CLEAN DEVELOPMENT MECHANISM

PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Title: Waste Heat Recovery and Utilization for Power Generation at Lucky Cement Limited, Karachi Plant
Version: 10
Date: 25/10/2012

Table A.1.1: PDD versions

Version	Issue Date	Rationale
01	10/07/2009	First issuance for Global Stakeholder Consultation (as large scale project – with AM0024 / Version 02.1)
02	22/01/2010	Issuance in response to the AM0024 based Validation Protocol
03	13/07/2010	Issuance in response to the AM0024 based Validation Protocol, 2nd loop
04	27/09/2010	Issuance in response to technical review observations by the DOE
05	18/05/2011	Reissuance for Global Stakeholder Consultation (as small scale project – with AMS-III.Q. /Version 04)
06	17/06/2011	Issuance in response to the AMS-III.Q. based Validation Protocol
07	05/07/2011	Issuance in response to the AMS-III.Q. based Validation Protocol, 2nd loop
08	08/10/2011	Issuance in response to additional queries raised by the DOE
09	02/12/2011	Issuance for update of start date of crediting period
10	25/10/2012	Issuance after INCOMPLETE message

A.2. Description of the small-scale project activity:

Lucky Cement Limited (hereafter Lucky Cement) has been sponsored by Yunus Brothers Group which is one of the largest business groups of Pakistan. The company has grown rapidly to become the leader among Pakistani cement manufacturers with the largest production capacity, highest sales and greatest market share. Lucky Cement operates two plants and manufactures Ordinary Portland Cement, Sulphate Resistant Cement and Slag Cement. One plant of Lucky Cement is at Karachi and other is at Pezu district Lakki Marwat.

The project is being implemented at Karachi plant of Lucky Cement which has three kilns; Kiln E, Kiln F and Kiln G. Each kiln has a clinker production capacity of 3300 Tons per Day (TPD). Kiln E and F have been in operation since October 2006 while Kiln G started operation in January 2009.

The waste heat generated at the cement plant in the clinker production process is vented to the atmosphere with only a small portion recycled to heat the incoming raw materials. The cement plant has a captive power plant of 80.35 MW which has twelve captive generator sets (gensets). Two of these gensets are HFO (Heavy Fuel Oil) based while remaining are natural gas (NG) based. There is no grid connection for electricity imports/exports.

The project activity involves installation of six (two on each kiln) Heat Recovery Steam Generators (HRSGs) of total capacity 63.54 TPH (tonnes per hour) to recover the waste heat from the kilns to generate electricity by a 15 MW (Megawatt) steam turbo generator. Details of the project equipment are given in Table A.4.2.2. The hot exhaust of HRSGs will still be utilized to preheat the incoming raw materials.

The project activity was commissioned in February 2010. The electricity generated by the project activity will partially displace the fossil fuel based electricity generated by the captive power plant. The project activity will supply 87,437 Megawatt hour per year (MWh/y) electricity and will result in, on average 43,138 tonnes CO_2 equivalent (tCO_2e) emission reductions per annum. No fuel will be used at HRSGs for steam production.

The project activity results in transfer of efficient and modern technology from China to the region. The successful operation of this new efficient technology will also encourage others to adopt similar technologies leading to further conservation of energy and sustainable development.

In the absence of project activity, Lucky Cement will continue to get all of its power demand from the dual fuel based captive power plant because this is the baseline scenario as identified in §B.4.

The project activity is in compliance with the national laws and results in sustainable development as evaluated by following criteria.

Environmental Development

- ✓ significant reduction in the emissions of greenhouse gases
- ✓ improvement of the local environment by reduction in temperature of the vented hot air
- ✓ improvement of the local environment by less contamination through replacement of fossil fuel based electricity by non-contaminating electricity source
- ✓ reduction in emission concentrations of heavy metal particles, SO_x, NO_x, and Carbon Oxides[1]
- ✓ conservation of local fossil fuel resources by avoiding fossil fuel based electricity from the existing captive power plant

Social Development

- ✓ alleviation of poverty by providing labour employment opportunities to the local community during construction phase
- ✓ less health impact for the population through less emission of greenhouse gases and particles

Economic Development

- ✓ creation of new jobs during construction and operation phase of the project
- ✓ cost effective way of generating electricity since no additional fuel is used

Technology Development

- ✓ introducing modern technology in the country
- ✓ improve technical knowledge of local population through technology transfer of the system by the supplier
- ✓ setting up an example of sustainable development to be followed by other cement factories.

[1] Source: IEE (Initial Environmental Examination) Report of the project activity. A copy of the IEE Report has been provided to DOE.

A.3. Project participants:

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The table A.3.1 illustrates the participants involved in the project activity. Contact information is provided in Annex 1.

Table A.3.1: Project Participants

Name of Party involved ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Islamic Republic of Pakistan (host)	Lucky Cement Limited (private entity)	No
Islamic Republic of Pakistan (host)	Carbon Services (Private) Limited (private entity)	No
Switzerland	First Climate (Switzerland) AG (private entity)	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Islamic Republic of Pakistan

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

Sindh

A.4.1.3. City/Town/Community etc:

Nooriabad, Karachi

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The project is located at:

Lucky Cement Factory,
58 km Milestone, Super Highway,
Nooriabad, Karachi, Sindh, Pakistan.

The company is headquartered at:

6 – A, M Ali Housing Society,
A. Aziz Hashim Tabba Road,
Karachi 75350, Sindh, Pakistan.

Lucky Cement Karachi Plant is located at following geographical coordinates:
Latitude: 25º 3’ 14”
Longitude: 67º 25’ 53”

Fig A.4.1.4.1: Location of Lucky Cement Plants in Pakistan

Fig A.4.1.4.2: Photograph of Lucky Cement Karachi Plant

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

In accordance with *Appendix B of* the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, the project activity falls under the following type and category:

Type III: Other project activities
Category Q: Waste energy recovery (gas/heat/pressure) projects
Sectoral Scope 4: **Manufacturing industries**

Lucky Cement Karachi Plant has three kilns; Kiln E, Kiln F and Kiln G. Each kiln has a clinker production capacity of 3300 TPD. Kiln E and F have been in operation since October 2006 while Kiln G started operation in January 2009.

The plant produces Ordinary Portland Cement, Sulphate Resistant Cement, and Slag Cement by dry process. The kilns primarily consume coal, and a small amount of HFO is used for elevating temperature at start up. In the baseline situation, almost all the waste heat from the clinker production process is vented to atmosphere; only a small portion of the waste heat from the feed ends of clinker production kilns is recycled to heat up incoming raw material. All the power demand is met by a captive power plant as there is no grid connection.

The current source of electricity is the 80.35 MW captive power plant which has seven CatMak gensets, four Rolls-Royce gensets, and one Wartsila genset. The details of the gensets are shown in Table A.4.2.1 below:

Table A.4.2.1: Details of gensets

Manufacturer	Rated Power	Fuel	Designed Efficiency
CatMak 16CM32C DF	7,300 kW	HFO	44.78%
CatMak 16CM32C DF	7,300 kW	HFO	
CatMak 16CM34	5,700 kW	Natural Gas	43.62%
CatMak 16CM34	5,700 kW	Natural Gas	
CatMak 16CM34	5,700 kW	Natural Gas	
CatMak 16CM34	5,700 kW	Natural Gas	
CatMak 16CM34	5,700 kW	Natural Gas	
Rolls-Royce B35:40V-20AGS	8,500 kW	Natural Gas	45.79%
Rolls-Royce B35:40V-16AGS	6,800 kW	Natural Gas	45.45%
Rolls-Royce B35:40V-16AGS	6,800 kW	Natural Gas	
Rolls-Royce B35:40V-16AGS	6,800 kW	Natural Gas	
Wartsila 20V34SG	8,350 kW	Natural Gas	44.16%

The project activity involves installation of waste heat recovery systems (HRSGs and steam turbo-generator) for power generation. HRSGs shall be installed at Preheater (PH) and Air Quenched Cooler (AQC) ends of the kilns. The project equipment is brand new and uses state of the art technology. The technology is environmentally safe as no additional or secondary fuel is used for power generation by waste heat recovery system. The project technology is transferred from China. A list of major equipment of project activity is given below in Table A.4.2.2.

Table A.4.2.2: Project equipment

Specifications of Heat Recovery Steam Generators		
Equipment	**Manufacturer**	**Capacity**
HRSG 1 At PH end of kiln E	Sinoma	13.95 tph
HRSG 2 At AQC end of kiln E		7.23 tph
HRSG 3 At PH end of kiln F		13.95 tph
HRSG 4 At AQC end of kiln F		7.23 tph
HRSG 5 At PH end of kiln G		13.95 tph
HRSG 6 At AQC end of kiln G		7.23 tph

Specification of Steam Turbine	
Manufacturer	HCTC
Type	Condensing
Rated power output	15 MW
Auxiliary consumption	8%
Shaft revolution	3000 rpm
Turbine inlet temperature	320 ºC
Turbine inlet pressure	1.25 MPa

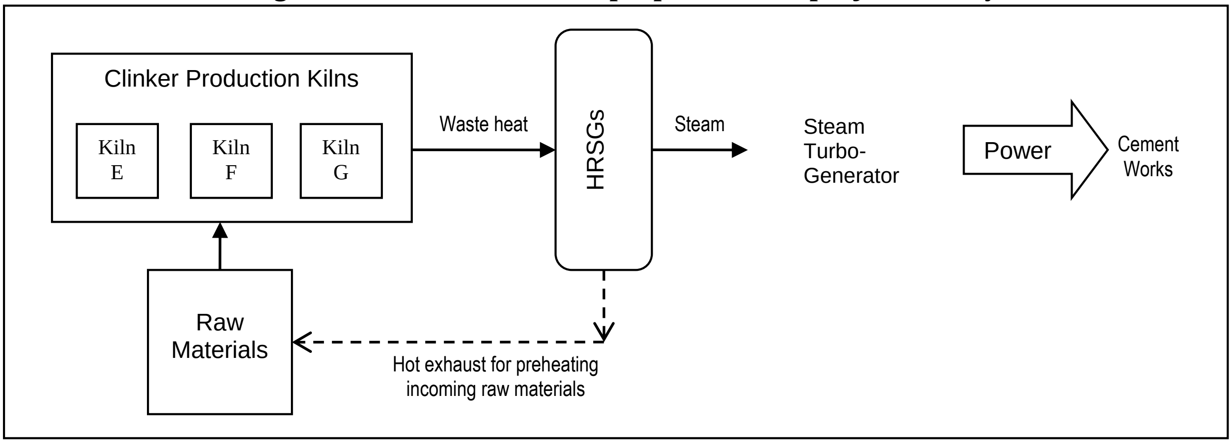
Table A.4.2.3: Operational characteristics of steam turbo-generator

Operational Characteristics of Steam Turbo-Generator	
Operational days per annum	330
Operational hours per day	24
Average load factor	80%
Gross electricity generation (MWh/y)	15*330*24*80% = 95,040
Auxiliary consumption (MWh/y)	95,040 * 8% = 7,603
Net electricity generation (MWh/y)	95,040 – 7,603 = 87,437

The project uses state of the art technology from China. The project technology is not likely to be substituted by other or more efficient technologies within the crediting period of the project activity.

All the waste heat from pre-heater and cooler end of kiln will be recovered for steam generation by six HRSGs (two on each kiln) which will be fed to a 15 MW steam turbo-generator for electricity generation. Hot exhaust of the HRSGs will still be used to preheat the incoming raw material. The net electricity generated by the project activity (87,437 MWh/y) will partially displace fossil fuel (natural gas & HFO) based captive electricity and will result in, on average 42,992 t CO_2 e emissions reduction per annum. Following is the schematic of proposed CDM project activity.

