CDM AS A SOLUTION FOR THE PRESENT WORLD ENERGY PROBLEMS (AN OVERVIEW WITH RESPECT TO THE BUILDING AND CONSTRUCTION SECTOR)

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ABSTRACT

One of the important responses of Kyoto Protocol towards mitigation of global warming is the Clean Development Mechanism (CDM), which has garnered large emphasis amidst the global carbon market in terms of Certified Emission Reductions (CERs). While CDM aims to achieve sustainable development in the energy production and its consumption in developing countries, the results achieved through its implementation are still uncertain. Presently, the domestic and commercial buildings are responsible for more than one third of the total conventional energy use and associated greenhouse gas emissions. The Inter-governmental Panel on Climate Change (IPCC) stated that, the building sector has the largest potential for significantly reducing greenhouse gas emissions. This paper envisages the important aspects such as, the non-inclusion of construction sector projects in CDM and its reasons, the role of energy efficiency buildings in the energy conservation arena and the new challenges being faced, while implementing the CDM portfolio in building energy sector.

1. INTRODUCTION

Greenhouse gas emissions from buildings worldwide are set to increase sharply over the next two decades, mainly due to construction booms all over the world. Estimated at 8.6 billion tonnes in 2004, building related Green House Gas (GHG) emissions could almost double by 2030 to reach 15.6 billion tonnes under the high-growth scenario, according to the IPCC. At the same time, today's commercially available technologies make it possible to halve energy consumption in both new and old buildings without significant investment. Simple measures such as improved ventilation and insulation, increased use of natural lighting, the use of energy efficiency appliances and lighting alongside the use of solar and other natural heat sources, can save energy and costs. Up to 90 percent of the energy a building uses during its entire life cycle is consumed for heating, cooling, lighting and other in house appliances. The remaining 10 percent is consumed during the construction, material manufacturing and demolition phases.

Energy use in buildings accounts for about one-third of greenhouse gas emissions, but the huge potential of the construction sector to combat climate change has not been realized, according to the United Nations Environment Programme (UNEP). The construction sector remains virtually untapped because six years after the start of the CDM, very few building projects have managed to enter its pipeline because nearly half of all proposals were rejected during the registration phase. As a result, the CDM's contribution to reducing GHG emissions in the building sector is almost nonexistent, and the vast energy saving potential of the sector remains virtually untapped (Baker *et al* 2004). Building sector energy efficiency projects currently implemented under the CDM have generated only approximately 2,000 carbon credit units till January 2010, which is the lowest among all project categories (CDM-EB, 2006a). The barriers for successful CDM implementation are high administrative and transaction costs, weak financial incentives, and the bringing small individual savings. A five-star hotel in India (ITC Sonar Hotel, Kolkata), was among the first registered commercial energy efficiency improvement project under CDM. This hotel implemented a wide range of measures targeting water heating, air conditioning and waste disposal. This project obtained carbon credits of 1,886 tonnes after the first year (CDM Executive Board, Annex 15, EB28, 2006c).

2. ENERGY EFFICIENCY IN BUILDINGS

Considerable amount of energy is spent in the manufacturing and transportation of various building materials. Conservation of energy becomes important in the context of limiting of green house gases emission into the atmosphere and reducing costs of building materials. Some issues pertaining to

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embodied energy in buildings particularly in the Indian context have been examined here. A detailed study of energy consumption in the production of basic building materials and different types of materials used for construction along with energy spent in transportation of various building materials has been made. Also, the energy in different types of alternative building construction systems has been studied and compared with the energy of conventional building systems.

2.1 Elements of Energy Efficient Buildings

Designing and constructing an energy-efficient building that conforms to many considerations put forth by the home builder can be a real challenge. However, any house style can be made to require relatively minimal amounts of energy to heat/cool and be comfortable and healthy. Some designs are more expensive to construct than others, but none of them need to be extremely expensive. Recent technological improvements in building elements, construction techniques, heating, ventilation and cooling systems allow most modern energy saving ideas to be seamlessly integrated into any type of building design without sacrificing comfort, health, or aesthetics. A discussion of the major elements of energy-efficient home design and construction systems are given in the following sub headings (CDM Executive Board, Small-scale methodology, AMS-IIE, 2007).

