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

CONTENTS

Annexes

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:

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Title: **Energy efficiency measures in office building at BKC**

Version: 01

Date: 15/11/2007

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

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The project activity is energy efficiency measures undertaken by K Raheja Corporate Services Private Limited[1] in a commercial office space building (here after referred as BKC-30) at Bandra Kurla Complex (BKC), Mumbai, India. This building houses several offices including the offices of the group companies.

The energy efficiency measures have been undertaken primarily in the Heating, Venting and Air-Conditioning (HVAC) system and lighting system of the building. The measures adopted in the HVAC system result in reduction in electrical energy consumption, in comparison to that for a conventional building with similar size (in terms of floor area, carpet area and number of storeys), capacity (in terms of occupancy) and architectural perspectives.

The energy efficiency measures undertaken in the HVAC system affect the electricity consumption in two major ways – (i) by reducing the design heat load in the building which in turn reduces the power requirement of the HVAC system and. (ii) by installation of energy efficient equipments and control systems to operate at variable loads through installation of variable frequency drives (VFDs).

The energy efficiency measures taken in the lighting system would reduce the electricity consumption of in two major ways: (i) by improving the utilization of natural lighting by optimizing the window openings (ii) by installation of energy efficient lighting systems and fixtures with occupancy sensors.

As a consequence, there will be an equivalent reduction in electricity generation in Western Regional Grid[2] connected power plants, which in turn will result in a reduction of Green House Gases as per the carbon intensity of the grid.

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[1] here after referred as Project Proponent

[2] BKC-30 is connected to the Maharashtra State Electricity Grid which is a part of the Western Regional Grid of India

The following table provides details of the proposed installations and energy efficiency measures taken in the energy efficient building vis-à-vis the measures that would be taken in a conventional office building (defined as the baseline building in Section B.3).

Parameters affecting the HVAC system	Baseline Building	Energy efficiency measures in 'Energy Efficient Building'	Remarks/ Comments
Comparison of various energy efficiency measures adopted in "Energy efficient building" which will impact the Design Heat Load and Power Consumption of the HVAC System- Fixed reduction in Heat Load and Power Consumption of HVAC system of Energy efficient building			
Exterior wall construction	The 9" thick mass wall with plaster inside and outside.	The wall is 8" thick brick made of Autoclaved Aerated Concrete (AAC) blocks with effective U value of 0.67-0.85 $w/m^2 K$	The measure taken in the exterior wall construction of "BKC-30" result in a reduction in the designed heat load of the HVAC system.
Exposure of glass wall area	The glasses used would be 6mm clear glass.	The glazing used in the building is of high performance double glazed panels coated with reflective low "e"-glass panes and having low U-value and solar heat gain co-efficient. For the upper floor glazing high performance glass i.e. Pilkington Eclipse Advantage with the following specifications is used; **U-Value**: 0.35 Btu/hr.ft2.ºF	The measures taken in the glazing of "Energy efficient building" result in a reduction in the designed heat load of the HVAC system

Parameters affecting the HVAC system	Baseline Building	Energy efficiency measures in 'Energy Efficient Building'	Remarks/ Comments
		Shading Coefficient: 0.34 **Light Transmittance**: 44%	
Roof Insulation	Mass Roof with a U-factor of 0.12 Btu/hr.ft2.ºF No terrace gardening would be there.	Concrete slab over deck R-15 extruded polystyrene insulation with water proofing. Terrace gardening has been done to provide additional insulation for the roof, as a result of which island heat effect will be reduced. The evapo-transpiration effect due to the terrace garden will also contribute to keeping the building heat load lower during summer season.	The measures taken in the roof of "Energy efficient building" result in a reduction in the designed heat load of the HVAC system.
Chillers	To meet the load demand, water cooled chillers with a full load efficiency of 1.17 kW/ton of refrigeration [kW/TR] (a co-efficient of performance i.e. COP of 3.0 at ARI conditions) would be used.	To meet the load demand, water-cooled screw chillers with full load efficiency of 0.735 kW/TR (COP of >5.20 at ARI conditions) is installed. 1670 ton-hours of thermal storage is considered.	With the installation of efficient chillers, the specific power consumption in kW/TR of the HVAC system is reduced.

Comparison of various energy efficiency measures adopted in 'Energy efficient building' which will impact the Heat Load and Power Consumption of the HVAC System based on the demand- Variable reduction in Heat Load and Electricity Consumption of HVAC system of Energy efficient building			
Air Handling Unit (AHU)	There would be no CO_2 sensors.	CO_2 sensors would control amount of fresh air taken based on the building occupancy there by reducing the HVAC load when the building is partially occupied.	The CO_2 sensors installed in the AHUs of "BKC-30" result in a reduction in the variable heat load and the power consumption taking into account the occupancy variations.
Installation of VFDs in the chilled water pumping system	Chilled water would be pumped with a primary-secondary pumping arrangement. The primary loop pumps would circulate chilled water through the chillers, and the secondary pumps would distribute chilled water to the building. When the secondary pumps, with motors operating at constant speeds are selected, they invariably have some extra head in the pump selection as compared to that of the actual demand at site. A balancing valve would be used after the chiller plant in order to	Chilled water is pumped with a primary-secondary pumping arrangement. The primary loop pumps circulate chilled water through the chillers, and the secondary pumps distribute chilled water to the building. VFDs are installed in secondary chilled water pumps and used to reduce the speed of the pump while a balancing valve after the chiller plant, is kept fully open. The electricity consumption of the pumps in the secondary chilled water loop, can thus be varied by operating the pump motors at	VFD installation in the chilled water pumping system results in reduction in electricity consumption. VFDs installed in the secondary pumping system of chillers, is not a business-as-usual scenario. So the reduction in electricity consumption from the same has been considered for computation of emission

	introduce this non existing head in the primary loop. The electricity consumption of the pumps in the secondary chilled water loop, therefore, would remain the same. Hence, no VFDs would be installed in the secondary chilled water loop, to accommodate the variations in the building demand. The chilled water system would be designed for 2.67 Gallons/per minute (GPM) flow per TR.	lower frequencies. VFDs in the pumps of secondary chilled water loop accommodate the variations in the chilled water demand depending on the quantity of water being handled by the water pumping system of the building. The chilled water system is designed for 1.9 GPM flow per TR.	reductions.
Comparison of various energy efficiency measures adopted in 'Energy efficient building' which will impact the Lighting Load and Power Consumption of the Lighting System based on the equipment selectiona and demand – Fixed and Variable reduction in Heat Load and Electricity Consumption of HVAC system of Energy efficient building			
Lighting System	Normal fluorescent lights were used for lighting. No daylight controls resulting in an average lighting power density of the base case building is 1.5 Watts/ ft^2	Energy efficient lighting like CFL bulbs and T5 fluorescent lights were used. Efficient lighting design is employed to maximize the utilization of natural lighting with day light controls resulting in the following light density: 1.0 W/ft^2 in office 1.5W/ft^2 in food court, and 0.9 W/ft^2 in service areas and daylighting Controls in Food Court	Energy efficient lighting and maximizing the usage of natural lighting would reduce the annual building energy consumption there by resulting in emission reduction.

For the project activity energy efficient building, the main power is sourced from the Western Region Grid. The primary objective of the project activity is to reduce the electricity consumption of the building as compared to the electricity consumption in the baseline building (*which has been arrived at in Section B.3*), through certain energy efficiency measures taken in the HVAC and Lighting system. Therefore, reduced electricity consumption by the energy efficient building will ultimately result in drawal of lesser amount electricity from Maharashtra State Electricity grid which is a part of the Western Regional electricity grid. Western Regional grid is a thermal power dominated grid. Thus an equivalent amount of GHG emissions in the form of CO_2 released from generation of fossil fuel based thermal power in the regional grid mix will be reduced by the project activity.

Over a crediting period of 10 years, a total electrical energy consumption of 20.17 GWh will be reduced owing to the project activity.

Project's contribution to sustainable development

The contribution of the project activity to sustainable development can be described as follows:

Socio-economic well being: There was a necessity of skilled and semi-skilled jobs during installation of the different energy efficiency equipment in the HVAC and lighting system required and so thorough training was imparted to relevant personnel on the commissioned system. The training covered design intent of the system, use of operation and maintenance manual, review of control drawings and schematics, optimizing energy performance, start-up, handling seasonal variations, trouble-shooting, health and safety issues and overview on how the system is environmentally responsive. Such an extensive training helped in building the knowledge and skill base of the employees involved in the construction of the building. The building provides its occupants with a comparatively better quality of working environment with a healthier and safer ambience resulting in better productivity at workplace. The energy efficiency measures taken in the HVAC system have also helped to create business opportunities for technology suppliers, technical consultants not just for "BKC- 30" but also for upcoming energy efficient buildings in the western region of the country.

