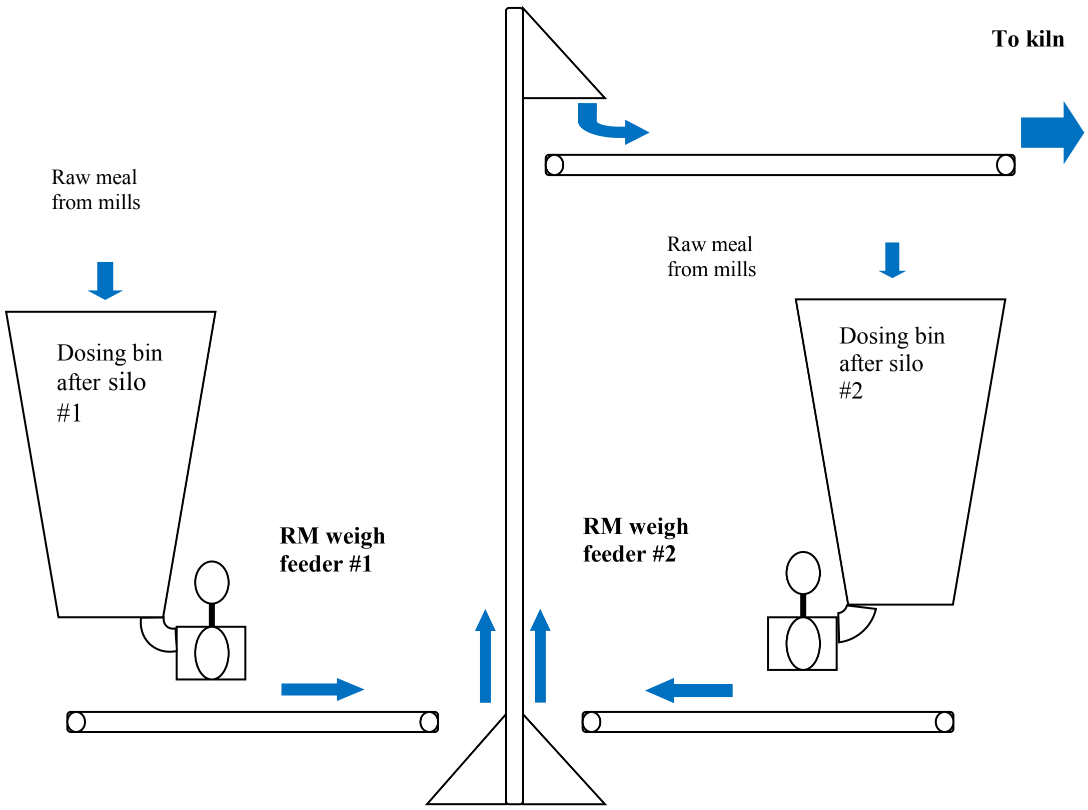

Figure 2: Raw meal flow and measurement scheme

B.1.1. Table providing information on the equipment used (incl. manufacturer, type, serial number, date of last calibration, information on accuracy, need for changes and replacements):

Gas meters

Table 7: Gas meters

Equipment	Variable	Unit	Producer/type	Serial number	Last calibration	Next calibration	Accuracy	Comments
Gas meter #1	$FC_{kiln,i,y}$[5]	m^3	Yokogawa	91K616641	02/02/2011	02/02/2013	± 0.1 %	Rotary kiln natural gas consumption
Gas meter #2			Yokogawa	91K616640	02/02/2011	02/02/2013	± 0.1 %	Kiln calciner natural gas consumption
Gas meter #3	$FC_{drums,i,y}$[6]	m^3	ABB 2600	6404031065	01/02/2011	01/02/2013	± 0.1 %	NG consumption drum#1
Gas meter #4			ABB 2600	6404031066	01/02/2011	01/02/2013	± 0.1 %	NG consumption drum#2
Gas meter #5			ABB 2600	6404031063	01/02/2011	01/02/2013	± 0.1 %	NG consumption drum#3
Gas meter #6			ABB 2600	6404031068	01/02/2011	01/02/2013	± 0.1 %	NG consumption drum#4

[5] Here *i* refers to natural gas ($FC_{kiln,NG,y}$)

[6] Here *i* refers to natural gas ($FC_{drums,NG,y}$)

Coal measurement equipment

Table 8: Coal measurement equipment

Equipment	Variable	Unit	Producer/type	Serial number	Calibration frequency	Accuracy	Comments
Coal weigh feeder #1	$FC_{kiln,i,y}$[7]	t	Pfister DRW 4.10/1,6	77068.20	Calibration is performed by plant personnel in accordance with the calibration instruction issued by the manufacturer. Calibration frequency is usually once per shift (12 hours)	± 2 %	Kiln calciner coal consumption
Coal weigh feeder #2			Pfister DRW 4.12/2	77068.30		± 2 %	Rotary kiln coal consumption

Power meters

Table 9: Power meters

Equipment	Location/meter abbreviation	Manufacturer/ type	Serial number	Unit	Accuracy	Last calibration	Next calibration	Comments
Power consumption for drying of raw materials in drying drums								
Consumption of draft fan №1, 6kV	DS8, cubicle14/ **EM1**	Elster-Metronica EA05RL-B-4	1090938	kWh	± 0.5 %	11/04/2011	11/04/2017	
Consumption of draft fan №2, 6kV	DS8 cubicle15/ **EM2**	Elster-Metronica EA05RL-B-4	1090930	kWh	± 0.5 %	11/04/2011	11/04/2017	
Consumption of draft fan №3, 6kV	DS8 cubicle16/ **EM3**	Elster-Metronica EA05RL-B-4	1090923	kWh	± 0.5 %	11/04/2011	11/04/2017	

