JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
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CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Usage of alternative raw materials at Kryvyi Rih Cement, Ukraine.

Sectoral scope 4: Manufacturing industries[1]

PDD version 2.0 dated 20 August 2010.

A.2. Description of the project:

Cement production is a highly energy intensive process that generates significant emissions of greenhouse gases, in particular CO_2. There are three main sources of CO_2 emissions in the cement production process. The first source is fossil fuel combustion and the second source is the chemical decomposition of the limestone into calcium oxide and carbon dioxide. The third source, being smaller as to compare with the first two, is the grid emissions due to electricity consumption of plants motor drives (e.g. kiln rotation, pumping, fans) and other power consumers.

The project is aimed at significant decrease of the emissions originating from calcination of raw materials in the clinker kiln at Kryvyi Rih Cement plant in Ukraine. Emissions from calcination can be decreased by addition of alternative raw materials[2] (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 producers in Central Ukraine. The plant is owned by HeidelbergCement, one of the world’s leading producers of building materials. Kryvyi Rih Cement was built in 1952 and fully modernized in 1983. Since the modernization the plant uses dry production process – one rotary kiln with calciner and multistage cyclone system capable to produce approximately 1.0 to 1.1mln ton 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 for the baseline as further described in Section B. To adopt such high proportion of AMC the composition of raw materials would be adjusted by increasing the number of components to keep the clinker chemical composition and quality within the required limits. The decision to implement the project was taken during 2002 to 2003 and respective preparatory steps were taken as described further in section A.4.

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

As stated in the plan, from 2004 blast furnace slag was being added into raw material mix, thus partially replacing the natural raw materials. The annual amount of slag added since the beginning of the project is presented in Supporting Document 5 (SD5). 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 has already passed the treatment at

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[1] http://cdm.unfccc.int/DOE/scopelst.pdf

[2] AMC is defined as de-carbonated materials (…), see ACM0015/version02

high temperature and does not contain calcium and magnesium carbonates. Therefore, during thermal processing in clinker kiln at high temperature it does not decarbonizes with emission of CO_2 like natural raw materials do. The more slag in the raw mill, the less CO_2 is emitted during burning of materials in the kiln.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (Host party)	PJSC Heidelbergcement Ukraine (Kryvyi Rih Cement)	No
Germany	HeidelbergCement	No
Netherlands	Global Carbon BV	No

Table 1. Project Participants.

Role of the Project Participants:
- PJSC Heidelbergcement Ukraine (former Kryvyi Rih Cement) is the legal entity operating and owning the cement plant. Kryvyi Rih Cement is implementing the proposed JI project;
- Heidelbergcement is the mother company owning OJSC Heidelbergcement Ukraine (former Kryvyi Rih Cement). It is providing specific technical expertise and supervision for this challenging project;
- Global Carbon BV is responsible for the preparation of the investment as a JI project including PDD preparation, obtaining Party approvals, monitoring and transfer of ERUs.

A.4. Technical description of the project:

Cement is one of the major constructions materials around the world. Production of cement is a highly energy intensive process and as a result its production contributes a significant share of world CO_2 emissions.

The project is aimed at reduction of CO_2 released during calcinations or decarbonisation of raw materials in the kiln at high temperature.

It was foreseen to increase alternative raw materials that do not contain carbonates (AMC) share in raw mix entering the kiln from some 4% to some 20% during the period of 2004 to 2007 and maintain this share in the future. The proportion of AMC would be increased gradually over several years to adopt the process in order to keep required clinker quality and composition.

AMC used in the project is mainly granulated blast furnace slag, some air cooled blast furnace slag and bottom ash from power plants.

Before project implementation, only traditional raw materials (limestone, clay, corrective additives) were used.

A.4.1. Location of the project:

A.4.1.1. Host Party(ies):

Ukraine

Figure1: Ukraine, the project location and neighboring countries

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

Dnipropetrovs'k oblast

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

City of Kryvyi Rih is located 80 km south-west from Dnepropetrovsk, the biggest regional centre of Central Ukraine, which is located at Dnipro river 500 km south-east from Kyiv, the country capital.

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

Kryvyi Rih is a large and developed industrial city in the centre of Ukraine. The industrial cluster of Kryvyi Rih includes biggest country full cycle metallurgical plant Arcelor-Mittal Kryvyi Rih, a number of machine building, construction and mining companies. The region possesses the country’s largest iron ore deposits.

The JI Project site location co-ordinates are: $47^0$52’ N, $33^0$26’ E. The project spatial boundaries are shown at the figure 2 below. They coincide with the cement plant site as shown in the figure.

Figure 2: The cement plant site at south-eastern part of Kryvyi Rih[3].

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

General description of cement production

The cement production process consists of four main steps:

1. Raw materials extraction

The main chemical compounds necessary for cement production are contained in limestone or chalk ($CaCO_3$) and clay or loam (SiO_2, Fe_2O_3 and Al_2O_3). Limestone (or chalk) and clay (or loam) are extracted from natural deposits, crushed and transported to the cement production site.

2. Processing of raw materials

Processing is required to crush, homogenize the materials and corrective additives. Crushed limestone and clay are mixed in a proportion of approximately 4:1. In the case of wet production technology water

[3] Google Earth

is added to form slurry, which is later evaporated in the drying section of the rotary kiln. In the dry process raw materials are mixed, (in some cases wet materials are preliminary dried to improve transport conditions), milled and homogenized without adding water. The waste heat from the dry kiln can be used to dry the raw materials on the preparation stage.

3. Clinker burning (pyroprocessing)
The raw meal is passed to a rotary kiln. Under the influence of high temperatures, limestone (calcium carbonate) is calcined into lime (calcium oxide) and carbon dioxide:

$$CaCO_3 + heat \Rightarrow CaO + CO_2$$

This chemical reaction is one of the two main sources of carbon dioxide during cement production.
The other main source of CO_2 is fuel burning in order to heat the kiln. After the calcination, the calcium oxide reacts with the other chemical compounds present at the temperatures between 1400 – 1450^{o}C. This reaction is called sintering. The final product of these reactions is called clinker. Clinker that comes out of the kiln is cooled and heat returned to the process by clinker coolers. Approximately 1.55 tons of raw materials are used to produce one ton of clinker.

4. Making cement from clinker
The last stage of cement production is fine crushing of clinker in cement mills to the state of powder. Mineral components (e.g. slag, fly ash, or gypsum) are added to the clinker and milled together in order to produce different types of cement.

Production process at Kryvyi Rih Cement

Plant operates one dry rotary kiln with calciner and cyclone system.

Capacity of the kiln is 4200 t/h of clinker. The fuel used is natural gas as predominant fuel in country cement industry. However, similarly to many Ukrainian cement plants, fuel switch from gas to local coals is scheduled in some middle to end 2009.

The process flow diagram is presented below.

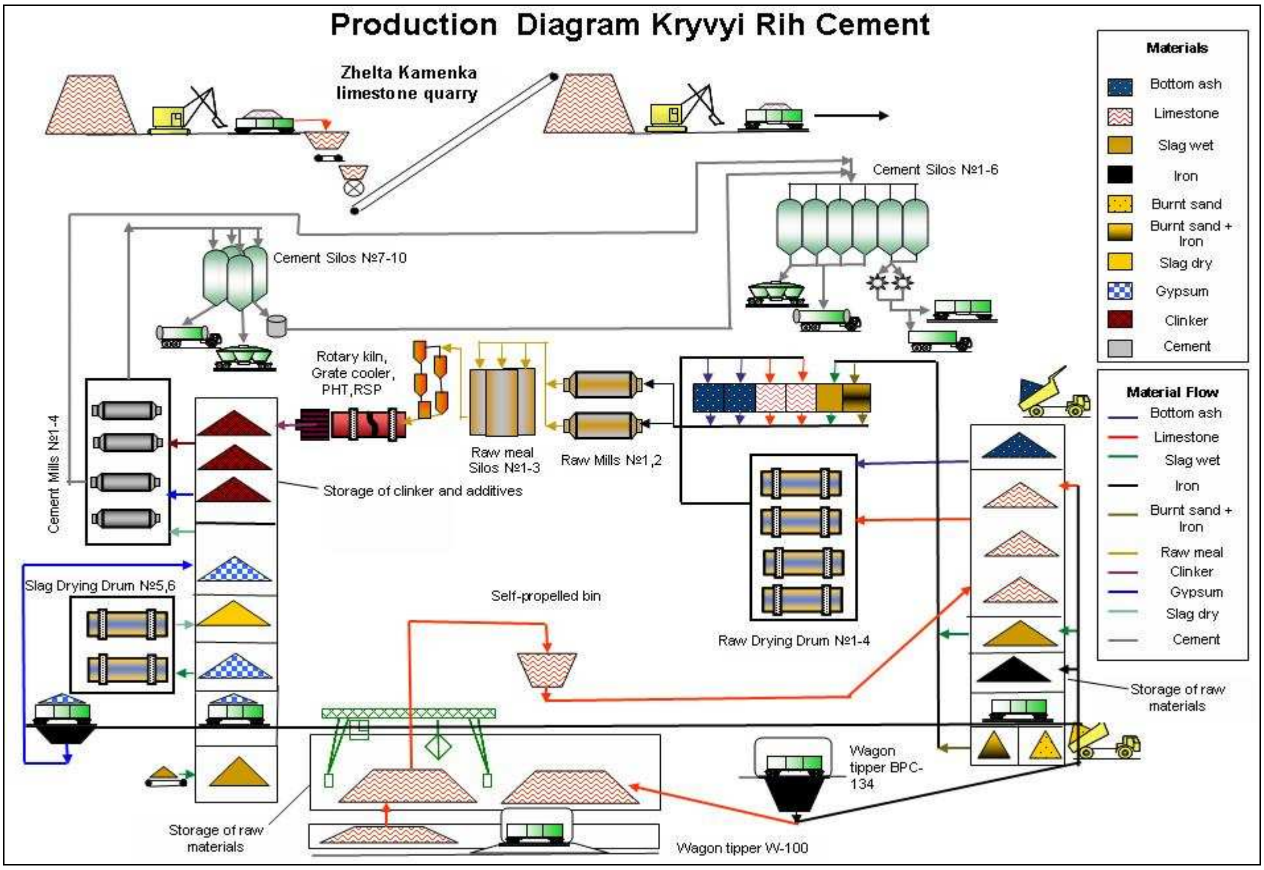

Figure 3: Existing dry process at Kryvyi Rih Cement.

Raw materials for clinker manufacturing
Situation before project implementation.
During long period of plant's operation since commissioning in 1983 only traditional raw materials (limestone and clay) were used. In late 1990-s (since 1997) certain test usage of AMC were performed and finally, by 2004 the proportion of AMC usage (GBFS[4]) was stabilized at the level of some 4% (Supporting Document SD5 for slag percentage addition over years and months and SD4 for data of raw material components and their chemical composition). It was found that the adoption of up to 4% of GBFS did not require significant changes of raw material composition and kiln operation and clinker quality remained stable.

The incentive to start of usage of AMC was the possibility to replace part of limestone which was transported from remote location by locally available slag disposed at Kryvyi Rih metallurgical plant. GBFS was chosen as AMC due to possibility to use it without separate grinding.

Situation after project implementation.
In order to use higher proportion of AMC process tests were made which has shown that increase the share of AMC higher than 4% would require changes of raw material composition i.e. more complex raw mix with some five components became necessary (see SD4). Before project implementation the raw mix contained only three components (limestone, clay and iron additive).

In order to adopt higher proportion of AMC Kryvyi Rih Cement, based on experience of addition of up to 4% of slag decided to make an investment of about 1,5 MEuro into additional equipment and instrumentation.

Over the period of 2004 to 2008 the proportion of slag was being increased from some 4% to 15-20% (see SD5 for slag addition percentage). These data show that the slag addition is not stable during the year and can vary from months to months. It can be explained by difficulties in adjusting the raw mix composition, clogging of materials into the kiln cyclones. Therefore, the annual average figures are to be used in order to measure the share of AMC addition.

Dry rotary kiln with cyclone system can be operated 300 to 320 days per year. The total production capacity of the existing installation can be approximately 1.1 million tonnes of clinker per year.

New equipment that will be installed for the project, including the sophisticated process control and measurement devices will require additional training for the operational personnel. Heidelberg cement, being an owner of Kryvyi Rih has substantial experience in operating and maintaining such equipment, will provide the necessary training.