Technological well-being: "BKC-30" is energy efficient due to (a) energy efficiency equipments in HVAC system, (b) online monitoring system and control system for optimization of energy performance (c) better roof insulation and (d) glass with glazing of low U factor[3] and solar heat gain co-efficient. These energy

[3] Source: http://www.nfrc.org/documents/U-Factor.pdf

efficiency measures have a high replication potential and "BKC-30" will encourage other builders to adopt similar measures.

Environmental well-being: Due to the energy efficiency measures taken in the building, the net electricity consumption in the building is reduced vis-à-vis a similar conventional building which would have been built in absence of the project activity. The project activity would therefore reduce the electricity load on the grid, which will in turn reduce generation of electricity in the grid connected power plants. Reduction in thermal power generation, not only conserves the non-renewable fossil fuels but also reduces the associated emissions of greenhouse gases (GHGs) and other localized pollutants like SPM, SO_X and NO_X.

A.3. Project participants:

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Name of the 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)
India	K Raheja Corporate Services Private Limited (Private Entity)	No

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

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

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Bandra Kurla Complex

A.4.1.1. Host Party(ies):

>>
India

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

>>
Maharashtra

A.4.1.3. City/Town/Community etc:

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Mumbai

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

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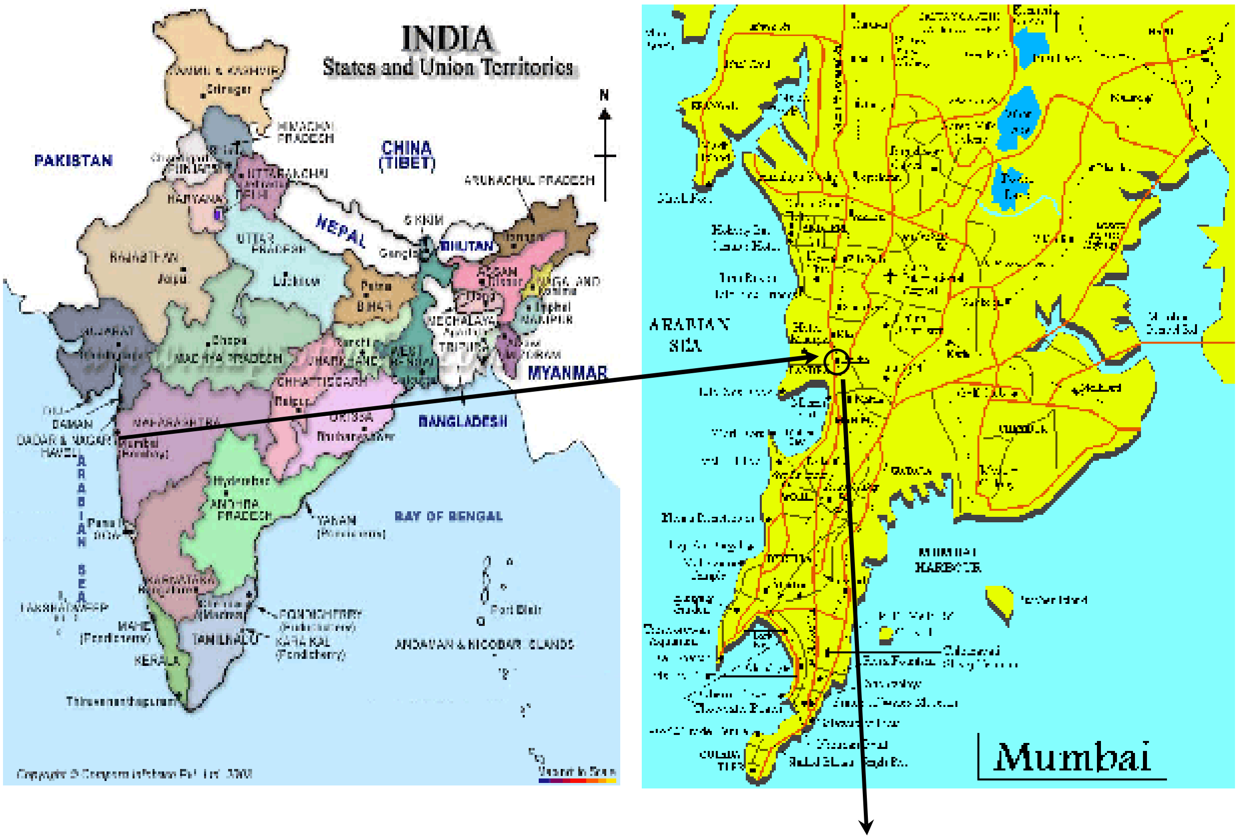
Energy efficient building is in Plot No. 30 of Bandra Kurla Complex (BKC) Bandra (East) Mumbai, Maharashtra. The project site is within 6 km of Dadar Railway station, the most important railway node-providing interface and transfer facilities of the Western and Central Railway. The project site is close to Chatrapati Shivaji International airport at Santacruz. It is well connected with the rest of the city through rail and road.

The detailed map is given below:



Project Activity
19^0 12' 10N & 72^0 52' 06E

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

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As per Appendix B of the simplified modalities and procedures for small scale CDM project activities, the small scale methodology AMS II.E[4] i.e. "Type II – Energy efficiency improvement projects of Category II.E – Energy efficiency and fuel switching measures for buildings" (Version 10, Scope 4 – EB 35) has been selected for the project as it meets requirements specified in the methodology.

[4] *Version 10, Scope 3 – EB 35* (http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html)

The description of how environmentally safe and sound technology and know how is being applied by the project activity is as described below:

Technology

In "Energy efficient building", the thermal resistance of the building envelope has been increased, thereby reducing the unwanted heat loss and heat gain from the outside. This in turn reduces the energy required for air conditioning in the building. Insulation also improves thermal comfort in addition to reducing air conditioning equipment sizes. Apart from the building envelope, the central plant also uses efficient chiller type, with proper sizing contributing to optimum energy utilization.

The major parameters which have resulted in the reduced electricity consumption in the HVAC system of "Energy efficient building", are detailed below:

[A] Exposure of glass wall area

(1) The glazing used in the building is of high performance double glazed panels coated with reflective low "e"-glass panes and having low U-value[5] and solar heat gain co-efficient. High quality glass with shading co-efficient of 0.34 and high visible light transmittance 24% has been used in order to reduce solar gains and to enhance available daylight in the space without compromising on energy efficiency. In "BKC-30" a simple optimization has been done between the energy reductions with less window area vis-à-vis lighting requirement accordingly an overall Window- Wall –Ratio (WWR) is 24% for Energy efficient building.

[B] Roof insulation

The material for the roof construction is concrete slab with R-15 extruded polystyrene for over deck insulation. U-value of the roof has been kept lower than 0.12 Btu/hr ft^2 F. Terrace gardening has been done to provide additional insulation for the roof. The evapo-transpiration effect due to the terrace garden will also contribute to keeping the building cool during summer season.

[C] Air Handling Unit

Regular office spaces have been divided into zones based on occupancy pattern and ease of air distribution. Each of these zones have been provided with an individual AHU comprising centrifugal supply and return air fans, cooling coil section, steel double sloping drain pan and filter section. Each AHU is provided with a

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[5] Glass industry measures the energy efficiency of their products in terms of thermal transmission, or U-factor. U-factor measures the rate of heat transfer through a product. Therefore, the lower the U-factor, the lower the amount of heat loss, and the better a product is at insulating a building. Apart from conductivity, U-factor also is affected by the airflow around the window and the emissivity (e) of the glass. The lower the conductivity and emissivity of the glass, the lower the rate of heat loss and the lower the U-factor.

two way valve control, sensing cooling coil leaving air temperature, filter monitoring switch, duct smoke detector unit to trip blower in case of smoke detection. AHUs are provided with CO_2 sensor. The volume of fresh air entering into the building is modulated based on CO_2 sensors, located within return air duct of AHU serving each occupied zone. Both the indoor and outdoor CO_2 levels are continuously logged through integrated building management system (IBMS), Based on the CO_2 differential the quantity of fresh air brought in to the building is varied using the dampers.

[D] Chillers

To meet the load demand, three 132 TR water-cooled screw chillers with COP of more than 5.2 are installed. The specific energy consumption of the chillers 0.735 kW/TR. Water-cooled chillers are more efficient than air cooled ones in air-conditioning of large buildings. Each water cooled chiller has two condenser pumps, one working and the other one as standby.

