Let There be Light in the CDM

Christiana Figueres and Martina Bosi

April 2007

This is a summary and update of a paper entitled
"Achieving Greenhouse Gas Emission Reductions In Developing Countries Through Energy Efficient Lighting Projects In The Clean Development Mechanism"
written by the same authors and published by World Bank's Carbon Finance Unit in November, 2006. (www.carbonfinance.org)

DISCLAIMER

This paper was prepared by Ms. Christiana Figueres (independent consultant) and Ms. Martina Bosi (World Bank Carbon Finance Unit). The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the Executive Board of the CDM, the World Bank, or of the Participants in any of the carbon funds managed by the World Bank.

INTRODUCTION

One of today's greatest sustainable development challenges is accelerating access to reliable and affordable modern energy services to the estimated 1.6 billion people in developing countries that are currently lacking it, while addressing the threat posed by climate change (World Bank 2006). There is no silver bullet and a suite of measures and technologies will be necessary. However, improvements in energy efficiency are a fundamental part of the solution.

Energy efficiency can reduce the need for capital-intensive supply investments and is one of the most promising sectors for improving the adequacy and reliability of power systems, increasing energy security and reducing emissions in developing countries. Unfortunately, these energy efficient options are not common practice due to well-documented market failures and policy barriers.

There are several end-use applications around the world where the CDM could help stimulate greater energy efficiency, contribute to sustainable development and reduce GHG emissions. This paper focuses specifically on the efficient lighting sector as a promising sector[1] which has broad applicability throughout the developing world.

In the medium term, what is likely needed is a phasing out of the least energy efficient lighting techniques and systematic dissemination of the most efficient technologies, akin to the process under the Montreal Protocol. In the meantime, the Kyoto Protocol's Clean Development Mechanism (CDM) could channel carbon finance to cover the cost of some of the programs that would eventually bring about the desired market transformation. However, the international emission reduction market has bypassed this opportunity. Out of the 1,783 projects currently in the CDM pipeline, 230 are energy efficiency projects (mostly – 86% - industrial efficiency), representing 7.6% of the expected annual certified emission reductions (CERs) of the market.[2] Among those there are only 4 projects targeting end-use applications. This is possibly due to the fact that they typically involve a large number of users in different sites, compared to the more common discrete single-site CDM project activities that dominate the CDM pipeline. Fortunately, the COP/MOP 1 decision to include "programs of activities" in the CDM has the potential to open the door to the implementation of more end-use energy efficiency (EE) projects in developing countries.

The purpose of the paper is to show the complementarities and synergies between the implementation of energy efficiency measures and the CDM.

1. POTENTIAL and BARRIERS

Although frequently overlooked, the lighting sector is a major source of GHG emissions. World-wide, grid-based lighting is responsible for 19% of total global electricity consumption (IEA 2006a). By 2030 developing countries are expected to account for 60% of global lighting electricity demand due to new construction, ongoing electrification, and rising illumination levels.

[1] According to the IEA (IEA 2006b), lighting accounts for almost 1.9 Gt CO_2 – more than Latin America's total 2004 energy-related CO_2 emissions - and offers considerable potential for electricity savings. There are also other interesting energy efficiency opportunities in other sectors which need to be further examined.
[2] Calculated based on CD4CDM website updated April 1, 2007 (http://www.cd4cdm.org/)

The International Energy Agency (IEA) points out that there is a "very large cost-effective potential to reduce energy demand and GHG emissions through more energy efficient lighting" (IEA 2006a). It estimates that approximately 735 TWh and 456 $MtCO_2$ could be reduced in non-OECD countries by 2020. Lighting energy can be saved in many ways, including improving the efficiency of the light source, of the ballast, of the luminaries, improving the control gear deployed, and making better use of daylight.

Governments and multilateral institutions have been implementing EE lighting programs since the energy crisis of the 1970's. Today all industrialized countries - but only a few developing countries - have various sorts of EE programs for lighting, differing in nature, scope and effectiveness.

The general lack of implementation of energy efficient lighting measures "reflects the fact that although there are already many cost-effective energy efficient lighting technologies available on the market, they are currently underutilized. Despite substantial improvements in average lighting-system efficiency, inefficient systems and practice are still commonplace" (IEA 2006a).

2. INTEGRATING THE CDM INTO EFFICIENT LIGHTING PROGRAMS

There are several well-documented impeding factors and market failures to the use of efficient lighting It is also important to keep in mind that even for seemingly cost-effective projects, these may not be undertaken due to their relatively high opportunity cost, i.e. the possibility to invest in other, more attractive activities/projects. The CDM cannot overcome all the known barriers to EE, but as a financial instrument, the CDM can help meet some of the financial challenges, since it creates a new asset (emission reductions) which has market value that can be converted into an additional income flow.