[7] Here *i* refers to coal ($FC_{kiln,Coal,y}$)

Consumption of draft fan №4, 6kV	DS8 cubicle17/ **EM4**	Elster-Metronica EA05RL-B-4	1090965	kWh	± 0.5 %	11/04/2011	11/04/2017	
Consumption of 0.4 kV dryer drums auxiliaries TS17/TR#1	DS8 cubicle27/ **EM5**	Elster-Metronica EA05RL-B-4	1090963	kWh	± 0.5 %	11/04/2011	11/04/2017	
Consumption of 0.4 kV dryer drums auxiliaries TS16/TR#2	DS8 cubicle20/ **EM6**	Elster-Metronica EA05RL-B-4	1090974	kWh	± 0.5 %	04/04/2011	04/04/2017	
Power consumption for raw materials milling								
Consumption of raw mill #1 at 6 kV	DS7 cubicle15/ **EM7**	Elster-Metronica EA05RL-B-4	1090968	kWh	± 0.5 %	18/02/2010	18/02/2016	
6 kV fan of raw mill #1 consumption	DS7 cubicle17/ **EM8**	Elster-Metronica EA05RL-B-4	1090900	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of raw mill #2 at 6 kV	DS7 cubicle16/ **EM9**	Elster-Metronica EA05RL-B-4	1090931	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of 6 kV fan of raw mill #2	DS7 cubicle20/ **EM10**	Elster-Metronica EA05RL-B-4	1090957	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of 0.4 kV auxiliaries of raw mills at TS13/TR#1	DS7 cubicle23/ **EM11**	Elster-Metronica EA05RL-B-4	1090925	kWh	± 0.5 %	04/04/2011	04/04/2017	
Consumption of 0.4 kV auxiliaries of raw mills at TS13/TR#2	DS7 cubicle26/ **EM12**	Elster-Metronica EA05RL-B-4	1090950	kWh	± 0.5 %	04/04/2011	04/04/2017	
Kiln power consumption								
Consumption of kiln main drive #1	DS6 cubicle14/ **EM13**	Elster-Metronica EA05RL-B-4	1090929	kWh	± 0.5 %	18/02/2010	18/02/2016	

Consumption of kiln main drive #2	DS6 cubicle5/ **EM14**	Elster-Metronica EA05RL-B-4	1090952	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of kiln end draft fan	DS7 cubicle27/ **EM15**	Elster-Metronica EA05RL-B-4	1090932	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of aspiration fan #1	DS6 cubicle15/ **EM16**	Elster-Metronica EA05RL-B-4	1090912	kWh	± 0.5 %	18/02/2010	18/02/2016	
Consumption of aspiration fan #2	DS6 cubicle24/ **EM17**	Elster-Metronica EA05RL-B-4	1090934	kWh	± 0.5 %	18/02/2010	18/02/2016	
6 kV consumption of after kiln fan	DS9 cubicle7/ **EM18**	Elster-Metronica EA05RL-B-4	1090933	kWh	± 0.5 %	04/04/2011	04/04/2017	
0.4 kV consumption of after kiln fan	DS9 cubicle2/ **EM19**	Elster-Metronica EA05RL-B-4	1090947	kWh	± 0.5 %	04/04/2011	04/04/2017	
0.4 kV consumption of kiln auxiliaries from TS11/TR#1	DS6 cubicle7/ **EM20**	Elster-Metronica EA05RL-B-4	1090906	kWh	± 0.5 %	04/04/2011	04/04/2017	
0.4 kV consumption of kiln auxiliaries from TS11/TR#2	DS6 cubicle12/ **EM21**	Elster-Metronica EA05RL-B-4	1090896	kWh	± 0.5 %	04/04/2011	04/04/2017	
0.4 kV consumption of kiln auxiliaries from TS14/TR#1	DS7 cubicle25/ **EM22**	Elster-Metronica EA05RL-B-4	1090954	kWh	± 0.5 %	04/04/2011	04/04/2017	
0.4 kV consumption of kiln auxiliaries from TS14/TR#2	DS7 cubicle28/ **EM23**	Elster-Metronica EA05RL-B-4	1090917	kWh	± 0.5 %	04/04/2011	04/04/2017	

Power consumption of Coal mill

Consumption of the coal mill	DS8 cubicle32/ **EM24**	Elster-Metronica EARALX-P4B-4	1150424	kWh	± 0.5 %	09/02/2007	09/02/2013	
Consumption of the coal mill fan	DS8 cubicle30/ **EM25**	Elster-Metronica EA05RAL-B-4	1140832	kWh	± 0.5 %	07/07/2006	07/07/2012	
Consumption of the coal mill fan	DS8 cubicle22/ **EM26**	Elster-Metronica EA05RL-B-4	1090905	kWh	± 0.5 %	18/02/2010	18/02/2016	

Raw meal measurement equipment

Table 10: Raw meal measurement equipment

Equipment	Variable	Unit	Producer/type	Serial number	Calibration frequency	Accuracy	Comments
RM weigh feeder #1 RM weigh feeder #2	RM_y	t	Producer: Schenck Process Unit: DCC-130-1 Flow meter: Multistream G400 D	Unit: HWFK/01038/1 Flow meter: V 020 919.B01 Unit: HWFK/01038/2 Flow meter: V 020 912.B01	Calibration is usually performed once per shift (12 hours)	± 1 %	Calibration is performed by plant personnel in accordance with the calibration instruction issued by the manufacturer.