[E] Chilled Water Pumping system

Chilled water is pumped with a primary-secondary pumping arrangement. Three primary water pumps and three secondary water pumps are installed in the chiller. The primary loop pump circulates chilled water through the chillers, and the secondary pumps distribute chilled water to the building. VFDs are installed only in the secondary chilled water pumps.. VFDs in the pumps of secondary chilled water loop accommodate the variations in the chilled water demand depending on the quantity of air being handled by the AHUs of the building.

A VFD is installed to the rotor of the electric drives to operate them at variable speed. Since the rotor can operate at any speed below its maximum capacity, the output of the motor can be made to vary by controlling the rotor speed by a VFD installation. A variable frequency drive can control two main elements of a 3-phase induction motor: speed and torque. This is adjusted by changing the frequency applied to the motor. If the required output of the rotor is lower than the present output capacity, the frequency of the rotor may be regulated below full operational capacity by the variable frequency drive. . Therefore under low occupancy scenarios, the VFDs would enable the motor to operate at lower operational capacity, which would reduce the quantity of chilled water required to be handled by the HVAC system, thereby reducing the power consumption of the chilled water pumps. With reduction in frequency of the rotor, the power input to the motor reduces proportionately..

The major parameters which have resulted in the reduced electricity consumption in the Lighting system of “Energy efficient building”, are detailed below:

[F] Lighting

Energy efficient lighting like CFL bulbs and T5 fluorescent lights were used in the project activity building and Efficient lighting design is employed to maximize the utilization of natural lighting with day light controls resulting in the following light density resulting in an light power density of 1.0 W/ft2 in office, 1.5W/ft2 in food court, and 0.9 W/ft2 in service areas. Energy efficient building also employs day lighting Controls in Food Court which would optimize the power consumption of lighting system when natural light is available.

With these measures in place, the HVAC and lighting system will operate at high energy efficiency and will have tremendous flexibility to run efficiently under part load conditions. Out of the many functions to be performed by the BMS, one major function will be energy management through optimization of all connected electrical and mechanical plants. BMS comprises the following HVAC automation services – chiller plant automation, AHU monitoring and control, stairwell pressurization and control, common area smoke extraction fan control, smoke extract fans of individual fans, VFDs, CO_2 sensor monitoring and modulating damper control, car park area CO sensor monitoring ,ventilation fan control and lighting control.

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

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The estimated amount of CO2 emission reduction would be about 16010 tons over 10 years crediting period. Table A.4.3 Estimated amount of Emission Reduction

Years	Annual estimation of emission reductions in tonnes of CO2-e
2008	**1601**
2009	**1601**
2010	**1601**
2011	**1601**
2012	**1601**
2013	**1601**
2014	**1601**
2015	**1601**
2016	**1601**
2017	**1601**

Total estimated reductions (tonnes of CO_2 e)	**16010**
Total number of crediting years	**10**
Annual average over the crediting period of Estimated reductions (tonnes of CO_2 e)	**1601**

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

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No public funding from parties included in Annex-I is available to the project activity.

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

As mentioned in Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM project activities, a 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:

- With the same project participants;
- In the same project category and technology/measure;
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small scale activity at the closest point.

The project proponent has not implemented any other project activity, which falls under Category- II.E of "Appendix B of the simplified modalities and procedures for small-scale CDM project activities" and deals with the same technology/measure. No such project activity, proposed by project proponent with the same project category and technology/ measure and whose boundary is within 1 km of the project boundary of the small-scale project activity under consideration at its closest point, is registered or in the advanced stage of registration with UNFCCC in the last two years.

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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Title: AMS. II.E (Version 10 Sectoral Scope: 3 EB 35)

TYPE II - Energy Efficiency Improvement Projects

II.E. Energy efficiency and fuel switching measures for buildings

Reference: http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

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

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As per Appendix B of the simplified modalities and procedures for small scale CDM project activities, the small scale methodology AMS II.E i.e. "Type II – Energy efficiency improvement projects of Category II.E – Energy efficiency and fuel switching measures for buildings" has been selected for the project activity as it meets the following requirements:

Methodology Requirement	Applicability of Project Activity
This category comprises any energy efficiency and fuel switching measure implemented at a single building, such as a commercial, institutional or residential building, or group of similar buildings, such as a school, district or university.	The Project activity is a set of energy efficiency measures and not fossil fuel switching measure, implemented at a building of project proponent.
This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B. Examples include technical energy efficiency measures (such as efficient appliances, better insulation and optimal arrangement of equipment) and fuel switching measures (such as switching from oil to gas).	The project activity improves the efficiency of building by adopting energy efficient building design and installation of energy efficient equipments and materials which reduce the building energy consumption when compared with conventional energy inefficient buildings in India.
The technologies may replace existing equipment or be installed in new facilities. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWh per year.	The maximum total energy reduction in the project activity is 2.17 GWh which is below the limit of 60 GWh as specified in the methodology AMS II.E.

This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).	The project activity utilizes Building Management System (BMS) which measures and monitors all the energy usage parameters of the building.
This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	The project activity has specific energy reduction measures like utilization of energy efficient materials and equipments (HVAC & Lighting system) which can be clearly distinguished from changes from other usage like building loads like computers etc.

From the above, it can be concluded that the project meets all the applicability criteria set out under the selected small-scale methodology and hence the project category is applicable to the project activity.

B.3. Description of the project boundary:

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As per paragraph 2 under "Type II.E: Energy efficiency and fuel switching measures for buildings" in Appendix B of the Simplified M&P for small scale CDM project activities (Sectoral Scope: 3, Version 10: EB 35), "the project boundary is the physical, geographical site of the building(s)". Therefore for the project activity under consideration, the project boundary will include energy efficient building where the energy efficiency measures have been taken and which result in consumption of lesser amount of electricity consumption by the building.

However, reduced electricity consumption by "Energy efficient building" will ultimately result in drawal of lesser amount electricity from Maharashtra Electricity grid which is a part of the Western Regional electricity grid. For computation of emission reductions resulting from the project activity, Western Regional electricity grid and all the power plants catering to the grid have been considered in order to arrive at the emission factor corresponding to power generation in the grid. However, the emission factor corresponding to power generation in the grid, has been taken to be constant for the computation of emission reduction for the entire crediting period.

B.4. Description of baseline and its development:

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The baseline category and methodology applicable for the project activity has already been justified in Section B.2. As per paragraphs 3 and 4 under Category II.E in Appendix B of the Simplified M&P for small scale CDM project activities (Sectoral Scope: 3, Version 10: EB 35), '***the energy baseline consists of the energy use*** *of the existing equipment that is replaced in the case of retrofit measures and* ***of the***

facility that would otherwise be built in the case of a new facility*. Each energy form in the emission baseline is multiplied by an emission coefficient. For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category I.D. For fossil fuels, the IPCC default values for emission coefficients may be used.*'

The baseline determination is a two-step study conducted to determine the Baseline emissions over the crediting period in absence of project activity.

Step I: Determination of Energy Baseline

The energy baseline for the project activity under consideration is the electrical energy use of the HVAC and Lighting system of the baseline building (Please refer to Section B.5 for definition of baseline building). The project activity reduces electricity consumption of the HVAC and Lighting system of "Energy efficient building" in comparison to the baseline scenario. However, there is an avenue kept for electricity generation by diesel generator (DG) set and consumption of the same electricity in "Energy efficient building" in case of exigencies like load-shedding by the grid. Emission reduction will be based on the reduced electricity drawal from the grid and also based on the reduced load on the DG set that would be used in case of exigencies, due to the reduced electricity consumption in the HVAC and Lighting system, in the project scenario compared to the baseline scenario.

Step II: Determination of carbon intensity of the chosen baseline

As stated above there are two energy sources

- ✓ Electrical energy drawn from Western Region Grid (major contributor)
- ✓ Electrical energy drawn from Backup Diesel Generator (minor contributor)

The emission coefficient for each of these sources has been determined herein:

[A] Emission Coefficient of the Western Regional Grid[6]

Present generation mix for western regional grid with sector wise installed capacities, emission co-efficient and generation efficiencies are used to arrive at the net emission coefficient of the chosen grid. As per the provisions of the methodology the emission coefficient for the electricity displaced would be calculated / considered in accordance with Baseline Carbon Dioxide Emission Database Version 3.0 from Central Electricity Authority (CEA), Ministry of Power, Government of India[7] . The provisions require the

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[6] Emission Factor of WR Grid from www.cea.nic.in based on ACM0002 version 07

[7] http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm

emission coefficient (measured in kg CO_2 eq / kWh) to be calculated in a transparent and conservative manner as:

(a) The average of the "approximate operating margin" and the "build margin" (or combined margin)

OR

(b) The weighted average emissions (in kg CO_2equ/kWh) of the current generation mix.