This second source of income is key to the dissemination of efficient lighting because it can help close the financial gap created by the split incentives, whereby those who invest in the lighting system and who want to keep upfront costs low, are frequently not those who will use the system in the long term and who would benefit from efficient systems that have low life cycle costs. Although CERs are the emission reduction equivalent of the energy savings, the income from the sale of CERs need not flow to those who benefit from the energy savings, but rather can be intentionally directed to the cost centers of the project, thus providing the missing financial link. Several concrete examples can illustrate this: *(A)* Projected income from the CERs could be used by the producers of high efficiency bulbs and lighting systems to lower the net cost of production, thus diminishing the cost to distributors, retailers, and consumers. *(B)* The cost incurred by landlords and developers to improve lighting installations could be offset by CERs. *(C)* The steady income flow from the sale of CERs could help fund the incentive scheme for consumers to purchase and install the more efficient equipment.

The COP/MOP 1 decision to include "programs of activities" opens the door to integrating the CDM into energy efficiency activities. An efficient lighting program can qualify as a CDM program of activities if it applies one approved CDM baseline and monitoring methodology across the entire program. Currently the Executive Board of the CDM has only approved one large scale methodology for efficient lighting[3] (which has not yet been used by a CDM project) but others are in preparation.

At the core of the CDM modalities and procedures is the accurate quantification of emission reductions. CDM Baseline and monitoring methodologies must address the following issues:

(a) Project boundary

[3] Distribution of efficient lightbulbs to households (AM0046).

The boundary of an efficient lighting program is the physical location of the targeted replacement or installation activities plus the grid supplying the electricity saved. The locations of the individual activities can be divided into several CDM program activities (CPAs) whose boundaries (area, city etc.) are clearly established in the baseline methodology. In some programs the exact location of the individual lighting activities is known at the outset (e.g. specific public sector buildings or specific municipal lighting systems). In other programs, the geographic coverage of the program is known at the outset, but not the specific location of the individual GHG reducing actions (e.g. a program of incentives to improve public street lighting). In these cases, the *targeted* geographic coverage of each CPA is made explicit and is considered fixed for the duration of the crediting period. The exact locations where actual emission reductions occur over time (e.g. streets where lumens are increased) can be determined *ex post*.

(b) Baseline

For purposes of the CDM, emission reductions are the difference between a counterfactual baseline emission level and the actual project emissions. The calculation of the respective baseline emissions is based on a baseline 'methodology'[4].

The lighting sector includes different types of energy efficiency programs, but under the CDM each program can have only one baseline. That baseline shall be appropriate to the market in which the program occurs: discretionary retrofit, planned replacement, and new installations (for a full discussion see Arquit Niederberger and Spalding-Fecher, 2006). For discretionary retrofits (premature replacement of existing technology for the primary purpose of improving energy efficiency), the baseline scenario of efficient lighting programs would usually be the existing actual or historical emissions, in the absence of the implementation of the program. The baseline emissions are the emissions associated with the energy use that would have occurred in the absence of the EE project. The baseline energy use can be derived as is typically done for energy efficiency projects through an energy audit of existing conditions or through baseline control groups. It is then multiplied by an emission factor determined with base year electricity use data and characteristics of the power plants supplying the electricity. The baseline of planned replacement projects (spurred by the decision to replace existing technology at the end of its lifetime with high efficiency equipment) and new construction projects (decision to install high-efficiency equipment at the time of construction) must refer to the energy use – and related emissions - that *would* occur without the CDM projects, e.g. referring to cases similar to the CDM project but where the intended EE program has not been performed (i.e. "common practice").

(c) Additionality

"A CDM project 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" (UNFCCC decision 17/CP.7). A CDM program must demonstrate additionality at the level of the program, and also at the level of the CPA. In the case of discretionary retrofits, the sale of the CERs may be the only source of cash income to the project implementer. As a result, additionality of the CPA can be demonstrated by the fact that without the CER revenues the entity implementing the program would lack the resources to disseminate the efficient lighting equipment, or to establish the necessary controls to ensure that manufacturers are complying with the standards and labeling requirements.[5] In the case of planned replacement or new construction, the demonstration of additionality must again be seen from the perspective of those who fund and implement the program. While efficient lghting is the least cost option from the perspective of the eventual energy bill payer, it is clearly not the least

[4] A list and description of all approved CDM methodologies can be found on the UNFCCC website: http://cdm.unfccc.int/methodologies

[5] This reflects the reality of most developing nations that are just introducing EE measures. In countries that are already on the verge of market transformation such as China, the demonstration of additionality may need to take into account expected trends and barriers to further market penetration.

cost option from the perspective of the builders/developers and landlords who take the decision on the investment.