2.1.1 Environment Friendly: Starting from project planning to project designing, an energy efficient building design should comply with the LEED (Leadership in Energy and Environmental Design) green building standards. Mainly it involves the environmental parameters for sustainable site development.

2.1.2 Energy Efficient: In this era of global warming and climate change, where the energy conservation is directly related to low carbon emissions and clean development mechanism, an environmentally responsible corporate growth is highly preferred. The energy frugal designs to improve and elevate environmental value discourage energy abuse and alleviate energy crisis has to be practiced by following the benchmarks of LEED standards (IGBC, 2008).

2.1.3 Water Conservation: With droughts, famines and floods denying human access to safe potable water for dwellings all over the world, water costs are expected to shoot up phenomenally in the coming decade. Water conservation is another dimension to green engineering blue prints. It will not only have a positive effect on the environment but also lead to high returns in the long run. To deal with the severity of this mega crisis, one has to positively practice green engineering expertise to save water in the all the aspects of building engineering like plumbing, HVAC equipment, rain water harvesting, solar water heating and zero discharge from the design premises.

2.1.4 Indoor Air Quality*:* The energy efficient buildings should maintain the purity of indoor environment by suitably proportionating outdoor air intake in dynamic proportion to occupancy and minimizing odour and contaminants in the indoor air. Thus productivity can be boosted in terms of employee attendance and improving their health and well-being.

2.1.5 Fire Safety*:* Energy efficient buildings are to be fully fire-safe from the perspective of the material used and the safety interlocks engineered in the building. It should posses intelligent smoke detection and alarm, water based fire-fighting and gas based fire suppression complying with the highest international fire safety codes and regulations.

2.1.6 Air/Vapour Retardation*:* Air/Vapour retarders are two things that sometimes can do the same job. But the design and installation of these depends a great deal on the climate and the method of construction chosen. Irrespective of the location of building, water vapor condensation is a major threat to the structure of a house. In cold climates, pressure differences can drive warm, moist indoor air into exterior walls and attics. It condenses as it cools. Also, as the humid outdoor air enters the walls to find cooler wall cavities it condenses into liquid water.

2.1.7 Foundations and Slabs*:* Foundation walls and slabs should be well insulated similar to the living space walls. Uninsulated foundations have a negative impact on home energy use and comfort, especially if the people in the building use the lower parts of the house as a living space. Also, appliances that produce heat as a by-product, such as domestic hot water heaters, washers, dryers, and freezers, are often located in basements. By carefully insulating the foundation walls and floor of the basement, these appliances can assist in the heating of the house, if needed.

2.1.8 Windows*:* Generally a typical home loses over 25% of its heat through windows. Since even modern windows insulate less than a wall, in general an energy efficient home in heating dominated climates should have few windows on the north, east, and west exposures. A rule-of-thumb is that window area should not exceed 8-9% of the floor area, unless the designer is well experienced in passive solar techniques. In cooling dominated climates, it is important to select east, west, and south facing windows with low solar heat gain coefficients. Metal window frames should be avoided, especially in cold climates. Always seal the wall air/vapour diffusion retarder tightly around the edges of the window frame to prevent air and water vapour from entering the wall cavities.

2.1.9 Thermal Envelope*:* A "thermal envelope" is everything about the house that serves to shield the living space from the outdoors. It includes the wall and roof assemblies, insulation, windows, doors, finishes, weather-stripping, and air/vapor retarders.

2.1.10 Air-Sealing*:* A well-constructed thermal envelope requires that insulating and sealing be precise and thorough. Sealing air leaks everywhere in the thermal envelope reduces energy loss significantly. Good air-sealing alone may reduce utility costs by as much as 50% when compared to other buildings of the same type and age. Buildings built in this way are so energy-efficient that specifying the correct sizing heating/ cooling system can be tricky. Rules-of-thumb system sizing is often inaccurate, resulting in over sizing and wasteful operation.