Figure A.4.2.1: Schematic of proposed CDM project activity



In the absence of the proposed CDM project activity, Lucky Cement will continue pre-project scenario because this is the baseline scenario as identified in §B.4.

The proposed CDM project activity results in transfer of efficient and modern technology from China to the region. The import of project equipment (steam turbo-generator, HRSG, and allied equipment) not merely means technology transfer but skill transfer as well. This kind of innovative and energy efficient technology would serve to demonstrate the operational efficiency of such systems and encourage others to adopt similar technologies leading to further conservation of energy, fuel and environment.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

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The annual & total estimation of emission reductions for the fixed crediting period of 10 years is provided below in Table A.4.3.1.

Table A.4.3.1: Emission reductions over the crediting period

Years	Annual estimation of emission reductions in tonnes of CO_2e
Year 1	**42,992**
Year 2	**42,992**
Year 3	**42,992**
Year 4	**42,992**
Year 5	**42,992**
Year 6	**42,992**
Year 7	**42,992**
Year 8	**42,992**
Year 9	**42,992**
Year 10	**42,992**
Total estimated reductions (tonnes of CO_2 e)	**429,920**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**42,992**

A.4.4. Public funding of the small-scale project activity:

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No public funding is involved in this project activity.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM Project Activities defines the following rules to determine whether the small-scale project activity is a debundled component of a large scale project activity or not:

"A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:
(1) With the same project participants;
(2) In the same project category and technology/measure;
(3) Registered within the previous 2 years; and
(4) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point."

The project activity is not a debundled component of a large project activity as there is no small scale CDM project activity, or an application registered by Lucky Cement in the same project category in the last two years within 1 km of the project boundary of the proposed small-scale project activity.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

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AMS-III.Q.: Waste Energy Recovery (gas/heat/pressure) Projects / Version 04
Valid from 29/04/2011

The methodology also refers to "ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" for the estimation of the capping factor. Therefore, corresponding section of ACM0012 / Version 04.0.0 (valid from April 15, 2011) is used.

B.2 Justification of the choice of the project category:

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The present project activity involves waste hear recovery from cement manufacturing kilns. For the waste heat from the kilns, AMS-III.Q is applicable. Here below the applicability conditions of the applied methodology are checked.

Table B.2.1: Applicability check

Applicability Condition	Applicability Check
1. The category is for project activities that utilize waste gas and/or waste heat at existing facilities as an energy source for: (a) Cogeneration; or (b) Generation of electricity; or (c) Direct use as process heat; or (d) Generation of heat in elemental process (e.g. steam, hot water, hot oil, hot air); or (e) Generation of mechanical energy.	The project utilizes waste heat from existing kilns[2] as energy source for generation of electricity (case b). **Condition is fulfilled.**
2. The category is also applicable to project activities that use waste pressure to generate electricity at existing facilities.	This **condition is not relevant** for the present project because waste pressure is not recovered.
3. The recovery of waste gas/heat/pressure should be a new initiative (no waste gas/heat/pressure was recovered from the project activity source prior to the implementation of the project activity).	No waste heat was recovered for energy generation purpose from the project activity source prior to the implementation of the project activity, only a small portion of the waste heat from the feed ends of clinker production kilns is recycled to heat up incoming raw material. So the project activity is a new initiative. **Condition is fulfilled.**
4. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.	The project activity results in emission reductions 42.992 kt CO_2

[2] The facility within which the project activity is implemented existed at the time of project start date (07/05/2008) as proven by the fact that kiln E and F were already in operation (since October 2006) and kiln G had become part of Lucky Cement Karachi Plant in Feb 2008. Documents supporting the existence of Kiln G before the start date of the project activity and its commercial operation before the start of validation of the project activity have been provided to DOE..

	equivalent annually which is less than 60 kt CO_2. **Condition is fulfilled.**
5. (a) The energy produced with the recovered waste gas/heat/or waste pressure should be measurable;	The electricity produced by the project activity is measurable as indicated in §B.7. of the PDD. **Condition is fulfilled.**
5. (b) Energy generated in the project activity may be used within the industrial facility or exported to other industrial facilities (included in the project boundary);	The energy generated in the project activity is used within the industrial facility. **Condition is fulfilled.**
5. (c) Electricity generated in the project activity may be exported to the grid or used for captive purposes; However, the methodology is not applicable to projects where the waste gas/heat/pressure recovery project is implemented in a single-cycle power plant (e.g. gas turbine or diesel generator) where heat (energy) generated on site is not utilizable for any other purposes on-site except to generate power. Such project activities shall consider AMS-III.AL "Conversion from single cycle to combined cycle power generation". The projects recovering waste energy from such power plants for the purpose of generation of heat only can apply this methodology;	The electricity generated in the project activity is used for captive purposes. Waste heat for power generation is implemented in cement manufacturing kilns instead of in any single-cycle power plant. **Condition is fulfilled.**
5. (d) For a project activity which recovers waste gas/heat/pressure for power generation from multiple sources (e.g. kiln and single-cycle power plant), this methodology can be used in combination with AMS-III.AL provided that: (i) Within the project activity it is possible to distinguish two distinct waste energy sources such that: • Waste energy source-I (e.g. kiln) belongs to such waste heat sources which are eligible under AMS-III.Q; • Waste energy source-II (e.g. single-cycle power unit) belongs to such waste heat sources which are eligible under AMS-III.AL; (ii) It is possible, for each waste energy source, to determine the baseline according to the specific methodology referred to; (iii) It is possible to objectively allocate the electricity produced in the project activity to each waste energy source, by means of one of the following methods: • Through separate measurements of the electricity produced by utilizing waste energy from each waste energy source; or • Through separate measurements of the energy content of the waste energy carrying medium (WECM) streams used for electricity production; or • Through separate measurements of the energy content of the waste energy streams that are associated with each waste energy source and used for electricity production or for the WECM generation in a common waste heat recovery system (e.g. if steam is generated by waste heat	This **condition is not relevant** because the project activity recovers waste heat for power generation from single waste heat type source, cement manufacturing kilns only.

from a kiln and waste heat from an internal combustion engine in a common waste heat recovery boiler);	
5. (e) The emission reductions are claimed by the generator of energy using waste energy;	The emission reductions are claimed by Lucky Cement, which is the generator of the waste heat. **Condition is fulfilled.**
5. (f) In cases where the energy is exported to other facilities (included in the project boundary), the following are required: (i) All historical information from the recipient plants; (ii) An official agreement exists between the owners of the project energy generation plant (henceforth referred to as generator, unless specified otherwise) with the recipient plant(s) that the emission reductions would not be claimed by the recipient plant(s) for using a zero-emission energy source;	This **condition is not relevant** because energy is not exported to other facilities but used by the same facility where waste energy is recovered.
5. (g) For those facilities and recipients included in the project boundary, that prior to implementation of the project activity (current situation) generated energy on-site (sources of energy in the baseline), the credits can be claimed for minimum of the following time periods: (i) The remaining lifetime of equipments currently being used; and (ii) Crediting period;	The sources of energy in the baseline are the kilns which have a technical lifetime that extends beyond the crediting period. Therefore the credits are claimed for the whole duration of the selected crediting period (10 years). **Condition is fulfilled.**
5. (h) The waste gas/heat/pressure utilized in the project activity would have been flared or released into the atmosphere in the absence of the project activity. This shall be proven by one of the following options: (i) By **direct measurements** of energy content and amount of the waste gas/heat/pressure for at least three years prior to the start of the project activity; (ii) **Energy balance** of relevant sections of the plant to prove that the waste gas/heat/pressure was not a source of energy before the implementation of the project activity. For the energy balance the representative process parameters are required. The energy balance shall demonstrate that the waste gas/heat/pressure was not used and also provide conservative estimations of the energy content and amount of waste gas/heat/pressure released; (iii) **Energy bills** (electricity, fossil fuel) to demonstrate that all the energy required for the process (e.g. based on specific energy consumption specified by the manufacturer) has been procured commercially. Project participants are required to demonstrate through the financial documents (e.g. balance sheets, profit and loss statement) that no energy was generated by waste gas/heat/pressure and sold to other facilities and/or the grid. The bills and financial statements should be audited by competent authorities; (iv) **Process plant** manufacturers' original specification/information, schemes and diagrams from the	The waste heat utilized in the project activity would have been released into the atmosphere in absence of the project activity. This is proven by the annual financial reports of the company, audited by a competent third party, which demonstrate that all the energy required for the process has been procured commercially (option iii). **Condition is fulfilled.**

construction of the facility could be used as an estimate of quantity and energy content of waste gas/heat/pressure produced for rated plant capacity per unit of product produced.	
6. For the purpose of this category waste energy is defined as: a by-product gas/heat/pressure from machines and industrial processes having potential to provide usable energy, for which it can be demonstrated that it was wasted. For example gas flared or released into the atmosphere, the heat or pressure not recovered (therefore wasted). Gases that have intrinsic value in a spot market as energy carrier or chemical (e.g., natural gas, hydrogen, liquefied petroleum gas, or their substitutes) are not eligible under this category.	The project activity utilizes waste energy (heat) from cement manufacturing kilns (industrial process). **Condition is fulfilled.**

B.3. Description of the project boundary:

According to paragraph 7 of AMS-III.Q. / Version 04, "the physical, geographical site of the facility where the waste gas/heat/pressure is produced and transformed into useful energy delineates the project boundary."

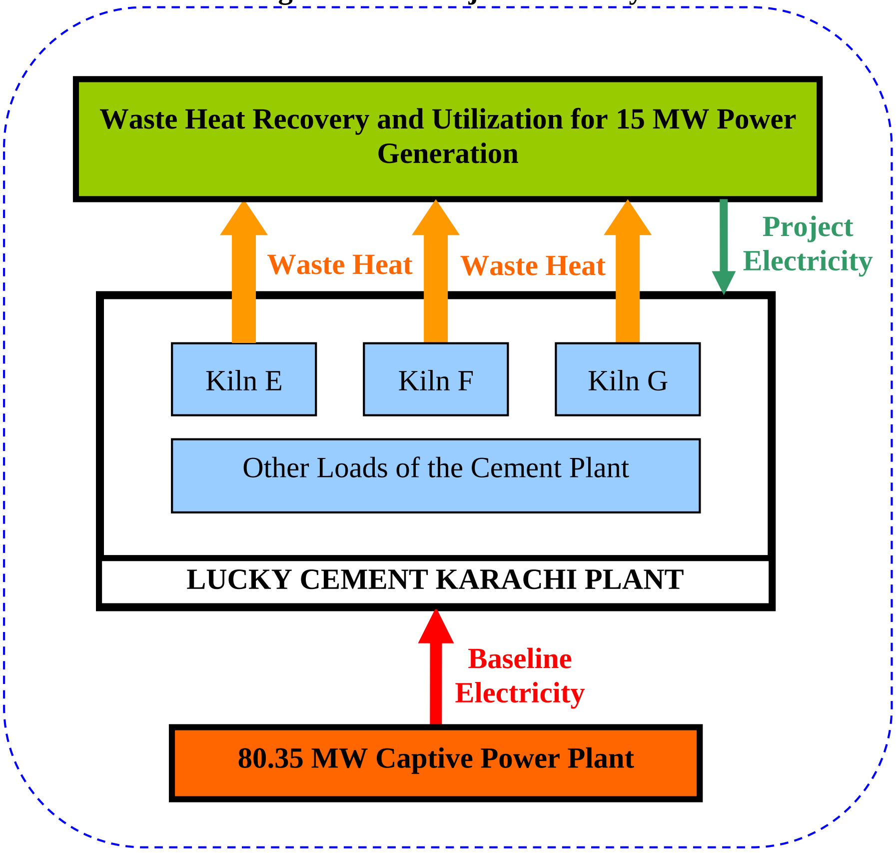
The geographical extent of the project boundary shall include the following:

(a) The industrial facility where waste energy is generated, including the part of the industrial facility where the waste gas was utilized for generation of captive electricity prior to implementation of the project activity;
(b) The facility where steam/process heat in the element process/electricity/mechanical energy is generated (generator steam/process heat/electricity/mechanical energy). Equipment providing auxiliary heat to the waste energy recovery process shall be included within the project boundary; and
(c) The facility(ies) where steam/process heat in the element process/electricity/mechanical energy is used (the recipient plant(s)) and/or grid where electricity is exported, if applicable.