B.1.2. Calibration procedures:

For natural gas meters

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 2 years	Calibration will be performed by the authorized representatives of the State Metrological System of Ukraine[8]

[8] http://www.dssu.gov.ua/control/en/publish/article/main?art_id=87456&cat_id=87455

For coal and raw meal weigh feeders

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is performed regularly	Plant internal services

Calibration of coal and raw meal weigh feeders is usually performed once per shift (12 hours). Calibration of coal weigh feeders is performed automatically after startup of the relevant program by the operator. Calibration of raw meal weigh feeders is performed by the operator in a semi-automatic way following the calibration instruction. The calibration instructions have been provided to the AIE as supporting documents.

For power meters

QA/QC procedures	Body responsible for calibration and certification
Calibration interval of such meters is 6 years	Calibration will be performed by the authorized representatives of the State Metrological System of Ukraine

B.1.3. Involvement of Third Parties:

Authorized representatives of the State Metrological System of Ukraine
Gas distribution company “Gaz Ukraina”
Coal distribution company “HC Fuels Ltd.”
Coal distribution company “Westlink Group Ltd.”

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

B.2.1. List of fixed default values:

Table 11: Default carbon dioxide emission factors

Data variable	Data unit	Value	Source of data	Comment
$EF_{CO2,NG}$ CO_2 emission factor for natural gas combustion	tCO_2/GJ	0.0561	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction[9], Table 1.4, Page 1.24	Value for natural gas. Measurement units have been converted from $kgCO_2/TJ$ into tCO_2/GJ
$EF_{CO2,Coal}$ CO_2 emission factor for coal combustion	tCO_2/GJ	0.0983	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction, Table 1.4, Page 1.23	Value for anthracite. Measurement units have been converted from $kgCO_2/TJ$ into tCO_2/GJ

Table 12: Baseline ex-ante factors

Data variable	Data unit	Value	Source of data
$CLNK_{Bsl}$ is the annual production of clinker in the baseline	t	738 567	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 23
RM_{Bsl} is the annual consumption of raw meal in the baseline	t	1 163 977	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 23
CaO_{CLNK_Bsl} is the non-carbonate CaO content in clinker in baseline	t of CaO/ t of clinker	0.6567	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25
CaO_{RM_Bsl} is the non-carbonate CaO content in raw meal in baseline	t of CaO/ t of raw meal	0.0161	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25
MgO_{CLNK_Bsl} is the non-carbonate MgO content in clinker in baseline	t of MgO/ t of clinker	0.0180	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25
MgO_{RM_Bsl} is the non-carbonate MgO content in raw meal in baseline	t of MgO/ t of raw meal	0.00212	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 25
KE_{BSL} is the specific baseline kiln calorific consumption	GJ/t	3.67	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 24

[9] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

$HC_{dry,Bsl}$ is the baseline heat consumption for raw meal drying and kiln fuel preparation	GJ	169 084	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 26
$EC_{RM,kiln,Bsl}$ is the specific grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in the baseline	kWh/t	101.06	PDD ver. 2.0 dated 20th of August 2010, Annex 2 Table 27
CKD_{Bsl} is the baseline amount of cement kiln dust (CKD) leaving kiln systems	t	656.791	Calculated as an annual average of amount of dust leaving kiln for 2001, 2002, 2003 (3 years preceding the project implementation)
d is the CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw materials)	fraction	0.5	Data from the plant laboratory

B.2.2. List of variables:

Table 13: Project monitored variables

Data variable	Data unit	Data collection and calculation method	Comments
$CLNK_y$ is the annual production of clinker in year y	t	Sum of daily kiln production reports	Calculated based on amount of RM fed to the kiln, and its chemical characteristics
RM_y is the annual consumption of raw meal in year y	t	Sum of daily RM consumption reports	Measured by raw meal weigh feeders (see Table 10)
$CaO_{CLNK,y}$ is the non-carbonate CaO content in clinker in year y	t of CaO/ t of clinker	Weighted average made on the basis of laboratory measurements	Chemical analysis made at plant chemical lab according to DSTU B V.2.7-202:2009
$CaO_{RM,y}$ is the non-carbonate CaO content in raw meal in year y	t of CaO/ t of raw meal	Weighted average made on the basis of laboratory measurements	Chemical analysis made at plant chemical lab according to DSTU B V.2.7-202:2009
$MgO_{CLNK,y}$ is the non-carbonate MgO content in clinker in year y	t of MgO/ t of clinker	Weighted average made on the basis of laboratory measurements	Chemical analysis made at plant chemical lab according to DSTU B V.2.7-202:2009
$MgO_{RM,y}$ is the non-carbonate MgO content in raw meal in year y	t of MgO/ t of raw meal	Weighted average made on the basis of laboratory measurements	Chemical analysis made at plant chemical lab according to DSTU B V.2.7-202:2009
$FC_{kiln,i,y}$	t or 1000 m^3	Sum of daily fuel consumption reports	Kiln natural gas consumption ($FC_{kiln,NG,y}$) is measured by gas