2.1.11 Controlled Ventilation*:* Since an energy-efficient building is tightly sealed, it is also important and fairly simple to deliberately ventilate the building in a controlled way. Controlled, mechanical ventilation of the building reduces air moisture infiltration and thus the health risks from indoor air pollutants, promotes a more comfortable atmosphere, and reduces the likelihood of structural damage from excessive moisture accumulation.

2.2 Types of Energy Efficient Buildings:

Different types of energy efficient buildings (EEB) are explained in the following sub sections.

2.2.1 Green building*:* Green Building, also known as green construction or sustainable building, is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle, starting from the preliminary idea to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are to be designed in order to reduce the overall impact of the built environment on human health and the natural environment (Indian Green Building Council, 2008). The following aspect needs essential consideration.

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation.

2.2.1a Environmental Impact: Green building practices aim to reduce the environmental impact of buildings. Buildings account for a large amount of land use, energy and water consumption. Also buildings cause some amount of and air and atmosphere alteration. Considering the statistics of reducing amount of natural resources, buildings consume and the amount of pollution given off is seen as crucial for future sustainability. The environmental impact of buildings is often underestimated, while the perceived costs of green buildings are overestimated. Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It is often emphasized for taking advantage of renewable resources. For example, using sunlight through passive solar, active solar and photovoltaic techniques and using plants/trees through green roofs, rain gardens, and for reduction of rainwater runoff. Many other techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well (Chiang *et al* 2004).

2.2.1b Energy Efficiency: Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope (the barrier between conditioned and unconditioned space), they may use high-efficiency windows and insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows, walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter.

2.2.2 Zero-Energy Building*:* A zero energy building (ZEB) or net zero energy building is a general term applied to a building's use with zero net energy consumption and hence zero carbon emissions annually. Zero energy buildings can be used autonomously from the energy grid supply. The zero fossil energy consumption principle is gaining considerable interest as renewable energy harvesting is an important means to cut greenhouse gas emissions. In poor countries many people are forced to live in zero-energy buildings out of necessity. Many people live in huts, yurts, tents and caves exposed to temperature extremes and without any access to electricity.

2.2.2a Energy Harvest by ZEB: ZEBs harvest available energy to meet their electricity and heating or cooling needs. In the case of individual buildings, various micro generation technologies may be used to provide heat and electricity to the building. Solar cells or wind turbines for electricity generation, and bio fuels or solar collectors linked to seasonal thermal stores for space heating. To cope with fluctuations in demand, zero energy buildings are frequently connected to the electricity grid, export electricity to the grid when there is a surplus and draw electricity when not enough electricity is being produced. Also, ZEB buildings may be fully autonomous as well (WBCSD, 2007).

2.2.2b Zero Energy Building Versus Green Building: The goal of green building and sustainable architecture is to use resources more efficiently and reduce a building's negative impact on the environment. Zero energy buildings achieve one key green-building goal of completely or very significantly, reducing energy use and greenhouse gas emissions for the life of the building. Zero energy buildings may or may not be considered "green" in all areas, such as reducing waste, using recycled building materials, etc. However, zero energy, or net-zero buildings do tend to have a much lower ecological impact over the life of the building compared with other 'green' buildings that require imported energy and/or fossil fuel to be habitable and meet the needs of occupants.

2.2. 3 Low-Carbon Building

Low carbon buildings (LCB) are that designed and constructed to release very little (or no carbon at all) during their lifetime. These are buildings which are specifically engineered with GHG reduction in mind. Hence by definition, a LCB is a building which emits significantly less GHG than regular buildings. GHG emissions associated with buildings operation are mainly coming from the following:

(i) Electricity consumption
(ii) Consumption of fossil fuels on site for the production of electricity, hot water, heat, etc.
(iii) On-site waste water treatment
(iv) On-site solid wastes treatment, and
(v) Industrial processes housed in the buildings.