This means that kilns E, F & G where the waste heat is generated, the entire cement plant where the electricity is consumed, and the waste heat recovery system are to be included in the project boundary.

The physical boundary of the project is fuel consumption and electricity generation by captive power plant, clinker production process by kilns, and electricity generated by the waste heat recovery project. This is illustrated below in Figure B.3.1.

Figure B.3.1: Project boundary



B.4. Description of baseline and its development:

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In the baseline situation, the high temperature exhaust of the kilns is vented to the atmosphere; only a small portion of waste heat is circulated and used for drying & preheating the incoming raw materials & fuel. There are no other potential alternatives of waste heat utilization in the vicinity of the factory. So in the absence of project activity the only possible baseline scenario is that the waste heat is released to the atmosphere and the project electricity used by cement plant is supplied by the existing fossil fuel based captive power plant.

Hence continuation of the current practice, venting the waste heat from kilns into the atmosphere and supply from existing capacity of captive power plant, is the baseline scenario in the absence of proposed CDM project activity.

Since the Lucky Cement Karachi Plant started its operation in October 2006, therefore historical data of only 19 months is available and emission reductions are done based on data from October 2006 to April 2008. Since kiln G started operation in January 2009, therefore no historical data before the starting date of the project activity (May 07, 2008) is available for kiln G. However, as kiln G is identical to the existing kilns E & F, all the parameters of kiln G (like fuel consumption and clinker production) have been calculated by taking average of the parameters of kiln E and kiln F. The historical data is given in Annex 3.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

CDM consideration before starting date of the project and continued effort to secure CDM status

The starting date of the project activity is 07/05/2008 corresponding to the date of signing of contract between Lucky Cement and the project equipment supplier, Sinoma Energy Conservation Limited. Lucky Cement was aware of CDM since Feb 2007 and it played an instrumental role in the investment decision taken on 22/10/2007 to implement the project[3]. Discussions with CDM consultants started in February 2007 and during the whole implementation phase before validation, Lucky Cement was accompanied by CDM consultants. The civil works started in September 2008 and the commissioning of the project was done in February 2010. In the following table, the key dates of the project timeline are resumed.

Table B.5.1: Project timeline

Milestone	Date	Source
CDM Awareness	Since Feb 2007	Letter from Director of Carbon Services (Private) Limited to Technical Director of Lucky Cement Limited
Proposal from CDM Consultant	02/08/2007	Proposal of CDM Service Agreement between Factor Consulting + Management AG (now First Climate) and Lucky Cement Limited
Investment Decision	22/10/2007	Extract from the minutes of the Board's Meeting
Project Start Date	07/05/2008	Contract between Lucky Cement Limited and Sinoma Energy Conservation Limited
Start of Civil Works	03/02/2009	Lucky Cement Limited Inter-office Memo from Manager Civil to Director Operation
Request for revision of AM0024 / Version 02.1	11/03/2009	AM_REV_0141
Request for quotation for CDM validation to DOE as large scale project – with AM0024 / Version 02.1	17/03/2009	Request for quotation for CDM validation to TUEV SUED Industrie Service GmbH
Environmental approval from Environmental Protection Agency (EPA) of Sindh	18/06/2009	Environmental approval
Quotation for CDM validation from DOE as large scale project – with AM0024 / Version 02.1	25/06/2009	Quotation for CDM validation from TUEV SUED Industrie Service GmbH
Application for Host Country Approval	30/06/2009	
CDM validation order to DOE as large scale project – with AM0024 / Version 02.1	10/07/2009	CDM validation order to TUEV SUED Industrie Service GmbH
First issuance for Global Stakeholder	10/07/2009	

[3] Proofs for CDM awareness and consideration have been provided to DOE.

Consultation (as large scale project – with AM0024 / Version 02.1)		
Start of Global Stakeholder Process (GSP) as large scale project – with AM0024 / Version 02.1	25/07/2009	UNFCCC CDM website
Issuance of Host Country Approval	14/10/2009	
Project Commissioning	Feb 2010	Company Information
Reply to AM_REV_0141 (methodology to be merged with ACM0012, but issues not addressed)	16/11/2010	AM_REV_0141
Request for revision of AMS-III.Q. / Version 03	10/12/2010	SSC_497
Approval of request for revision and issuance of AMS-III.Q. / Version 04	15/04/2011	Annex 22 to EB 60

According to Attachment A to Appendix B of the simplified modalities and procedures for small scale CDM project activity categories, "project participants shall provide an explanation to show that the project activity would not have occurred anyway due at least to one of the following barriers:" investment barrier, technological barrier, prevailing practice barrier or other barriers.

The investment barrier is chosen to demonstrate the financial unattractiveness of the project activity. Below it is demonstrated that the Internal Rate of Return for the project activity (project IRR) is lower than the benchmark return (which corresponds to the minimum opportunity cost of capital invested in the project activity), and the project IRR surpasses the benchmark return only with an additional revenue stream from sale of Certified Emission Reductions (CER) generated under the project activity.

As mentioned in section B.4, the only possible use of the waste heat from the kilns was electricity generation. However, without CDM, this option faces a financial barrier, as it is not financially attractive. Given that this option is to be checked against the option without any investment (baseline scenario, where electricity is continued to be sourced from the existing captive power plant), the Benchmark approach is deemed adequate for the investment analysis. As shown below, in the absence of the CDM revenues, the project activity would have not happened due to a financial barrier, i.e. the project would have not been considered financially attractive, as the savings provided by the increased efficiency were not sufficient to justify the investment needed.

Description of Investment Analysis

The reasoning provided in the following paragraphs reveals that the criteria employed for the selection of type of IRR and the corresponding benchmark are as per the guidance provided in *paragraphs 12-14 of Annex 5 to EB 62* and that the approach with respect to the selection of the benchmark is conservative.

Selection of Type of IRR and Benchmark

It is stated in *Paragraph 12 of Annex 5 to EB 62* that *"In cases where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR. Required/expected returns on equity are appropriate benchmarks for an equity IRR. Benchmarks supplied by relevant national authorities are also appropriate if the DOE can validate that they are applicable to the project activity and the type of IRR calculation presented"*

Furthermore, *Paragraph 13 of* Annex 5 to EB 62 states that *"In the cases of projects which could be developed by an entity other than the project participant the* ***benchmark*** *should be based on parameters that are standard in the market."*

With regard to the proposed CDM project activity:

- The investment analysis is in compliance with the requirements of *Paragraph 12 of Annex 5 to EB 62* as it is based on the calculation of project IRR and its comparison with the commercial lending rate (11.73%) evaluated at the time of investment decision.

- The chosen benchmark is in compliance with the requirements of *Paragraph 13 of Annex 5 to EB 62* as the project activity could have been implemented by an entity other than Lucky Cement. For instance, Lucky Cement could have hired the services of an Energy Service Company (ESCO) who would bear all the project related costs and recover its investment by claiming a portion of savings generated by the project activity.

- As per guidance provided in *Paragraph 14 of Annex 5 to EB 62, "Internal company benchmarks/expected returns (including those used as the expected return on equity in the calculation of weighted average cost of capital-WACC) should only be applied in cases where there is only one possible project developer..."* The reasoning provided in the preceding paragraph clearly shows that this is not the case; therefore, use of equity IRR or internal benchmark is not appropriate the context of the current project activity.

The discussion provided above clearly shows that the selection of project IRR and the corresponding benchmark are appropriate for the purpose of conducting investment analysis of the project activity.

Description of the Chosen Benchmark (Commercial Lending Rate): The local lending and borrowing rates in Pakistan are based on Karachi Inter-bank Offered Rate (KIBOR) plus the credit spread over the KIBOR charged by the local bank. In February 2004, KIBOR was officially introduced by State Bank of Pakistan as a reference rate for all corporate in Pakistan[4]. Thus the KIBOR portion of the commercial lending rate is always determined by SBP. The credit spread calculation is performed by local banks which determine it based on various project specific risks or characteristics of a project type.

For the determination of the benchmark (commercial lending rate) for the project activity, Lucky Cement considered a 3 month tenor average KIBOR of 9.73 % for September 2007[5] and assumed a credit spread of 200 basis points which was based on a loan offer extended to Lucky Cement by Bank Alfalah Limited, a local bank in Pakistan[6]. The benchmark thus evaluated was (9.73 % + 2.0%) 11.73 %.

This corporate lending rate calculation is in line with the guidance provided by Citibank[7] which estimates a credit spread between 200 to 350 basis points above the 3 or 6 month KIBOR as appropriate for a 7 year term loan (including 2 years grace period), for a loan amount over PKR 100 million.

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[4] Press release by State Bank of Pakistan: http://www.sbp.org.pk/press/2004/jan-21-04.pdf

Third Quarterly report of State Bank of Pakistan FY04:
http://sbp.org.pk/reports/quarterly/fy04/thirdQtr/Money%20Market.pdf

[5] KIBOR rate of 2007 are available at the website of State Bank of Pakistan: http://sbp.org.pk/ecodata/kibor/2007/

[6] A copy of the Bank Alfalah Limited's loan offer letter to Lucky Cement has been provided to DOE

[7] Citibank letter has been provided to the DOE.

Furthermore, the chosen benchmark value (11.73 %) is conservative as it is below the range of commercial lending rate of 12.57-13.57 %, prevalent at the time of investment decision[8].

Comparison of the Chosen Benchmark with Other Benchmarks

As per guidance provided in *Paragraphs 12 and 13 of Annex 5 to EB 62* **,** Weighted Average Costs of Capital (WACC) and benchmark determined by relevant national authority are also appropriate benchmarks for a project IRR which could be used to conduct the investment analysis for the project activity; the appropriateness, conservativeness and relevance of these benchmarks is discussed below.

Weighted Average Costs of Capital (WACC): The WACC for financial year 2007 for Lucky Cement is 13.10%[9]. However, it is less conservative when compared with the commercial lending rate of 11.73%.

Benchmark determined by relevant national authority: There is no benchmark established by the Government of Pakistan for WHR based power projects. Benchmarks do exist for hydropower and thermal power projects, but those are ROE (required/expected return on equity) based benchmarks, hence irrelevant in the context of the current project activity.
In view of the aforementioned facts it can be concluded that the benchmark chosen for the project activity- commercial lending rate of 11.73% - is in compliance with the guidance provided in *paragraphs 12-14 of Annex 5 to EB 62* and is both appropriate and conservative.

Calculation and comparison of the project IRR with the selected benchmark

The following general assumptions have been made to calculate the project IRR of the project activity:

Table B.5.2: General assumptions for project IRR calculation

General Information	Value	Unit	Source of data
Exchange rate US $ --> PKR	60.00	PKR	Feasibility study
Depreciation period	20	years	Feasibility study
Technical lifetime of the plant	20	years	Feasibility study
Tax on net income	35%		Feasibility study
Project investment[10]	1,260,000,000	PKR	Feasibility study

The total investment amount includes machinery and material, training, management and technical services, duties, taxes and freight charges as well as local costs. As the analysis period corresponds to the depreciation period of 20 years, the fair value of the project investments will be 0 at the end of the analysis period. Depreciation and financial expenses are only used for tax calculation and added back to net profits for the calculation of the project IRR.

