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Cement Manufacturing Plant Guidelines

An Approach to Reconciling the Financing of Cement Manufacturing Plants with Climate Change Objectives

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ABBREVIATIONS

ADB	Asian Development Bank
APP	Asia-Pacific Partnership
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CSI	Cement Sustainability Initiative
EBRD	European Bank for Reconstruction and Development
ECRA	European Cement Research Academy
EU	European Union
GHG	Greenhouse Gas
GNR	Getting the Numbers Right
HHV	Higher Heating Value
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
LHV	Lower Heating Value
MDBs	Multilateral Development Banks
MJ	Mega Joules
MIGA	Multilateral Investment Guarantee Agency
PCA	Portland Cement Association
PS3	Performance Standard 3
TC	Technical Cooperation
UK	United Kingdom
USA	United States of America
WB	World Bank Group
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

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I. EXECUTIVE SUMMARY

1.1 The Inter-American Development Bank (IDB) is developing Guidelines for particular sectors and sub-sectors that are known to significantly contribute to climate change.[1] These Guidelines aim to provide clear and quantitative Minimum Climate Change Performance Criteria necessary for IDB to support projects, as well as guidance on assessing and reducing the greenhouse gas (GHG) emissions of projects. The purpose of the Cement Manufacturing Plant guidelines is to set forth an approach for the financing of new cement manufacturing plants[2] in a manner consistent with IDB's commitment to protecting the environment and reducing adverse impacts on the global climate.

1.2 Cement manufacturing is an energy intensive process, requiring high fuel consumption for the operation of cement kilns, which in turn generates carbon dioxide (CO_2). In addition, CO_2 is generated from the chemical conversion of limestone to clinker[3] and from the production of electricity for other parts of the process where electricity is used. Technological development in recent decades has led to some technologies that increase the energy efficiency of a cement plant (thus reducing CO_2 emissions per unit of cement produced) or significantly decrease hazardous air pollutants (e.g., particulate matter, nitrogen oxides) and therefore, its overall environmental impact. In spite of these environmental improvements, not all CO_2 emissions originating from cement plants can be abated with existing technologies.[4] As a result, cement plants are significant contributors to global climate change, representing some 5% of global anthropogenic sources.

1.3 IDB and the other Multilateral Development Banks (MDBs) are therefore facing a dilemma. On the one hand, access to construction materials like cement is important to infrastructure development intended to reduce poverty, promote social equity and enhance competitiveness. Conversely, financing inefficient

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[1] Directive B.11 of IDB's Environment and Safeguards Compliance Policy states that "the Bank encourages the reduction and control of greenhouse gas emissions in a manner appropriate to the nature and scale of operations."

[2] This guideline currently applies only to new cement plants being presented to the IDB prior to initiation of operations and not to retrofits or upgrades of existing operational plants.

[3] Clinker, the first stage product in cement production consists of the conversion of limestone from $CaCO_3$ to CaO and CO_2, normally releasing CO_2 to the atmosphere.

[4] While Carbon Capture and Storage (CCS) is a promising technology, it is unlikely to be available on commercial basis in the immediate future.

cement plants may undermine MDBs' objectives of supporting climate change mitigation efforts and its commitment to protecting the environment. To overcome this dilemma, the IDB will balance the environmental and economic benefits of cement production projects by being more selective with respect to the type of technology proposed to encourage those processes known to perform at a higher level.

1.4 IDB will continue supporting those cement plants that are designed to use the best proven available technology appropriate to the particular characteristics of the project. This is intended to promote high efficiency and therefore lower GHG emissions as well as to meet internationally recognized and proven best practices and standards. To be evaluated by the Bank as part of its project review (due diligence), projects presented to the Bank will be required at the eligibility stage to either comply with the minimum performance criteria or commit to comply with those criteria. For a project to be eligible for IDB financing, compliance with minimum performance criteria must be verified during analysis or due diligence and confirmed prior to Board approval. In addition to greenhouse gas emissions, during the due diligence process the project will also be evaluated for compliance with the Bank's environmental and social safeguard policies.