2.2.4 Natural Building

A natural building involves a range of building systems and materials that place major emphasis on sustainability. Ways of achieving sustainability through natural building focus on durability and the use of minimally processed, plentiful or renewable resources, as well as those which, while recycled or salvaged, produce healthy living environments and maintain indoor air quality. Natural building tends to rely on human labour, more than technology. To increase sustainability, various approaches to lower energy consumption are used in conjunction with natural building which include

- Sun shading or other passive cooling techniques
- Passive solar heating
- Geo exchange heating and cooling
- Short-cycle and annualized passive (and PV-assisted) solar space and water heating
- Hot water heat recycling
- Biologic air purification by indoor plants
- Passive or air-to-air/heat-recovery ventilation
- Solar or annualized cooling
- Insulated glazing and selective glazing films
- Night and cold-weather movable insulation
- On site electric power generation by renewable energy in the form of photovoltaics (PV)
- Wind generators
- Micro-hydro (either with fully-independent systems referred to as "off-grid" or with "grid-tied" systems feeding into the public electric network)
- Low voltage electric and avoidance of electro-magnetic and other possibly harmful forms of
- radiation.

2.2.5 Passive Solar Building Design

Passive solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles whilst reducing the requirement for active heating and cooling systems. Passive solar building design is one part of green building design, and does not include active systems such as mechanical ventilation or photovoltaics. The scientific basis for passive solar building design has been developed from a combination of climatology, thermodynamics and human thermal comfort. Specific attention is directed to the site and location of the dwelling, the prevailing climate, design and construction, solar orientation, placement of glazing and shading elements, and incorporation of thermal mass. While these considerations may be directed to any building, achieving an ideal solution requires careful integration of these principles (Energy Sector Management Assistance Program & UNEP, 2006).

3. CDM AND ENERGY EFFICIENCY IN BUILDINGS

In principle, the CDM's project-based approach and quality assurance features offer a good platform for promoting energy efficiency in the building sector. But, it seems unlikely that the CDM alone will be sufficient to overcome the many challenges to energy efficiency projects in the building sector. The possibility for a large number of interrelated project activities, referred to as CDM Programme Activities (CPAs) in different locations, (even in different countries) to be registered as a single CDM project and implemented in a coordinated fashion. Since the Programs of Activities is essentially a program to coordinate individual CDM activities, it is commonly referred as Programmatic CDM (P-CDM) (Michaelowa *et al* 2007). It can be implemented in a larger scale and enables a bottom up approach. But most of the CDM projects are small scale projects. In order to get worthwhile investment, the energy end use projects which are offering very little emission reductions need to be aggregated. Because of this the total activities can be replicated and per unit transaction cost can be lowered. In making such a coordination of small dispersed projects, the programmatic CDM has given its unlimited scope and support to systematic Energy Efficient Building (EEB) interventions. But effective coordination is essential to the success of P - CDM (Koeppel *et al* 2007).

3. 1 CDM and Quality Assurance in EEB

The CDM's rules and procedures contain quality assurance and quality control measures aimed at ensuring real, measurable and verifiable emission reductions. In the case of EEB projects these rules also contribute to the effective management of energy features in the design, construction, and operational stages of a building (CDM Executive Board, Small-scale methodology, AMS-IIC, 2007f). After eight years of development, the CDM has become better tailored to support different kinds of projects. In the building sector, CDM project management could potentially help to introduce much-needed energy management practices and positively change end-user behavior.

Indeed, an additional benefit of the CDM's strong quality assurance requirements is that it seems to inspire project owners to take on additional quality control measures, such as voluntarily adopting internationally recognized standards and management tools. Apart from end-users, stakeholders in the building and construction business require various levels of training and commitment to implement effective energy-saving features in building construction. Engaging stakeholders in CDM's quality control and project management scheme could provide necessary learning-by-doing and helping building professionals to internalize best practices (Linden *et al* 2007).

3.2 Financial Aspect of CDM in EEB

The three major methods in which the CDM could serve as a good mechanism for financing EEB projects are:

(i) By reducing various financial risks inherent in EEB projects

(ii) By making life cycle-based financing more acceptable to investors and

(iii) By providing complementary financing to offset increased investment and transaction costs.