Concerning the fuel consumption and costs, the calculations were based on the historical values from October 2006 until September 2007[11]chosen as per the data period selected in the Feasibility Study

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[8] This is evidenced by a news article a copy of which has been provided to DOE. The article is also available at http://www.dawn.com/2007/05/24

[9] Pakistan cement sector review report by IGI Pakistan: http://www.igisecurities.com.pk/pdf/Pakistan-Cement-Sector-Review-May-2007.pdf

[10] Breakdown of the project investment and list of the supporting documents for each item is included in the IRR calculation sheet.

Report. The following table describes the baseline and project fuel costs for the total captive power generation.

Table B.5.3: Fuel costs for electricity generation

		Baseline	Project
Captive Power Generation	MWh/y	306,072	218,635
HFO			
HFO consumption	tons/y	21,921	15,659
Cost of HFO	PKR/y	454,904,143	324,949,731
Natural Gas			
NG consumption	Nm^3/y	62,515,464	44,656,404
Cost of NG	PKR/y	490,168,217	350,139,766
Diesel			
Diesel consumption	Ltrs/y	208,449	148,901
Cost of Diesel	PKR/y	6,549,173	4,678,243

The Operation and Maintenance (O&M) costs considered for the project activity represent 5% of the total investment costs with an annual increase of 10% due to rapidly increasing labour wages and costs associated with technical services. Such increase is conservative compared to the one estimated on the basis of the Consumer Price Index (CPI) values reported for years 2003 to 2007 in the State Pakistani Bank (SPB) Annual Report 2006-2007, and extrapolated with a logarithmic curve[12], as shown in the CPI Forecast spread sheet, included in the IRR calculation Excel file.
From the estimated values for the 20 years following the investment decision, an average increase of 13% per year has been calculated. The approach of using CPI as an indicator of the inflation for wages and technical services is considered appropriate as it is consistent with the method for determination of increase in O&M cost as specified in Lucky Cement technical service/maintenance contract with the supplier of existing power generation equipment providing the same output as provided by the project activity. It is clearly mentioned in this contract that any increase in O&M cost would be determined based on the CPI prevalent at the time of determining such increase[13].

Also, every 5 years, an overhaul is necessary. This represents 3% of the investment costs indexed by the annual increase of 10%, same as O&M costs: this assumption (10% increase in overhaul cost) is considered reasonable because inflation dynamics of major overahaul cost and O&M cost are similar, as both depend on the domestic evolution of labour and technical service costs.

The increase of the fuel costs is not linked to the CPI but instead determined as per the guidance provided in the Petroleum Policy of Pakistan according to which any future change in fuel prices in Pakistan is intrinsically linked to fluctuations in crude oil prices in the international market. Thus increase in fuel costs is evaluated on the basis of the Annual Energy Outlook 2006 (AEO 2006, a database of international fuel prices) prepared by the Energy Information Administration[14] and fuel prices data provided in Pakistan Energy Year Book 2006; five years historical data (2002 to 2006) for fuel prices

[11] Since the Lucky Cement Karachi Plant started its operation in October 2006, therefore historical data of only 19 months is available and emission reductions are calculated based on data from October 2006 to April 2008.

[12] The choice of logarithmic curve for data extrapolation is appropriate as it yields the most realistic as well as conservative value for increase in CPI. Detailed CPI forecast analysis has been provided to DOE.

[13] Copy of the Maintenance Agreement with Wartsila Pakistan has been provided to the DOE.

[14] www.eia.doe.gov

both in the indigenous (national) and international market as well as the projected international fuel prices (2007 to 2030), from Annual Energy Outlook, were used to forecast the increase in fuel prices.[15]
The results of the future price increase as estimated in Energy Prices Future Evolution Calculation were adjusted by the yearly inflation rate and by the change rate between US Dollars and the Pakistani Rupee.[16]
The average price increase (from 2007 to 2030) resulted in 2.00% for HFO, 1.27% for Diesel and 0.41% for Natural Gas. Detailed calculations are presented in the separate Excel file. Table B.5.4 describes the information concerning the O&M Costs as well as the Estimated Cost Increases of fuels.

Table B.5.4: Operation & Maintenance costs and fuel cost increases

General Information	Value	Unit	Source of Data
O&M Cost	63,000,000	PKR	Consultants Letter
Major Overhaul Cost (base year)	37,800,000	PKR	Consultants Letter
Price Increase O&M Costs	10.00%	per year	Feasibility study
Price Increase Overhaul Costs	10.00%	per year	Feasibility study
Price Increase HFO	2.00%	per year	Energy Prices Future Evolution Calculation
Price Increase Diesel	1.27%	per year	Energy Prices Future Evolution Calculation
Price Increase Natural Gas	0.41%	per year	Energy Prices Future Evolution Calculation

The resulting project IRR of the project saving potential by introducing the project activity is 8.81%. As the benchmark is determined at 11.73%, the project activity would not be implemented. Considering the CER revenues, the project IRR would come up to 13.29% and so gets an economically attractive investment option for Lucky Cement.

Sensitivity analysis

To show the robustness of the results, a sensitivity analysis is carried out for the variation (+/- 10%) of the decisive variables of the project activity. These are the initial project investment, HFO price, NG price, O&M cost and the Load Factor of the Steam Turbine[17]. The results of the sensitivity analysis are shown in Table B.5.5.

Table B.5.5: Sensitivity analysis

-10%	Base Case	10%	Break Even Point	
Project Investment	11.11%	8.81%	6.86%	-12.4%

[15] It should be noted the fuel prices in Pakistan are set by independent national bodies who, as per Petroleum Policy, index these to crude oil prices in the international market. Therefore, forecasting any increase in the fuel prices solely on the basis of national historical fuel prices would not be appropriate. Thus, the future price evolution calculation is appropriate as it takes into account both international as well as national trends in fuel price variation hence more realistic.

[16] The analysis is based on the fuel prices (in real term) provided by AEO 2006, and firstly adjusts them with the inflation and then correlates them to fuels used in the project activity and their prices in Pakistan. A very high correlation is found (the statistical correlation factor R^2 is 99% and 96% for HFO and diesel respectively). This proves that the use of international prices is a correct proxy for the Pakistani price evolution, on the long term.

[17] The diesel cost and the overhaul costs, over the 20 year period, count less than 20% of the total costs, therefore are not included in the Sensitivity analysis, according to clause 20 of the Guidelines on the assessment of investment analysis (v.05).

HFO Price	6.58%	8.81%	10.55%	18.2%
NG Price	6.68%	8.81%	10.50%	18.8%
O&M Cost	10.42%	8.81%	6.64%	-20.3%
Load Factor	3.88%	8.81%	11.95%	9.2%

The sensitivity analysis shows that the results are robust: even a variation of +/- 10% in the key parameters is not sufficient to make the project economically attractive. For the project investment, the limit of additionality is situated at a total investment cost decrease of 12.4%. This could not be considered likely at the time of investment decision, due to the precise cost estimates sourced from suppliers and the significant expected inflation, which could actually bring the total investment up, rather than down.[18] Likewise, an increase of more than 18.2% in HFO price, an increase of more than 18.8% in NG price or a decrease of 20.3% in O&M costs would turn the project non-additional; however, it is impossible to adopt different initial values (in the fuel prices or O&M costs) because these are determined from the historical data. Different levels of inflations are also highly unlikely, given that the forecast of increase in fuel prices based on the AEO 2006 and Pakistan Energy Year Book data is much lower.

A variation of +10% in the load factor of steam turbine results into project IRR value higher than the benchmark. As mentioned in Table A.4.2.3, the load factor of the steam turbine is 80%. An increase of 9.2% in the load factor (87.36% load factor of the steam turbine) shall make the project IRR equal to the benchmark however this variation is not practically possible because:

- The operational capacity of the WHR plant is dependent on the waste heat liberated from the kilns. The WHR plant shall operate on 80% load factor only when all the three kilns E, F, G are simultaneously operating at their maximum capacity. All the three kilns do not run 330 days continuously on maximum capacity therefore achieving a plant load factor of greater than 80% (especially 87.36%) is not possible due to technical and commercial limitations. The plant operation depends upon demand of cement in the market which is always variable. The technical limitations include scheduled and unscheduled maintenance of kilns and the WHR plant itself.
- Furthermore, as per technical design, turbines are always operated between 75-85% load to cater the surges in the electricity demand, and to safely operate within the electrical protection limits.

As explained in the investment analysis, the present project would not be economically attractive without the consideration of the CER revenue and would not be realised. Therefore, the proposed CDM project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The emission reductions of the project activity were calculated according to AMS-III.Q. / Version 04.

Baseline emissions

In the situation where the electricity is obtained from a specific existing power plant or from the grid, baseline emissions can be calculated as follows:

[18] Anyway, ex-post project investment auditing proves that the total investment has not been lower than expected.

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_j \sum_i (EG_{i,j,y} * EF_{Elec,i,j,y}) \quad \textbf{(1)}$$

Where:

$BE_{elec,y}$	Baseline emissions due to displacement of electricity during the year *y* in tons of CO_2
$EG_{i,j,y}$	The quantity of electricity supplied to the recipient *j* by generator, that in the absence of the project activity would have been sourced from i^{th} source (*i* can be either grid or identified source) during the year *y* in MWh
$EF_{elec,i,j,y}$	The CO_2 emission factor for the electricity source *i* (*i*=gr (grid) or *i*=is (identified source)), displaced due to the project activity, during the year *y* in tons CO_2/MWh
f_{wcm}	Fraction of total electricity generated by the project activity using waste energy. This fraction is 1 if the electricity generation is purely from use of waste energy. If the boiler providing steam for electricity generation uses both waste and fossil fuels, this factor is estimated using equation (7). If the steam used for generation of the electricity is produced in dedicated boilers but supplied through common header, this factor is estimated using equation (7)/(9). Note: For project activity using waste pressure to generate electricity, electricity generated from waste pressure use should be measurable and this fraction is 1
f_{cap}	Capping factor to exclude increased waste energy utilization in the project year *y* due to increased level of activity of the plant, relative to the level of activity in the base years before project start. The ratio is 1 if the waste energy generated in project year *y* is same or less than that generated in base years. f_{cap} shall be estimated according to the corresponding section of ACM0012 “Consolidated baseline methodology for GHG emission reductions from waste energy recover projects”

The baseline generation source is an identified existing plant, the parameter $EG_{i,j,y}$ corresponds to $EG_{is,y}$ and the emission factor $EF_{elec,i,j,y}$ corresponds to $EF_{Elec,is,y}$. The CO_2 emission factor shall be determined as follows:

$$EF_{Elec,is,j,y} = \frac{EF_{CO2,i,j}}{\eta_{Plant,j}} \times 3.6 * 10^{-3} \quad \textbf{(2)}$$

Where:

$EF_{CO2,i,j}$	The CO_2 emission factor per unit of energy of the fossil fuel used in the baseline generation source *i* in (tCO_2/TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors
$\eta_{Plant,j}$	The overall efficiency of the existing plant that would be used by j^{th} recipient in the absence of the project activity
$3.6*10^{-3}$	Conversion factor, expressed as TJ/MWh

In case in the baseline situation more than one type of fossil fuel is used in the captive power plant, the relative contribution to the total output of each fossil fuel shall be considered and the formulas for baseline emissions shall be adjusted accordingly.