Fuels in the cement sector
Important for cement sector projects is the type of fuel used.
In the countries - former Soviet Union members natural gas has been subsidized, allowing cement factories to continue using natural gas whereas in Western Europe and worldwide coal has been the main source of fuel[5]due to the higher cost of natural gas. Over past 3 years all the cement plants in the country have been facing an increasing price of natural gas. During 2005-2007 a doubling of gas prices

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[4] GBFS is defined as granulated blast furnace slag, see Global Slag webpage http://www.propubs.com/GS/SlagBasics.htm

[5] "Best Available Techniques" for the cement industry, CEMBUREAU, 1999

occurred for the industrial consumers and it is very unlikely that gas prices will not only return to previous level, but even stay at the current level[6].

As the fuel cost is an important factor in the production cost of cement, as well as reliability of its supply, Heidelbergcement decided to install a coal milling and handling system at Kryvyi Rih cement to enable the factory to switch to coal in the middle to end of 2009. The coal equipment is expected to be fully commissioned in the middle 2009.

The trend of the price of natural gas is upwards and will, in time, approach a level similar to those of Western and Central Europe. It is therefore unrealistic to assume that the plant will continue using natural gas as main kiln fuel after the commissioning of the coal mill (for reference: the conventional fuel in cement factories in Western Europe, USA, China and India is coal). Due to these factors only coal can be regarded as credible type of fuel in both, baseline and project scenarios.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

The objective of the proposed project is to partially replace the natural raw materials used for clinker manufacturing by slag. Slag being de-carbonated material allows the reduction in carbon emissions due to calcinations of raw materials containing calcium and magnesium carbonates into the kiln at high temperature. The project anticipates a usage of about 20% of slag in the raw mix which would replace the natural raw materials like limestone and clay.

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

	Years
Period before 2008 for which emission reductions are estimated	4
Year	Estimate of annual emission reductions in tones of CO_2 equivalent
2004	51,694
2005	93,252
2006	119,561
2007	106,684
Total estimated emission reductions over the period before 1 January 2008 (tones of CO2 equivalent)	371,191
Annual average of estimated emission reductions over the period before 1 January 2008 (tones of CO2 equivalent)	92,798

Table 2: Estimated emission reduction before the start of the crediting period

[6] http://en.wikipedia.org/wiki/Russia-Ukraine_gas_dispute

	Years
Length of the crediting period 2008-2012	5
Year	Estimate of annual emission reductions in tones of CO_2 equivalent
Year 2008	104,388
Year 2009	123,199
Year 2010	123,199
Year 2011	123,199
Year 2012	123,199
Total estimated emission reductions over the crediting period (tones of CO2 equivalent)	597,182
Annual average of estimated emission reductions over the crediting period (tones of CO2 equivalent)	119,436

Table 3: Estimated amount of emission reductions over the crediting period

Period after 2012 for which emission reductions are estimated	Estimate of annual emission reductions in tones of CO_2 equiv.
Year 2013	123,199
Year 2014	123,199
Year 2015	123,199
Year 2016	123,199
Year 2017	123,199
Year 2018	123,199
Year 2019	123,199
Year 2020	123,199
Total estimated emission reductions over the period indicated (tones of CO2 equiv.)	985,588
Annual average of estimated emission reductions over the period within 2013-2020 (tones of CO2 equiv.)	123,199

Table 4: Estimated amount of emission reductions generated after the crediting period

A.5. Project approval by the Parties involved:

On the 15 of January 2004 the Ministry of Environment of Ukraine has issued a Letter of Endorsement #273/21-7 supporting the slag addition project at Kryvyi Rih Cement.

On the 30 of October the Letter of Approval of the Netherlands #2009JI12 has been issued.

On the 19 of January 2010 the German Federal Environment Agency; German Emission Trading Authority has issued the German Letter of Approval for the proposd project.

On the 26 of July 2010 the National Environmental Investment Agency of Ukraine (DFP) has issued a Letter of Approval #1106/23/7 for the proposed project.

SECTION B. Baseline

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

Any baseline for a JI project should be set in accordance with the "Guidance on criteria for baseline setting and monitoring"[7]. In accordance with this Guidance, the project participants may use approved CDM methodologies (article 20 (a) of the Guidance) or can establish a baseline in accordance with appendix B of the JI guidelines using selected elements or combinations approved CDM baseline and monitoring methodologies (….) as appropriate (article 20 (b) of the Guidance).

For the cement industry for projects related to usage of alternative raw materials the existing CDM "Approved consolidated baseline and monitoring methodology" elements of ACM0015 version 02[8] can be used.

This methodology is applicable to project activities that use alternative raw materials that do not contain carbonates (AMC) in cement kilns for the production of clinker. The AMC partially or fully substitutes raw materials that contain calcium and/or magnesium carbonates (e.g. limestone) and that would otherwise be used in the kiln. This methodology is applicable under the following additional conditions:

- Use of alternative materials shall increase neither the capacity of clinker production nor the lifetime of the equipment;
- The methodology is applicable to existing as well as to greenfield plants;
- Type and quality of produced clinker remain the same in both baseline and project case;
- Alternative raw materials have been never used in the manufacturing facility prior to the implementation of the project activity;
- The quantity of AMC available shall be at least 1.5 times the quantity required for meeting the demand of all existing users, (…).
- There is sufficient historical information about the clinker manufacturing facility, the raw materials used and energy performance of the kiln.

This methodology is not applicable for the following activities:

- Energy efficiency initiatives for improvements in process equipment (…)
- Fuel switching

The proposed project activity has deviations from requirements of ACM0015 and therefore do not allow full application of ACM0015:

- Kryvyi Rih cement plant was using the AMC prior to project activity start, however to a small extent (less then 4%).

Due to the difference mentioned above, the ACM0015 can be used only partially.
A JI specific approach was chosen based on elements of the ACM0015.

Finally, for proving the additionality of the project the most recent "Tool for the demonstration and assessment of additionality (version 05.2)" has been applied. Please refer to section B.2.

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[7] http://ji.unfccc.int/Ref/Guida.html

[8] http://cdm.unfccc.int/EB/036/eb36_repan15.pdf

The following step by step approach is applied in order to describe and justify the baseline chosen.

Step 1. Indication and description of the theoretical approach chosen regarding baseline setting

The baseline is the scenario that reasonably represents the anthropogenic emission by source of greenhouse gases that would occur in absence of the proposed project[9]. The proposed project, not developed as a JI project, has been included as an alternative as well. These alternatives are assessed whether or not these alternatives are credible and plausible. The consistency between the baseline scenario determination and additionality determination has been checked.

In accordance with the Article 20 of JISC Guidance, option B for establishment of the baseline is selected:

(b) Alternatively, the project participants may establish a baseline that is in accordance with appendix B of the JI guidelines. In doing so, selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools may be used, as appropriate.[10]

Taking into account the JI specific approach selected for baseline establishment above, in accordance with the Article 21 of JISC Guidance, baseline will be identified according to option B of this article:

(b) By identifying and listing plausible future scenarios on the basis of conservative assumptions and identifying the most plausible one.[11]

The approach described above has been used to identify the baseline scenario for Kryvyi Rih Cement.

The most plausible future scenario will be identified by checking that all alternatives are consistent with mandatory applicable laws and regulations and by performing a barrier analysis. Should only two alternatives remain, of which one alternative should represent the project scenario with the JI incentive, the CDM Tool “Tool for the demonstration and assessment of additionality” shall be used to prove that the project scenario cannot regarded at the most plausible one.

Step 2. Application of the approach chosen

Sub step 2a. Identifying and listing plausible future scenarios.

To identify all realistic and plausible alternatives, all options which are consistent with current laws and regulations were regarded. According to ACM0015, at least the following scenarios have to be considered:

- The continuation of the current practice, i.e. a scenario in which the company continues cement production using the existing technology, fuel materials and raw materials;
- A scenario in which traditional raw materials, limestone and clay, are partially substituted by AMC[12] at a different rate than that of the project scenario. If relevant, different scenarios varying the degrees of different raw materials has to be developed;
- The proposed project activity not undertaken as CDM or JI project.

[9] JI guidelines, appendix B

[10] *Guidance For Criteria On Baseline Setting And Monitoring*, Joint Implementation Supervisory Committee, Article 20 (b)

[11] *Guidance For Criteria On Baseline Setting And Monitoring*, Joint Implementation Supervisory Committee, Article 21 (b)

[12] Alternative raw materials for clinker manufacturing that do not contain carbonates

At Kryvyi Rih Cement several options of slag usage are technically feasible and are discussed below.

Slag amount usage:

a. Using 0% slag
b. Using 4% slag
c. Using 20% slag

Type of AMC used:

There can be various types of AMC used for clinker manufacturing. Commonly available is the blast furnace slag (BFS). Different forms of BFS are produced depending on the method used to cool the molten slag in the iron production process. These products include air-cooled blast furnace slag (ACBFS), expanded or foamed slag, pelletized slag, and granulated blast furnace slag.

The two main types of BFS originate from pig iron production in Ukraine are ACBFC and GBFC. Second type of AMC is the electric arc furnace slag (EAFS) originating from steel production. Power generation can be the source of another AMC, the bottom ash, produced during combustion of coal in the boilers of thermal power plants (TPP).

According to abovementioned, the following AMCs or their combination can be considered:

a. EAFS;
b. Bottom ash from TPPS;
c. Air-cooled blast furnace slag ACBFC ;
d. Water cooled BFC (granulated slag or GBFC);
e. Mixture of GBFC and ACBFC of different proportion

Availability of EAFS is low in Ukrainian metallurgy as the share of steel produced in EAF is low. Moreover, there is no EAF operating at metallurgical plants in Kryvyi Rih region. Hence, usage of EAFS as AMC is unlikely as it is i) much less available in the country in general, ii) if to be used, shall be transported from remote location. Therefore, EAFS can be excluded from further consideration as project AMC type.

Bottom ash chemical composition depends to a great extent from types of coals combusted at the TPP and storage or disposal conditions.

Kryvyi Rih TPP typical bottom ash is very low in CaO and MgO (see Annex 4). It has been used as an aluminosilicate additive rather than as AMC. Therefore, it is further excluded from consideration of types of AMC.

Combining the remaining available options generates seven alternative baseline scenarios:

1. Slag usage of 0%
2. Air cooled slag usage of 4%
3. Air cooled slag usage of 20%
4. Granulated slag usage of 4%(continuation of the current practice)
5. Granulated slag usage of 20%(proposed project activity)
6. Addition of 4% of GBFC/ACBFC mixture
7. Addition of 20% of GBFC/ACBFC mixture

The seven alternatives are described below in more detail.

1) Production of clinker without slag addition

Kryvyi Rih Cement started production of clinker from the very beginning using traditional composition of raw material mix which consisted of approximately 74% of limestone and 24% of clay (see SD5 for raw material mix composition). Such basic composition was kept during many years approximately up to the end of 1990s. This alternative would constitute to full cancellation of slag usage as AMC for clinker production and return to initial design raw mix composition as it was in 1980-1990s.

2) Production of clinker adding 4% of air cooled slag

This alternative represents addition of some 4% of air cooled slag into the raw material mix. The incentive for this alternative is the reduction of specific kiln fuel consumption due to lower calcination of raw materials in the kiln.

To use the ACBFC, it has to pass crushing and screening. Additional equipment installation can be required or the slag supplier has to crush and screen it prior to shipment to Kryvyi Rih cement site. As BFS has different chemical composition than that of traditional raw material mix, it would be necessary to change the proportion of other raw materials for clinker kilns.

3) Production of clinker using 20% of air cooled slag

Similarly to Alternative 2 above, slag would be added to raw material mix in bigger volumes of approximately 20%.

4) Production of clinker using 4% of granulated slag

In this scenario some 4% of GBFS would be added to the raw material mix for clinker production. The incentive for this alternative is the reduction of specific kiln fuel consumption due to lower calcination of raw materials in the kiln.

Unlike the ACBFC, the GBFS does not require separate preliminary processing like crushing and screening. It is grinded and mixed together with other components.

Similarly to alternatives 2 and 3 above, BFS has different chemical composition than that of traditional raw material mix, it would necessary to change the proportion of other raw materials for clinker kilns.
This alternative represents the continuation of existing activity.

5) Production of clinker using 20% of granulated slag

Similarly to Alternative 4 above, GBFS would be added in just bigger proportion of approximately 20%. In practice, the proportion of slag addition during different times of the year could vary in the range of some 15 to 25% and the actual slag share would be monitored annually.