1.5 In light of changing global objectives on the control of CO_2 and other GHGs, as new data on CO_2 performance and mitigation options becomes available and as the Bank gains experience implementing these guidelines with projects, these guidelines and criteria will need to be periodically reviewed and updated. These revisions may include refining the criteria as well as proposing new criteria or mitigation measures. Projects that meet the criteria and guidelines when declared eligible for IDB financing will be grandfathered in with regard to any future change specific to this sector or subsector. The grandfathering in of projects vis-à-vis the climate change criteria and guidelines applicable at eligibility stage will allow the IDB to react dynamically to new climate change developments while keeping its commitments to borrowers or clients.

II. INTRODUCTION

2.1 This document delineates the basic elements of IDB's approach to the financing of new cement plants.[5] The document is divided into four parts: (i) the trends and need to increase cement production; (ii) the types of cement plants and associated environmental issues, with a specific focus on climate change impacts; (iii) the approach of other MDBs with regard to financing of cement plants and the current cement industry's approach with regards to climate change and (iv) the proposed IDB approach to financing cement plants.

[5] This guideline is intended to be applicable only to new cement plants presented to the IDB for potential financing.

2.2 This document was developed using a background paper developed by URS France and publicly available data. A technical review was undertaken, including distribution of the guidelines, as well as meetings and interactions with other multilateral development institutions, specialized consulting firms, and cement industry and cement industry associations. Feedback and comments received were taken into account in this version of the guidelines and were essential to making these guidelines better in form and content.

III. CEMENT PRODUCTION, GLOBAL DEMAND AND CO_2 EMISSIONS

3.1 The key steps of cement production are quarrying limestone and other raw materials, preparing the raw mix (dosing, grinding and homogenization of raw materials), calcination and clinkering of the raw mix (chemical reactions which occur between 850°C and 1450°C in the kiln), cooling the clinker, grinding the clinker with gypsum and other additives to produce cement and finally storing, packaging and transporting the cement to the end user. The clinker to cement ratio is dictated by a number of factors, including local regulation and the end use of the cement.

3.2 50 to 60% of cement production CO_2 emissions are generated during the decomposition of limestone and other calcareous material to produce clinker. Emissions related to clinker production are difficult to reduce because they are associated with transformation of the limestone, the core of the process. Minor reductions in CO_2 emissions can nevertheless be achieved by substituting part of the limestone in the kiln during the clinkering process.

3.3 30 to 40% of CO_2 emissions are produced by burning fossil fuels, mainly to reach the required high temperatures in the kiln and associated equipment such as dryers. The main factors that affect the thermal energy needs are the raw materials and the process used (dry, wet or intermediate), resulting in a range from 3,000 to 6,500 MJ of fuel per tonne of clinker produced.

3.4 The remaining 10% of CO_2 emissions result from transportation and the generation of electricity necessary for other plant processes. The main users of electricity are the mills (finish grinding and raw grinding) and the exhaust fans (kiln/raw mill and cement mill), which together account for more than 80% of electricity usage.

3.5 The Getting the Numbers Right (GNR) Project[6] launched by the Cement Sustainability Initiative (CSI) of the World Business Council for Sustainable Development (WBCSD) indicates that economic development and population growth historically correlate with an increase in cement consumption, until a

[6] Cement Industry Energy and CO_2 Performance, “Getting the Numbers Right”, World Business Council for Sustainable Development Cement Sustainability Initiative (CSI), June 2009.

certain level of development is reached where per-capita demand stagnates or declines.

3.6 Between 2000 and 2006 clinker production has increased by 54% worldwide. In the meantime, the associated CO_2 emissions have increased by 42%.[7] As shown in Figure 1 below, between 2006 and 2050, cement production is expected to grow 0.8 to 1.2% per year, and to reach 3.7 billion tonnes (low scenario) or 4.4 billion tonnes (high scenario) in 2050. This corresponds to an increase of 43 to 72% compared to 2006 production levels.

3.7 Demand in the Latin American and Caribbean markets is expected to reach 200 Million tons by 2015, 280 Million tonnes in 2030 (a bit less than 10% of the worldwide market) and between 350 and 400 Million tonnes in 2050. In other words, by 2050 demand will have more than doubled since 2006, when levels were approximately 150 Million tonnes.