The baseline emission factor is calculated based on both approaches above and the combined margin emissions factor of generation mix has been selected to calculate the baseline emission factor.

Combined Margin

The baseline methodology suggests that the project activity will have an effect on both the operating margin (i.e. the present power generation sources of the grid, weighted according to the actual participation in the regional grid mix) and the build margin (i.e. weighted average emissions of recent capacity additions) of the selected western regional grid and the baseline emission coefficient would therefore incorporate an average of both these elements.

Operating Margin

As mentioned above the project activity will have some effect on the Operating Margin (OM) of the western regional grid. The emission coefficient as per the operating Margin takes into consideration the present power generation mix of 2000 to 2006 excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation of the selected grid, efficiency of thermal power plants and the default value of emission factors of the fuel used for power generation.

The real mix of power in a particular year is based on actual units generated from various sources of power. The data collected and used is presented in the calculations.

The most important parameter in estimating the emissions is the thermal efficiency of the power plant. On basis of references from CEA report the average efficiency of coal based power plant is taken 36.5% and Diesel based power plant is taken as 41.71 and gas based power plant for base line calculations is considered as 45%. Standard emission factors given in IPCC for coal and gas (thermal generation) are applied along with the Oxidation Factor (IPCC) over the expected generation mix and net emission factors are determined.

Build Margin

The project activity will have some effect on the Build Margin (BM) of the western regional electricity grid. The baseline emission coefficient as per the Build Margin takes into consideration the delay effect on the future projects and assumes that the past trend will continue in the future. As per the baseline methodology, the baseline factor for Build Margin is calculated as the weighted average emissions of recent capacity additions to the system, defined as the greater (in MWh) of most recent 20% of plants built or the 5 most recent plants. In case of western regional electricity grid capacity additions (in MWh) of most recent 20% of the existing plants are greater than that of 5 most recent plants. The data is presented in calculation excel sheets. The thermal efficiencies of coal and gas based plants for calculating build margin has been assumed same as that for calculating operating margin.

Combined Margin Emission Coefficient of Western Regional State Grid is = **0.79371 kg of CO_2 / kWh**[8] generation.

[B] Emission Coefficient for Diesel Generator

Emission reductions corresponding to reduced DG set based electricity consumption by the HVAC and Lighting system, will be obtained by multiplying reduction in DG set based electricity consumption of the HVAC system with the emission factor for electricity generated by the DG set. For the project activity under consideration, the emission factor (EF_{DG}) for the electricity generated by DG set, for both the baseline and project scenarios have been taken to be equal to the 0.8 kg CO_2 e/kWh, a value provided in table I.D.1 in AMS. I.D in Appendix B of the Simplified M&P for small scale CDM project activities (Version 13, Sectoral Scope: 1, EB 36). In considering the value, it has been assumed that the DG sets of CPP is a mini grid with temporary service (2 hours a day), operating at 50% load factor.

Baseline Emissions

The Baseline emissions associated to grid electrical energy are computed as a product of the Energy Baseline (i.e. electrical energy use of the baseline building) and emission coefficient of western grid.

The Baseline emissions associated to electrical energy from DG are computed as a product of the Energy Baseline (i.e. electrical energy use of the baseline building during power failure from gird) and emission coefficient of Diesel based power generator.

The sum of above two would give the total baseline emissions.

Leakage

[8] Emission Factor of WR Grid from www.cea.nic.in based on ACM0002 version 07

The project activity involves installation of energy efficient equipments / technologies utilized in building to conserve energy.

As per the Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories, "if the energy efficiency technology is equipment transferred from another activity, leakage is to be considered".

The energy efficiency technologies adopted in the project activity does not involve any equipment transfers from another activity or vice versa. The same may be verified on site. Therefore there would be no net change of anthropogenic emissions by sources of greenhouse gases outside the project boundary. Therefore as per the AMS II – E guidance project proponent does not need to consider these emission sources as leakage in applying this methodology. Therefore project proponent has not taken leakage into consideration.

Key information and data used to determine the baseline scenario are as provided in the following table - Table B.3:

Sl. No.	Variable	Parameters	Data sources
01	$E_{Chiller,b}$	Electricity that would have been consumed by the chiller plant (air cooled chiller of COP 3 without CO_2 sensors in the AHUs) of "Energy efficient building" in the baseline scenario (in MWh)	Energy simulation based on the design parameters for the baseline building
02	$E_{Pumps,b}$	Electricity that would have been consumed by the chilled water pumping system (without VFDs in the pumps of the primary chilled water loop) of "Energy efficient building" in the baseline scenario (in MWh)	Energy simulation based on the design parameters for the baseline building
03	$E_{AHUs,b}$	Electricity that would have been consumed by the AHUs (without VFDs on the fans) of "Energy efficient building" in the baseline scenario (in MWh)	Energy simulation based on the design parameters for the baseline building
04	$E_{Lighting,b}$	Electricity that would have been consumed by the Lighting (without CFLs and occupancy sensors) of "Energy efficient building" in the baseline scenario (in MWh)	Energy simulation based on the design parameters for the baseline building
05	$T_{op,HVAC,b}$	Operating hours of the HVAC system of "Energy efficient building" in the baseline scenario	Expected occupancy pattern report for "Energy efficient building"

06	$EF_{Grid,}$	Combined margin emission factor (in tCO_2/kWh) of the Western Regional Electricity grid (calculated ex-ante and kept constant for the entire crediting period)	CEA published CDM – Carbon dioxide baseline database[9]
07	EF_{DG}	CO_2 emission factor (in tCO_2/kWh) for electricity generated by the DG set in "Energy efficient building"	Table I.D.1 in AMS. I.D in Appendix B of the Simplified M&P for small scale CDM project activities (Version 13, Sectoral Scope: 1, EB 36).

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:

As per the decision 17/CP.7 paragraph 43, a CDM project activity is additional if anthropogenic emissions of greenhouse-gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity. The project activity is installation of energy efficient equipments/building materials in energy efficient building resulting in net CO_2 emission reductions through reduced energy consumption when compared with conventional building.

The project proponent identified plausible project options, which include all possible courses of actions that could be adopted. These plausible options were further analysed as per the guidance in Attachment A to Appendix B of the small scale modalities and procedures to establish project additionality and determine an appropriate baseline scenario.

There were only two plausible alternatives available with the project proponent with regard to selecting equipments for the energy efficient building. They were

Alternative I: Selection of Conventional Building equipments/materials (Baseline Scenario);

In the above alternative project proponent would utilized conventional building equipments which are less energy efficient when compared with energy efficient building. This alternative is in compliance with all

[9] Source: http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm

applicable legal and regulatory requirements. This alternative has been operative at other buildings of project proponent. Therefore this alternative does not entail any additional investment, neither does it have any technological or other operational risks associated to its implementation and may be the baseline.

Alternative 2- Implementation of the project activity (Energy Efficient building);

This alternative is in compliance with all applicable legal and regulatory requirements but there is no legal binding on the project proponent to take up the project activity. Further this alternative was exposed to limitations related to the project activity implementation. These barriers were primarily related to investment issues, technological issues like design and operation of HVAC and lighting system and risks involved with the adaptation of the new technology and its outcome and other operational barriers. These barriers and the risks associated with the implementation of the project activity were realized during the conceptualization stage of project activity and are detailed below.

The project participant is required to provide a qualitative explanation[10] to show that the project activity would not have occurred anyway and **at least one** of the listed elements should be identified in concrete terms to show that the activity is either beyond the regulatory and policy requirement or improves compliance to the requirement by removing barrier(s). The barriers faced by the project proponent for this project activity for determining the project additionality are shown below:

- Investment Barrier
- Technological barrier
- Barrier due to prevailing practice
- Other barriers

1. Investment Barriers:

The construction of energy efficient buildings by the project proponent has been a voluntary step undertaken to mitigate the impacts of climate change. Such a building is an attractive option as far as the energy efficiency is concerned but involves high investment. A financially more viable alternative to the project activity would have led to higher GHG emissions. The project proponent has taken the initiative of considering the best practice in building construction so that there is reduction in electricity consumption.

The “BKC 30” would not be used by the project proponent, instead would be either rented or leased out. The “BKC 30” Building would be rented or leased out for five years. The energy efficiency measures

[10] EB 35 Report, Annex 34 - Non-binding best practice examples to demonstrate additionality for SSC project activities

undertaken in the building would reduce the electricity consumption of the HVAC system and the Lighting system. The overall impact of energy reduction would be reflected in the annual electricity bill, which would be lesser when compared against the electricity bill of an equivalent conventional baseline building. Since the reduced electricity bill will be directly paid by the lessee, the benefit of reduced cost of operation would be would be accrued by the lessee and not by the project proponent.