6) Production of clinker using 4% of slag mixture of GBFS and ACBFS

This alternative represents using both, granulated and air cooled slag in certain proportion, to partially replace traditional raw materials in clinker production. The incentive of slag addition would be, similarly to alternatives above, the reduction of specific kiln fuel consumption due to lower calcination of materials into the kiln. GBFS and ACBFS have similar chemical composition, but rather different mechanical properties. Unlike the GBFS, the ACBFS can require preliminary crushing and screening before introduction to the raw material flow. The incentive to use ACBFS in addition to GBFS is the better availability of the latter from the metallurgical plans, because it is less demanded and used by cement and other industries. In most cases big volumes of ACBFS are still disposed close to metallurgical plants.

7) Production of clinker using 20% of slag mixture of GBFS and ACBFS

Similarly to Alternative 6 above, mixture of GBFS and ACBFS would be used to partially replace the traditional raw materials in c linker production. The share of slag added would be increased to some 20%. In practice, the proportion of slag addition during different times of the year could vary in the range of some 15 to 22% and the actual slag share would be monitored annually.

This Alternative represents the proposed JI project in which Kryvyi Rih Cement would increase the addition of slag to some 20% and use mixture of GBFS and ACBFS. It does not take any JI incentive (transferring ERUs) into account. The required investment would be approximately 1.5 million Euro. This alternative had become fully possible with the increase of slag addition since 1 Jan 2004.

Sub step 2b. Consistency with mandatory applicable laws and regulations.

Existing Ukrainian laws and regulations does not restrict the usage of AMC in clinker manufacturing. Therefore, it can be considered that all listed alternatives do not contradict existing laws and regulations.

Sub step 2c. Barrier analysis

Kryvyi Rih Cement has been supplying cement for the Ukrainian market for a long time. Within this market it should work within the following constraints:

- The factory should meet the quality requirements of its clients;
- Technical risks, including the risks related to AMC usage shall be minimized and properly mitigated;
- The factory should be able to meet the growing demand for cement on the Ukrainian market;
- And the factory should be efficient and profitable at the same time;

Kryvyi Rih Cement started producing cement using traditional raw materials (limestone and clay) since the very beginning in 1982. Usage of traditional raw materials has been the predominant practice in the cement industry in Ukraine.

Addition of AMC in small amounts and irregularly, however, can be traced back to 1997. The incentive for it was, in absence of CO_2 trading prospective, primarily the usage of relatively cheap slag, being disposed by metallurgical plants and, secondly, the possibility of minor reduction of specific kiln fuel consumption. Addition of AMC was limited by just several percents due to technical difficulties related to operation of kiln system caused by slag.

Below the barriers are described that prevent slag usage:

1) Difficulties and disturbances in kiln system operation. Addition of both, GBFS and ACBFS into a raw mill. Due to higher sulphur and chlorine content in slag as to compare with traditional raw materials, increasing the share of slag leads to increase of sulphur and chlorine content in hot raw meal in cyclone system which creates clogging of the raw meal in the cyclones. This results in interruption of product flow through the kiln system, forces outages of the kiln and negatively impacts to its operation which can be considered as risk of technological failure (see SD2);

2) Slag represent a rock-like or glassy material which is harder and coarser than traditional raw materials which results in faster wear of raw mill separators, gas ducts, raw mill ducts and calciner. This result in increased repair cost and decrease of interval between repairs;
3) Usage of AMC increases the complexity of raw mix as to compare with traditional raw materials for clinker production. In order to maintain the required clinker quality and composition, more components shall be used. Before project implementation only three components were used. Implementation of project would require using five components (see SD4) which would require implementing on-line monitoring of raw mill and clinker chemical composition in order to maintain required clinker quality.

The existing dry kiln system is in good operational conditions and can be operated at least till 2012. The clinker production will be approximately 1 million ton a year.

Assessment of alternative 1: Production of clinker without addition of AMC
Usage of traditional natural raw materials is a predominant practice in country cement industry. Kryvyi Rih Cement was operating on natural raw material mix since the very beginning till the end of 1990s, when testing of small percentage of AMC addition started. The test proved the possibility to use small percentage of slag.

There are no legal or environmental requirements which would enforce Kryvyi Rig Cement to use AMC. The existing production equipment can continue operation at least until 2012. Therefore, the Alternative 1 is reasonable and feasible.

Assessment of alternative 2: Production of clinker adding 4% of air cooled slag
ACBFS has never been tested as the AMC. It has considerable differences in structural properties and important for the kiln operation difference in sulfur content as to compare with GBFS (tests were made during several years by 2004).

These differences may require installation of separate grinding/screening facility for slag (at project site or, alternatively, at slag origin site), sophisticated modernization of kiln gas side elements (e.g. introduction of gas bypass). These measures would require at least two years to be implemented and all the adjustments made. The result could be not successful, however. This represents an unnecessary risk. Therefore, this alternative is not reasonable.

Assessment of alternative 3: Production of clinker adding 20% of air cooled slag
Similarly to Alternative 2, ACBFS would be added to the raw material mix, but in higher proportion of approximately 20%. Due to same reasons as are described in Alternative 2 above, Alternative 3 is not a reasonable one.

Assessment of alternative 4: Production of clinker adding 4% of granulated slag
In this scenario some 4% of GBFS would be added to the raw material mix for clinker production. Other AMC like ACBFS would not be added. The incentive for this alternative is the reduction of specific kiln fuel consumption due to lower calcination of raw materials in the kiln.

Unlike the ACBFC, the GBFS does not require separate preliminary processing like crushing and screening. It is grinded and mixed together with other components. Tests were made during 2000-2003 to adopt the slag usage (to find out the optimum material composition and to install necessary equipment and instruments) which had proven the possibility of admission of certain proportion of slag.
Thus the Alternative 4, which represents the continuation of existing practice, is credible and plausible.

Assessment of alternative 5: Production of clinker adding of 20% of granulated slag

Similarly to Alternative 4 above, GBFS would be added in a bigger proportion of approximately 20%. In practice, the proportion of slag addition during different times of the year could vary in the range of some 15 to 25% and the actual slag share would be monitored annually. Other AMC like ACFS would not be added.

The GBFS is available from Ukrainian metallurgical plants (the nearest one is located in the same town of Kryvyi Rih). GBFS is widely used as an aggregate and insulating material. It is also been used as sand blasting shot materials. But mostly GFBS is used commercially as a supplementary cementitious material in Portland cement concrete (as a mineral admixture or component of blended cement). Increasing consumption of GBFS can lead to rising of its price and reduce availability of it on the market.

Thus, increasing the share of GBFS in clinker production to considerably high proportion of 20% may represent a risk (material cost and availability). From this point of view, usage only GBFS as AMC in large proportion for clinker production is realistic but not a credible alternative.

Assessment of alternative 6: Production of clinker using 4% of slag mixture of GBFS and ACBFS
This alternative would represent using both, granulated and air cooled slag in certain proportion, to partially replace traditional raw materials in clinker production. The incentive for this Alternative would be adoption of more complex AMC consisting of a mixture of GBFS and ACBFS and better availability of ACBFS. This alternative does not offer other benefits (like reduction of CO_2 emissions or decrease in specific kiln fuel consumption) as to compare to the Alternative 2 (addition of 4% of GBFS).

This alternative would become fully possible after successful fulfillment of tests to adopt the mixture of granulated and air cooled BFS and possibly installation of additional equipment and instruments.
Alternative 6 is a realistic but not a plausible one.

Assessment of alternative 7: Production of clinker using 20% of slag mixture of GBFS and ACBFS
Similarly to Alternative 6 above, GBFS and ACBFS would be used. The proportion of AMC would be increased to some 20%. In practice addition of AMC can float in the range of 15 to 25 % in function of kiln operation requirements and raw material composition. The incentives of this alternative would be i) decrease of specific kiln fuel consumption due to lower calcinations of AMC in the kiln and ii) possibility of usage of disposed ACBFS being less used by cement and other industries.
Increase the usage of AMC to such high extent bears the number of technical risks which could result in distortion of kiln system operation and which are accessed in section B.2. From this point of view the Alternative 7 is not credible and plausible.

Sub step 2d. Baseline identification

Alternatives 1 and 4 are the remaining realistic and credible alternatives, which do not face prohibitive barriers. The Alternative 4 has the lowest emissions and, in accordance with the methodology, is identified as the most conservative baseline scenario.

Baseline Emissions

The baseline emissions are established in the following way:
1. Emission sources in the baseline are: calcination; combustion of fuel in the kiln; consumption of electricity for raw mill preparation, kiln operation, fuel preparation and feeding; consumption of additional fuel for drying of raw meal or fuel drying (e.g. if coal is used).
1. The baseline emission of the kiln fuel is based on a three years average kiln efficiency and the carbon emission factor of the (or mix of) fuel used in the project scenario. This approach is identical

to the approach used in the project JI0001 "Switch from wet-to-dry process at Podilsky Cement" which determination was made final;
2. Similarly to the approach used in the project JI0001, baseline setting of AMC percentage and non-carbonated CaO and MgO contents in the raw mill and clinker;
3. Clinker and raw mill volume were set in a similar way to ACM0015;
4. The baseline emissions of the grid are established using the Ukrainian standardized grid factor as mentioned in Annex 2;

In order to elaborate baseline emissions the following assumptions were made:

- The emissions at the quarry would remain the same. Actually, substitution of quarried raw materials by AMC would lead to fewer raw materials quarried. Not taking this reduction into account is conservative;
- The technical life time of the existing kiln extends to at least the end of the crediting period;
- AMC (slag), used to replace traditional raw materials, is being transported from the adjacent metallurgical plant Arcelor Mittal Steel Kryvy Rih which is located in the same city of Kryvy Rih. Replacement of the amount of traditional raw materials by slag reduces the volume to be transported to the plant site. Therefore, there are no additional emissions due to slag transportation and hence leakages due to transportation are not applicable.

Similarly to ACM0015, the baseline emissions are calculated as follows:

Baseline emissions are calculated as follows:
Where:

$$BE_y = BE_{Calcin} + BE_{FC} + BE_{Dust} + BE_{dry} + BE_{EL\_grid}$$

Where:
BE_y is the baseline emissions for the year y (tCO_2)
BE_{Calcin} is the baseline CO_2 emissions from calcinations of calcium carbonate and magnesium carbonate contained in the raw materials during burning in the clinker kiln (tCO_2)
BE_{FC} is the baseline emissions due to kiln fuel combustion (tCO_2)
BE_{Dust} is the baseline emissions due to discarded dust from kiln bypass and kiln exhaust de-dusting system (tCO_2)
BE_{dry} is the baseline emissions due to additional fuel consumption for raw materials or fuel preparation, (tCO_2)
BE_{EL_grid} is the baseline emissions due to grid electricity consumption (tCO_2)

Baseline emission from calcinations

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

Where:
BE_{Calcin} is the baseline CO_2 emission from calcinations of calcium carbonate and magnesium carbonate (tCO2)
0.785 is the stoichiometric emission factor for CaO (tCO2/tCaO)
1.092 is the stoichiometric emission factor for MgO(tCO2/tMgO)
CaO_{CLNK_Bsl} is the non-carbonate CaO content in clinker in baseline (tonnes of CaO/tonne of clinker)
CaO_{RM_Bsl} is the non-carbonate CaO content in raw meal in baseline (tonnes of CaO/tonne of raw meal)

MgO_{CLNK_Bsl} is the non-carbonate MgO content in clinker in baseline (tonnes of MgO/tonne of clinker)
MgO_{RM_Bsl} is the non-carbonate MgO content in raw meal in baseline (tonnes of MgO/ tonne of raw meal)
$CLNK_{Bsl}$ is the annual production of clinker in the baseline (tonnes)
$ClNK_y$ is the actual annual production of clinker in the project year y (tonnes)
RM_{Bsl} is the annual consumption of raw meal in the baseline (tonnes)

Baseline emissions from combustion of fuels in the kiln
In order to obtain the baseline value of emissions due to combustion of fuel(-s) in the kiln, the historical specific kiln energy consumption values were used

$$BE_{FC} = KE_{BSL} \times \frac{\sum_i \left(FC_{i,y} \times NCV_i \times EF_{CO_2,y}\right)}{\sum_i \left(FC_{i,y} \times NCV_i\right)} \times CLNK_y$$