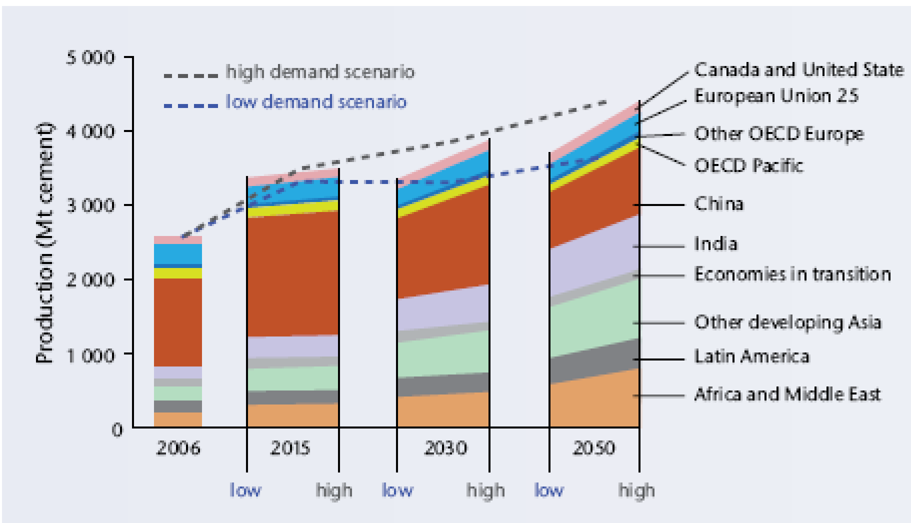

Figure 1. Cement global production from 2006 to 2050[8]

IV. AVAILABLE TECHNOLOGIES AND IMPACT ON CLIMATE CHANGE

4.1 There are two main types of technology for cement production: the dry and wet processes, with the intermediate semi-dry and semi-wet processes. Dry technology with multiple-stage pre-heater and pre-calciner is currently the standard technology used for new cement plants.[9] Based on data reported by CSI members through the GNR project, an average of 3,374 MJ/tonne clinker was

[7] Cement Technology Roadmap 2009, World Business Council for Sustainable Development (WBCSD) and International Energy Agency (IEA), December 2009.

[8] *ibid*

[9] "…State of the art is dry manufacturing process with preheater and precalciner technology" and "The industry is phasing out inefficient long dry kilns and the wet production process," Cement Technology Roadmap 2009, WBCSD and IEA, December 2009.

achieved in 2007 for the dry process with preheater and precalciner.[10] Wet technology requires approximately 50% more energy.

4.2 Significant improvements in thermal energy efficiency (kiln) and associated processes have been implemented worldwide to reduce energy costs, which represent 30 to 40% of production costs. Between 1990 and 2007, average annual thermal energy consumption per tonne of clinker was reduced by 14% in Brazil, 10% in South America excluding Brazil and 8% for Central America, while the worldwide average reduction was 14% to reach 3,690 MJ/tonne clinker (for GNR reported data).[11] These reductions were achieved by (i) optimizing kiln systems (software assisted method), (ii) recovering excess heat from kiln, (iii) using appropriate fuels and (iv) converting non-dry processes to dry processes. Due to the important progress achieved on energy efficiency so far, there appears to be limited potential for new technologies to appear on the market in the near future with significantly higher energy efficiency in design specifications.[12]

4.3 Traditional sources of thermal energy for clinker production are fossil fuels (e.g., gas, coal, and petcoke) depending mainly on a country's energy sources endowment. The quantity of CO_2 released per unit of energy produced by the combustion of coal and petcoke is higher than that of gas, however the availability and cost of these fossil fuels are key factors in their selection as source of thermal energy.