is the fuel of type *i* consumed by the kiln in year *y*			meters (see Table 7); The natural gas consumption value is converted from m^3 into 1000 m^3 using multiplication factor of 0.001; Kiln coal consumption $(FC_{kiln,Coal,y})$ is measured by coal weigh feeders (see Table 8)
$FC_{drums,i,y}$ is the fuel of type *i* consumed by the drying drums in year *y*	1000 m^3	Sum of daily fuel consumption reports	Drying drums natural gas consumption ($FC_{drums,NG,y}$) is measured by gas meters (see Table 7) The natural gas consumption value is converted from m^3 into 1000 m^3 using multiplication factor of 0.001
$NCV_{i,y}$ is the net calorific value of fuel of type *i* in year *y*	GJ/t or GJ/1000 m^3	$NCV_{NG,y}$: Natural gas supplier provides the NCV certificates on a monthly basis $NCV_{Coal,y}$: NCV of coal was monitored by the plant laboratory, which has been carried out analysis of NCV of coal supplied to the kiln.	NCV given in the certificates and laboratory measurements in kcal/1000 m^3 and kcal/t. It is further converted into GJ/1000 m^3 and GJ/t using multiplication factor of 4.1868[10] and 0.001
SKC_y is the specific kiln calorific consumption in year *y*	GJ/t	Calculated based on $FC_{kiln,i,y}$, $NCV_{i\,y}$ and $CLNK_y$	
$EC_{RM,kiln,y}$ is the grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in year *y*	MWh	Sum of daily electricity consumption reports	Electricity consumption for clinker production ($EC_{RM,kiln,y}$) is measured by group of power meters (see Table 9). The value is converted from kWh into MWh using multiplication factor of 0.001
CKD_y is the annual amount of cement kiln dust (CKD) leaving kiln systems in year *y*	t	Plant reporting according to state form 2-TP “Air pollutions” based on periodical flue gas sampling for dust content	Periodical testing of kiln flue gases after dedusting units
d_y is the CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw	fraction	Data from the plant laboratory	Laboratory tests

[10] http://www.unitconversion.org/unit_converter/energy.html

materials) in year *y*			
$EF_{EL,y}$ is the CO_2 emission factor for electricity consumed by the project activity in period y equal to the indirect specific carbon dioxide emissions from electricity consumption by the 1st class electricity consumers according to the Procedure for determining the class of consumers, approved by the National Electricity Regulatory Commission of Ukraine from August 13, 1998 # 1052	tCO_2/MWh	Order #75[11] dated 12/05/2011 by National Investment Agency of Ukraine	Calculated by the Ukrainian DFP The data units have been converted from $kgCO_2/kWh$ into tCO_2/MWh

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

Table 14: Data used for project scenario emissions calculation

Variable	Description	Unit	Value
	Period: 01.01.2011-31.12.2011		
$CLNK_y$	Annual production of clinker in year *y*	t	993 000
RM_y	Annual consumption of raw meal in year *y*	t	1 599 836
$CaO_{CLNK,y}$	Non-carbonate CaO content in clinker in year *y*	t of CaO/ t of clinker	0.6513
$CaO_{RM,y}$	Non-carbonate CaO content in raw meal in year *y*	t of CaO/ t of raw meal	0.0313
$MgO_{CLNK,y}$	Non-carbonate MgO content in clinker in year *y*	t of MgO/ t of clinker	0.018
$MgO_{RM,y}$	Non-carbonate MgO content in raw meal in year *y*	t of MgO/ t of raw meal	0.0037
$FC_{kiln,NG,y}$	Fuel of type *i* consumed by the kiln in year *y* (NG consumption)	$1000\ m^3$	5 287.730
$FC_{kiln,Coal,y}$	Fuel of type *i* consumed by the kiln in year *y* (Coal consumption)	t	133 113.7
$FC_{drums,NG,y}$	Fuel of type *i* consumed by the drying drums in year *y* (NG consumption)	$1000\ m^3$	5 258.866
SKC_y	Specific kiln calorific consumption in year *y*	GJ/t	3.535
$EC_{RM,kiln,y}$	Grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in year *y*	MWh	83 084.184

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

CKD_y	Annual amount of cement kiln dust (CKD) leaving kiln systems in year *y*	t	41.706
d_y	CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw materials) in year *y*	fraction	0.5
$NCV_{NG,y}$	Net calorific value of fuel of type *i* in year *y* (NCV of natural gas)	$GJ/1000\ m^3$	34.009
$NCV_{Coal,y}$	Net calorific value of fuel of type *i* in year *y* (NCV of coal)	GJ/t	25.0212
$EF_{EL,y}$	CO_2 emission factor for electricity consumed by the project activity in period y equal to the indirect specific carbon dioxide emissions from electricity consumption by the 1^{st} class electricity consumers according to the Procedure for determining the class of consumers, approved by the National Electricity Regulatory Commission of Ukraine from August 13, 1998 # 1052	tCO_2/MWh	1.09

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

Table 15: Data used for baseline scenario emissions calculation

Variable	Description	Unit	Value
$CLNK_{Bsl}$	Annual production of clinker in the baseline	t	738 567
RM_{Bsl}	Annual consumption of raw meal in the baseline	t	1 163 977
CaO_{CLNK_Bsl}	Non-carbonate CaO content in clinker in baseline	t of CaO/ t of clinker	0.6567
CaO_{RM_Bsl}	Non-carbonate CaO content in raw meal in baseline	t of MgO/ t of clinker	0.0161
MgO_{CLNK_Bsl}	Non-carbonate MgO content in clinker in baseline	t of CaO/ t of raw meal	0.0180
MgO_{RM_Bsl}	Non-carbonate MgO content in raw meal in baseline	t of MgO/ t of raw meal	0.00212
KE_{BSL}	Specific baseline kiln calorific consumption	GJ/t	3.67
$HC_{dry,Bsl}$	Baseline consumption of heat for raw meal drying and kiln fuel preparation	GJ	169 084
$EC_{RM,kiln,Bsl}$	Specific grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in the baseline	kWh/t	101.06
CKD_{Bsl}	baseline amount of cement kiln dust (CKD) leaving kiln systems	t	656.791
d	CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw materials)	fraction	0.5

B.2.5. Data concerning leakage:

No leakage has been identified in the PDD; therefore this section is not applicable

B.2.6. Data concerning environmental impacts:

The project foresees usage metallurgical slag and fly ash being the waste products for metallurgy and power generation. Usage of such AMC does not directly influence the plant pollutions. The slag addition project required development of the separate environmental impact assessment (EIA). Such an assessment was performed in 2005 by the Special Design & Engineering Bureau "Cement" (Kharkiv, Ukraine). This EIA received positive decision of the State Authority on Environmental Protection in Dnipropetrovs'k Region (# 168, 12 July 2006) and of the Dnipropetrovs'k Regional Sanitary Epidemic Station (# 140, 14 March 2006).