Also, the price at which the building has been rented or leased out is comparable with the existing market price[11]. The buildings under this project activity have been leased out at Rs 315/Sq ft per month. However even though the buildings are energy efficient, the rate of leasing is comparable with the prevailing market price, which is Rs 165/Sq ft per month. This clearly demonstrates that, the project proponent doesn't gain any additional revenue for constructing energy efficient buildings (Project activity). Thus, in spite of the reduction in electricity consumption over baseline building, the benefits are not claimed by the project proponent who has invested in such an energy efficient building. Thus CDM benefits would help the project proponent in building up the gap between the investments done on energy efficient building.

The other technological barriers faced by the project proponent have been described below:

2. Technological Barriers:

The alternatives for various energy efficiency measures to determine the baseline along with the barriers for each project activity is presented in following table

Table B.1: Alternatives for the different energy efficiency measures taken in the HVAC and lighting system of Energy efficient building:

Parameters affecting Energy Consumption	Alternatives	Barriers	Baseline Option
A. Civil Work including Exterior wall construction	Alternative A-1: Mass wall of U-factor 0.58 Btu/hr. ft^2. ^0F	This type of wall construction would entail low capital investment. The expected cost of such wall would be INR 90.6 Million	Alternative A-2 would not be a credible and realistic alternative option for Project Proponent to

[11] Market Report Survey by Cushman & Wakefield

	Alternative A-2: 8" thick AAC blocks with plaster inside and outside and effective U value would be 0.32 Btu/hr. ft^2. ^0F	AAC block wall construction would entail comparatively higher capital investment. The investment required would be INR 96.1 Million.	implement because of the high investment involved and can be excluded from further consideration as a possible baseline scenario. Instead, alternative A-1 which is a lower investment option, can be concluded to be the viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option for the exterior wall construction.
B. Exposure of glass wall area	Alternative B-1: The glasses used would be plain glass. The U-value of the fenestration would be 1.22 Btu/hr.ft^2 .^0F on the north and non-north sides. The glass would have shading co-efficient of 0.51 on all sides and 70% visible light transmittance on all sides.	Such a quality of glass is easily available in India. The total cost of glazing for the building would be around INR 10.8 Million	Alternative B-2 would not be a credible and realistic alternative option for Project Proponent to implement because of the high investment involved and can be excluded from further consideration as a

	Alternative B-2: The glazing used in the building would be of high performance double glazed panels coated with reflective low "e"-glass panes and having low U-value and solar heat gain co-efficient. The U-value of the fenestration would be 0.35 Btu/hr.ft^2 .^{0}F on the north. High quality glass (with shading co-efficient of 0.34 on all sides), would be used. The fenestration would have a visible light transmittance of 44% all sides.	The kind of glass that has been used for glazing of "Energy efficient building" is not yet locally manufactured by Indian glass industry. The cost of glazing for "Energy efficient building" was around INR 13.6 Million.	possible baseline scenario. Instead, alternative B-1 which is a lower investment option, can be concluded to be the viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option for the exposure of glass wall area.
C. Roof insulation	Alternative C-1: Mass Roof with a U-factor of 0.12 Btu/hr.ft^2.^{o}F	Capital cost as well as operating cost is low.	The alternative C-2 would not be a credible and realistic alternative option for Project Proponent to implement due to the higher capital as well as operating cost. It can be excluded from further consideration as a possible baseline scenario. Instead, alternative C-1 entailing lower capital as well as operating cost, can be
	Alternative C-2: Insulation would be entirely above deck, with R=15 extruded polystyrene, terrace gardening and roof reflectivity of 0.30.	Capital cost is high. Moreover maintenance of the R15 insulation is necessary, thereby requiring additional manpower and increasing the operating cost. The investment is INR 3.25 Million.	

			concluded to be the viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option for roof insulation.
D. Air Handling Unit (AHU) and Secondary and Primary Chilled water pumps	Alternative D-1: The air handling system would be a constant air volume system and reset by warmest zone.. The chilled water pumps would be with out VFDs.	Low investment requirement (INR 25.4 Million) Conventional method of control which and easy & simple to operate No risks related to performance of AHU fans	The alternative D-2 would not be a credible and realistic alternative option for Project Proponent to implement due to the higher costs involved in investment, operation and maintenance, requirement of extensive metering. Therefore this alternative can be excluded from further consideration as a possible baseline scenario. Instead, alternative D-1 which is a much cheaper option can be concluded to be the
	Alternative D-2: The air handling system would be a variable air volume system and reset by warmest zone, with VFD and CO_2 Sensors. The chilled water pumping system would be provided with VFDs.	➢ High capital investment of INR 26.6 Million when compared with Alternative 1 like damper control or valve controls ➢ Requires setting of the VFD & CO_2 Sensors should be changed by skilled man power ➢ Cooling profile inside the building may get disturbed, if some faults occur in VAV & VFD circuitry thereby	

		affecting building atmosphere. ➢ VFD in the secondary pumps creates harmonics, which reduce real power factor and creates transients in the power system which may lead to failure of other equipments[12]. ➢ The temperature of drive and control panel has to be maintained. The drive may fail in case the temperature exceeds	viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option.

[12] Variable Speed Drives, http://www.synergyenergy.com.au visited 10 July 2007

		beyond limits. ➢ VFD driven equipments (screw compressors & blowers) is a very new technology in India. Only recently have they been applied to areas like AHUs and Pumps. The application of this technology calls for sophistication of operational practices and skilled manpower is required for maintenance[13].	
E. Chillers	Alternative E-1: Water cooled chillers with a full load efficiency of 1.17 kW/TR (a COP of 3.0 at ARI conditions).	Capital cost of implementation is low since low efficiency water cooled reciprocating chiller is used (INR 5.1 Million). Operation and maintenance cost is also low.	The alternative E-2 would not be a credible and realistic alternative option for Project Proponent to implement without consideration of CDM benefits and can be excluded from further consideration as a possible baseline scenario. Instead, alternative E-1 which is a much cheaper option, can be
	Alternative E-2: Water cooled chillers with a full load efficiency of 0.735 kW/TR (a COP of > 5.2 at ARI conditions) along with thermal storage. These are the measures taken in the chiller plant of "Energy efficient	Capital cost of implementation is much higher since water cooled screw chillers have been used. (INR 8.8 Million) Operation and maintenance cost is also much higher.	

[13] Training records available with the Project Proponent.

	building", without consideration of CDM benefits.		concluded to be the viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option for the Chiller.
F. Lighting	Alternative F-1: Conventional Fluorescent / incandescent lights without occupancy sensors were used.	Capital cost (INR 3.0 Million) as well as operating cost is low.	The alternative F-2 would not be a credible and realistic alternative option for Project Proponent to implement due to the higher capital as well as maintenace cost. It can be excluded from further consideration as a possible baseline scenario. Instead, alternative F-1 entailing lower capital cost can be concluded to be the viable option available to Project Proponent in absence of the project activity. Therefore this alternative option is the baseline option for lighting.
	Alternative F-2: Efficient fluorescents (T5s) will be used along with occupancy sensors in offices and food courts.	Capital cost would be high for the energy efficient lighting with occupancy sensors (INR 4.1 Million). Moreover maintenance of the occupancy sensors and lighting fixtures is necessary, thereby requiring additional manpower and increasing the maintenance cost.	

Conclusion: As elucidated above, net effect of reduction in electricity consumption of "BKC30" building, is the cumulative effect of each and every energy efficiency measure. Further, Project Proponent also had to keep adequate stock of certain expensive spare parts of the HVAC & lighting system, thereby incurring additional expense. The common practice assessment further substantiated the fact that the project activity is not a baseline scenario. The project activity Energy efficient building is among the first few projects of its kind in the country. The additional investment for the project activity would have to be entirely borne by the project proponent.

However with objective of contribution to GHG abatement and thereby availing the credits from GHG emission reduction, the management of Project Proponent has gone ahead with the project option. The corporate decision to invest

- in overcoming the barriers encountered in the project activity implementation
- in the project activity

has been guided by the anthropogenic greenhouse gas emission reductions the project activity would result in and the associated carbon financing the project activity would receive through sale of Certified Emission Reductions under the Clean Development Mechanism .

Therefore, the project activity is not a plausible baseline option. The baseline scenario would be a combination of the baseline options for each of the parameters in the HVAC and lighting system, that are conducive to energy conservation in "Energy efficient building", i.e. the baseline option is a combination of alternatives A-1, B-1, C-1, D-1, E-1 and F-1 which together can be concluded to form the baseline building.