(d) Predictability of emission reductions

An issue that is often raised in the context of most energy efficiency projects is how well *ex-ante* estimates of energy savings compare with the *ex-post* measurement of the achieved savings. In the case of CDM efficient lighting projects, the issue is the required comparison of the expected emission reductions (forecasted prior to the installation of the efficient lighting equipment and typically based on engineering calculations) to the actual achieved reductions (based on post-implementation monitoring and verification). The experience from energy efficiency industry should be useful. It is also important to underscore that CERs are issued only after emission reductions have been actually verified (*ex-post*), and are thus not dependent on projections.

(e) Free riders and positive spill over[6]

For certain CPAs, it is possible that some of the individual actions implemented might not be additional even if the CPA is demonstrated to be additional. These individual actions are considered "free riders". The energy efficiency industry has for a long time evaluated free riders, either explicitly or implicitly (Wiel and McMahon 2005). Explicit evaluations can be made using a control group, econometric methods, participant surveys, review of documents in business decision processes, payback comparisons, and engineering modeling. Implicit evaluations are often made comparing the target users' behavior to that in other regions or in other countries where there are similar baseline conditions and no program in place (Wiel and McMahon 2005). Not all of the approaches are suitable for a given program, and the approaches differ with respect to their cost and the accuracy of their estimates. A CPA needs to specify the proposed approach used to estimate the emission reductions attributed to free riders as part of the proposed baseline and monitoring methodology. All other emission reductions would be deemed additional.

Independently of how free riders are measured, in many cases free riders are more than offset by positive project spillover, i.e. additional energy efficiency impacts that result from the project, but are viewed as indirect rather than direct impacts. In these projects, actual reductions in energy use are greater than those strictly attributed to the project activity (Vine and Sathaye 1999, Quality Tonnes 2005). In efficient lighting programs, positive spillover effects can occur through a variety of channels including: an individual hearing about the benefits of the efficient equipment and deciding to purchase it on his/her own ("free drivers"); or program participants that, based on positive experience with the equipment, exchange additional equipment beyond the maximum allotted per user by the program, or continue to purchase and use equipment with higher efficiency after the program's end. Spillover is an unintended but welcome consequence of energy efficiency programs, and could make free riders a non issue.

(f) Rebound effect and suppressed demand

The rebound effect refers to the increase in the demand for energy services (heating, refrigeration, lighting, etc.) when the cost of the service declines as a result of technical improvements in energy efficiency. The argument is that because of the lower cost, consumers and businesses change their behavior, e.g. raise thermostat levels in the winter; cool their buildings more in the summer; buy more appliances and/or operate them more frequently, thus eroding the savings from energy efficiency. There is a large body of literature suggesting that the rebound effect is indeed real in many situations, but that it does not usually wipe out projected savings. Empirical evidence suggests that the size of the rebound effect is small to moderate, with the exact magnitude dependent on the location, sector of the economy, and end-use. The rebound effect for residential lighting in industrialized countries has been shown to vary between 5-12%, while that for commercial lighting varies between 0-2% (IEA 2005:6). In the CDM, the energy savings of efficient lighting projects could be adjusted for the level of

[6] For a more elaborate definition of these concepts, see, for example IEA 2003 (p. 160).

rebound effect (e.g. through an agreed default discount factor that could be the midpoint of the various estimates), thereby avoiding the cost of measuring the rebound in each individual project.

However, in the case of many developing countries, it is important to recognize that any rebound effect resulting from projects improving energy efficiency is often linked to situations of suppressed demand due to insufficient supply. The CDM modalities and procedures stipulate that "the baseline may include a scenario where future anthropogenic emissions by sources are projected to rise above current levels…" (Para 46)[7]. In this context, it remains to be seen whether meeting suppressed demand through EE will be accepted in the CDM.

(g) Double counting

Under the CDM, double counting of emission reductions must be avoided. Efficient lighting programs involve various stakeholder groups, all of which in theory could claim ownership of the energy savings and the associated CERs: the manufacturers of the technology, the intermediaries (wholesalers, retailers, utilities, etc.) the consumers (who may or may not pay the lighting energy bill), the entity that manages the financing, etc. However, double counting can be avoided by stipulating that the entity running the program is the only one authorized to claim CERs for the program, in order to defray the costs of running the program. The other potential claimants would have to cede their claims to this entity in a separate agreement or in the agreement regarding the distribution of CERs.

(h) Leakage

Leakage is the net change of GHG emissions outside the CDM project boundary that is measurable and attributable to the CDM project activity. A CDM project activity must estimate the associated leakage, and if it occurs, deduct the net leakage from the emission reductions achieved within the project boundary. In efficient lighting programs, any leakage would mostly come from the unauthorized recycling of still functioning lighting equipment that has been displaced by the more efficient equipment. Strictly speaking, in order to minimize leakage, efficient lighting programs that replace equipment would likely need to include a monitored scrapping component that ensures that replaced equipment is not used by others[8]. However, from a scarce resources and development point of view, one might question the advisability of destroying functioning equipment in countries where there is evidence of unmet demand and elastic supply.[9]

(i) Monitoring and verification

Monitoring and verification are key to ensuring that CERs correspond to actual emission reductions. Emission reductions from single-site projects are rather straight-forward to monitor and verify. Efficient lighting programs that typically involve a large number of activities at different sites over a period of time require a feasible - but still rigorous and effective - approach. For such projects, monitoring of each CPA can be done through statistically robust sampling techniques.