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

Fuel consumption

Kiln and calciner natural gas consumption is measured by use of two gas meters; two coal weigh feeders are used for measuring the coal consumption of the kiln and the calciner (shown at Figure 1, Table 7 and Table 8).

Fuel consumption for drying of raw materials and AMC is measured by four identical gas meters.

All the data collected, transferred to the monitoring system and stored. Responsible for data collection and storage is within the energy department.

Power consumption

Metering of power consumed for raw meal preparation and handling, operation of the kiln, including the auxiliaries is organized by 26 power meters (See Table 9). All the data metered are transferred to the monitoring system and stored. Responsible for data collection and storage is within the energy department.

CaO and MgO contents

CaO and MgO contents in clinker are being periodically (daily) measured by chemical test at plant laboratory as a part of quality assurance procedure. Data are stored and archived.

Non-carbonated CaO and MgO contents in raw meal are calculated at chemical laboratory on monthly basis using the result of chemical tests of all AMC added during the period and amounts of each types of AMC.

Raw meal consumption

RM consumption is measured constantly by weigh feeders (see Fig. 2 and Table 10). Daily reports on amount of raw meal consumption are transferred to the department of economic planning and analysis. Based on daily data, monthly and annual reports are produced and stored.

Clinker production

Clinker production is calculated based on constant metering of raw meal volume and chemical composition of RM (moisture and chemical composition measured my on-line x-ray spectrometer). Quantity of clinker is obtained by multiplying special transition coefficient by weigh of raw meal supplied to the calciner and the kiln. Daily reports on amount of clinker production are transferred to the department of economic planning and analysis. Based on daily data, monthly and annual reports are produced.

CKD volume

The annual volume of CKD leaving the kiln system is obtained by regular testing (4 times a year) of dust contents in kiln exhaust gases after the filters. The data are collected and included in the state reporting form 2-TP "Air pollution".

B.4. Special event log:

Not applied

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 Chief engineer for environment through coordinating activities. On-site day-to-day (operational) management is implemented by the heads of corresponding units.
The data on fuel consumption by kiln, decarbonizer and RM drying drums, as well as the electricity consumption for clinker production are collected in the department of chief power engineer and then transferred to the department of Chief engineer for environment.
The data on CaO and MgO contents in clinker and AMC are collected in the plant laboratory that is certified for performing the analyses. The data on raw meal consumption and clinker production are collected in the department of economic planning and analysis and then are supplied to the department of Chief engineer for environment.
Reporting procedures in place are approved by plant instructions which include, among others, daily collection and reporting of RM consumption, clinker and cement production, slag usage as raw material, fuel and power usage. Based on these data regular daily reports are produced.
All data necessary for the CO_2 emission reductions calculation are collected in the department of Chief engineer for environment. The calculation of emission reduction is made on a regular basis by Global Carbon.
The organization chart below represents the departments of the plant involved in the current monitoring:

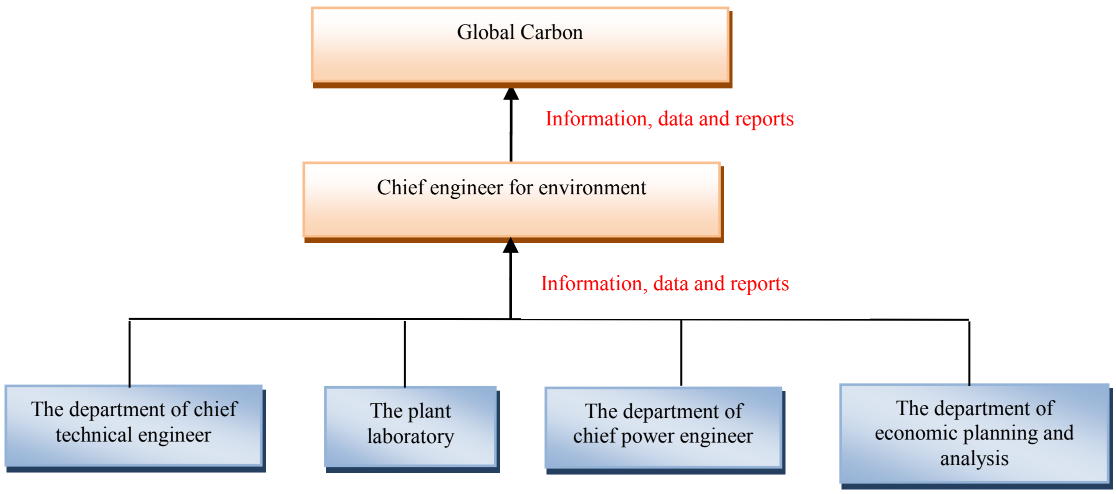

Figure 3: Organization chart

C.1.2. Trainings:

All the equipment supplied foresaw personnel training as a separate contract clause. Training is providing by manufacturers. Technical and scientific support is being regularly provided to Kryvyi Rih plant by Heidelberg Technical Centre, a research unit responsible for new technologies/projects implementation support within the Heidelbergcement group worldwide.