Since the captive power plant consumes more than one type of fossil fuel (HFO, NG, and diesel) therefore CO_2 emission factor per unit of energy of the fossil fuels used in the baseline shall be weighted emission factor calculated as follows:

$$EF_{CO2,i,j} = \frac{\sum_i (FC_{i,y} \times NCV_i \times COEF_i)}{\sum_i (FC_{i,y} \times NCV_i)} \qquad \textbf{(3)}$$

Where:

$EF_{CO2,i,j}$	The CO_2 emission factor per unit of energy of the fossil fuels used in the baseline generation source *i* in (tCO_2/TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors
$FC_{i,y}$	Consumption of fossil fuel (mass or volume unit) in project situation at captive power plant
NCV_i	Net calorific value (energy content per unit mass or energy content per unit volume units) of fossil fuel used in baseline
$COEF_i$	Coefficient of fossil fuel (tCO_2/TJ) used in baseline situation
i	Fossil fuel type

Efficiency of existing captive plant

According to AMS-III.Q / Version 04, efficiency of the power plant *($\eta_{plant,j}$)* shall be one of the following:

(i) Assume a constant efficiency of the captive plant and determine the efficiency, as a conservative approach, for optimal operation conditions i.e., design fuel, optimal load, optimal oxygen content in flue gases, adequate fuel conditioning (temperature, viscosity, moisture, size/mesh etc.), representative or favorable ambient conditions (ambient temperature and humidity); or

(ii) Highest of the efficiency values provided by two or more manufacturers for power plants with specifications similar to that that would have been required to supply the recipient with electricity that it receives from the project activity; or

(iii) Assume a captive power generation efficiency of 60% based on the net calorific values as a conservative approach.

The efficiency of the captive plant has been determined according to option (i) mentioned above. The existing captive power plant has five types of gensets as listed in Table A.4.2.1. As a conservative approach, the highest optimal operation (designed) efficiency among the five types of gensets is selected as constant efficiency of the existing captive plant.

Table B.6.1.1: Efficiency of existing captive plant

CatMak 16CM32C DF Gensets		
Heat value of HFO for efficiency test	kJ/kg	42,270
HFO consumption at 85% load	g/kWh	190.2
Heat rate of CatMak 16CM32C DF gensets	kJ/kWh	8,040
Efficiency of CatMak 16CM32C DF gensets	%	44.78%
CatMak 16CM34 Gensets		
Heat rate of CatMak 16CM34 gensets	kJ/kWh	8,254
Efficiency of CatMak 16CM34 gensets at 85% load	%	43.62%
Rolls-Royce B35:40V-20AGS Gensets		
Heat rate of Rolls-Royce B35:40V-20AGS Gensets	kJ/kWh	7,862
Efficiency of Rolls-Royce B35:40V-20AGS Gensets	%	45.79%
Rolls-Royce 40V-16AGS Gensets		
Heat rate of Rolls-Royce 40V-16AGS Gensets	kJ/kWh	7,920
Efficiency of Rolls-Royce 40V-16AGS Gensets	%	45.45%
Wartsila 20V34SG Genset		
Heat rate of Wartsila 20V34SG genset	kJ/kWh	8,153
Efficiency of Wartsila 20V34SG genset	%	44.16%

For CatMak 16CM32C DF gensets, the consumption and net calorific values of fuel have been taken from Acceptance Test Record conducted by OEM (Original Equipment Manufacturer). Heat rate and efficiency has been calculated based on the test record. Similarly, efficiency of CatMak 16CM34 gensets has been calculated from the heat rate value provided in the Acceptance Test Record conducted by OEM. For the Rolls-Royce gensets and Wartsila 20V34SG genset, heat rate values have been taken from the Acceptance Test Record conducted by corresponding OEM. The calculation of efficiency has been done in the emission reduction calculation excel sheet and the relevant evidences have been provided to DOE.

The highest efficiency among all the gensets of the captive power plant is of Rolls-Royce gensets. As a conservative approach, a constant efficiency of 45.79% for the captive power plant is selected as per option (i) for efficiency of power plant. Hence:

$\eta_{plant,j}$ = 45.79%

Calculation of f_{wcm}

The electricity generation of the project is purely from use of waste heat, then according to the methodology f_{wcm}= 1.

Calculation of f_{cap}

According to the requirements of AMS.III.Q / Version 04 the capping factor f_{cap} should be calculated using proper equations from ACM0012 "Consolidated baseline methodology for GHG emission reductions from waste energy recover projects"

The methodology requires the baseline emissions to be capped irrespective of planned/unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuel type and quantity resulting in an increase in generation of waste energy. The cap can be estimated using the three methods described below, following this hierarchy: (i) Method-1 can be used to estimate the capping factor if required data is available; (ii) if the project activities implemented in a Greenfield facility, or in existing facilities where the required data is unavailable Method-2 shall be used; (iii) If the project proponents demonstrate technical infeasibility in direct monitoring of waste heat / pressure of waste energy carrying medium (WECM), then Method-3 is used.

Method-1

Where the historical data on energy released by the waste energy carrying medium is available, the baseline emissions are capped at the maximum quantity of waste energy released into the atmosphere under normal operation conditions in the three years previous to the project activity.

Method-2

If three-year historical data is not available, the manufacturer's data for the facility shall be used to estimate the amount of waste energy the facility generates per unit of "product". The "product" is produced by the process that generates waste energy (departmental process or process of entire project facility, whichever is more justifiable and accurate). If any modification is carried out by the project proponent or if the manufacturer's data is not available for an assessment, this should be carried out by independent qualified/certified external process experts such as a chartered engineer on a conservative quantity of waste energy generated by the project facility per unit of product manufactured by the process generating waste energy. The value arrived at based on above sources of data, shall be used to estimate the baseline cap (f_{cap}). Under this method, the following equations should be used to estimate $f_{cap.}$

Method-3

In some cases, it may not be possible to measure the waste energy (heat, sensible heat, heat of reaction, heat of combustion, etc.) enthalpy or pressure content of WECM (Method-1 requirement), nor the specific amount of WECM per unit of product (Method-2 requirement). In such cases, the capping shall be based on indirect information about specific parameters allowing to estimate the amount of waste energy available. These parameters should be related to the characteristics of a product or a by-product of the facility from which waste energy can be recovered (e.g. volume and heat content of hot clinker produced by a kiln in a cement plant, if this heat can be recovered using air as the WECM). These cases may be of the following two types.

Case 1: The energy is recovered from WECM and converted into final output energy through a waste heat recovery equipment. For example, the useful energy (e.g., steam) is produced using waste energy generated by a chemical reaction. For such cases f_{cap} should be the ratio of maximum energy that could be recovered (MER) by the waste heat recovery equipment implemented under the CDM project activity and the actual energy recovered under the project activity (using direct measurement). The MER should be based on information on the characteristics of the key product/by product. For existing facilities this can be obtained from historical information and for Greenfield facilities, manufacturer's specifications on these key parameters can be used.

Case 2: The energy is recovered from WECM in an intermediate energy recovery equipment using an intermediate source. For example, an intermediate source to carry energy from primary WECM may include the sources such as water, oil or air to extract waste energy entrapped in chemicals (heat of reaction) or solids (sensible heat), which is further recovered in the waste heat recovery equipment to generate final output energy. For such cases f_{cap} should be the ratio of maximum energy that could be recovered (MER) by waste heat recovery equipment implemented under the CDM project activity (considering the losses due to exchange of energy) and actual intermediate energy recovered under the project activity (using direct measurement). The MER should be based on information on the characteristics of the key product/by product. For existing facilities this can be collected from historical information and for Greenfield facilities, manufacturers' specifications on these key parameters can be used.

Since there is no historical data on parameters of the waste energy from the clinker production and it is not possible to measure it due to several technical reasons, Method-3 for f_{cap} calculation is chosen. Since the waste energy from the WECM (i.e. heated air from the kilns) is recovered and converted into useful

energy (the electricity output) in a single set of waste heat recovery equipment (without any additional intermediate energy recovery equipment), Case 1 of Method-3 for f_{cap} calculation is applicable.

Following equation (40) of ACM0012 / Version 04.0.0 is used to determine f_{cap}:

$$f_{cap} = \frac{Q_{OE,BL}}{Q_{OE,y}} \quad \textbf{(4)}$$

Where:

$Q_{OE,BL}$	=	Output/intermediate energy that can be produced (TJ), to be determined on the basis of maximum energy that could be recovered from the WECM (MER), which would have been released (or WECM would have been flared or energy content of WECM would have been wasted) in the absence of CDM project activity.
$Q_{OE,y}$	=	Quantity of actual output/intermediate energy generated during year *y* (TJ)

In the proposed project, the theoretical electricity output $Q_{OE,BL}$ is calculated as follows:

Gross capacity of Steam Turbine = 15 MW (Waste Heat Recovery Plant design value provided by the equipment supplier, which represents maximum waste heat recovery potential of the waste heat recovery equipment)

Based on 80% load factor and 330 days/year of clinker production/kiln operation
Gross electricity generation is thus equal to 15*0.8*330*24 = 95,040 MWh/y
Thus, maximum energy that could be recovered by waste heat recovery equipment,
$Q_{OE,BL}$ = 95,040 MWh/y * 3600 * 10^{-6} = 342.144 TJ/y electrical.

The actual output electricity $Q_{OE,y}$ will be determined ex post by actual measurement. As per project plan, there is no reason to believe that the energy recovered will be different from the theoretical value for which the waste heat recovery system has been designed. Therefore, the ratio is assumed to be 1 for ex ante calculations and will be settled ex post.

Project emissions

Regarding project emissions, paragraph 13 & 14 of AMS-III.Q / Version 04 are quoted below:

13. Project Emissions include emissions due to combustion of auxiliary fuel to supplement waste gas and emissions due to consumption of electricity by the project activity.

14. If the waste gas contains carbon monoxide or hydrocarbons, other than methane, and the waste gas is vented to the atmosphere in the baseline situation, project emissions have to include CO_2 emissions due to the combustion of the waste gas.