The vast experience with EE programs worldwide over the past fifteen years has produced a series of widely accepted monitoring protocols.[10] Since energy savings are easily translated into the equivalent GHG reductions - using CO2 emission factors for the relevant grid or source of power (e.g. see the CDM Approved Consolidated Methodology ACM0002) - these protocols can be effectively incorporated into monitoring methodologies for CDM programs of activities. The International Performance Measurement and Verification Protocol (IPMVP)[11] is perhaps the internationally preferred approach for monitoring

---

[7] Text of the 2001 Marrakech Accords (FCCC/CP/2001/13/Add.1) can be found on the UNFCCC website (www.unfccc.int).

[8] Ensuring safe disposal could address the environmental problem associated with the mercury content of light bulbs and waste material created by the destruction.

[9] On the margin, replaced equipment could replace even less efficient equipment.
[10] See Hirst and Reed, 1991; Vine and Sathaye, 1999; FEMP, 2000; IPMVP, 1996-2004; ASHRAE, 2002; and TecMarket Works Framework Team, 2004.

[11] http://www.ipmvp.org

and evaluating energy efficiency projects. While the IPMVP is not detailed enough to serve as a CDM monitoring methodology, it does provide a common conceptual framework and terminology that can form the basis for specific CDM methodologies.

3. CONCLUSION

Energy efficiency is one of the most promising sectors for making energy more affordable, improving energy security and reducing emissions in developing countries. End-use energy efficiency accounts for about 67% of energy-related abatement potentials identified in International Energy Agency analyses such as the World Energy Outlook (2006) and the Energy Technology Perspectives (2006). It is hoped that the new option of "programs of activities" in the CDM will open the door to the implementation of numerous end-user energy efficiency projects in developing countries, serving as a learning ground for future energy market transformations.

Established efficient lighting practices can be used in new methodologies that comply with CDM requirements. The development of rigorous evaluation practices and protocols, along with years of experience in assessing the impacts and results of energy efficiency programs, has done much to improve the ability to accurately estimate program impacts on energy use. Experience has shown that the only effective way to accelerate the efficient use of energy is to combine the "push" of minimum performance standards with the "pull" from financial mechanisms. By integrating the CDM into energy efficiency programs, the market value of the CERs can facilitate both the push and the pull.

REFERENCES

Arquit Niederberger, A., and R. Spalding Fecher, *Demand -side energy efficiency promotion under the Clean Development Mechanism: Lessons learned and future prospects*. Energy for Sustainable Development,(in press), 2006.

Figueres, C. with Econergy International Corp. and Margaree Consultant Inc., *Programmatic CDM Project Activities: Eligibility, Methodological Requirements and Implementation*, Carbon Finance Unit of the World Bank, November 2005

Heister, J., P. Karani, K. Poore, C. Sinha, R. Selrod: "The World Bank's Experience with the Activities Implemented Jointly Pilot Phase", Chapter 11 in Dixon, Robert editor, The UN Framework Convention on Climate Change Activities Implemented Jointly Pilot: Experiences Learned and Lessons Learned. Kluwer Academic Publishers. 1999

Hirst, E. and J. Reed, Handbook of Evaluation of Utility DSM Programs, Oak Ridge National Laboratory, 1991

International Energy Agency, Cool Appliances: Policy Strategies for Energy-Efficient Homes. Paris, France. 2003

International Energy Agency, Light's Labour's Lost. Paris, France 2006a

International Energy Agency, The Experience with Energy Efficiency Policies and Programmes in IEA Countries: Learning from the Critics. Paris, France 2005

International Energy Agency, World Energy Outlook 2006, Paris, France, 2006b

OECD/IEA, *Energy Efficiency Case Study* in Emission Baselines: Estimating the Unknown. Paris, France. 2000

Vine, E. and J. Sathaye, Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Energy-Efficiency Projects For Climate Change Mitigation, LBNL-41543 Lawrence Berkeley National Laboratory, Berkeley, CA, 1999

Vine, E., M. Kushler and D. York, "Myth #14: Energy Efficiency Measures are Not Reliable, Predictable, or Enforceable," in B. K. Sovacool and M. A. Brown (eds.), Energy and American Society: Fourteen Myths, Springer Press, New York, forthcoming.

World Bank, *Clean Energy and Development: Towards an Investment Framework*. 2006