C.2. Involvement of Third Parties:

Authorized representatives of the State Metrological System of Ukraine

C.3. Internal audits and control measures:

The flows of materials (raw meal consumption, clinker production, cement production, slag consumption and other) are additionally audited by conducting of monthly inventory reports. This would allow for regular cross checking of values. All energy flows (electricity, coal and NG) are logged on the server at Energy department.

C.4. Troubleshooting procedures:

In case of a failure of any meter, the latter is being replaced by an operational one. The consumption during meter failure period will be calculated using cross checking method. Operating hours, capacity, working load of equipment, data from other meters will be analyzed and used for estimations.

SECTION D. Calculation of GHG emission reductions

D.1. Table providing the formulae used for calculation of emission reductions:

Please see section D.3 for description of formulae used for calculation of baseline, project emissions and resulting emission reductions for the monitoring period stated in Section A.4.

D.2. Description and consideration of measurement uncertainties and error propagation:

The uncertainties related to activity data (RM consumption, clinker production, consumption of energy and fuel) as well as the chemical composition of materials can be considered low as described in 2006 IPCC Volume 3, Chapter 2 (mineral industry emissions), 2.2.2 Uncertainty assessment.
The higher uncertainty associated with the calcination rate of discarded CKD, however does not present material influence on the resulting emissions due to very low volume of CKD discarded.

D.3. GHG emission reductions (referring to B.2. of this document):

D.3.1. Project emissions:

The project emissions are calculated according to the Equation 1 described below:

$$PE_y = PE_{calc,y} + PE_{Fuel\_kiln,y} + PE_{dust,y} + PE_{dry,y} + PE_{EL\_grid,y} \quad \textbf{(1)}$$

Where:
PE_y is the project emissions in year y (tCO_2)
$PE_{calc,y}$ is the project emissions due to raw meal calcination in year y (tCO_2)
$PE_{Fuel\_kiln,y}$ is the project emissions from combustion of kiln fuels in year y (tCO_2)
$PE_{dust,y}$ is the project emissions due to discarded dust from kiln bypass and dedusting units in year y (tCO_2)
$PE_{dry,y}$ is the project emissions due to fuel consumption for raw meal drying and fuel preparation in year y (tCO_2)
$PE_{EL\_grid,y}$ is the project emissions due consumption of grid electricity for clinker production in year y (tCO_2)

Calcination
Emissions from raw meal calcination are defined as follows:

$$PE_{calc,y} = 0.785(CaO_{CLNK,y} \times CLNK_y - CaO_{RM,y} \times RM_y) + 1.092(MgO_{CLNK,y} \times CLNK_y - MgO_{RM,y} \times RM_y) \quad \textbf{(2)}$$

Where:
$PE_{calc,\,y}$ is the project emissions due to raw meal calcination in year y (tCO_2)
0.785 is the stoichiometric emission factor for CaO (tCO_2/tCaO)
$CaO_{CLNK,y}$ is the non-carbonate CaO content in clinker in year y (t of CaO/ t of clinker)
$CLNK_y$ is the annual production of clinker in year y (t)
$CaO_{RM,y}$ is the non-carbonate CaO content in raw meal in year y (t of CaO/ t of raw meal)
RM_y is the annual consumption of raw meal in year y (t)
1.092 is the stoichiometric emission factor for MgO (tCO_2/tMgO)
$MgO_{CLNK,y}$ is the non-carbonate MgO content in clinker in year y (t of MgO/ t of clinker)
$MgO_{RM,y}$ is the non-carbonate MgO content in raw meal in year y (t of MgO/ t of raw meal)

Combustion of fuels in the kiln
The emissions due to kiln fuel combustions above are defined as follows:

$$PE_{Fuel\_kiln,y} = SKC_y \times \frac{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y} \times EF_{CO_2,i}\right)}{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y}\right)} \times CLNK_y \qquad \textbf{(3)}$$

Where:
$PE_{Fuel\_kiln,y}$ is the project emissions from combustion of kiln fuels in year *y* (tCO_2)
SKC_y is the specific kiln calorific consumption in year *y* (GJ/t)
$FC_{kiln,i,y}$ is the fuel of type *i* consumed by the kiln in year *y* (t or 1000 m^3)
$EF_{CO2,i}$ is the CO_2 emission factor for fuel of type *i* combustion (tCO_2/GJ)
$NCV_{i,y}$ is the net calorific value of fuel of type *i* in year *y* (GJ/t or GJ/1000 m^3)
$CLNK_y$ is the annual production of clinker in year *y* (t)
i is the fuel consumed by the kiln (coal and natural gas)

Project emissions due to discarded dust from kiln exhaust gases de-dusting units
If there is a discarded bypass dust from kiln bypasses (ByPass) or dedusting units (cement kiln dust or CKD), the project emissions due to discarded dust shall be determined as follows:

$$PE_{dust,y} = PE_{calc,y} \times ByPass_y + \frac{PE_{calc\,y} \times d_y}{\left[PE_{calc,y}(1-d_y)+1\right]} \times CKD_y \qquad \textbf{(4)}$$

Where:
$PE_{dust,y}$ is the project emissions due to discarded dust from kiln bypass and dedusting units in year *y* (tCO_2)
$PE_{calc,y}$ is the project emissions due to raw meal calcination in year *y* (tCO_2)
$ByPass_y$ is the annual production of bypass dust leaving kiln system in year *y* (t)
CKD_y is the amount of cement kiln dust (CKD) leaving kiln systems in year *y* (t)
d_y is the CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw materials) in year *y* (fraction)
The dry kiln system of Kryvyi Rih Cement plant has no bypass duct, therefore ByPass = 0 and only CKD will be taken into account