4.4 The cement industry has pursued the use of alternative fuels instead of the traditional fossil fuels. Burning alternative fuels may not result in lower direct CO_2 emissions from the cement plants but is recognized as a means to re-direct waste flows from landfills or improper destruction.[13] Burning alternative fuels usually requires additional infrastructure and appropriate control, monitoring and emissions treatment equipment that is available and well known by cement companies. In addition, use of alternative fuels may increase a plant's thermal energy consumption. Based on the CSI GNR data, in 2007, Brazil was using alternative fuels for 23% of its cement production energy needs, Central America 7%, other South American countries 4% (GNR worldwide average is 14%).[14]

4.5 In order to limit electricity consumption and related CO_2 emissions, cement plants can mainly improve the energy efficiency of grinders and fans. It is estimated that the electricity demand of cement production (as a global weighted yearly average) may decrease from 110 kWh/t cement in 2006 to roughly 105 kWh/t cement in

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10 Global Cement Database on CO2 and Energy Information, WBCSD, CSI, 2007.

11 *ibid*

12 The specific fuel energy demand of clinkerization may decrease from 3,690 MJ/t clinker in 2006 to a level of 3,300 to 3,400 MJ/t clinker in 2030 and to 3200 to 3,300 MJ/t clinker in 2050 "Development of State of the Art-Techniques in Cement Manufacturing: Trying to Look Ahead", CSI and the European Cement Research Academy, June 2009.

13 Tracking Industrial Energy Efficiency and CO_2 emissions, OECD/IEA, 2007.

14 Global Cement Database on CO_2 and Energy Information, WBCSD, CSI, 2007.

2030 and to 95 to 100 kWh/t cement in 2050.[15] Information currently available on electricity consumption per unit of production is not sufficient to compare data with similar clinker to cement ratios and identify trends for the LAC region.

4.6 Another method used to reduce CO_2 emissions from the cement production process is to increase the ratio of additives (i) during the clinker manufacturing process (less emissions from limestone decarbonation and reduced energy use) and (ii) at the cement blending stage (either by cement manufacturer or end user). However, availability of suitable materials, regulatory constraints and quality constraints depending on the end use of cement may leave only limited leeway for cement manufacturers. Based on 2007 GNR data, Brazil uses 27.4% additives, Central America 22.9% and South America excluding Brazil 24.9%.[14] It is estimated that by 2030 the worldwide clinker-to-cement ratio might be 70 to 75% and 65 to 70% by 2050. Forecasts for Latin America (South and Central America and the Caribbean) indicate ratios between 70 and 72% by 2050.[15]

4.7 Other methods used to reduce CO_2 emissions include developing renewable energy production projects such as wind farms, which reduce emissions from power generation specific to the region or country and is similar to what other industry sectors have been implementing.

4.8 As GHG emissions originating from cement plants cannot be significantly abated with existing technologies, Carbon Capture and Storage (CCS) may be a possible way to mitigate climate change impacts of cement manufacturing plants in the mid to long term. CCS consists of separation of the CO_2 from other gasses emitted by the kiln process, transportation to a storage location and long-term isolation from the atmosphere. It is a promising development[16] for effective mitigation of GHG emissions from cement plants; however, a complete CCS system has not yet been applied at a cement plant. In addition, CCS is expected to increase power consumption by 50 to 120% at plant level.[17]

V. OTHER MDBS' APPROACH TO THE FINANCING OF CEMENT PLANTS AND CURRENT APPROACH OF THE CEMENT INDUSTRY

5.1 Most MDBs finance cement plants (new plants and rehabilitation of existing plants), while being more selective on the type of technology supported to balance the environmental and economic benefits, and more stringent on their emissions performance. However, IDB is the first MDB to propose specific guidelines and criteria related to GHG emissions for the cement industry.

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[15] Cement Technology Roadmap 2009, WBCSD and IEA, December 2009.

[16] Cemex USA will receive a $1.14 million US Department of Energy grant for its CCS project. The project includes designing a dry sorbent CO_2 capture and compression system, a pipeline (if necessary), and an injection station. This commercial-scale CCS pilot project may remove up to 1 million tons of CO_2 annually.

[17] "Development of State of the Art-Techniques in Cement Manufacturing: Trying to Look Ahead" report, CSI and the European Cement Research Academy (ECRA), June 2009.