Where:
BE_{FC} is the baseline emissions due to kiln fuel combustion (tCO_2)
KE_{BSL} is the specific baseline kiln calorific consumption (kiln efficiency) (GJ/t clnk)
$FC_{i,\ y}$ is the kiln fuel of type i consumption during he year y (tons or thousand Nm^3)
$EF_{CO2,i}$ is the carbon emission factor of fuel of type i (tCO_2/GJ)
NCV_i is the net (lower) calorific value of fuel of type I (GJ/ton or thousand Nm^3)
$CLNK_y$ is the annual clinker production in year y (tonnes)

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

$$BE_{dust} = \left(BE_{calc} \times ByPass + \frac{BE_{calc} \times d}{\left[BE_{calc}(1-d)+1\right]} \times CKD_{Bsl} \right) \times \frac{CLNK_y}{CLNK_{Bsl}}$$

Where:
BE_{dust} is the annual baseline emission due to discarded dust from bypass and deducting unit (tCO_2)
BE_{calc} is the baseline emissions from calcination of the raw mill (tCO_2)
$ByPass_y$ is the annual production of bypass dust living kiln system (tonnes)
CKD_{Bsl} is the baseline production of CKD dust leaving kiln systems (tonnes)
d is the CKD calcinations rate % (released CO_2 expressed as a fraction of the total carbonates CO_2 in the raw meal)
$CLNK_y$ is the annual clinker production in year y (tonnes)
$CLNK_{Bsl}$ is the annual clinker production in baseline (tonnes)

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). Emission due to additional fuel consumption are defined as follows:

$$BE_{dry} = \sum_i \left(FC_{dry,Bsl} \times EF_{CO2,i}\right) \times \frac{CLNK_y}{CLNK_{Bsl}}$$

Where:
BE_{dry} is the baseline emissions due to additional fuel consumption for raw materials or fuel preparation, (tCO_2)
FC_{dry_Bsl} is the baseline consumption of fuel of type i for raw meal drying and kiln fuel preparation (GJ)
$EF_{CO2,i}$ is the carbon emission factor of fuel of type i (tCO_2/GJ)
$CLNK_y$ is the annual clinker production in year y (tonnes)
$CLNK_{Bsl}$ is the annual clinker production in baseline (tonnes)

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

$$BE_{El\_grid} = EL_{RM,kiln,Bsl} \div 1000 \times EF_{el,y} \times CLNK_y$$

Where:
$BE_{el,y}$ is the baseline emissions due to grid electricity consumption (tCO_2)
$EF_{el,y}$ is the carbon emission factor of electricity grid of Ukraine in year y (tCO_2/MWh)
$EL_{RM,kiln,Bsl}$ is the 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 (kWh/ton clinker)

Key information and data used to establish the baseline are provided below in tabular form:

Data/Parameter	**$CLNK_{Bsl}$**
Data unit	t
Description	Amount of clinker produced in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	738 567 tonnes
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**RM_{Bsl}**
Data unit	t
Description	Amount of raw mill consumed in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003

Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	1 163 977 tonnes
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**CaO_{RM_Bsl}**
Data unit	%
Description	Content of non-carbonated CaO in the raw mill in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	1.61
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**MgO_{RM_Bsl}**
Data unit	%
Description	Content of non-carbonated MgO in the raw mill in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	0.212
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**CaO_{CLNK_Bsl}**

Data unit	%
Description	Content of CaO in the clinker in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	65.67
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**MgO_{CLNK_Bsl}**
Data unit	%
Description	Content of non-carbonated MgO in the clinker in the baseline
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	1.8
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**$KE_{\_Bsl}$**
Data unit	GJ/ton of clinker
Description	Baseline kiln efficiency (baseline kiln economy)
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	3.67
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.

Any comment	No

Data/Parameter	**$EL_{RM, kiln, Bsl}$**
Data unit	kWh/ton of clinker
Description	Baseline grid electricity specific consumption for clinker production, including consumption of electricity for raw mill preparation, kiln electricity consumption, fuel preparation and feeding.
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	101.06
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

Data/Parameter	**FC_{dry_Bsl}**
Data unit	GJ
Description	Baseline consumption of fuel of type for raw meal drying and kiln fuel preparation
Time of determination/monitoring	Fixed ex-ante as average annual for 2001-2003
Source of data (to be) used	Project owner records
Value of data applied (for ex ante calculations/determinations)	169084
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Measured on site.
QA/QC procedures (to be) applied	According to the project owner policy.
Any comment	No

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

The latest "tool for demonstration and assessment of additionality (version 05.2)" has been applied to show that the anthropogenic emissions of the greenhouse gases are reduced below those that would have occurred in the absence of the JI project.

Preliminary screening
a) The project activity has been started since 1 January 2004 and the JI activity has started after 1st January 2004 as well. The PIN was elaborated during 2003 and the Letter of Endorsement supporting the project was issued by Ministry of Environment of Ukraine 15 January 2004.

b) Additional revenue from JI has been taken into account from the very beginning of the project development activities. The following documents are available providing evidence:
1. In 2002 Heidelbergcement group management made a decision to prepare a preliminary assessment of the JI eligibility of the project and to estimate of the emission reduction potential;
2. During 2003 a Project Idea Note was prepared and presented to the Ukrainian Ministry of Environment (MoE);
3. On the 15 of January 2004 the MoE had issued a Letter of Endorsement #273/21-7 supporting the project at Kryvyi Rih Cement

Step 1. Identification of alternatives to the project activity

The identified alternatives are identical to the alternatives mentioned in section B.1.

Step 2. Investment analysis
Not applicable. Barrier analysis has been chosen for additionality proof.

Step 3. Barrier analysis

Sub-step 3a. Identification of barriers that would prevent the proposed JI project activity

Investment barriers.
Investment cost of some 3 MEuro does not represent real barrier for cement industry. In the meantime, the possibility of AMC price increase (mainly price for GBFS, being more demanded and widely used for other application, while ACBFS is used to less extent, can increase) which could make the usage of AMC not profitable represent a financial risk (see slag price record by KRC in Annex5: Slag price record).

Technological barriers and prevailing practice barriers:
Below the main technological barriers are described which prevent from implementation of the project.

1. Difficulties and disturbances in kiln system operation. Addition of both, GBFS and ACBFS into a raw mill. Due to higher sulphur and chlorine content in slag as to compare with traditional raw materials, increasing the share of slag leads to increase of sulphur and chlorine content in hot raw meal in cyclone system which creates clogging of the raw meal in the cyclones. This result in interruption of product flow through the kiln system, forces outages of the kiln and negatively impacts to its operation which can be considered as risk of technological failure (see SD2);
2. Slag is harder and coarser than traditional raw materials which results in faster wear of raw mill separators, gas ducts, raw mill ducts and calciner. This result in repair cost and frequency increase;
3. Usage of AMC increases the complexity of raw mix as to compare with traditional raw materials for clinker production. In order to maintain the required clinker quality and composition, more components shall be used. Before project implementation only three components were used. Implementation of project would require using five components (see

SD4) which would require implementing on-line monitoring of raw mill and clinker chemical composition in order to maintain required clinker quality.

The barrier described above make the increase of slag share, and especially, admission of ACBFS difficult and risky. Technical difficulties and estimate of financial losses incurred by the increase of slag share addition are described in SD2.

Sub-step 3 b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except for the proposed project activity):

Identified barriers above do not prevent the implementation of at least one alternative to project activity, which is the Alternative 4 (usage of 4% of GBFS). By 2004 continuous testing of admission of up to some 4 % of slag allowed Kryvyi Rih Cement to build sufficient expertise and practice, construct optimum raw material composition to safely and reliably operate kiln system with 4% of slag. See SD5 where the slag addition record is provided.
During several years prior to the project start in 2004, the plant conducted experiments to add small ammounts of slag (up to 4%) in order to determine the best raw mix composition and to study how the slag admission affected the kiln's operation. It was found that slag in such small proportions does not seriously affect the kiln's operation, on the condition that the selection of raw mix composition is done properly. However, the addition of higher ammounts of slag would affect the kiln's operation (clogging of raw mix in the cyclone system prior to the kiln entrance). Thus, barriers identified do not prevent Alternative 4.

Step 4: Common practice analysis
Production of clinker from traditional raw materials being limestone and clay is a predominant practice in the cement industry of Ukraine, and also in neighboring Belarus and Russian Federation. The traditional raw materials are in vast majority of cases available from the quarries located near the cement plants.

Sub-step 4a: Analysis of other activities similar to the proposed project activity:

Among all 12 cement plants producing clinker in Ukraine only one – Dniprocement - has been using AMC in a large share. Dniprocement, being built in 1936, has been operating dry kilns designed to use BFS from adjacent Dneprodzerzhinsk metallurgical plant, does not have limestone quarry from the start of production. The raw mix consist of 35% of AMC, mainly GBFS (see SD3 for Dniprocement data).

The kiln at Dniprocement is of a long dry rotary type without cyclone system and without pre-calciner. This kiln configuration is much less sensitive to sulphur and chlorine content in raw materials then are the kilns with multi-stage cyclone system and pre-calciner as the one at Kryvyi Rih Cement. It represents a specific plant for usage of high percentage of non-carbonated materials.

Sub-step 4b: Discuss any similar Option that are occurring:

Except for Dniprocement no similar plants can be observed in the region that use non-carbonated raw material in excess of 4%.
The proposed project differs significantly from similar project observed in the sub-step above.

Due to
i) different kiln system and ii) design raw material mix oriented on locally generated slag usage:
ii) absence of limestone quarry:

Dniprocement case represent an essential distinction from the proposed project activity and therefore can be excluded from the consideration of usage of slag as AMC for clinker production in Ukraine.

Usage of AMC in Ukrainian Cement industry is uncommon. No other cement plant in Ukraine operating dry kilns are using AMC and slag in particular. There is no Ukrainial law or regulation in force that requires cement plants to use alternative raw materials, including slag as partial substitute of raw materials for clinker manufacturing.

Therefore, the prevailing practice of usage of natural raw materials and predominant usage of wet kilns without cyclone system in the cement industry of Ukraine represent a barrier to the proposed JI project activity.

The proposed JI project activity is not common practice and is first of its kind in Ukrainian Cement industry.

Conclusion
The registration of the proposed JI activity would help to overcome the technical barriers and help in bearing financial losses caused by interruptions in kiln system operation caused by slag addition which represents the main technological barrier to the project implementation. In addition, it would soften the risk of AMC price increase. For example, annual losses due to clogging estimated as doubled half-year losses are equal to 703,820 Euro which is about a half of expected JI revenue of 1,618,125 Euro from 107,875 tCO_2 to be generated in 2008. Estimated price for 1 ERU is 15 Euro.

Conclusion: the impact of the proposed JI project activity will alleviate financial risks of AMC price increase and will alleviate technological barriers and risks to the project.

This JI project provides a reduction in emissions that is additional to any that would otherwise occur.

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

There are three different sources of GHG emissions while producing cement:
- Fuel combustion;
- Geogenic emission from the calcination (decarbonisation) process of the limestone or chalk contained in the raw materials during burning in the clinker kiln;
- GHG emission in the Ukrainian Power grid as a result of electricity consumption.

In the table below an overview of all emission sources in the cement production process are given. The following approach has been used in determining whether they have been included in the project boundary:
- All sources of emissions that are not influenced by the project have been excluded;
- All sources of emissions that are influenced by the project have been included.

No	Source	Gas[13]			Justification/Explanation

[13] Only CO_2 emissions are taken into account. CH_4 and N_2O emission reduction are omitted. This is conservative and is in line with all cement CDM methodologies mentioned in section B.1. Please refer also to the general remarks in section D.1.

1	Change in fuel consumption at the quarry and raw material transport	CO_2	Direct	Excluded	• Fossil fuel consumption will decrease[14]. Excluding it is conservative.
2	Change in grid electricity consumption at the quarry	CO_2	Indirect	Excluded	• Electricity consumption will decrease[15]. Excluding it is conservative
3	Change in grid electricity in the raw material transport:	CO_2	Indirect	Included	• The electricity consumption will decrease • Emissions calculated using standardized electricity baseline Ukraine[16]
4	Change in grid electricity consumption at the raw milling preparation:	CO_2	Indirect	Included	• The electricity consumption will decrease • Emissions calculated using standardized electricity baseline Ukraine[17]
5	Change in electricity consumption of the kiln (e.g. motors for rotation, fans)	CO_2	Indirect	Included	• The electricity consumption will decrease • Emissions calculated using standardized electricity baseline Ukraine
6	Change in fossil fuel combustion in kiln	CO_2	Direct	Included	• The fossil fuel combustions will decrease
7	Change in grid electricity consumption at the coal mill	CO_2	Indirect	Included	• The electricity consumption will decrease • Emissions calculated using standardized electricity baseline Ukraine
8	Fuel combustion to dry the coal	CO_2	Direct	Included	• The fuel consumption will decrease in the project scenario
9	Change in geogenic emission (calcination)	CO_2	Direct	Included	The specific geogenic emission from calcination will be decreased due to use of slag in raw material. It represents main emission source.