Based on the baseline methodology, it is calculated that (see section E for the calculation) the project activity will avoid 16350 tonnes of CO_2 equivalent emissions in a 10 year credit period, by drawing lesser amount of electricity generated in the Western Regional electricity grid. Hence, the project activity is not a baseline scenario and without the project activity there will be generation of additional quantum of electricity in the grid thereby leading to GHG emissions as per the power generation sources of the grid mix.

3.0 Other Barriers:

(a) Since there is no know-how available at Project proponent to implement the project activity, the project proponent's management could fore-see many operational limitations. The in-house team had no technical experience of implementing the project activity and project proponent had to depend primarily on the technology suppliers for any operational problems.

(b) The technology design is driven by software and control systems installed with PLC and DCS control systems (Building Management System). Any operational failure of these controls will lead to HVAC downtime and its associated problems to the tenants. These control devices rectifications cannot be done by the in-house team. Any problem in the control devices requires addressal by technology supplier and therefore leading to large losses in plant operation.

Therefore adaptation of an entirely new technology was challenging in all respects. At the decision stage itself the project proponent had anticipated the operational limitations and its impacts on the financial considerations. Each of them, especially the Investment barrier and the technological barriers could have resulted in project failure and huge financial losses. Without the CDM revenue, this alternative was not a feasible option for project proponent to adopt.

The project proponent's management chose to undertake the project activity and to invest in the CDM process only after adjusting for the potential carbon financing.

In summary, the corporate decision to invest:

- in overcoming the barriers facing project implementation and operation;
- in the CDM project activity and,
- in additional transaction costs such as preparing documents, supporting CDM initiatives and developing and maintaining M&V protocol to fulfill CDM requirements

was guided by the anthropogenic greenhouse gas emission reductions the project activity would result in and its associated carbon financing the project activity would receive through sale of CERs under the Clean Development Mechanism .

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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<u>Calculation of electricity that would be consumed by the HVAC and Lighting system in the baseline scenario</u>

$$E_{Building,b} = E_{Chiller,b} + E_{Pumps,b} + E_{AHUs,b} + E_{Lighting,b}$$

Where,

$E_{Building,b}$: Electricity that would have been consumed by the "Energy efficient building" in the baseline scenario (in MWh)

$E_{Chiller,b}$: Electricity that would have been consumed by the chiller plant (water cooled chiller of COP 3 without CO_2 sensors in the AHUs) of "Energy efficient building" in the baseline scenario (in MWh)

$E_{Pumps,b}$: Electricity that would have been consumed by the chilled water pumping system (without VFDs in the pumps of the primary chilled water loop) of "Energy efficient building" in the baseline scenario (in MWh)

$E_{AHUs,b}$: Electricity that would have been consumed by the AHUs (without VAVs on fans) of "Energy efficient building" in the baseline scenario (in MWh)

$E_{Lighting,b}$: Electricity that would have been consumed by the Lighting system (without occupancy sensors) of "Energy efficient building" in the baseline scenario (in MWh)

$$E_{Building,b,y} = \frac{E_{Building,b}}{T_{op,Building,b}} \times T_{op,Building,y}$$

Where,

$E_{Building,b,y}$: Electricity that would have been consumed by the building "Energy efficient building" in the baseline scenario corresponding to the operating hours of the chiller plant in the year y of the project scenario (in MWh)

$T_{op,Building,b}$: Operating hours of the building "Energy efficient building" in the baseline scenario

$T_{op,Building,y}$: Operating hours of the building "Energy efficient building" in a year y in the project activity scenario

Calculation of electricity consumption in the project activity scenario

$$E_{Building,p,y} = E_{Chiller,y} + E_{Pumps,y} + E_{AHUs,y} + E_{Lighting,y}$$

Where,

$E_{Building,p,y}$: Electricity that will be consumed by the building "Energy efficient building" in the year y in the project activity scenario(in MWh)

$E_{Chiller, y}$: Electricity that will be consumed by the chiller plant (water cooled screw chillers of COP >4.0) of "Energy efficient building" in the project activity scenario (in MWh)

$E_{Lighting,,y}$: Electricity that will be consumed by the Lighting system of "Energy efficient building" in the year y in the project activity scenario (in MWh)

$E_{Pumps, y}$: Electricity that will be consumed by the chilled water pumping system (with VFDs in the pumps of the primary and secondary chilled water loops) of "Energy efficient building" in the year y in the project activity scenario (in MWh)

$E_{AHUs, y}$: Electricity that will be consumed by the AHUs (with VAVs on fans and CO_2 Sensors) of "Energy efficient building" in the year y in the project activity scenario (in MWh)

Calculation of Average Emission Factor with respect to drawal of electricity from the grid and DG

$$EF_{Avg,y} = \left(\frac{E_{Grid,y} \times EF_{Grid,y} + E_{DG,y} \times EF_{DG,y}}{E_{Grid,y} + E_{DG,y}} \right)$$

Where,

$EF_{Avg,,y}$: Average Emission Factor with respect to Grid as well as DG power consumption in "Energy efficient building" (in tCO_2/MWh)

$E_{Grid, y}$: Electricity drawn from the Western Regional Electricity grid by "Energy efficient building" in the year y in the project activity scenario (in MWh)

$E_{DG, y}$: Electricity generated by Diesel Generator (DG) set of "Energy efficient building" in the year y (in MWh)

$EF_{Grid,y}$: Western region Grid Emission Factor (in tCO_2/MWh)

$EF_{DG,y}$: DG grid Emission Factor (in tCO_2/MWh)

Calculation of baseline emissions (BE_y)

$$BE_y = E_{Building,b,y} \times EF_{Avg,y}$$

Where,

BE_y : Baseline Emissions for the year y in Energy efficient building (in t CO_2/annum)

Calculation of baseline emissions (PE_y)

$$PE_y = E_{Building,p,y} \times EF_{Avg,y}$$

Where,

PE_y : Project Emissions for the year y in Energy efficient building (in t CO_2/annum)

Leakage

As per paragraph 5 of Appendix B of Category II.E (Version 10, EB 35, Sectoral Scope: 03) small scale methodologies, "*if the energy efficiency technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered*". For the project activity under consideration, the energy efficient technology includes installation of electrical equipments, fenestration and insulations in a new building. All the energy efficient technologies are new installations and not diverted from already existing utilization areas. Therefore, there is no leakage that needs to be considered for the project activity under consideration and leakage (L_y) = 0.

Calculation of Emission reductions (ER_y)

$$ER_y = BE_y - PE_y - L_y$$

Where

ER_y: Emission Reduction in year y for Energy efficient building in tCO_2/annum.

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

(Copy this table for each data and parameter)

Data / Parameter:	$E_{Chiller,b}$
Data unit:	MWh
Description:	Electricity that would have been consumed by the chiller plant (water cooled chiller of COP 3 without CO_2 sensors & VAVs in the AHUs) of "Energy efficient building" in the baseline scenario
Source of data used:	Energy simulation based on the design parameters for the baseline building
Value applied:	2364.590
Justification of the choice of data or description of measurement methods and procedures actually applied :	An energy simulation has been done for the chiller plant of the baseline building which is a conventional building with the same occupancy-type in the same region as "Energy efficient building". The specifications of the chiller plant for the baseline building have been provided in Table A.1 in Section A.1
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$E_{Pumps,b}$
Data unit:	MWh
Description:	Electricity that would have been consumed by the chilled water pumping system (without VFDs in the pumps of the primary chilled water loop) of "Energy efficient building" in the baseline scenario
Source of data used:	Energy simulation based on the design parameters for the baseline building

Value applied:	158.27
Justification of the choice of data or description of measurement methods and procedures actually applied :	An energy simulation has been done for the chiller plant of the baseline building which is a conventional building with the same occupancy-type in the same region as "Energy efficient building". The details of the measures in the chilled water pumping system for the baseline building have been provided in Table A.1 in Section A.1
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$\mathbf{E_{AHUs,b}}$
Data unit:	MWh
Description:	Electricity that would have been consumed by the AHUs (without VAVs on the fans) of "Energy efficient building" in the baseline scenario
Source of data used:	Energy simulation based on the design parameters for the baseline building
Value applied:	485.24
Justification of the choice of data or description of measurement methods and procedures actually applied :	An energy simulation has been done for the AHUs of the baseline building which is a conventional building with the same occupancy-type in the same region as "Energy efficient building". The details of the measures in the AHUs for the baseline building have been provided in Table A.1 in Section A.1
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$\mathbf{E_{Lighting,b}}$
Data unit:	MWh
Description:	Electricity that would have been consumed by the Lighting system (without CFLs and occupancy sensors) of "Energy efficient building" in the baseline scenario
Source of data used:	Energy simulation based on the design parameters for the baseline building
Value applied:	793.45
Justification of the choice of data or description of measurement methods and procedures actually applied :	An energy simulation has been done for the Lighting System of the baseline building which is a conventional building with the same occupancy-type in the same region as "Energy efficient building". The details of the measures in the Lighting sytem for the baseline building have been provided in Table A.1 in Section A.1
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$\mathbf{T_{op,Building,b}}$
Data unit:	hours
Description:	Operating hours of the HVAC system of "Energy efficient building" in the baseline scenario
Source of data used:	Expected occupancy pattern report for "Energy efficient building"
Value applied:	16
Justification of the choice of data or description of measurement methods and procedures actually	"Energy efficient building" is an commercial office space. It is meant for commercial office spaces which entail average occupancy time of 16 hours/day per head in the offices.