By encouraging coordination and enabling the bundling of multiple small investment opportunities the CDM, and in particular P-CDM, helps to create economies of scale that lower transaction costs and increase investor interest in project financing. By this way the financial risk associated can be very much reduced. Also, the CDM's strict rules for evaluating a project's emissions reductions could help to define and confirm energy cost savings. In this sense, CDM validated projects offer a degree of certainty that other projects lacking verifiable baselines and energy saving features cannot offer. This is especially important in new buildings where the relative energy savings are difficult to estimate. Along with this, the CDM has the potential to complement and enhance the financial sector's ability to fund energy efficiency projects. The CDM's risk reduction function and quality control mechanism could help projects to achieve healthy financing conditions. In addition, funding from CERs for CDM project management could complement capital available from financial institutions to increase the overall amount of funds available for EEB projects (UNEP, Buildings and Climate Change, 2007).

3. 3 CDM and Green Technology

The "climate friendly" brand identity of CDM projects is useful for verifying a building's energy savings, climate friendly features and, therefore, added value. This aspect of the CDM is especially attractive to business stakeholders, including builders, owners, tenants, and even banks. CDM's green identity is an important motivation for building projects, as it is clear now that the financial incentive is not a sufficient driver for CDM projects in buildings. As of now, all commercial building CDM projects have been motivated to a greater or lesser extent by the added value that CDM's green identity.

3. 4 Barriers to CDM in Building Sector

The challenges for use of CDM in construction sector include the following:

(i) The economic revenue from (EEB) projects is normally not significant and can frequently even offset transaction costs.

(ii) The typical EEB project uses a combination of many measures to reduce energy consumption. In this each measure needs to be validated and verified. Also, some measures are difficult to verify with applicable CDM verify with applicable CDM methodologies.

(iii) Buildings are often unique to their function and location. They have a long life span, and often survive technology development. Identifying comparative buildings for baseline development is therefore often difficult.

(iv) The additionality criteria of CDM, that is- a CDM project should not be the financially most attractive option- are not always valid. EEB projects are the financially most attractive option, if life cycle costs are considered. Yet they are not implemented.

(v) Many building projects in developing countries aim to provide housing for the poor. Their default energy consumption is minimal and need to increase. The level of energy efficiency in such buildings will directly affect the ability of the poor to afford energy, as well as the total CO_2 emissions. However, if the project produces very high emissions (as compared to a highly unsatisfactorily present situation) CDM cannot support the project.

Therefore we can say that the CDM is not properly working for the building sector as of now, because of the existing conditions in the building sector and the flaws in the CDM design (Michaelowa *et al* 2004).

3. 5 How to Make CDM Work

In order to make CDM more effective, the following measures are needed:

(i) Allow CDM EEB projects to use performance based indicators (energy use per area) for validation, monitoring and verification. For this,

- Reduce the transaction costs for EEB projects that are combining several kinds of energy efficiency measures in one project.
- Uncertainties of 'what measures' can be included are removed. Any action leading to reduced emissions is accepted.
- Soft measures are made eligible.
- Encourage continuous pursuit of energy efficiency, as all measures resulting in emission reduction can be credited.

(ii) Develop common performance based baselines for different types of buildings. For this,

- Baselines need to take into account local conditions such as climate, building type, and availability of materials and technologies.

(iii) Give economic credit to sustainability aspects of CDM projects. For this,

- Consider to provide "premium credits" for projects with a "strong sustainability component".
- Recognize the concept of "avoided emissions".

(iv) Allow CDM to support projects aiming at meeting performance based sector standards. For this,

- Encourages countries to establish standards.
- Assists in implementing standards, which in many cases otherwise are ignored.
- Still there is need for defining a minimum crediting baseline (Torcellini *et al.* 2006).

4. CONCLUSIONS

With the present tremendous growth rate all over the world, energy efficiency in buildings assumes paramount importance. The energy saving potential can be as high as 40-50%, if addressed right at the design stage. For sustainable building or for building energy efficiency, national regulations or standards have to be developed. Proper evaluation tools are very essential for the financial analysis of energy efficiency building CDM projects. Also, common baselines and benchmarking is very much needed for the CDM-EEB projects. Along with this, the global building sector offers a huge potential for greenhouse gas reduction, but only a small part can realistically be tapped by the CDM. This is due to the fact that transaction costs may be prohibitive for all but the biggest commercial buildings or large-scale appliance diffusion programs.

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