[14] Raw material extraction will decrease as it will be partially replaced by slag. Therefore, fuel and electricity consumption at the quarry will decrease as well. Not taking the decrease into account is conservative.

[15] Raw material extraction will decrease as it will be partially replaced by slag. Therefore, fuel and electricity consumption at the quarry will decrease as well. Not taking the decrease into account is conservative.

[16] Kryvyi Rih Cement does not have on-site power generation facilities.

[17] Kryvyi Rih Cement does not have on-site power generation facilities.

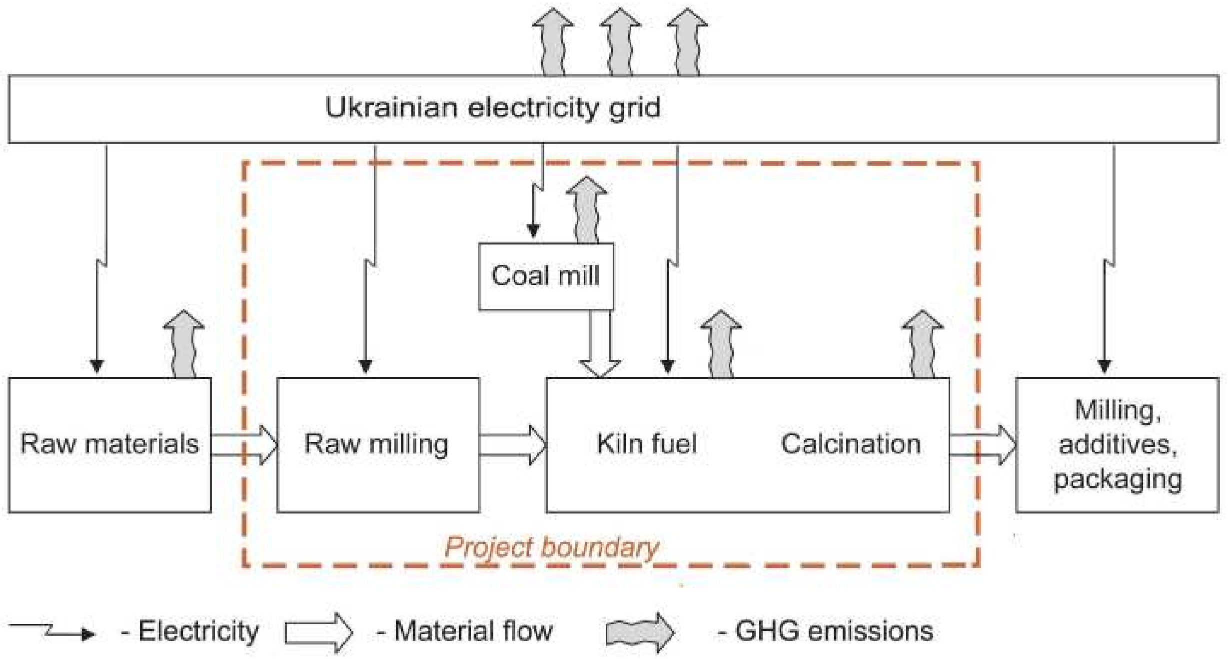

Figure 4: Sources of emissions and project boundary

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

Date of completion of the baseline study: 20/08/2010

Name of person/entity setting the baseline:
Alexey Doumik
E-mail: Doumik@global-carbon.com
Web: www.global-carbon.com
Global Carbon BV

See Annex1 for detailed contact information.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

Date of project beginning: 1 January 2004 for increase of slag addition as raw material.

C.2. Expected operational lifetime of the project:

At least untill 2023 or 228 months.

The project does not foresee replacement or major upgrade of kiln and raw mill system, but the lifetime of them are essential. The lifetime achieved of such systems is in excess of 30 years, with many examples exceeding even 40 years. Kiln and raw mill system at Kryvyi Rih Cement has been commissioned in 1983 which represents one of the most recently installed capacities, and therefore can continue operation at least nineteen years from project start date (untill 2023).

C.3. Length of the crediting period:

Start of crediting period: 01/01/2008.
Length of crediting period: 5 years or 60 months.

Emission reductions generated before and after the crediting period may be used in accordance with an appropriate mechanism under the UNFCCC.

For the period up to 31 December 2007 Early Credits will be claimed to be transferred through Article 17 of the Kyoto Protocol (IET).
For the period up to 31 December 2007: 4 years or 48 months.

For the period from 31 December 2012 till 2023: 11 years or 132 months.

All emission reductions have been calculated by applying an identical approach regarding baseline setting and monitoring.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

In order to provide a detailed description of the monitoring plan chosen a step-wise approach is used:

Step 1. Indication and description of the approach chosen regarding monitoring

Option *b* provided by the Guidelines For The Users Of The Joint Implementation Project Design Document Form, Version 03[18] is used: JI specific approach is used in this project and therefore will be used for establishment of monitoring plan.

Step 2. Application of the approach chosen

As elaborated in section B.3, the project activity only affects the emissions related to the kiln fuel, calcination (decarbonisation), the electricity consumption of the raw milling, the kilns. For the purpose of establishing the baseline emissions and to monitor the project emissions, only these emissions will be monitored.

Baseline emissions

- The baseline emission of the kiln fuel is based on a three years average kiln efficiency and the carbon emission factor of the (or mix of) fuel used in the project scenario. This approach is identical to the approach used in the project JI0001 "Switch from wet-to-dry process at Podilsky Cement" which determination was made final;
- Similarly to the approach used in the project JI0001, baseline setting of AMC percentage, CaO and MgO contents in the raw mill and clinker;
- Clinker and raw mill volume were set in a similar way to ACM0015;
- The baseline emissions of the grid are established using the Ukrainian standardized grid factor as mentioned in Annex 2;

Project emissions

In the project scenario some 20% of AMC is being added thus reducing the amount of natural raw materials used. It would allow to reduce the emissions due to calcinations of raw materials in the kiln. The actual content of non-carbonated CaO and MgO in raw mill and clinker will be measured to calculate the amount of CO_2 released during calcinations process. Reduction of amount of natural raw materials replaced by AMC would, in addition result in reduction of kiln fuel or reduction of specific fuel consumption in the kiln.

[18] http://ji.unfccc.int/Ref/Documents/Guidelines_%28version_03%29.pdf

Data and parameters that are not monitored throughout the crediting period, but are determined only once are provided in respective tables of section D.

Assumptions:

- The emissions at the quarry would remain the same. Actually, substitution of quarried raw materials by AMC would lead to fewer raw materials quarried. Not taking this reduction into account is conservative;
- The technical life time of the existing kiln extends to at least the end of the crediting period;
- AMC (slag), used to replace traditional raw materials, is being transported from the adjacent metallurgical plant Arcelor Mittal Steel Kryvy Rih which is located in the same city of Kryvy Rih. Replacement of the amount of traditional raw materials by slag reduces the volume to be transported to the plant site. Therefore, there are no additional emissions due to slag transportation and hence leakages due to transportation are not applicable.

General remarks:

- Social indicators such as number of people employed, safety record, training records, etc, will be available to the verifier if required;
- Environmental indicators such as dust emissions, NOx, or SOx will be available to the verifier if required;
- For the greenhouse gas emissions only the CO_2 emissions are taken into account. Cement kilns normally have a CH_4 emission of 0.06 g/kg of clinker and N2O emissions of 0.001 g/kg of clinker compared with more than 650 g CO2 / kg of clinker. Omitting these two emissions for a cement kiln is conservative, because they contribute to less than 0.01% of the total emissions, far below the confidence level for the CO2 data calculations. This is confirmed in the VDZ Environmental Report 2001 (English) and 2004 (German). The CH_4 and N_2O emission reductions will not be claimed. This is conservative.

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
P1	PE_y	Plant records	tCO_2	C	Annually	100%	Electronic and paper	

P2	$PE_{calc,y}$	Plant records	tCO_2	C	Annually	100%	Electronic and paper	
P3	$PE_{Fuel\_kiln,y}$	Plant records	tCO_2	C	Annually	100%	Electronic and paper	
P4	$PE_{dust,y}$	Plant records	tCO_2	C	Annually	100%	Electronic and paper	
P5	$PE_{dry,\ y}$	Plant records	tCO_2	C	Annually	100%	Electronic and paper	
P6	$PE_{EL\_grid,y}$	Plant records	tCO_2	C	Annually	100%	Electronic and paper	
P7	$CaO_{clnk,y}$	Plant records	%	M/C	daily	100%	Electronic and paper	Kryvyi Rih Cement plant laboratory measurement
P8	$CLNK_{y}$	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	
P9	$CaO_{RM,y}$	Plant records	%	M/C	daily	100%	Electronic and paper	Kryvyi Rih Cement plant laboratory measurement
P10	$RM_{,y}$	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	
P11	$MgO_{CLNK,y}$	Plant records	%	M/C	daily	100%	Electronic and paper	Kryvyi Rih Cement plant laboratory measurement

P12	$MgO_{RM,y}$	Plant records	%	M/C	daily	100%	Electronic and paper	Kryvyi Rih Cement plant laboratory measurement
P23	SKC_y	Plant records	GJ/tonne of clinker	M/C	annually	100%	Electronic and paper	
P24	$FC_{i,kiln,\ y}$	Plant records	GJ	M/C	Annually	100%	Electronic and paper	Weighted average of all shipments
P25	$EF_{CO2,\ i}$	Plant records	tCO_2/GJ	M/C	Annually	100%	Electronic and paper	
P26	$ByPass_{,\ y}$	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	It is not foreseen to equip the existing dry kiln system with bypass, therefore ByPass=0
P27	$CKD_{,\ y}$	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	
P28	$d_{,\ y}$	Plant records	%	M/C	Annually	100%	Electronic and paper	
P29	$FC_{drums,\ y}$	Plant records	GJ	M/C	Annually	100%	Electronic and paper	
P30	$EF_{el,\ y}$	Plant records	tCO_2/MWh	M/C	Annually	100%	Electronic and paper	BEF of Ukrainian grid
P31	$EC_{RM,\ kiln,\ y}$	Plant records	MWh	M/C	Annually	100%	Electronic and paper	

Table 5: Data to be collected in the project scenario

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

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

Where:

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

Calcination

Emissions from calcinations is defined as follows:

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

Where:

$PE_{calc,y}$	is the project emission due to calcination of calcium carbonate and magnesium carbonate contained in the raw mill during pyroporocessing in clinker kiln in year y (tCO_2)
0.785	is the stoichiometric emission factor for CaO (tCO2/tCaO)
1.092	is the stoichiometric emission factor for MgO(tCO2/tMgO)
$CaO_{CLNK,y}$	is the non-carbonate CaO content in clinker in year y (tonnes of CaO/tonne of clinker)
$CaO_{RM,y}$	is the non-carbonate CaO content in raw meal in year y(tonnes of CaO/tonne of raw meal)
$MgO_{CLNK,y}$	is the non-carbonate MgO content in clinker in year y (tonnes of MgO/tonne of clinker)
$MgO_{RM\_PR,y}$	is the non-carbonate MgO content in raw meal in year y (tonnes of MgO/ tonne of raw meal)
$CLNK_y$	is the annual production of clinker y (tonnes)
RM_y	is the annual consumption of raw meal in year y (tonnes)

Kiln fuel

The emissions due to kiln fuel combustions above are defined as follows:

$$PE_{kiln,y} = \frac{SKC_y \times \sum(FC_{i,kiln,y} \times NCV_{i,y} \times EF_{CO2,i})}{\sum FC_{i,kiln,y} \times NCV_{i,y}} \times CLNK_y \qquad (3)$$

Where:

$PE_{Fuel\_kiln,y}$ Project emission from combustion of kiln fuels in year y (tCO_2)
SKC_y is the Specific Kiln Calorific consumption, (GJ/tonne of clinker)
$FC_{i,kiln,y}$ is the fuel of type *i* consumed by the kiln during the year y (ton ot thousand Nm^3)
$EF_{CO2,i}$ fuel of type *i* Emission Factor (tCO_2/GJ)
$NCV_{i,y}$ is the net (lower) calorific value of fuel of type i in year y(ton or thousand Nm^3)
$CLNK_y$ is the annual production of clinker y (tonnes)