applied :	
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	**EF_{Grid}**
Data unit:	t CO_2/MWh
Description:	Western Grid Emission Factor
Source of data used:	CEA Emission Factor
Value applied:	0.79371
Justification of the choice of data or description of measurement methods and procedures actually applied :	Western Grid Emission factor obtained from published data Central Electricity Authority (CEA), Government of India (www.cea.nic.in) CO_2 Baseline Database for the Indian Power Sector Version 3.0.
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	**EF_{DG}**
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor for the DG set of CPP
Source of data used:	Table I.D.1 in AMS. I.D in Appendix B of the Simplified M&P for small scale CDM project activities (Version 12, Sectoral Scope: 1, EB 33)
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	For the project activity under consideration, EF_{DG} is taken to be equal to the 0.8 kg CO_2 e/kWh, a value provided in table I.D.1 in AMS. I.D in Appendix B of the Simplified M&P for small scale CDM project activities (Version 12, Sectoral Scope: 1, EB 33). In considering the value, it has been assumed that the DG sets of CPP is a mini grid with temporary service (2 hours a day), operating at 50% load factor.
Any comment:	EF_{DG} has been considered as the ex-ante emission factor and will be kept constant for the entire crediting period

B.6.3 Ex-ante calculation of emission reductions:

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The following table elucidates how the project activity reduces the emissions corresponding to the reduced electricity consumption with respect to the baseline scenario:

Alternative	**Electrical End-use Totals (MWh/annum)**				
	Chiller $E_{Chiller}$	**AHUs** E_{AHUs}	**Pumps** E_{Pumps}	**Lighting** $E_{Lighting}$	**Total electricity consumption** $E_{Building}$
Baseline Building	2364.59	485.24	158.75	793.45	3801.56
Energy efficient building as designed	950.41	93.09	59.15	681.94	1784.59

Considering the operating hours of the Energy efficient building both in Baseline Scenario and Project Scenario same and operating hours of DG power generation as zero hours per year we can calculate the following:

Emission Factor for electricity drawn from Western Regional Electricity Grid	**0.79371**
Baseline Emissions (tCO_2/annum)	**3017**
Project Emissions (tCO_2/annum)	**1416**
Emission Reductions due to energy efficiency measures taken in the building "Energy efficient building" (in t CO_2/annum)	**1601**

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

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Year	Estimation of project activity emissions (tCO_2 e)	Estimation of baseline emissions (tCO_2 e)	Estimation of leakage (tCO_2 e)	Estimation of overall emission reductions (tCO_2 e)
2008	**1416**	**3017**	**0.0**	**1601**
2009	**1416**	**3017**	**0.0**	**1601**
2010	**1416**	**3017**	**0.0**	**1601**
2011	**1416**	**3017**	**0.0**	**1601**
2012	**1416**	**3017**	**0.0**	**1601**
2013	**1416**	**3017**	**0.0**	**1601**
2014	**1416**	**3017**	**0.0**	**1601**
2015	**1416**	**3017**	**0.0**	**1601**
2016	**1416**	**3017**	**0.0**	**1601**
2017	**1416**	**3017**	**0.0**	**1601**
Total Emission	**14160**	**30170**	**0.0**	**16010**
Crediting years	**10**	**10**	**10**	**10**
Average Emission Reductions over the Crediting Years (10 Years)	**1416**	**3017**	**0.0**	**1601**

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

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Title: Monitoring Methodology for – ***Energy efficiency and fuel switching measures for buildings***

Reference: Paragraph 7 of Category II.E as provided in Appendix B of the Indicative Simplified Baseline and Monitoring Methodologies for selected small-scale CDM project activity categories.

As per the provisions of Simplified Modalities and Procedures for Small Scale CDM Project Activities [FCCC/CP/2002/7/Add.3, English, Page 21] the "Project participants may use the **simplified baseline and monitoring methodologies specified in appendix B** for their project category" if they meet the applicability criteria of Small scale CDM project activity. Since the project activity is a small-scale project of a new energy efficient facility classifiable under II.E category the monitoring methodology and plan has been developed in line with the guidance provided in Paragraph 9 of Category II.E, Appendix B.

Description of Monitoring Methodology:

According to Appendix B of the simplified M&P for small-scale CDM project activities of the UNFCCC CDM website, the project has been identified to belong to Category II.E [***Energy efficiency and fuel switching measures for buildings***]. Paragraph 6 under Category II.E of the same document specifies that for the said category of CDM projects, **'In the case of a new facility, monitoring shall consist of:**

(a) Metering the energy use of the building(s);

(b) Calculating the energy savings of the new building(s).'

B.7.1 Data and parameters monitored:

Data / Parameter:	$E_{Chiller,y}$
Data unit:	MWh
Description:	Electricity that will be consumed by the chiller plant of "Energy efficient building" in the project activity scenario
Source of data to be used:	BMS maintained log-sheets
Value of data	For the purpose of arriving at an estimate of the emission reductions, the impacts of the AAC blocks, Glazing on the heat load and on the electricity consumption have been considered in the chiller plant electricity consumption as per the energy simulation done for the HVAC system of "Energy efficient building". The value

	applied is 950.41 MWh.
Description of measurement methods and procedures to be applied:	Continuous measurement of electrical energy consumption will be done by energy meters installed for each of the two operating chillers of “Energy efficient building”. The electricity consumption by a chiller, will be recorded on an hourly basis in the BMS. Sum of the hourly electricity consumption by a chiller, for all operating hours of the chiller in a year, will yield its annual value of electricity consumption for the year. Sum of the electricity consumption in each chiller, will provide the measure of total electricity consumption in chiller plant of “Energy efficient building” in the particular year.
QA/QC procedures to be applied:	Meters will be calibrated annually. The Maintenance Engineer will review the data on a monthly basis.
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$E_{Lighting,y}$
Data unit:	MWh
Description:	Electricity that will be consumed by the Lighting system of “Energy efficient building” in the year y in the project activity scenario
Source of data to be used:	BMS maintained log-sheets
Value of data	681.94
Description of measurement methods and procedures to be applied:	Continuous measurement of electrical energy consumption will be done by energy meter installed for the Lighting feeder. The electricity consumption by the lighting system will be recorded on an hourly basis in the BMS.
QA/QC procedures to be applied:	Meter will be calibrated annually. The Maintenance Engineer will review the data on a monthly basis.
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$E_{Pumps,y}$
Data unit:	MWh
Description:	Electricity that will be consumed by the chilled water pumping system (with VFDs in the pumps of the primary and secondary chilled water loops) of “Energy

	efficient building" in the year y in the project activity scenario
Source of data to be used:	BMS maintained log-sheets
Value of data	59.15
Description of measurement methods and procedures to be applied:	Continuous measurement of electrical energy consumption will be done by energy meters installed for each of the chilled water circulating pumps in the HVAC system. The electricity consumption by a pump, will be recorded on an hourly basis in the BMS. Sum of the hourly electricity consumption by the pump, for all operating hours of the chiller plant in a year, will yield the yearly value of electricity consumption of that pump for the year. Sum of the electricity consumption of each pump, will provide the measure of total electricity consumption in the chilled water pumping system of the HVAC system of "Energy efficient building" in the particular year.
QA/QC procedures to be applied:	Meters will be calibrated annually. The Maintenance Engineer will review the data on a monthly basis.
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$E_{AHU,y}$
Data unit:	MWh
Description:	Electricity that will be consumed by the AHUs (with VFDs on fans and HRWs) of "Energy efficient building" in the year y in the project activity scenario
Source of data to be used:	BMS maintained log-sheets
Value of data	For the purpose of arriving at an estimate of the emission reductions, the electricity consumption of the all the fans in the AHUs have been considered and the value used is 93.09 MWh.
Description of measurement methods and procedures to be applied:	Continuous measurement of electrical energy consumption will be done by energy meters installed for all the AHU rooms of "Energy efficient building". The electricity consumption by an AHU, will be recorded on an hourly basis in the BMS. Sum of the hourly electricity consumption by an AHU, for all operating hours of the AHU in a year, will yield the yearly value of electricity consumption of that AHU for the year. Sum of the electricity consumption in each AHU room,