5.2 The World Bank Group's (WB) Strategic Framework for Development and Climate Change adopted in October 2008 lays out general criteria that operations should meet to receive traditional financing from any of the entities within the WB, including the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA). IFC's approach to project-level GHG emissions is defined in Performance Standard 3. Relevant requirements include for the client to "incorporate in its operations resource conservation and energy efficiency measures," and to "promote the reduction in project-related GHG emissions in a manner appropriate to the nature and scale of project operations and impacts." IFC is currently revising its Performance Standards. The IFC's Cement and Lime Manufacturing Guidelines, from April 2007, set performance criteria ranges to be achieved to be eligible for financial assistance mainly for several significant contaminants (e.g., particulate matter, nitrogen oxides, heavy metals and sulfur dioxide) but not for GHG emissions.[18] The IFC Guidelines provide a reference to industry benchmarks of 3,000 to 4,200 MJ per tonne of clinker produced.

5.3 The European Bank for Reconstruction and Development (EBRD) refers to CO_2 and GHG emissions in its 2008 Environmental Policy and several of the supporting Performance Requirements. There are provisions for both measuring GHGs and also consideration of reductions through "technically and financially feasible and cost-effective options," and that reduction of GHG emissions will be promoted "in a manner appropriate to the nature and scale of the project operations and impacts." The client is requested to "assess technically and financially feasible and cost-effective options to reduce its carbon intensity during the design and operation of the project, and pursue appropriate options." EBRD has broken down GHG emissions into categories of significance with indicative sectors for each. They place small cement plants in the Medium-Low category, and large plants in the Medium-High category of emitters.

5.4 Under its Renewable Energy, Energy Efficiency and Climate Change Program, the Asian Development Bank (ADB) has financed pre-feasibility studies for the use of waste fuel by cement plants (in China and the Philippines) and supported CDM projects for the cement industry also focused on the use of waste fuel.

5.5 The cement industry has responded to climate change-related issues through national level associations (such as the UK's British Cement Association) as well as international ones such as the EU's Cembureau, the Portland Cement Association (PCA) for the USA and Canada, and the WBCSD and CSI. Based on the work of these organizations, Charters and agreements have been signed in favor of sustainable development and CO_2 emissions reduction. As part of the Agenda for Action decided by the WBCSD and CSI members, each reporting CSI company has set individual CO_2 emissions reduction targets.

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[18] http://www.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines

5.6 Several attempts have been made to develop indicators for performance of the cement industry with regard to CO_2 emissions. Most notable are those by the IEA, IPCC, CSI, and the Asia-Pacific Partnership (APP) on Clean Development and Climate (see Table 1). Most of these indicators have been developed for the purpose of global comparison or industry-wide comparison. However, these indicators can be used at the project level to determine where on the spectrum of performance, and within the existing confines of raw material and fuel availability, a particular project falls. Most importantly, these indicators can assist in identifying quickly those areas where improvements may be most effectively employed to the greatest benefit.

Table 1: **Cement Roadmap Indicators**

	2012	2015	2020	2025	2030	2050
Thermal energy consumption per tonne of clinker GJ / tonne	3.9	3.8	3.5-3.7	3.4-3.6	3.3-3.4	3.2
Share of alternative fuel & biomass use (1)	5-10%	10-12%	12-15%	15-20%	23-24%	37%
Clinker to cement ratio	77%	76%	74%	73.5%	73%	71%
CCS						
no. of pilot plants	2	3				
no. of demo plants operating		2	6			
no. of commerical plants operating				10-15	50-70	200-400
Mt stored	0.1	0.4	5-10	20-35	100-160	490-920
Tonne CO_2 emissions per tonne cement (2)	0.75	0.66	0.62	0.59	0.56	0.42

Notes: (1) assumes 25 to 30 Mtoe of alternative fuel use in 2015 and 50 to 60 Mtoe in 2030, and excludes energy from CCS and electricity use, (2) includes reduction from CCS
Source: IEA, 2009

5.7 Through CSI's GNR program, a number of major cement manufacturers have agreed to report CO_2 emissions based on a common Cement CO_2 Protocol, developed jointly by the WBCSD and the World Resources Institute. The GNR covers 67% of cement production in Latin America.

5.8 Based on the GNR data, WBCSD with the CSI working group and IEA have joined efforts to set up the Cement Technology Roadmap 2009, which defines objectives and targets for CO_2 emissions reductions up to 2050. Five indicators were established: (i) thermal energy consumption, (ii) alternative fuels, (iii) clinker to cement ratio, (iv) Carbon Capture and Storage and (v) CO_2 emissions per tonne cement.