Bypass dust

If there is a discarded bypass dust from kiln bypasses and dedusting units (CDK), the project emissions due to discarded dust shall be determined as follows:

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

Where:

$PE_{dust,y}$ is the annual emission due to discarded dust from bypass and deducting unit (tCO_2)
$PE_{calc,y}$ is the project emissions from calcination of the raw mill in the year y (tCO_2)
$ByPass_y$ is the annual production of bypass dust living kiln system (tonnes)
CKD_y is the annual production of CKD dust leaving kiln systems (tonnes)
d_y is the CKD calcinations rate % (released CO_2 expressed as a fraction of the total carbonates CO_2 in the raw meal)
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 mill and fuel

In addition to fuel consumption by the clinker kiln and calciner, fuel is also consumed by raw mill drying drums and dryer of coal mill.

$$PE_{dry,y} = FC_{drums,y} \times NCV_{fd,y} \times EF_{CO2} \quad (5)$$

Where:

$PE_{dry,\,y}$ is the project emission due to additional fuel consumption for raw mill drying in the drying mill in year y (tCO_2)
EF_{CO2} is the fuel of type *i* used for raw mill drying Emission Factor (tCO_2/GJ)
$FC_{drums,y}$ is the fuel consumption for drying drums (ton or thousand Nm^3)
$NCV_{fd,y}$ is the net (lower) calorific value of fuel used for drying in year y(ton or thousand Nm^3)

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 mill and for fuel preparation and feeding in the kiln system

$$PE_{El\_grid,y} = EL_{RM,kiln,y} \div 1000 \times EF_{el,y} \quad (6)$$

Where:

$PE_{El\_grid,\,y}$ is the project emission due to electricity consumption for preparation of raw mill, for clinker kiln system operation and for fuel feeding y (tCO_2)
$EF_{el,\,y}$ is the carbon emission factor of electricity grid of Ukraine in year y (tCO_2/MWh)
$EL_{RM,\,kiln,y}$ is the grid electricity consumption for clinker production, including consumption of electricity for raw mill preparation, kiln electricity consumption, fuel preparation and feeding in year y (kWh)

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

B1	BE_y	Plant records	tCO2	C	annually	100%	Electronic and paper	
B2	$BE_{calc,y}$	Plant records	tCO2	C	annually	100%	Electronic and paper	
B3	$BE_{FC,y}$	Plant records	tCO2	C	annually	100%	Electronic and paper	
B4	$BE_{Dust,y}$	Plant records	tCO2	C	annually	100%	Electronic and paper	
B5	$BE_{dry,y}$	Plant records	tCO2	C	annually	100%	Electronic and paper	
B6	$BE_{El\_grid,y}$	Plant records	tCO2	C	annually	100%	Electronic and paper	BEF of Ukrainian grid
B7	$CLNK_{Bsl}$	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	For setting details see Annex2
B8	RM_{Bsl}	Plant records	tonnes	M/C	Annually	100%	Electronic and paper	For setting details see Annex2
B9	$CaO_{clnk,Bsl}$	Plant records	%	M/C	daily	100%	Electronic and paper	For setting details see Annex2
B10	$CaO_{RM,Bsl}$	Plant records	%	M/C	daily	100%	Electronic and paper	For setting details see Annex2
B11	$MgO_{clnk,Bsl}$	Plant records	%	M/C	daily	100%	Electronic and paper	For setting details see Annex2
B12	$MgO_{RM,Bsl}$	Plant records	%	M/C	daily	100%	Electronic and paper	For setting details see Annex2

B13	KE_{Bsl}	Plant records	GJ/ton clinker	M/C	annually	100%	Electronic and paper	For setting details see Annex2
B14	$FC_{i,y}$	Plant records	Tons or volumetric units	M/C	annually	100%	Electronic and paper	
B15	NCV_i	Plant records	GJ/ton or volumetric unit	M/C	Per shipment	100%	Electronic and paper	Weighted average of all shipments will be taken over a calendar year for each fuel.
B16	*ByPass*	Plant records	tonnes	M/C	annually	100%	Electronic and paper	In the baseline the kiln system is not equipped with bypass, therefore ByPass=0
B17	*d*	Plant records	%	M/C	annually	100%	Electronic and paper	
B18	CKD_{Bsl}	Plant records	tonnes	M/C	annually	100%	Electronic and paper	
B19	$FC_{dry,\ i}$	Plant records	Tonnes or volumetric units	M/C	annually	100%	Electronic and paper	Weighted average of all shipments will be taken over calendar year for each fuel
B20	$EL_{RM,\ kiln,\ Bsl}$	Plant records	MWh	M/C	annually	100%	Electronic and paper	

Table 6: Data to be collected in the baseline scenario

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

Baseline emissions are calculated as follows:
Where:

$$BE_y = BE_{Calcin} + BE_{FC} + BE_{Dust} + BE_{dry} + BE_{EL\_grid} \qquad (7)$$

Where:

BE_y	is the baseline emissions for the year y (tCO_2)
BE_{Calcin}	is the baseline CO_2 emissions from calcinations of calcium carbonate and magnesium carbonate contained in the raw materials during burning in the clinker kiln (tCO_2)
BE_{FC}	is the baseline emissions due to kiln fuel combustion (tCO_2)
BE_{Dust}	is the baseline emissions due to discarded dust from kiln bypass and kiln exhaust de-dusting system (tCO_2)
BE_{dry}	is the baseline emissions due to additional fuel consumption for raw materials or fuel preparation, (tCO_2)
BE_{EL_grid}	is the baseline emissions due to grid electricity consumption (tCO_2)

Baseline emission from calcinations

$$BE_{Calcin} = \frac{CLNK_y}{CLNK_{Bsl}} \times \left(0.785 \times \left(CaO_{CLNK\_Bsl} \times CLNK_{Bsl} - CaO_{RM\_Bsl} \times RM_{Bsl}\right) + 1.092 \times \left(MgO_{CLNK\_Bsl} \times CLNK_{Bsl} - MgO_{RM\_Bsa} \times RM_{Bsl}\right)\right) \qquad (8)$$

Where:

BE_{Calcin}	is the baseline CO_2 emission from calcinations of calcium carbonate and magnesium carbonate (tCO2)
0.785	is the stoichiometric emission factor for CaO (tCO2/tCaO)
1.092	is the stoichiometric emission factor for MgO(tCO2/tMgO)
CaO_{CLNK_Bsl}	is the non-carbonate CaO content in clinker in baseline (tonnes of CaO/tonne of clinker)
CaO_{RM_Bsl}	is the non-carbonate CaO content in raw meal in baseline (tonnes of CaO/tonne of raw meal)
MgO_{CLNK_Bsl}	is the non-carbonate MgO content in clinker in baseline (tonnes of MgO/tonne of clinker)
MgO_{RM_Bsl}	is the non-carbonate MgO content in raw meal in baseline (tonnes of MgO/ tonne of raw meal)
$CLNK_{Bsl}$	is the annual production of clinker in the baseline (tonnes)
$ClNK_y$	is the actual annual production of clinker in the project year y (tonnes)

RM_{Bsl} is the annual consumption of raw meal in the baseline (tonnes)

Baseline emissions from combustion of fuels in the kiln

In order to obtain the baseline value of emissions due to combustion of fuel(-s) in the kiln, the historical specific kiln energy consumption values were used

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

Where:

BE_{FC} is the baseline emissions due to kiln fuel combustion (tCO_2)

KE_{BSL} is the specific baseline kiln calorific consumption (kiln efficiency) (GJ/t clnk)

$FC_{i,\,y}$ is the kiln fuel of type i consumption during he year y (tons or thousand Nm^3)

$EF_{CO2,i}$ is the carbon emission factor of fuel of type i (tCO_2/GJ)

NCV_i is the net (lower) calorific value of fuel of type I (GJ/ton or thousand Nm^3)

$CLNK_y$ is the annual clinker production in year y (tonnes)

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

$$BE_{dust} = \left(BE_{calc} \times ByPass + \frac{BE_{calc} \times d}{\left[BE_{calc}(1-d)+1\right]} \times CKD_{Bsl} \right) \times \frac{CLNK_y}{CLNK_{Bsl}} \qquad (10)$$

Where:

BE_{dust} is the annual baseline emission due to discarded dust from bypass and deducting unit (tCO_2)

BE_{calc} is the baseline emissions from calcination of the raw mill (tCO_2)

$ByPass_y$ is the annual production of bypass dust living kiln system (tonnes)

CKD_{Bsl} is the baseline production of CKD dust leaving kiln systems (tonnes)

d is the CKD calcinations rate % (released CO_2 expressed as a fraction of the total carbonates CO_2 in the raw meal)

$CLNK_y$ is the annual clinker production in year y (tonnes)

$CLNK_{Bsl}$ is the annual clinker production in baseline (tonnes)

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). Emission due to additional fuel consumption are defined as follows:

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

Where:

BE_{dry}	is the baseline emissions due to additional fuel consumption for raw materials or fuel preparation, (tCO_2)
FC_{dry_Bsl}	is the baseline consumption of fuel of type i for raw meal drying and kiln fuel preparation (GJ)
$EF_{CO2,i}$	is the carbon emission factor of fuel of type i (tCO_2/GJ)
$CLNK_y$	is the annual clinker production in year y (tonnes)
$CLNK_{Bsl}$	is the annual clinker production in baseline (tonnes)

Baseline emission from grid electricity consumption for clinker production

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

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

Where:

$BE_{el,y}$	is the baseline emissions due to grid electricity consumption (tCO_2)
$EF_{el,y}$	is the carbon emission factor of electricity grid of Ukraine in year y (tCO_2/MWh)
$EL_{RM,kiln,Bsl}$	is the 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 (kWh/ton clinker)

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

Not applicable.

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

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

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

D.1.3. Treatment of leakage in the monitoring plan:

Due to short slag transport distance between slag deposits from Kryvyi Rih Arcelor Mittal steel and Kryvyi Rih Cement the effect of leakage from slag transportation can be neglected.In addition, the influence of slag transportation is offset as slag replaces the equal anmount of natural raw materials which otherwise would have to be transported to the plant site. For concervativeness the effect of reduction of volume of natural raw materials transportation is not claimed in overall emission reductions. Other leakages were not identified.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

Not applicable

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

$$ER_y = BE_y - PE_y \quad (13)$$

Where:
ER_y is emission reduction of the JI project in year y (tCO_2e)
BE_y is the baseline emissions in year y (tCO_2e)
PE_y is the project emissions in year y (tCO_2e)

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

Atmospheric emissions are the only important source of pollution at Kryvyi Rih Cement that has an impact on the local environment. According to the national requirements, atmospheric emissions have to be measured by making samples according to the special schedule, agreed with authority.

Kryvyi Rih Cement systematically collects data on the pollutants that have an impact on the local environment. As of September 2008 the independent sub-contract environmental laboratory makes measurements of the following emissions:

Gaseous pollutants (CO, NOx & SOx)

Gaseous pollutants are measured by means of a mobile gas spectrometer. It is used to measure the gaseous emissions periodically, according to the special schedule by taking samples with mobile gas spectrometer. Currently there are little emissions of SOx at Kryvyi Rih Cement, but the existing gas spectrometer would measure SOx emissions should they appear.