	will provide the measure of total electricity consumption in AHUs of the HVAC system of "Energy efficient building" in the particular year.
QA/QC procedures to be applied:	Meters will be calibrated annually. The Maintenance Engineer will review the data on a monthly basis.
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$\mathbf{T_{op,HVAC,y}}$
Data unit:	hours
Description:	Operating hours of the HVAC system of "Energy efficient building" in the year y in the project activity scenario
Source of data to be used:	BMS generated report for "Energy efficient building"
Value of data	16
Description of measurement methods and procedures to be applied:	The hours of operation of the HVAC system of "Energy efficient building" will be monitored continuously by the BMS. The total operating hours at the end of the year will yield $T_{op,HVAC,y}$
QA/QC procedures to be applied:	-
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$E_{DG,\,y}$
Data unit:	MWh
Description:	Amount of electricity generated by Diesel Generator (DG) set that is consumed in "Energy efficient building" in year y
Source of data to be used:	Log-sheets maintained by Project Proponent
Value of data	Not considered in emission reduction estimation since DG set will be operated only in case of exigencies
Description of measurement methods and procedures to be applied:	Continuous measurement through energy meter installed at the DG end
QA/QC procedures to be applied:	The Maintenance Engineer will review the data on a monthly basis
Any comment:	Data archived: Crediting period + 2 yrs

Data / Parameter:	$E_{Grid,\,y}$

Data unit:	MWh
Description:	Amount of electricity drawn from the Western Regional Electricity grid by "Energy efficient building" in year y
Source of data to be used:	Summation of individual power consumption of building components reflected in BMS reports.
Value of data	1784.59
Description of measurement methods and procedures to be applied:	Continuous measurement through net metering at main feeder connected to BMS.
QA/QC procedures to be applied:	The Maintenance Engineer will review the data on a monthly basis
Any comment:	Data archived: Crediting period + 2 yrs

B.7.2 Description of the monitoring plan:

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The project proponent has designed a measurement and verification plan in order to ensure the proper, regular measurement and recording of the data pertaining to the energy conservation measures taken in "Energy efficient building". There is a Head – Facility Management, assisted by a Maintenance Engineer who will conduct monthly review of all the relevant data for the energy efficiency measures. They will also be responsible for proper archiving of data required for estimating emission reductions. There will be annual calibration of all the meters.

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

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Name of the responsible person(s)/entity(ies): Experts and consultants of K Raheja Corporate Services Private Limited

Date of completion of the application of the baseline and monitoring methodology: 27/11/2007

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:

>>
22/07/2005

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

>>
20 Years

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

C.2.1. Renewable crediting period

NA

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

>>

C.2.1.2. Length of the first crediting period:

>>

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01/09/2008 or the date of registration with UNFCCC, whichever occurs later.

C.2.2.2. Length:

>>
10 Years 0 Months

SECTION D. Environmental impacts

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

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The Project activity building is a place where the people have the opportunity to occupy spaces that have the maximum impact on their well-being and a minimal impact on the environment.

The consultants and contract managers for the HVAC system have certified that there is no CFC-based refrigerants in the HVAC and refrigeration systems used in energy efficient building. Apart from that, in view of the health hazards posed by tobacco smoke entering office work space, the entire energy efficient building is strictly a no-smoking zone. Air quality in each space is closely monitored through CO_2 sensors installed in return air path from various zones served by the air handling units. A log of indoor and outdoor CO_2 levels is maintained through an advanced IBMS.

Care has been taken to ensure that all fresh air intakes are located at least 25 feet away from possible sources of contamination like building exhaust fans, cooling towers, standing water, parking, sanitary vents and outside smoking vents.

High efficiency pre-filters are provided in supply air stream of all air handling units to remove any contaminants from outside air. In addition to that, continuous building flush out is conducted over a fourteen calendar day period to reduce possible indoor air quality contamination after completion of construction and prior to occupancy. This involves running the mechanical system with 100% outside air for the stipulated period of time.

The purpose of this flushing out is to get rid of particulate matter and VOCs produced by particle emitting construction materials, furnishings, interior finishes and cleaning agents. Care is taken with regard to humidity levels and microbial growth depending on the seasonal weather conditions. All ventilation air filters are changed as a final step of building flush out.

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:

>> Not Applicable.

SECTION E. Stakeholders' comments

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

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Some of the major stakeholders identified for the project activity are Mumbai Municipality, Building Occupants, the different technology suppliers for the building, the technical consultants, the employees of project proponent and also the contract workers.

Some of the above stakeholders were involved in the project at various stages of obtaining the statutory clearances for the building. The project proponent has not only communicated with the relevant stakeholders under statutory obligations but also has engaged the other stakeholders in a proactive manner in expressing and accounting their opinions on the project.

As a corporate policy of the company, the project proponent is engaged in an on-going initiative to educate all of their own employees and contractual workers. A series of programmes were administered at site.

E.2. Summary of the comments received:

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Comments received so far appreciate the energy efficiency measures taken in the HVAC and Lighting system of "Energy efficient building".

Contractors

The contractors have commended the project activity to be an exemplary energy efficient building. They have also commended the efforts of Project proponent towards registration of the project as a CDM project due to its potential of reducing electricity generation related GHG emissions.

Tenants

The tenants of the building commented that through the design and installations of the different energy efficiency measures, project proponent has not only focussed on the comfort of the occupants but as a responsible corporate house, it has also prioritized the sustainable development of the country through optimum utilization of electricity.

Municipality Commissioner

Appreciated the project proponents concern towards the Mother Nature and the steps taken the project proponents company in this direction, which is essential in the current global environmental scenario. Also recommended to propagate the concept of "Energy Efficient Buildings" to all over Mumbai Region, so that, many more such Buildings may be undertaken.

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

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Views of some of the relevant stakeholders on the energy efficiency in the HVAC & Lighting system of the building have been collated through notification on the project activity and the invitation of comments. The relevant comments and important clauses mentioned in the project documents / clearances like Detailed Project Report (DPR), EIA Report, local clearances, newsletter were considered while preparing the Project Design Document.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	K Raheja Corporate Services Private Limited.
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Represented by:	
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Salutation:	Mr
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Middle Name:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No funding from Annex I party.

Annex 3

BASELINE INFORMATION

As per Section B.

Annex 4

MONITORING INFORMATION

The project activity has employed the state-of-the-art monitoring and control equipment that will measure, record, report and monitor various key parameters like electricity consumption in the different areas of the HVAC & Lighting system of "Energy efficient building".

The instrumentation system comprises of microprocessor-based instruments of reputed make with the best accuracy available. All instruments will be calibrated and marked at regular intervals so that the accuracy of measurement can be ensured all the time. The calibration frequency too is a part of the monitoring and verification parameters.

Project Parameters affecting Emission Reduction Claims:

Monitoring:

GHG performance parameter and the emission reductions achieved through the project activity will be determined based on the following parameters:

- Electrical energy reduction from the energy efficiency measures taken in the building
- Emission factor for electricity generation in the Western Regional grid (calculated ex-ante for the project activity under consideration and the particular constant value is used for estimation of the emission reductions for the entire crediting period)

Please refer to Section B.7.1 for the details of the parameters that need to be monitored for calculation of the emission reductions arising out of the project activity.

CDM stands on the quantification of emission reduction and keeping the track of the emissions reduced. The project activity would reduce the carbon dioxide whereas an appropriate monitoring system would ensure this reduction is quantified and helps maintaining the required level.

Also a monitoring system brings about the flaws in the system if any are identified and opens up the opportunities for improvement.

The general monitoring principles are based on:

- Frequency
- Reliability
- Registration and Reporting

Frequency of Monitoring

Since the emission reduction units from the project activity would be determined by the reduction in electrical energy consumption in the HVAC & Lighting system, it becomes important for the project activity to monitor the reduced electricity consumption on real time basis. An on-line metering system will be in place to monitor and record the net electricity consumption in the HVAC system.

Reliability

As the reliability of the monitoring system is governed by the accuracy of the measurement system and the quality of the equipment to produce the result:

- All measuring instruments will be calibrated by third party/ government agency once in a year for ensuring reliability of the system.
- The Standard Testing Laboratory (under Central/State Government) will verify the reliability of the meter readings; thereby ensuring the monitored results are highly reliable.

Registration and Reporting:

Registration of data would be on-line in the BMS as well as in log-books. Monthly reports would be prepared stating the electricity consumption and the operating hours of the HVAC & Lighting system of "Energy efficient building"

The project proponent will also maintain a GHG performance procedure on a regular basis. All the monitored parameters will be recorded for crediting period plus two years.

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