Leakage

Paragraph 15 of AMS-III.Q / Version 04 states that:

15. If equipment currently being utilised is transferred from outside the boundary to the project activity, leakage is to be considered.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(5)}$$

Where:

ER_y	Emission reductions in year *y* (t CO_2e/y)
BE_y	Baseline emissions in year *y* (t CO_2e/y)
PE_y	Project emissions in year *y* (t CO_2/y)
LE_y	Leakage emissions in year *y* (t CO_2/y)

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**NCV_{HFO}**
Data unit:	TJ/t (Tera joule per metric tonne)
Description:	Net Calorific Value of HFO
Source of data used:	Laboratory analysis
Value applied:	0.040
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value of NCV of HFO 17,148 BTU/lb was taken from laboratory test of HFO sample. For emission reduction calculations this value was converted into TJ/ton using the following formula: NCV in TJ/t = NCV in BTU/lb *0.001055056/(0.0004535924*10^6) The NCV calculated by above formula is 0.040 TJ/t
Any comment:	Laboratory test is available with the project proponent

Data / Parameter:	**NCV_{NG}**
Data unit:	MJ/Nm^3 (Mega joule per normal cubic meter)
Description:	Net Calorific Value of natural gas
Source of data used:	Laboratory analysis
Value applied:	31.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The NCV value of 937.95 BTU/ft^3 has been taken from the laboratory test of natural gas sample. For emission reduction calculations, the value was converted to MJ/Nm^3 by using following formula: NCV in MJ/Nm^3 = NCV in BTU/ft^3 *0.001055056 / 0.02831685 The NCV calculated by above formula is 31.00 MJ/Nm^3
Any comment:	Laboratory test is available with the project proponent

Data / Parameter:	**NCV_{Diesel}**
Data unit:	MJ/l (Mega joule per litre)
Description:	Net Calorific Value of diesel
Source of data used:	Laboratory analysis

Value applied:	35.93
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value of NCV of diesel 18,301 BTU/lb was taken from laboratory test of diesel sample. For emission reduction calculations this value was converted into MJ/Ltr using the following formula: NCV in MJ/l = NCV in BTU/lb*0.001055056/0.4535924*Density of diesel The density of diesel taken from the laboratory test report is 0.8441 kg/l The NCV calculated by above formula is 35.96 MJ/Ltr
Any comment:	Laboratory test is available with the project proponent

Data / Parameter:	**$E_{HFO,historical}$**
Data unit:	MWh/y (Megawatt hours per year)
Description:	Electricity generated on HFO at captive power plant in historical year
Source of data used:	Power Generation Reports
Value applied:	108,341.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The electricity generated on HFO during Oct 06 – Sep 07 is taken from Power generation reports of Lucky Cement Limited Karachi Plant.
Any comment:	

Data / Parameter:	**$FC_{HFO,historical}$**
Data unit:	t/y (metric tonnes per year)
Description:	HFO consumption for electricity generation at captive power plant in historical year
Source of data used:	Power Generation Reports
Value applied:	22,650.53
Justification of the choice of data or description of measurement methods and procedures actually applied :	The HFO consumption for electricity generation during Oct 06 – Sep 07 is taken from Power generation reports of Lucky Cement Limited Karachi Plant.
Any comment:	

Data / Parameter:	**$E_{NG,historical}$**
Data unit:	MWh/y (Megawatt hours per year)
Description:	Electricity generated on natural gas at captive power plant in historical year
Source of data used:	Power Generation Reports
Value applied:	210,839.17
Justification of the choice of data or description of measurement methods and procedures actually applied :	The electricity generated on natural gas during Oct 06 – Sep 07 is taken from Power generation reports of Lucky Cement Limited Karachi Plant.
Any comment:	

Data / Parameter:	**$FC_{NG,historical}$**
Data unit:	Nm^3/y (Normalized cubic meter per year)
Description:	Natural gas consumption for electricity generation at captive power plant in historical year
Source of data used:	Power Generation Reports
Value applied:	67,593,239.24
Justification of the choice of data or description of measurement methods and procedures actually applied :	The natural gas consumption for electricity generation during Oct 06 – Sep 07 is taken from Power generation reports of Lucky Cement Limited Karachi Plant.
Any comment:	

Data / Parameter:	**$FC_{diesel,historical}$**
Data unit:	l/y (litres per year)
Description:	Diesel consumption at captive power plant in historical year
Source of data used:	Power Generation Reports
Value applied:	169,590.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The diesel consumption at captive power plant during Oct 06 – Sep 07 is taken from Power generation reports of Lucky Cement Limited Karachi Plant.
Any comment:	

Data / Parameter:	**$COEF_{HFO}$**
Data unit:	tCO_2/TJ (tonnes of Carbon Dioxide per Tera joule)
Description:	Emission Coefficient of HFO
Source of data used:	The Carbon emission factor is taken as per “Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction” Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in kg CO_2 / TJ.
Value applied:	77.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn’t have any GHG inventory data. Therefore, IPCC default value is used which is permissible by the applied methodology AMS-III.Q. / Version 4. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$COEF_{diesel}$**
Data unit:	tCO_2/TJ (tonnes of Carbon Dioxide per Tera joule)
Description:	Emission Coefficient of diesel
Source of data used:	The Carbon emission factor is taken as per “Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction”

	Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in kg CO_2 / TJ.
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn't have any GHG inventory data. Therefore, IPCC default value is used which is permissible by the applied methodology AMS-III.Q. / Version 4. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$COEF_{NG}$**
Data unit:	tCO_2/TJ (tonnes of Carbon Dioxide per Tera joule)
Description:	Emission Coefficient of natural gas
Source of data used:	The Carbon emission factor is taken as per "Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction" Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in kg CO_2 / TJ.
Value applied:	56.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn't have any GHG inventory data. Therefore, IPCC default value is used which is permissible by the applied methodology AMS-III.Q. / Version 4. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$Q_{OE,BL}$**
Data unit:	TJ/y (Tera joule per year)
Description:	Maximum recoverable energy by the waste heat recovery equipment implemented under the CDM project activity
Source of data used:	Calculated based on the project technical data (15 MW x 80% load factor x 330 days/y of clinker production x 24 h/d x 3600 MJ/MWh x 10^{-6} TJ/MJ)
Value applied:	342.144
Justification of the choice of data or description of measurement methods and procedures actually applied :	In case, during the project activity, the waste heat is increased, this parameter is used to cap the emission reductions according to the waste heat quantity in the baseline scenario.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

>>

Ex-ante calculation of emission reductions is based on AMS-III.Q / Version 04. The equations involved in *ex-ante* calculations are enumerated in section B.6.1. Details of input parameters and notations used in emission reduction calculations are referred in Annex 3.

Baseline emissions

Baseline emissions are calculated as:

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(EG_{i,j,y} * EF_{Elec,i,j,y}) \quad \textbf{(1)}$$

= 1 * 1 * 87,437 * 0.4917

= 42,992 tCO_2/y

The baseline generation source is an identified existing plant, the parameter $EG_{i,j,y}$ corresponds to $EG_{is,y}$ and the emission factor $EF_{elec,i,j,y}$ corresponds to $EF_{Elec,is,y}$. The CO_2 emission factor shall be determined as follows:

$$EF_{Elec,is,j,y} = \frac{EF_{CO2,i,j}}{\eta_{Plant,j}} \times 3.6 * 10^{-3} \quad \textbf{(2)}$$

= 62.541 / 45.79% * 3.6 * 10^{-3}

= 0.4917 tCO_2/MWh

The emission factor calculated as 0.4917 tCO2/MWh is used for ex ante calculation of baseline emissions (detailed calculations of emission factor are provided in ER Calculation sheet and also in Annex 3). It is based on the actual fuel mix used in the captive generation (see below), and on the highest efficiency (regardless the actual engine providing the captive electricity), which is the most conservative choice.

Fuel (HFO and NG with Diesel being auxiliary fuel) consumption of captive power plant and fuel NCVs will be monitored for ex-post calculation of emission factor of the captive power plant.

Since the captive power plant consumes more than one type of fossil fuel (HFO, NG, and diesel) therefore CO_2 emission factor per unit of energy of the fossil fuels used in the baseline is weighted emission factor calculated as follows:

$$EF_{CO2,i,j} = \frac{\sum_{i}(FC_{i,y} \times NCV_i \times COEF_i)}{\sum_{i}(FC_{i,y} \times NCV_i)} \quad \textbf{(3)}$$

= 62.541 tCO_2/TJ

Following equation is used to determine f_{cap}:

$$f_{cap} = \frac{Q_{OE,BL}}{Q_{OE,y}} \quad \textbf{(4)}$$

= 342.144 / 342.144 = 1

Project emissions

There is no auxiliary fuel combusted in the project activity to supplement waste gas and the waste heat recovery system consumes its own electricity for auxiliary needs. Similarly, the project activity does not incinerate any waste gas to generate energy. Therefore, the project emissions are considered zero.

$PE_y = 0$

Leakage

The project activity involves only installation of new equipment; no retrofit or replacement will take place and hence no existing equipment can be transferred outside the project boundary. Since no transfer of equipment is considered in the project activity, the leakages are zero.

$LE_y = 0$

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(5)}$$

= 42,992 – 0 – 0 = 42,992 tCO_2/y

B.6.4 Summary of the ex-ante estimation of emission reductions:

>>

A summary of the ex-ante estimation of emission reductions for the fixed crediting period of 10 years is provided below.

Table B.6.4.1: Ex-ante estimation of emission reductions

Year	**Estimation of project activity emissions (tonnes of CO_2 e)**	**Estimation of baseline emissions (tonnes of CO_2 e)**	**Estimation of leakage (tonnes of CO_2 e)**	**Estimation of overall emission reductions (tonnes of CO_2 e)**
Year 1	0	42,992	0	42,992
Year 2	0	42,992	0	42,992
Year 3	0	42,992	0	42,992
Year 4	0	42,992	0	42,992
Year 5	0	42,992	0	42,992
Year 6	0	42,992	0	42,992
Year 7	0	42,992	0	42,992
Year 8	0	42,992	0	42,992
Year 9	0	42,992	0	42,992
Year 10	0	42,992	0	42,992
Total (tonnes of CO_2 e)	**0**	**429,920**	**0**	**429,920**

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**NCV_{HFO}**
Data unit:	TJ/t (Tera joule per metric tonne)
Description:	Net calorific value of HFO

Source of data to be used:	Laboratory analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.040
Description of measurement methods and procedures to be applied:	Monitoring method: external data Data type: measured Archiving procedure: Paper and Electronic Recording Frequency: Annually
QA/QC procedures to be applied:	Quality Management System (QMS) procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	**NCV_{NG}**
Data unit:	TJ/Nm^3 (Tera joule per normalized cubic meter)
Description:	Net calorific value of natural gas used for power generation
Source of data to be used:	Laboratory analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.000031
Description of measurement methods and procedures to be applied:	Monitoring method: external data Data type: measured Archiving procedure: Paper and Electronic Recording Frequency: Annually
QA/QC procedures to be applied:	QMS procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	**NCV_{diesel}**
Data unit:	TJ/l (Tera joule per litre)
Description:	Net calorific value of diesel used as auxiliary fuel at captive power plant
Source of data to be used:	Laboratory analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.00003596
Description of measurement methods and procedures to be applied:	Monitoring method: external data Data type: measured Archiving procedure: Paper and Electronic Recording Frequency: Annually
QA/QC procedures to be applied:	QMS procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	**$COEF_{HFO}$**
Data unit:	tCO_2/TJ (metric tonnes of Carbon Dioxide per Tera joule)
Description:	Emission coefficient of HFO
Source of data used:	IPCC 2006 default value: "Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction" Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in $kgCO_2/TJ$.
Value applied:	77.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn't have any GHG inventory data. Therefore, IPCC default value is used. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$COEF_{NG}$**
Data unit:	tCO_2/TJ (metric tonnes of Carbon Dioxide per Tera joule)
Description:	Emission coefficient of natural gas
Source of data used:	IPCC 2006 default value: "Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction" Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in $kgCO_2/TJ$.
Value applied:	56.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn't have any GHG inventory data. Therefore, IPCC default value is used. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$COEF_{diesel}$**
Data unit:	tCO_2/TJ (metric tonnes of Carbon Dioxide per Tera joule)
Description:	Emission coefficient of HFO
Source of data used:	IPCC 2006 default value: "Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction" Chapter 2: Stationary Combustion, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is available in $kgCO_2/TJ$.
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local value is not available as Pakistan doesn't have any GHG inventory data. Therefore, IPCC default value is used. Value in $kgCO_2/TJ$ was converted to tCO_2/TJ units by following procedure. Value in tCO_2/TJ = Value in $kgCO_2/TJ$ / 1000
Any comment:	