Dust emissions

The emissions of dust are measured by the independent sub-contract laboratory using the weighing method. The level of dust is being measured by weighing a filter installed for a certain time in the exhaust air flow. Samples are taken also according to the special schedule.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Table 5		
P7 $CaO_{clnk, y}$	low	Accredited laboratory of Kryvyi Rih Cement is taking samples and conduct the test. The data are archived. Frequency of tests every 1 hour. The laboratory department will calculate the average.
P8 $CLNK_y$	low	Annual sum of daily reports of kiln department. The measurements are based on constant measurements of raw meal consumption of the kiln and take into account composition, moisture content and loss of ignition (LOI) of raw meal. These properties of raw meal are tested every 2 hours by plant laboratory
P9 $CaO_{RM\ y}$	See P7	Please, refer to P7. Frequency of sampling is 4 hours.
P10 RM_y	medium	Annual sum of daily reports of kiln department. See P8
P11 $MgO_{CLNK, y}$	low	Please, refer to P7
P12 $MgO_{RM, y}$	See P11	Please, refer to P11
P24 $FC_{i, kiln, y}$	low	Metering of kiln fuel consumption for each of the fuels used is done by metering system. Data is collected and stored. Calibration is done according to suppliers requirements by authorised organisation
P27 CKD_y	medium	
P28 d_y	medium	

P29 $FC_{drums, y}$	medium	Fuel (natural gas) consumption of drying drums is measured by metering system. Data is collected and stored. Calibration is done in accordance with suppliers requirements by authorised organisation.
P31 $EC_{RM, kiln, y}$	medium	Individual electricity meters are installed to measure the consumption of electricity of raw mill preparation and kiln equipment. They are to be calibrated every 3 to 6 years in function of manufacturer and type. Calibration is done by an authorised organisation. The reading is collected by energy department and stored.
Table 6		
B7 $CLNK_{Bsl}$	low	See Annex2 where baseline setting is described
B8 RM_{Bsl}	medium	See Annex2 where baseline setting is described
B9 $CaO_{clnk, Bsl}$	low	See Annex2 where baseline setting is described
B10 $CaO_{RM, Bsl}$	low	See Annex2 where baseline setting is described
B11 $MgO_{CLNK, Bsl}$	low	See Annex2 where baseline setting is described
B12 $MgO_{RM, Bsl}$	low	See Annex2 where baseline setting is described
B13 KE_{Bsl}	low	See Annex2 where baseline setting is described
B14 $FC_{i, y}$	low	See Annex2 where baseline setting is described
B15 NCV_i	low	See Annex2 where baseline setting is described
B17 d	medium	See Annex2 where baseline setting is described
B18 CKD_{Bsl}	medium	See Annex2 where baseline setting is described
B19 $FC_{dry, i}$	low	See Annex2 where baseline setting is described
B20 $EL_{RM, kiln, Bsl}$	low	See Annex2 where baseline setting is described

Table 7: Quality control and quality assurance.

Internal quality system at Kryvyi Rih Cement

The internal quality system at Kryvyi Rih Cement is functioning in accordance with the national standards and regulations in force and ISO9001. The quality of cement, clinker and all raw components is continuously controlled by the laboratory of the plant. The laboratory is certified by the Kryvyi Rih State Metrology, Standardisation and Accreditation Agency of Ukraine, certificate № ПЄ0047/2005 (Ukr) from23/11/2005, valid until 23/11/2008.

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

Three departments of Kryvyi Rih Cement will be responsible for collecting the information for monitoring purposes.

The laboratory of Kryvyi Rih Cement
The laboratory of Kryvyi Rih Cement is responsible for quality control of cement, clinker, raw mill and raw materials/corrective additives.

Energy department
The energy department is responsible for control of fuel and electricity consumption at Kryvyi Rih Cement. It collects data from the commercial power meters at the plant feeding power transformers and individual electricity meters installed at the production units that consume electricity. The data from individual electricity meters is cross-checked with the data of the commercial meters. For the purposes of monitoring, the energy department will report electricity consumption level of the kiln system and the raw milling system, and provide it to the environmental department.

Environmental department
Environmental department is responsible for management of environmental aspects of plant's operation and relationships with local and central state regulation bodies. It collects, calculates, stores and processes all the emission data.

It will hold the overall responsibility for implementation of the monitoring plan for the proposed JI project, like organizing and storing the data and calculation the emission reductions. The environmental department will also prepare the annual Monitoring Protocols, to be presented to a Verifier of the emission reductions. Other departments of Kryvyi Rih Cement will submit relevant data to the environmental department for the monitoring purposes. In addition to the preparation of the Annual Monitoring Protocols, the laboratory will conduct an internal audit annually to assess project performance and if necessary make corrective actions.

Financial department
The financial department is responsible for accounting, controlling and planning.

Apart of internal departments of Kryvyi

Rih Cement, four independent external organizations will be contracted to provide the data necessary for monitoring plan implementation:

The laboratory of the Dnipropetrovsk regional gas distribution system
The laboratory will provide data on the net calorific value of the natural gas consumed.

Independent environmental laboratory
Kryvyi Rih Cement outsourcers the service of independent laboratory to conduct measurements of pollutants.

Independent certification body
This body will be contracted by Kryvyi Rih Cement to measure the net calorific value of fuel delivered.

Independent surveying company
This company will be contracted if needed, to supervise and approve the in-house survey of the opening (and closing) stocks of coal, cement, clinker, and mineral components.

The data from all external organizations will be collected by the laboratory of Kryvyi Rih Cement for monitoring purposes. For the usual routine procedures all the data has to be stored for three years for the purposes of the independent financial audit. For the purpose of the monitoring system implementation, the collected data will be stored by the Laboratory department at least for two years after the end of the crediting period – i.e. at least until 2014. For a detailed description of each measured value, please refer to section D.2.

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

- Public Joint Stock Company "HeidelbergCement Ukraine", Kryvyi Rih, Ukraine,
- Global Carbon B.V., Netherlands

For contact details refer to Annex1.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Project emissions		2004	2005	2006	2007
Calcination emissions	[tCO2/yr]	425,461	408,093	415,984	446,350
Kiln fuel combustion	[tCO2/yr]	174,907	188,714	186,551	184,563
Dust from kiln	[tCO2/yr]	0	0	0	0
Fuel for drying	[tCO2/yr]	12,878	11,022	12,261	9,813
Grid electricity consumption	[tCO2/yr]	80,299	82,172	86,481	84,573
Total	[tCO2/yr]	693,545	690,001	701,278	725,299
Total 2004 – 2007	[tCO2]	2,810,122			

Table 8: Estimated project emissions before the start of crediting period.

Project emissions		2008	2009	2010	2011	2012
Calcination emissions	[tCO2/yr]	447,838	447,838	447,838	447,838	447,838
Kiln fuel combustion	[tCO2/yr]	185,371	317,779	317,779	317,779	317,779
Dust from kiln	[tCO2/yr]	0	0	0	0	0
Fuel for drying	[tCO2/yr]	9,813	9,813	9,813	9,813	9,813
Grid electricity consumption	[tCO2/yr]	84,573	84,573	84,573	84,573	84,573
Total	[tCO2/yr]	727,595	860,003	860,003	860,003	860,003
Total 2008 – 2012	[tCO2]	4,167,606				

Table 9: Estimated project emissions within the crediting period.

Project emissions		2013	2014	2015	2016	2017	2018	2019	2020
Calcination emissions	[tCO2/yr]	447,838	447,838	447,838	447,838	447,838	447,838	447,838	447,838
Kiln fuel combustion	[tCO2/yr]	317,779	317,779	317,779	317,779	317,779	317,779	317,779	317,779
Dust from kiln	[tCO2/yr]	0	0	0	0	0	0	0	0
Fuel for drying	[tCO2/yr]	9,813	9,813	9,813	9,813	9,813	9,813	9,813	9,813
Grid electricity consumption	[tCO2/yr]	84,573	84,573	84,573	84,573	84,573	84,573	84,573	84,573
Total	[tCO2/yr]	860,003	860,003	860,003	860,003	860,003	860,003	860,003	860,003
Total 2013 – 2020	[tCO2]	6,880,023							

Table 10: Estimated project emissions generated after the crediting period

E.2. Estimated leakage:

No leakage occurs in the project scenario.

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

Project emissions and leakage		2004	2005	2006	2007
Calcination emissions	[tCO2/yr]	425,461	408,093	415,984	446,350
Kiln fuel combustion	[tCO2/yr]	174,907	188,714	186,551	184,563

Dust from kiln	[tCO2/yr]	0	0	0	0
Fuel for drying	[tCO2/yr]	12,878	11,022	12,261	9,813
Grid electricity consumption	[tCO2/yr]	80,299	82,172	86,481	84,573
Leakage	[tCO2/yr]	0	0	0	0
Total	[tCO2/yr]	693,545	690,001	701,278	725,299
Total 2004 – 2007	[tCO2]	2,810,122			

Table 11: Project emissions and leakage before the start of crediting period.

Project emissions and leakage		**2008**	**2009**	**2010**	**2011**	**2012**
Calcination emissions	[tCO2/yr]	447,838	447,838	447,838	447,838	447,838
Kiln fuel combustion	[tCO2/yr]	185,371	317,779	317,779	317,779	317,779
Dust from kiln	[tCO2/yr]	0	0	0	0	0
Fuel for drying	[tCO2/yr]	9,813	9,813	9,813	9,813	9,813
Grid electricity consumption	[tCO2/yr]	84,573	84,573	84,573	84,573	84,573
Leakage	[tCO2/yr]	0	0	0	0	0
Total	[tCO2/yr]	727,595	860,003	860,003	860,003	860,003
Total 2008 – 2012	[tCO2]	4,167,606				

Table 12: Project emissions and leakage within the crediting period.

Project emissions and leakage		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Calcination emissions	[tCO2/yr]	447,838	447,838	447,838	447,838	447,838	447,838	447,838	447,838
Kiln fuel combustion	[tCO2/yr]	317,779	317,779	317,779	317,779	317,779	317,779	317,779	317,779
Dust from kiln	[tCO2/yr]	0	0	0	0	0	0	0	0
Fuel for drying	[tCO2/yr]	9,813	9,813	9,813	9,813	9,813	9,813	9,813	9,813
Grid electricity consumption	[tCO2/yr]	84,573	84,573	84,573	84,573	84,573	84,573	84,573	84,573
Leakage	[tCO2/yr]	0	0	0	0	0	0	0	0
Total	[tCO2/yr]	860,003	860,003	860,003	860,003	860,003	860,003	860,003	860,003
Total 2013 – 2020	[tCO2]	6,880,023							

Table 13: Project emissions after the crediting period

E.4. Estimated baseline emissions:

Baseline emissions		**2004**	**2005**	**2006**	**2007**
Calcination emissions	[tCO2/yr]	472,053	496,132	519,939	526,998
Kiln fuel combustion	[tCO2/yr]	189,633	199,307	208,870	211,706
Dust from kiln	[tCO2/yr]	0	0	0	0
Fuel for drying	[tCO2/yr]	0	0	0	0
Grid electricity consumption	[tCO2/yr]	83,553	87,815	92,029	93,278
Total	[tCO2/yr]	745,239	783,253	820,838	831,983
Total 2004 – 2007	[tCO2]	3,181,313			

Table 14: Estimated baseline emissions before the start of crediting period.

Baseline emissions		2008	2009	2010	2011	2012
Calcination emissions	[tCO2/yr]	526,998	526,998	526,998	526,998	526,998
Kiln fuel combustion	[tCO2/yr]	211,706	362,925	362,925	362,925	362,925
Dust from kiln	[tCO2/yr]	0	0	0	0	0
Fuel for drying	[tCO2/yr]	0	0	0	0	0
Grid electricity consumption	[tCO2/yr]	93,278	93,278	93,278	93,278	93,278
Total	[tCO2/yr]	831,983	983,201	983,201	983,201	983,201
Total 2008 – 2012	[tCO2]	4,764,788				

Table 15: Estimated baseline emissions within the crediting period.

Baseline emissions		2013	2014	2015	2016	2017	2018	2019	2020
Calcination emissions	[tCO2/yr]	526,998	526,998	526,998	526,998	526,998	526,998	526,998	526,998
Kiln fuel combustion	[tCO2/yr]	362,925	362,925	362,925	362,925	362,925	362,925	362,925	362,925
Dust from kiln	[tCO2/yr]	0	0	0	0	0	0	0	0
Fuel for drying	[tCO2/yr]	0	0	0	0	0	0	0	0
Grid electricity consumption	[tCO2/yr]	93,278	93,278	93,278	93,278	93,278	93,278	93,278	93,278
Total	[tCO2/yr]	983,201	983,201	983,201	983,201	983,201	983,201	983,201	983,201
Total 2013 – 2020	[tCO2]	7,865,611							

Table 16: Estimated baseline emissions after the crediting period

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

Reductions		2004	2005	2006	2007
Total	[tCO2/yr]	51,694	93,252	119,561	106,684
Total 2004 - 2007	[tCO2]	371,191			

Table 17: Estimated emission reductions before the start of crediting period.

Reductions		2008	2009	2010	2011	2012
Total	[tCO2/yr]	104,388	123,199	123,199	123,199	123,199
Total 2008 - 2012	[tCO2]	597,182				

Table 18: Estimated emission reduction within the crediting period.

Reductions		2013	2014	2015	2016	2017	2018	2019	2020
Total	[tCO2/yr]	123,199	123,199	123,199	123,199	123,199	123,199	123,199	123,199
Total 2008 - 2012	[tCO2]	985,588							

Table 19: Estimated emission reduction after the crediting period.