5.9 Furthermore, policy recommendations[19] were issued by geographic area. For Latin America, and as illustrated by Table 2, targets are in line with worldwide objectives for clinker to cement ratio and are even more ambitious than

[19] Cement Technology Roadmap 2009, WBCSD and IEA, December 2009.

worldwide objectives for the use of alternative fuels (between 39 and 40% by 2050 against 37% worldwide).

Table 2: Policy recommendations for Latin America						
	Low demand estimate			**High demand estimate**		
	2015	2030	2050	2015	2030	2050
Energy use (Mtn)	14.5	18.4	26.4	14.4	18.5	32.7
Share of alternative fuel use	16%	25%	39%	16%	25%	40%
Clinker to cement ratio	73%	71%	70%	73%	71%	72%
CO_2 capture	0	9.7%	49.7%	0	11.8%	73.3%

VI. GUIDELINES TO BE FOLLOWED FOR IDB TO FINANCE NEW CEMENT PLANTS

6.1 The IDB will support the development of new cement plants that adhere to the principle of sustainable development and reduced climate impact. Both principles are essential for an industry that already emits high levels of CO_2 and has a growing market outlook.

6.2 For IDB to continue promoting countries' development and self-sufficiency with construction material while not undermining IDB's objective of supporting climate change mitigation efforts or its commitment to protecting the environment, IDB will continue supporting those cement plants that are designed to meet minimum efficiency and GHG emissions performance criteria[20] and to use the best appropriate available technology to allow for high efficiency and therefore lower GHG emissions intensity.

6.3 Projects presented to the Bank will be required at the eligibility stage to either comply with the Minimum Performance Criteria or commit to comply with those criteria. During the due diligence process, the Bank will work with potential borrowers to develop ways for the project to meet the criteria. For a project to be eligible to receive IDB financing, compliance with the Minimum Performance Criteria must be verified during analysis or due diligence and confirmed prior to Board approval.

6.4 Tables 3 and 4 in Section VII provide Minimum Performance Criteria for IDB to finance new cement plants. These Minimum Performance Criteria are based on average design specifications for newly built cement plants. While these criteria preclude IDB financing of inefficient cement plants, they are in the intermediate range of efficiencies achievable with a typical design for a new plant.

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[20] In addition to internationally recognized best practices and standards on other aspects of environmental and social sustainability, such as the World Bank Group Environmental, Health and Safety Guidelines for Cement and Lime Manufacturing Plants.

6.5 The Minimum Performance Criteria presented in Tables 3 and 4 will be reviewed periodically to take into account new technological and institutional developments. In updating the criteria, the Bank will take into account the increased availability of reliable energy efficiency and CO_2 emissions data from cement plants, including the Bank's experience implementing these guidelines with projects. Data is currently limited but is expected to progress significantly as a result of increased climate change-related pressure. For instance, most of the data currently available on energy consumption per unit of cement produced has an unclear definition of cement.

6.6 In addition to meeting the Minimum Performance Criteria, the project will be evaluated during due diligence to ensure that, in relation to greenhouse gas emissions, the cement plant design employs the best appropriate available technology and is operated in accordance with cement industry best practice, each evaluated in the context of the particular characteristics of the project (size; location; economic, environmental and social considerations; and overall GHG emissions). The project evaluation should take into account: (i) overall energy efficiency of the technology (thermal and electric), (ii) reliability and availability of the technology, (iii) availability of various sources of fuel, (iv) capital and operational cost, (v) availability of renewable sources of electricity, (vi) possibilities to decrease the clinker to cement ratio, (vii) availability of waste biomass, and (viii) level of GHG emissions per tonne of clinker and cement produced.

VII. OTHER ACTIONS TO BE PURSUED BY THE IDB

7.1 The IDB may also help transfer more advanced cement technologies, research and development to the countries, for instance through providing Technical Cooperation (TC) funds to research and development activities and implementation of pilot projects.