Project emission from combustion of fuel for drying of raw meal and fuel
In addition to fuel consumption by the clinker kiln and calciner, fuel is also consumed by raw meal drying drums. Coal drying is performed using thermal energy of kiln flue gases, without additional combustion of natural gas or other fossil fuels. The project emissions are calculated as follows:

$$PE_{dry,y} = FC_{drums,i,y} \times NCV_{i,y} \times EF_{CO2,i} \qquad \textbf{(5)}$$

Where:
$PE_{dry,y}$ is the project emissions due to fuel consumption for raw meal drying and fuel preparation in year *y* (tCO_2)
$FC_{drums,i,y}$ is the fuel of type *i* consumed by the drying drums in year *y* (1000 m^3)
$NCV_{i,y}$ is the net calorific value of fuel of type *i* in year *y* (GJ/t or GJ/1000 m^3)
$EF_{CO2,i}$ is the CO_2 emission factor for fuel of type *i* combustion (tCO_2/GJ)
i is the fuel consumed by the drying drums (natural gas)

Project emission from grid electricity consumption for clinker manufacture
Within the frames of the project electricity is consumed for clinker kiln and its auxiliary systems operation, for preparation (handling, drying, grinding) of raw meal and for fuel preparation and feeding in the kiln system. The project emissions are calculated as follows:

$$PE_{El\_grid,y} = EC_{RM,kiln,y} \times EF_{EL,y} \qquad \textbf{(6)}$$

Where:
$PE_{El\_grid,y}$ is the project emissions due consumption of grid electricity for clinker production in year *y* (tCO_2)
$EC_{RM,kiln,y}$ is the grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in year *y* (MWh)
$EF_{EL,y}$ CO_2 emission factor for electricity consumed by the project activity in period y equal to the indirect specific carbon dioxide emissions from electricity consumption by the 1st class electricity consumers according to the Procedure for determining the class of consumers, approved by the National Electricity Regulatory Commission of Ukraine from August 13, 1998 # 1052 (tCO_2/MWh)

Table 16: Project emissions

Parameter	Project emissions	Unit	Year 2011
$PE_{calc,y}$	Project emission due to raw meal calcination in year *y*	tCO_2	481 437
$PE_{Fuel\_kiln,y}$	Project emissions from combustion of kiln fuels in year *y*	tCO_2	337 470
$PE_{dust,y}$	Project emissions due to discarded dust from kiln bypass and dedusting units in year *y*	tCO_2	42
$PE_{dry,y}$	Project emissions due to fuel consumption for raw meal drying and fuel preparation in year *y*	tCO_2	10 033
$PE_{El\_grid,y}$	Project emissions due consumption of grid electricity for clinker production in year *y*	tCO_2	90 562
PE_y	Project emissions in year *y*	tCO_2	**919 544**

D.3.2. Baseline emissions:

Baseline emissions are calculated as follows:

$$BE_y = BE_{Calcin,y} + BE_{FC,y} + BE_{dust,y} + BE_{dry,y} + BE_{EL\_grid,y} \quad \textbf{(7)}$$

Where:
BE_y is the baseline emissions in year *y* (tCO_2)
$BE_{Calcin,y}$ is the baseline emissions due to raw meal calcination in year *y* (tCO_2)
$BE_{FC,y}$ is the baseline emissions due to kiln fuel combustion in year *y* (tCO_2)
$BE_{dust,y}$ is the baseline emissions due to discarded dust from kiln bypass and kiln exhaust de-dusting system in year *y* (tCO_2)
$BE_{dry,y}$ is the baseline emissions due to fuel consumption for raw meal drying and fuel preparation in year *y* (tCO_2)
$BE_{EL\_grid,y}$ is the baseline emissions due to grid electricity consumption in year *y* (tCO_2)

Baseline emissions from calcination

$$BE_{Calcin,y} = \frac{CLNK_y}{CLNK_{Bsl}} \times \begin{pmatrix} 0.785 \times \left(CaO_{CLNK\_Bsl} \times CLNK_{Bsl} - CaO_{RM\_Bsl} \times RM_{Bsl}\right) + \\ +1.092 \times \left(MgO_{CLNK\_Bsl} \times CLNK_{Bsl} - MgO_{RM\_Bsl} \times RM_{Bsl}\right) \end{pmatrix} \quad \textbf{(8)}$$

Where:
$BE_{Calcin,y}$ is the baseline emissions due to raw meal calcination in year *y* (tCO_2)
$CLNK_y$ is the annual production of clinker in year *y* (t)
$CLNK_{Bsl}$ is the annual production of clinker in the baseline (t)
0.785 is the stoichiometric emission factor for CaO (tCO_2/tCaO)
CaO_{CLNK_Bsl} is the non-carbonate CaO content in clinker in baseline (t of CaO/ t of clinker)
CaO_{RM_Bsl} is the non-carbonate CaO content in raw meal in baseline (t of CaO/ t of raw meal)
RM_{Bsl} is the annual consumption of raw meal in the baseline (t)

1.092 is the stoichiometric emission factor for MgO ($tCO_2/tMgO$)
MgO_{CLNK_Bsl} is the non-carbonate MgO content in clinker in baseline (t of MgO/ t of clinker)
MgO_{RM_Bsl} is the non-carbonate MgO content in raw meal in baseline (t of MgO/ t of raw meal)

Baseline emissions from combustion of fuels in the kiln

$$BE_{FC,y} = KE_{BSL} \times \frac{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y} \times EF_{CO_2,i}\right)}{\sum_i \left(FC_{kiln,i,y} \times NCV_{i,y}\right)} \times CLNK_y \qquad \textbf{(9)}$$