Emission reductions generated in 2004 - 2007 will be transferred as AAUs in the frame of International Emissions Trading mechanism of the Kyoto Protocol. The emission reductions generated during 2008-2012 are to be transferred as ERUs in the frame of Joint Implementation mechanism of the Kyoto Protocol. The baseline setting and monitoring of reductions is done identical for the whole period, i.e. 2004-2012.

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tones of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
Year 2004	693,545	0	745,239	51,694
Year 2005	690,001	0	783,253	93,252
Year 2006	701,278	0	820,838	119,561
Year 2007	725,299	0	831,983	106,684
Total (tonnes of CO_2 equivalent)	2,810,122	0	3,181,313	371,191

Table 20: Estimated emissions before crediting period

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
Year 2008	727,595	0	831,983	104,388
Year 2009	860,003	0	983,201	123,199
Year 2010	860,003	0	983,201	123,199
Year 2011	860,003	0	983,201	123,199
Year 2012	860,003	0	983,201	123,199
Total (tonnes of CO_2 equivalent)	4,167,606	0	4,764,788	597,182

Table 21: Estimated emissions within crediting period.

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
Year 2013	860,003	0	983,201	123,199
Year 2014	860,003	0	983,201	123,199
Year 2015	860,003	0	983,201	123,199
Year 2016	860,003	0	983,201	123,199
Year 2017	860,003	0	983,201	123,199
Year 2018	860,003	0	983,201	123,199
Year 2019	860,003	0	983,201	123,199
Year 2020	860,003	0	983,201	123,199
Total (tonnes of CO_2 equivalent)	6,880,023	0	7,865,611	985,588

Table 22: Estimated emissions after the crediting period.

SECTION F. Environmental impacts

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

Cement production has certain impact on the local environment. In Ukraine emission levels in industry are regulated by emission permits issued by regional offices of the Ministry for Environmental Protection on the individual basis for every enterprise that has significant impact on the environment. The current levels of the emissions of the main pollutants (dust, sulphur oxides and nitrogen oxides), are in compliance with the requirements of the plant's emission permits.

Types of atmospheric emissions (as described in the emission permit) and relevant measurement techniques are presented below.

The project foresees usage of different types of metallurgical slag being in most cases a waste product for metallurgy. Usage of such AMC does not directly influence the plant emissions.

Starting slag addition requires fulfilling the separate assessment of environmental impact (OVNS in Ukrainian abbreviation).

Such assessment was completed in 2005 by the Special Design & Engineering Bureau “Cement” (Kharkiv, Ukraine). This OVNS has 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).

According to the OVNS, the project will not be harmful to the environment of Kryvyi Rih, and therefore will not have negative transboundary effects

Dust
Dust, emitted from cement production processes, is not a toxic substance but is considered a nuisance. The main sources of dust from cement production are the raw materials mill, the kiln, clinker coolers and cement mills. Dust emissions from Kryvyi Rih Cement are monitored on a regular basis in compliance with norms and regulations in force.

Dust concentration in the exhaust gases is determined on the basis of changes in filter weight measured in a flow of a dust-laden gas for certain period of time. Dust is sampled by gravimetric method in accordance with the national “Methodology of dust concentration measurement in dust-laden process gases”. Accuracy of the measurement is within +/-15%. Testing (calibration) of measurement equipment used to measure dust emissions is carried out by independent company contracted by Kryvyi Rih Cement to conduct environmental measurements by an independent state body (State Organization for Standardization, Metrology and Certification).

Dust emissions are expected not to be influenced by the slag addition project.

Nitrogen and sulphur oxides
NO_x is formed due to the inevitable oxidation reaction of the atmospheric nitrogen at high temperatures in the cement kiln. It is expected that after project commissioning the emissions will stay within the

requirements of the Ukrainian legislation and within the range of the Best Available Technology[19] levels of IPPC.
SOx emissions in cement production originate mainly from raw material and also from coal with sulphur content combustion. The sulphur content in the raw materials used at Kryvyi Rih Cement is insignificant and SOx emissions are not observed and should not increase after the implementation of the project. However, the gas analyzing equipment used for measurements will allow monitoring the gaseous emissions of sulphur oxide in case they will appear.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

The environmental impacts of the project are positive as the project expects to reduce the impact of the existing facility (see section F1).
The environmental impacts were assessed at the starting phase of the project. The general principles of assessment of the environmental impact (OVNS, which is the Ukrainian abbreviation) procedure in Ukraine are described by the national laws “On the environmental protection” and “On the environmental expertise”. According to the national legislation in force, every project or new activity that can be potentially harmful for the environment, must evaluate the environmental impact[20] [21].

These environmental impacts as a general rule are analysed after the development of the detailed project design in order to obtain a construction permit. The OVNS document must provide a list of viable project alternatives, a description of the current state of local environment, description of the main pollutants, risk evaluation and an action plan for pollution minimisation. The final OVNS document has to be presented as a separate volume of the project documentation for the evaluation by a state expert company and, optionally may be the subject of public hearing. In many cases, especially when the project does not foresee installation of major new equipment of process change, the OVNS is carried out simultaneously with project implementation or even shortly after commissioning.

As described in section F1, the OVNS for addition of larger quantities of slag was conducted and received a positive resolution from state environmental authorities.

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[19] IPPC Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries, December 2001

[20] The Law of Ukraine “On the environmental expertise”, Articles 8, 15, 36

[21] The Law of Ukraine “On the environmental protection”, Article 51

SECTION G. Stakeholders' comments

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

JI projects are not required to go through a (local) stakeholders' consultation. Addition of different types of slag into the raw materials fro clinker manufacturing would not influence plant emissions.

Annex1

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Annex2

BASELINE INFORMATION

Determination of baseline factors

Adoption of BFS into a raw material mix results in reduction of CO_2 emission from calcination and also from kiln fuel combustion. The project has started from 1 January 2004.

Baseline AMC addition percentage
The baseline AMC addition is taken as 4% as shown in SD5. It is fixed as average of AMC annual share of the most recent three years preceding the project start (2001, 2002 and 2003). The average value is 3.5% which is lower than 4%. Taking higher value of 4% is conservative.

Baseline volume of clinker production and consumption of raw mill
Baseline volumes of clinker produced $CLNK_{Bsl}$ and raw mill consumed RM_{Bsl} is determined by taking the average of the most recent three years preceding project start available measurements by the following formulae:

$$CLNK_{Bsl} = \sum_{y} CLNK_{y} \times \frac{1}{3} \qquad (14)$$

Where:
$CLNK_y$ is the production of clinker in year y (tonnes)
y are the years 2001, 2002 and 2003

$$RM_{Bsl} = \sum_{y} RM_{y} \times \frac{1}{3} \qquad (15)$$

Where:
RM_y is the consumption of raw mill in year y (tonnes)
y are the years 2001, 2002 and 2003

The result is presented below in a table:

Year	2001	2002	2003	Average
Raw mill	1 136 830	994 300	1 360 800	1 163 977
Clinker	725700	642 000	848 000	738 567

Table 23: Measured raw mill consumption, production of clinker and calculated average

Baseline kiln efficiency
The baseline kiln economy KE_{Bsl} is determined by taking the average of the most recent three years preceding project start available measurements by the following formula:

$$KE_{BSL} = \sum_{y} \frac{FC_{y} \times NCV_{y}}{CLNK_{y}} \times \frac{1}{3} \qquad (16)$$

Where:
KE_{Bsl} Average baseline kiln economy per tonne of clinker (GJ/t clinker)
y Years 2001, 2002 and 2003
$FC_{,y}$ Quantity of fossil fuel burnt for clinker production in year y (1000 Nm3)

NCV_y Net calorific value fossil fuel in year y (GJ/1000 Nm3)
$CLNK_y$ Amount of clinker produced in year y (tonne of clinker)

The result is presented below in the table:

Year	2001	2002	2003	Average
Kiln economy (GJ/t clinker)	3.76	3.67	3.58	3.67

Table 24: Measured kiln economy and calculated average

As can be seen in the table above, the kiln economy is rather a stable figure with small fluctuations. Therefore the baseline kiln economy can be established by taking the historic average value of the kiln economy and the BKE_{Bsl} is taken as 3.67 GJ/tonne of clinker.

Baseline content of CaO and MgO in the raw meal and in the clinker
The content of CaO and MgO in the raw material mix and in the clinker produced has been determined by extrapolating historic measured content.

Year	2001		2002		2003		Average	
	CaO	MgO	CaO	MgO	CaO	MgO	CaO	MgO
Content in raw meal,%	1.461	0.193	1.636	0.216	1.732	0.228	1.61	0.212
Content in clinker	65.72	1.77	65.57	1.75	65.72	1.88	65.67	1.80

Table 25: Measured CaO and MgO content in raw mill and clinker

As shown in the table below, the fluctuation of Ca and Mg oxides content in raw meal fluctuates in a narrow range and therefore the average values will be taken as 1.61 % for CaO_{RM_BL} and 0.12 % for MgO_{RM_BL}. Similarly, for the clinker the respective values are fixed as 65.67 and 1.80%.

Baseline fuel consumption for raw materials drying
Additional fuel (natural gas) is consumed to dry the raw materials in the drying drums.
The baseline fuel consumption for drying FC_{dry_bsl} is determined by taking the historic average value of fuel consumption as shown in a table below:

Year	2001	2002	2003	Average
Fuel consumption for RM drying, GJ	161 534	140 964	204 753	169 084

Table 26: Measured consumption of fuel (natural gas) used for raw materials drying and average figure

The baseline fuel consumption for drying FC_{dry_bsl} is fixed as 169 084 GJ.

Baseline electricity consumption for raw milling and kiln consumption
The specific electricity consumption for raw material drying, raw milling and clinker kiln $EL_{RM,\ kiln,\ Bsl}$ (MWh/t clinker) has been determined using historic measured consumption.

The specific data are presented in a table below.

Year	2001	2002	2003	Average
BEL_{RM_wet}, kWh/t clinker	106.95	99.93	96.31	101.06

Table 27: Measured electricity consumption of raw milling and kiln drives and calculated average

The average $EL_{RM,\ kiln,\ Bsl}$ is 101.06 kWh/t clinker.

Baseline electricity factor

The baseline emission factor of the Ukrainian grid $EF_{el,y}$ is taken as 0.896 tCO2 /MWh as set in the standardized baseline factor for Ukrainian electricity grid for JI projects reducing electricity consumption in years 2008-2012 and presented in the document below. The baseline electricity factor received final determination through the final determination of the JI project: Utilization of Coal Mine Methane at the Coal Mine named after A.F. Zasyadko, project # 0035[22].

[22] http://ji.unfccc.int/JI_Projects/DB/DA22OPURGI092XUFLIK0INB5GIYEGA/Determination/TUEV-SUED1207051469.52/historicalDeterminationReport.html

Annex3

MONITORING PLAN

See section D for monitoring plan

Annex4

BOTTOM ASH COMPOSITION

Bottom ash is originated from Kryvyi Rih thermal power plant where it is currently disposed. It can be used as aluminosilicate corrective additive. Start of bottom ash usage at KRC - 2004

Composition of bottom ash in 2007

LOI (1050 ^oC) – 8 %
SiO_2– 50.8 %
AL_2O_3 – 21.8 %
Fe_2O_3 – 10.8 %
CaO – 2.37 %
MgO – 1.33 %

Chemical composition can vary in function of type of coals used at TPP and ash storage condition.

Annex5

Slag price record

Year	Average price for 1 ton dry mass, UAH, without VAT tax[23]	Average price for 1 ton dry mass. EURO, without VAT tax	Exchange rate UAH/EURO 100[24]
2000	2.46	0.49	502.89
2001	2.5	0.52	481.36
2002	2.5	0.50	503.01
2003	2.5	0.41	602.44
2004	2.91	0.44	660.94
2005	4.14	0.65	638.99
2006	6.46	1.02	633.69
2007	24.29	3.51	691.79
2007 January	7.57	1.15	657.37
2008 January	82.18	11.07	742.67
2008 February	90.69	12.20	743.61
2008 March	100.06	12.81	781.34
2008 April	110.2	13.84	796.23
2008 May	120.76	15.57	775.73

[23] Plant data of prices for granulated blast furnace slag. Based on invoices.

[24] National Bank of Ukraine. http://www.bank.gov.ua/ENGL/Fin_mark/Kurs_mid/kurs_96-last.htm