7.2 Whenever opportunities arise, the IDB may provide support for the development of appropriate national regulatory frameworks that reflect environmental costs, including CO_2 emissions, in the cost-benefit analysis of a project, for example through TC projects or as part of targeted country environmental analysis or country-specific analysis.

VIII. MINIMUM PERFORMANCE CRITERIA

8.1 Two "Minimum Performance" criteria per tonne of clinker have been selected to evaluate projects: (i) Thermal Energy Consumption per tonne of clinker and (ii) Gross CO_2 emissions per tonne of clinker. Each of the indicators detailed below can be calculated based on the CO_2 Accounting and Reporting Standard for the Cement Industry protocol.[21]

A. Thermal Energy Consumption

8.2 This criterion represents the amount of energy required (in Mega Joules) to produce one tonne of clinker. Clinker is used as a reference material because it is the common denominator for all types of cement. The value corresponds to the average performance results of energy efficient technologies using preheaters and precalciner. This criterion does not make specific reference to (i) the process type, (ii) the fuel type or (iii) the by-product content of the clinker.

Table 3: Thermal Energy Consumption

Minimum Performance Criteria #1	Proposed value	Comment
Thermal energy consumption (for limestone with moisture content less than 8.5% and clinker production capacity equal to or above 1,500 t/d)[22]	Equal to or less than 3200 MJ / tonne clinker	Based on average design performance of new plants using energy efficient technologies

B. Gross CO_2 Emissions per Tonne of Clinker

8.3 Gross CO_2 emissions are all direct CO_2 emissions excluding on-site electricity production and CO_2 emissions from biomass, which are considered climate neutral. This criterion does not make specific reference to (i) the process type, (ii) the fuel type or (iii) the by-product content of the clinker.

Table 4: Gross CO_2 Emissions

Minimum Performance Criteria #2	Proposed value	Comment
Gross CO_2 Emissions (for limestone with moisture content less than 8.5% .)	Equal or less than 820 kg CO_2 / tonne clinker	Based on average design performance of new plants using energy efficient technologies

21 Instructions are available at www.wbcsdcement.org/climate. In addition, the indicators have assumed a calculation using the Lower Heating Value (LHV). For comparison with the Higher Heating Value (HHV) methodology a conversion must first be made.

22 Cement plants that fall under the excluded categories will be assessed on a case-by-case basis to determine the applicable average design performance using energy efficient technologies. In no case shall the energy efficiency of plants with clinker production capacity below 1,500 t/d. exceed 3264 MJ / tonne clinker (2% higher than the 3200 MJ / tonne clinker minimum performance criteria applicable for larger plants).

IX. ENCOURAGING EMERGING PRACTICES

9.1 Innovations and new practices aimed at reducing CO_2 emissions are being developed by the cement industry. The Bank will encourage their implementation as appropriate to the nature of the individual projects. The following opportunities will be considered on a case-by-case basis during the due diligence, analysis, and audit stages prior to IDB board approval, with a view towards maximizing potential additional reductions in CO_2 emissions:

a) Fuel mix for clinker production: The possibility or opportunity to use low carbon fuel (e.g., natural gas) and alternative fuels (e.g., waste biomass, hazardous waste) should be evaluated by the project proponents;

b) Alternative raw materials: Project proponents should look at the opportunity to add alternative raw materials such as fly ash or slag during clinkering process (i.e., limestone substitute);

c) Clinker to cement ratio: Blending clinker with clinker substitutes for cement production should be considered, within the limits of regulatory and quality requirements necessary for a safe use of cement;

d) Energy efficient electricity-consuming equipment: High efficiency fans and motors should be used, as well as energy efficient mill technologies such as vertical roller mills or roller presses instead of ball mills, as appropriate;

e) Automated kilns: Kiln operation should be computer assisted whenever possible, as it ensures process, quality, and energy consumption optimisation as well as better management of air emissions;

f) Environmental Management Systems: Such systems allow for effective management of environmental issues and continuous improvement to the sustainability of operations. Together with an Energy Management System, they can provide energy efficiency improvements that result in reduced CO_2 emissions;

g) Associated sustainable energy projects: Projects such as wind and solar farms or other types of alternative energy production system can be promoted as part of cement manufacturing plant projects.