Where:
$BE_{FC,y}$ is the baseline emissions due to kiln fuel combustion in year *y* (tCO_2)
KE_{BSL} is the specific baseline kiln calorific consumption (GJ/t)
$FC_{kiln,i,y}$ is the fuel of type *i* consumption in year *y* (t or 1000 m^3)
$NCV_{i,y}$ is the net calorific value of fuel of type *i* (GJ/t or GJ/1000 m^3)
$EF_{CO2,i}$ is the CO_2 emission factor for fuel of type *i* combustion (tCO_2/GJ)
$CLNK_y$ is the annual production of clinker in year *y* (t)
i is the fuel consumed by the kiln (coal and natural gas)

Baseline emissions due to discarded dust from kiln exhaust gases de-dusting units

$$BE_{dust,y} = \left(BE_{Calcin,y} \times ByPass_y + \frac{BE_{Calcin,y} \times d}{\left[BE_{Calcin,y}(1-d)+1\right]} \times CKD_{Bsl} \right) \times \frac{CLNK_y}{CLNK_{Bsl}} \qquad \textbf{(10)}$$

Where:
$BE_{dust,y}$ is the baseline emissions due to discarded dust from kiln bypass and kiln exhaust de-dusting system in year *y* (tCO_2)
$BE_{calc,y}$ is the baseline emissions from calcination of the raw meal (tCO_2)
$ByPass_y$ is the annual production of bypass dust living kiln system (t)
CKD_{Bsl} is the baseline amount of cement kiln dust (CKD) leaving kiln systems (t)
d is the CKD calcination rate (released CO_2 expressed as a fraction of the total carbonate CO_2 in the raw materials) (fraction)
$CLNK_y$ is the annual production of clinker in year *y* (t)
$CLNK_{Bsl}$ is the annual clinker production in the baseline (t)

Existing dry kiln at Kryvyi Rih Cement is not equipped with kiln gases by-pass; therefore discarded dust can occur only from cement kiln de-dusting units and only CKD will be taken into account.

Baseline emissions from fuel consumption for drying of raw meal or fuel preparation
Additional (to the kiln consumption) fuel can be consumed to pre-dry the raw materials and to dry the fuel (consumption of fuel by dryer of coal mill). Emissions due to additional fuel consumption are defined as follows:

$$BE_{dry,y} = \sum_i \left(HC_{dry,Bsl} \times EF_{CO2,i}\right) \times \frac{CLNK_y}{CLNK_{Bsl}} \qquad \textbf{(11)}$$

Where:
$BE_{dry,y}$ is the baseline emissions due to fuel consumption for raw meal drying and fuel preparation in year *y* (tCO_2)
HC_{dry_Bsl} is the baseline consumption of heat for raw meal drying and kiln fuel preparation (GJ)
$EF_{CO2,i}$ is the CO_2 emission factor for fuel of type *i* combustion (tCO_2/GJ)
$CLNK_y$ is the annual production of clinker in year *y* (t)
$CLNK_{Bsl}$ is the annual clinker production in the baseline (t)
i is the fuel consumed by the drying drums (natural gas)

Baseline emissions from grid electricity consumption for clinker production
Grid electricity is consumed in the baseline for kiln operation, raw meal preparation and for fuel preparation and feeding. Emissions from grid electricity consumption for these purposes are defined as follows:

$$BE_{El\_grid,y} = EC_{RM,kiln,Bsl} \div 1000 \times EF_{EL,y} \times CLNK_y \qquad \textbf{(12)}$$

Where:
$BE_{El\_grid,y}$ is the baseline emissions due to grid electricity consumption in year *y* (tCO_2)
$EC_{RM,kiln,Bsl}$ is the specific grid electricity consumption for clinker production, including consumption of electricity for raw meal preparation, kiln electricity consumption, fuel preparation and feeding in the baseline (kWh/t).
1/1000 is the transition factor from kWh to MWh
$EF_{EL,y}$ is the CO_2 emission factor for electricity consumed by the project activity in period y equal to the indirect specific carbon dioxide emissions from electricity consumption by the 1st class electricity consumers according to the Procedure for determining the class of consumers, approved by the National Electricity Regulatory Commission of Ukraine from August 13, 1998 # 1052 (tCO_2/MWh)

Table 17: Baseline emissions

Parameter	Baseline emissions	Unit	Year 2011
$BE_{Calcin,y}$	Baseline emissions due to raw meal calcination in year *y*	tCO_2	508 018
$BE_{FC,y}$	Baseline emissions due to kiln fuel combustion in year *y*	tCO_2	350 358
$BE_{Dust,y}$	Baseline emissions due to discarded dust from kiln bypass and kiln exhaust de-dusting system in year *y*	tCO_2	883
$BE_{dry,y}$	Baseline emissions due to fuel consumption for raw meal drying and fuel preparation in year *y*	tCO_2	12 753
$BE_{EL\_grid,y}$	Baseline emissions due to grid electricity consumption in year *y*	tCO_2	109 384
BE_y	Baseline emissions in year *y*	tCO_2	**981 396**

D.3.3. Leakage:

No leakage occurred. Not applicable.

D.3.4. Summary for the emission reductions during the monitoring period:

$$ER_y = BE_y - PE_y \qquad \textbf{(13)}$$

Where:
ER_y is emission reduction of the JI project in year *y* (tCO_2)
BE_y is the baseline emissions in year *y* (tCO_2)
PE_y is the project emissions in year *y* (tCO_2)

Table 18: Emission reduction for the reported monitoring period

Parameter	Emission reductions	Unit	Year 2011
ER_y	Emission reduction of the JI project in year	tCO_2e	61 852

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.