Data / Parameter:	**$Q_{OE,y}$**

Data unit:	TJ/y (Tera joule per year)
Description:	Electrical output generated by waste heat recovery based steam turbo-generator during year *y* in TJ
Source of data to be used:	Electricity generation report
Value of data	342.144
Description of measurement methods and procedures to be applied:	Monitoring Method: Electricity generation measurement Data type: measured in MWh and converted to TJ by multiplying with $3.6*10^{-3}$ Monitoring instrument: Energy meter Frequency of calibration: annually Frequency of measurement: continuous Frequency of recording: daily Archiving procedure: Electronic and Paper Responsibility: See Table B.7.2.2
QA/QC procedures to be applied:	QMS procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	$\mathbf{EG_{i,j,y}}$
Data unit:	MWh/y (Megawatt hours per year)
Description:	Net electricity generated by waste heat recovery based steam turbo-generator
Source of data to be used:	Electricity generation report
Value of data applied for the purpose of calculating expected emission reductions in section B.5	87,436.80
Description of measurement methods and procedures to be applied:	Monitoring Method: Electricity generation measurement Data type: measured Monitoring instrument: Energy meter Frequency of calibration: annually Frequency of measurement: continuous Frequency of recording: daily Archiving procedure: Electronic and Paper Responsibility: See Table B.7.2.2
QA/QC procedures to be applied:	QMS procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	$\mathbf{FC_{HFO,y}}$
Data unit:	t/y (Metric tonnes per year)
Description:	HFO consumption by captive power plant
Source of data to be used:	Internal records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	15,943.02

Description of measurement methods and procedures to be applied:	Monitoring method: Flow measurement Data type: Measured Frequency of measurement: Continuous Monitoring instrument: Flow meter Calibration frequency: Annually Calibration done by: Power Generation Department Archiving procedure: Electronic & paper Recording Frequency: Daily
QA/QC procedures to be applied:	QMS procedures shall be followed in measurement, recording, and reporting of the parameter.
Any comment:	

Data / Parameter:	**$FC_{NG,y}$**
Data unit:	Nm^3/y (Normal cubic meter per year)
Description:	Natural gas consumption by captive power plant
Source of data to be used:	Internal records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	47,576,836.29
Description of measurement methods and procedures to be applied:	Monitoring method: Flow measurement Data type: Measured Frequency of measurement: Continuous Monitoring instrument: Flow meter Archiving procedure: Electronic & paper Recording Frequency: Daily
QA/QC procedures to be applied:	QMS procedures will be followed in recording & reporting of parameter.
Any comment:	

Data / Parameter:	**$FC_{diesel,y}$**
Data unit:	l/y (Litres per year)
Description:	Diesel consumption by captive power plant
Source of data to be used:	Internal records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	119,369.27
Description of measurement methods and procedures to be applied:	Monitoring method: Flow measurement & level measurement Data type: Measured Frequency of measurement: Continuous Monitoring instrument: Flow meter & level meter Calibration frequency: Annually Calibration done by: Power Generation Department Archiving procedure: Electronic & paper Recording Frequency: Daily

QA/QC procedures to be applied:	QMS procedures will be followed in recording & reporting of parameter.
Any comment:	

B.7.2 Description of the monitoring plan:

>>

Data will be collected by the Shift Operator and Shift Supervisor at captive power plant. Shift Incharge at captive power plant will prepare daily log sheets of fuel consumption for captive power generation. Power Plant Incharge will verify the data.

Table B.7.2.1 describes the devices used at Lucky Cement to measure different parameters and Table B.7.2.2 shows the designation of the personnel involved in the monitoring plan.

All the data is annually audited by 3rd party auditors. In case of erratic data, corrections and trend from the historical data will be sought.

Table B.7.2.1: Monitoring Information

Item	Parameter	Recording Frequency	Description of equipment used	Calibration Mode		Calibration Frequency
				Internal Calibration	External Calibration	
Fuel Consumption at Captive Power Plant	HFO consumption	Daily	Flow meter	Power Generation Department	-	Annually
	Natural Gas consumption	Daily	Flow meter	-	SSGCL	-
	Diesel consumption	Daily	Flow meter & Level meter	Power Generation Department	-	Annually
Project Electricity	Gross electricity generated by steam turbo-generator	Daily	Energy meter	-	By third party	Annually
	Net electricity generated by steam turbo-generator	Daily	Energy meter	-	By third party	Annually

Table B.7.2.2: Designation of personnel involved in monitoring plan

Parameter	12 - Hourly Data Collection	Daily Data Log Preparation	Data Verification	Data Auditing	
				Designation	Frequency
Fuel consumption at captive power plant	Shift Operator - Shift Supervisor	Shift Incharge	Incharge Power Plant	External Audit	Annually
Electricity generation by steam turbo-generator	Shift Operator	Shift Incharge	Incharge Power Plant	External Audit	Annually

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

Date of completion:

25/10/2012

Name of the responsible entities:

First Climate (Switzerland) AG
Stauffacherstrasse 45
CH-8004 Zurich
Switzerland
URL: www.firstclimate.com
Contact person: Mr Nikolaus Wohlgemuth
Email: nikolaus.wohlgemuth@firstclimate.com

Carbon Services (Private) Limited
19 Davis Road, 2nd Floor, Al Maalik, Lahore
Pakistan
URL: www.carbon.com.pk
Contact person: Mr Omar M Malik
Email: omar.malik@carbon.com.pk

Both, First Climate (Switzerland) AG and Carbon Services (Private) Limited, are project participants.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
07/05/2008[19]

C.1.2. Expected operational lifetime of the project activity:

>>
20 years 0 months

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>>
Not applicable

C.2.1.2. Length of the first crediting period:

>>
Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01/12/2012

C.2.2.2. Length:

>>
10 years 0 months

[19] Date of the contract between Lucky Cement and the main equipment supplier

SECTION D. Environmental impacts

>>

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

According to the host country regulations, the project activity had to receive an Environmental Approval from the Environment Protection Agency of the local government, upon submission of an Initial Environmental Examination (IEE) Report by the project proponent.

The IEE points out that the project will be beneficial to the environment as utilization of waste heat and thus lower consumption of fossil fuels are made possible by the new technology. No negative environmental impacts are to be considered, as the technology to be adopted is mature and safe, once appropriate operation and maintenance procedure are in place.

The environmental analyses conducted by Lucky Cement for the project are consistent in demonstrating that the project activity is expected to remain fully compliant with NEQS (National Environmental Quality Standards). In fact, it is expected that pollutant emissions (both of local concern and global concern, such as CO_2) will reduce from the current levels.

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

>>

Neither the project participants nor the host Party have any concern about negative environmental impacts associated with the project activity, given that project activity aims at reducing the local and global environmental impacts of the industrial site where the project activity is to be implemented.

IEE Report (Initial Environmental Examination Report) and the accompanying approval request letter were submitted on June 01, 2009. Approval letter was issued on 2009. A copy is shown in Annexure 5 as reference to the context. The approval letter does not raise any particular issue with regard to the environmental impact of the project.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

The local stakeholders' consultation meeting is a requirement by Designated National Authority (DNA) of CDM Pakistan, as well as it is required for the CDM PDD. The DNA issues Host Country Approval to the project participants after the stakeholders' consultation meeting is conducted and all the evidences are provided to it.

Stakeholders were informed about the project activity through specific advertising published by the project owner in the local media (newspaper, public notice boards within and surrounding the Lucky Cement Karachi Plant). Advertisement is shown in Annex 6.

The Stakeholder consultation meeting was held on Apr 09, 2009 at Lucky Cement Limited Karachi Plant and was open to anybody willing to participate (private citizens, representatives of associations, interest groups, unions, public authorities, NGOs, etc.).

The meeting was introduced by the representative of the project owner who explained in details the project activity and stimulated the debate and the expression of comments. Pictures of the Meeting are shown in Annex 7.

E.2. Summary of the comments received:

>>

Comments from the stakeholders were collected in written form during and after the meeting. These are summarized below in Table E.2.1.

Table E.2.1: Summary of the comments

Sr. No.	Stakeholder's Name	Address	Comments/Views about the Project
1	Rahim Dad	Goth Umer Jamoot, Kathore, Malir Karachi	Our children will get opportunity of learning technical education by installation of this project.
2	Ghulam Nabi	Goth Umer Jamoot, Kathore, Malir Karachi	Education will be promoted by installation of this project.
3	Essa Khan	Village Walidad Jokio Distt. Jamshoro P.O. Nooriabad Thama Bula Khan	We will get new jobs because of this project.
4	Ghulam Nabi	Goth Jokhio, Gattap Town, Kathore	We are very happy that this project is being implemented in our area. It shall be beneficial for our people.
5	Nazir Ahmad Jokhio	P.O. Kathore, Goth Kathore, Superhighway Karachi	Pollution will decrease by installation of this project.
6	Niaz Ahmad Jokhio	Goth Rais Walidad Jokhio, P.O. Nuriabad, Jamshoro Distt.	We had problem of unemployment which we think now will be solved by installation of this project.
7	Abdul Salam Jokhio	Goth Rais Walidad Jokhio, P.O. Nuriabad, Jamshoro Distt.	People will get employment and education by installation of this project.

E.3. Report on how due account was taken of any comments received:

>>

All the comments received at the stakeholders meeting were expressing a positive opinion of the project. The personnel at Lucky Cement explained in detail the technical, environmental, and social consequences of utilization of waste heat recovery for power generation. The stakeholders were satisfied, and were supportive to the project. In conclusion, no concerns were expressed by the stakeholders, which eventually expressed appreciation for initiative of Lucky Cement.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Lucky Cement Limited
Street/P.O.Box:	A. Aziz Hashim Tabba Street
Building:	6-A M. Ali Housing Society
City:	Karachi
State/Region:	Sindh
Postcode/ZIP:	
Country:	Pakistan
Telephone:	+92-21-111 786 555
FAX:	+92-21-34534302
E-Mail:	info@lucky-cement.com
URL:	www.lucky-cement.com
Represented by:	
Title:	Director Power Generation
Salutation:	Mr
Last name:	Haqqi
Middle name:	
First name:	Intisar ul Haq
Department:	Power Generation
Mobile:	+92-300-8550883
Direct FAX:	
Direct tel:	
Personal e-mail:	intisarhaqqi55@yahoo.com

Organization:	Carbon Services (Private) Limited
Street/P.O.Box:	19 Davis Road
Building:	2nd Floor, Al Maalik,
City:	Lahore
State/Region:	Punjab
Postfix/ZIP:	
Country:	Pakistan
Telephone:	+92-42-36313235 / 36313236
FAX:	+92-42-36312959
E-Mail:	
URL:	www.carbon.com.pk
Represented by:	Mr. Omar M. Malik
Title:	Director
Salutation:	Mr
Last Name:	Malik
Middle Name:	M
First Name:	Omar
Department:	
Mobile:	+92-300-8463743
Direct FAX:	+92-42-36312959
Direct tel:	+92-42-36313235 / 36313236
Personal E-Mail:	omar.malik@carbon.com.pk

Organization:	First Climate (Switzerland) AG
Street/P.O.Box:	Stauffacherstr.45
Building:	
City:	Zurich
State/Region:	Zurich
Postcode/ZIP:	8004
Country:	Switzerland
Telephone:	+41-44-298 2800
FAX:	+41 44-298 2899
E-Mail:	info@firstclimate.com
URL:	www.firstclimate.com
Represented by:	
Title:	Board Member
Salutation:	Mr
Last name:	Lüchinger
Middle name:	
First name:	Alexander
Department:	
Mobile:	
Direct FAX:	+41 44 298 28 99
Direct tel:	+44 44 298 28 07
Personal e-mail:	alexander.luechinger@firstclimate.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding has been used in this project activity

Annex 3

BASELINE INFORMATION

Fuel Characteristics

Fuel Characteristics				
NCV of HFO		BTU/lb	17,148	Analysis
NCV of NG		BTU/ft^3	831.95	External analysis
NCV of diesel	NCV_{diesel}	BTU/lb	18,301	Analysis
Density of diesel	$Denisty_{diesel}$	kg/Ltr	0.8441	Analysis
GCV of coal	GCV_{coal}	kCal/kg	6,620	Company analysis
NCV of coal		kCal/kg	6,289	IPCC guidelines
NCV of HFO	NCV_{HFO}	TJ/ton	0.040	Conversion
NCV of NG	NCV_{NG}	MJ/Nm^3	31.00	Conversion
NCV of diesel	NCV_{diesel}	MJ/Ltr	35.93	Conversion
NCV of coal	NCV_{coal}	TJ/ton	0.026	Conversion
Emission Coefficient of HFO	$COEF_{HFO}$	tCO_2/TJ	77.4	IPCC default
Emission Coefficient of NG	$COEF_{NG}$	tCO_2/TJ	56.1	IPCC default
Emission Coefficient of diesel	$COEF_{diesel}$	tCO_2/TJ	74.1	IPCC default

HFO:

The lab test report[20] of HFO sample shows following parameters:

Flash point: 68 ºC
Density: 0.9631 kg/l

According to Table 1.1 of Volume 2, Chapter 1 of IPCC 2006, these characteristics respond to "Residual Fuel Oil" which states that:

This heading defines oils that make up the distillation residue. It comprises all residual fuel oils, including those obtained by blending. Its kinematic viscosity is above 0.1 cm^2(10 cSt) at 80ºC. The flash point is always above 50ºC and the density is always more than 0.90 kg/l.

Hence the default emission factor provided for Residual Fuel Oil i.e. 77.4 tCO_2/TJ has been used for calculations. Local or country-specific value of emission factor is not available and it is permissible by the applied methodology AMS-III.Q. / Version 4 to use the IPCC default emission factors for fuels.

[20] The lab test report has been provided to DOE.

Historical Data

Historical Operation of Karachi Plant (October 2006 to April 2008)				
Total clinker production	tons/yr	3,037,395.00		
Total electricity consumed by cement plant	MWh/yr	319,180.17		
Specific consumption of electricity by cement plant	MWh/ton clinker	0.11		
Kilns				
		Kiln E	**Kiln F**	**Total**
Clinker production	tons/yr	1,547,045.00	1,490,350.00	3,037,395.00
HFO consumption	tons/yr	384.76	362.00	746.76
Coal consumption	tons/yr	215,501.66	207,837.38	423,339.04
Specific energy consumption for clinker production	GJ/ton clinker	3.68	3.68	3.68
Specific consumption of HFO	tons/ton clinker	0.00025	0.00024	
Specific consumption of coal	tons/ton clinker	0.14	0.14	
Captive Power Plant				
Electricity generation on HFO	MWh/yr	108,341.00		
Electricity generation on natural gas	MWh/yr	210,839.17		
Total electricity generation	MWh/yr	319,180.17		
HFO consumption	tons/yr	22,650.53		
Natural gas consumption	Nm^3/yr	67,593,239.24		
Diesel consumption	Ltrs/yr	169,590.00		
Specific consumption of HFO	tons/MWh	0.21		
Specific consumption of natural gas	Nm^3/MWh	320.59		
Specific consumption of diesel	Ltrs/MWh	0.53		
Electricity generation on HFO	%	33.94%		
Electricity generation on natural gas	%	66.06%		

Comparison of Baseline & Project Situation

Baseline & Project Situation

Clinker production load on kiln E		TPD	3,000.00	
Clinker production load on kiln F		TPD	3,000.00	
Clinker production load on kiln G		TPD	3,000.00	
Operational days of plant		days/yr	330.00	
Specific consumption of electricity		MWh/ton	0.105	
Specific consumption of HFO by captive		tons/MWh	0.209	
Specific consumption of natural gas by captive		Nm^3/MWh	320.591	
Specific consumption of diesel by captive		Ltrs/MWh	0.53	
Generation on HFO		%	33.94%	
Generation on natural gas		%	66.06%	

Electricity Generation Comparison

			Baseline_{BL}	Project_y
Electricity consumption of plant		MWh/yr	312,098.07	312,098.07
Gross electricity generation by ST		MWh/yr	-	95,040.00
Net electricity generation by ST		MWh/yr	-	87,436.80
Generation by captive power plant		MWh/yr	312,098.07	224,661.27
Generation on HFO	E_{HFO}	MWh/yr	105,937.08	76,257.95
Generation on NG	E_{NG}	MWh/yr	206,160.98	148,403.31
HFO consumption	FC_{HFO}	tons/yr	22,147.95	15,943.02
NG consumption	FC_{NG}	Nm^3/yr	66,093,451.97	47,576,836.29
Diesel consumption	FC_{diesel}	Ltrs/yr	165,827.07	119,369.27

Clinker Production Comparison

			Baseline	Project
Clinker production by kiln E		tons/yr	990,000.00	990,000.00
Clinker production by kiln F		tons/yr	990,000.00	990,000.00
Clinker production by kiln G		tons/yr	990,000.00	990,000.00
Total clinker production		tons/yr	2,970,000.00	2,970,000.00
HFO consumption by kiln E		tons/yr	246.22	246.22
Coal consumption by kiln E		tons/yr	137,905.91	137,905.91
HFO consumption by kiln F		tons/yr	240.47	240.47
Coal consumption by kiln F		tons/yr	138,060.86	138,060.86
HFO consumption by kiln G		tons/yr	243.34	243.34
Coal consumption by kiln G		tons/yr	137,983.38	137,983.38

Emissions Reduction Calculation

Emissions Reduction Calculation			
Baseline emissions	**EB_y**	**t CO_2/yr**	**42,992**
Project emissions	**PE_y**	**t CO_2/yr**	**0**
Leakage emissions	**LE_y**	**t CO_2/yr**	**0**
Emissions reduction	**ER_y**	**t CO_2/yr**	**42,992**
Baseline Emissions			
Electrical output that can be theoratically produced	$Q_{OE,BL}$	TJ/yr	342.144
Electrical output ex ante estimation	$Q_{OE,y}$	TJ/yr	342.144
Capping factor	f_{cap}		1.00
Fraction of total electricity generated using waste heat	f_{wcm}		1
Electricity supplied by project activity	$EG_{i,j,y}$	MWh/yr	87,437
Efficiency of the existing power plant	$\eta_{Plant,j}$	%	45.79%
Weighted average coefficient of captive power plant	$EF_{CO2,i,j}$	t CO_2/TJ	62.541
Baseline emission factor	$EF_{Elec,is,j,y}$	t CO_2/MWh	0.4917
Baseline emissions	**$BE_{elec,y}$**	**t CO_2/yr**	**42,992**
Project Emissions			
Project emissions	**PE_y**	**t CO_2/yr**	**0**
Leakage Emissions			
Leakage emissions	**LE_y**	**t CO_2/yr**	**0**

Annex 4

MONITORING INFORMATION

Please refer to sections B.7.1 and B.7.2.

Annex 5

Approval from Environmental Protection Agency

Reference No: EPA/2009/06/01/IEE/39/

ENVIRONMENTAL PROTECTION AGENCY

GOVERNMENT OF SINDH

Plot # ST-2/1, Sector 23, KIA, Karachi-74900
Ph: 5065950, 5065598, 5065637
5065532, 5065946, 5065621
epasindh@cyber.net.pk
Facsimile: 5065940

Dated: 18th June, 2009

SUBJECT: DECISION ON INITIAL ENVIRONMENTAL EXAMINATION (IEE).

1.	**Name & Address of Proponent:**	Mr. I.H.Haqqi, Director Power Generation, Lucky Cement Limited, 6-A, M.Ali Housing Society, Karachi-75350.
2.	**Description of Project:**	Waste Heat Power Generation System.
3.	**Location of Project:**	58 Kilometer milestone at super Highway, Karachi.
4.	**Date of Filing of IEE:**	01st June, 2009.

5. After careful review of the Initial Environmental Examination (IEE) report, the Environmental Protection Agency (EPA), Sindh has decided to accord its Approval subject to the following conditions:

   i. The mitigation measures recommended in the IEE report including the monitoring plan and environmental management plan should be adopted by the proponent.
   ii. Green belt in the Factory premises, if damaged due to project construction should be restored to the level possible with appropriate plantation and landscaping after completion of the construction work.
   iii. Appropriate construction techniques should be adopted during construction of proposed project in order ensure least disturb area to environment.
   iv. A comprehensive waste disposal plan should be developed to effectively manage all wastes generated during construction.
   v. During construction the impact of noise and vibration should be controlled and monitored through best available practices. For this purpose generators should be placed in the canopies or inside the civil structure. World Bank standards for noise levels should be complied during construction.

Always Remember--- Reuse, Reduce & Recycle

vi. Complete procedure of Health, Safety and Environment (HSE) should be developed, to ensure workplace safety. Proponent to ensure that the operating instructions and emergency actions are made available to every worker, labors and officers by at the site.

vii. The proponent shall ensure that no unfortunate incident(s) are caused due to construction and operation of project. The compensation of damage to the environment, property and life of the people/workers shall rest with the proponent.

viii. The proponent shall also monitor hazards, dust emissions and noise level(s) and other environmental releases due to construction and operation of the proposed project.

6. This approval shall be treated null and void if the conditions, mentioned in para-5 above, are not complied with.
7. The proponent shall be liable for compliance of Section 13, 14, 17 and 18 of EIA/IEE Regulation 2000, which direct for condition for approval, confirmation of compliance, entry inspection and monitoring.
8. The approval is accorded only for the project activity described in the IEE report. Proponent shall submit separate EIA or IEE as required under regulation for any enhancement or change in the design of project.
9. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any other law in force.
10. All the environmental conditions of this approval shall be incorporated in the terms and conditions of tender document of the project for commitment and compliance. The tender document incorporating the conditions shall be provided to this office.

(Shakil. A.Hashmi) 18/06/09
Director General

Annex 6

Advertisement for Stakeholders' Consultation Meeting

Daily Times
Thursday, April 2, 2009

Lucky Cement Limited

Concrete Progress

LOCAL STAKEHOLDERS MEETING ON CDM PROJECT

In order to avoid the green house gases effect caused due to the use of fossil fuels for power generation. Lucky Cement Limited is setting up waste heat recovery system for power generation to be utilized in the Cement Production Process.

The project activity significantly contributes to the reduction of GHG emission to atmosphere by partially displacing fossil fuel based captive generation as no fossil fuel will be used in the operation of waste heat recovery system.

LCL has structured the above project activity as Clean Development Mechanism (CDM) Project under the Kyoto Protocols.

LCL as required by the protocol under CDM, would like to understand the comments and opinions of the stakeholders. The local stakeholders consultation would help LCL in further improving the project thus contributing to sustainable development.

The local stakeholders meeting will take place at 10:30 a.m. on April 09, 2009 at LCL Karachi plant.

Agenda of stakeholders meeting will be:

1. Election of the chair of the meeting and approval of the proposed agents.
2. Presentation of the project undertaking at LCL.
3. Presentation of the CDM protocol and role of the local stakeholders.
4. Discussion and articulation of the concerns.
5. Chair summarizing the local stakeholders concerns.
6. Vote of thanks.

All interested employees, community members, regulators and other are requested to attend the meeting. In case you are not able to attend the meeting but would like to obtain information and inform us of your opinion and concerns you may do so by contacting in person through phone, e-mail or fax.

Phone No.021-8300001 - Fax No.021-5206421

Lt. Col. (Retd.) Imran Mohammad Khan
Sr. Manager Administration
58 Km Milestone Super Highway, Karachi.

Annex 7

Pictures of Stakeholders' Consultation Meeting