



The Carbon Finance Unit at the World Bank

ACHIEVING GREENHOUSE GAS EMISSION
REDUCTIONS IN DEVELOPING COUNTRIES
THROUGH ENERGY EFFICIENT LIGHTING
PROJECTS IN THE CLEAN DEVELOPMENT
MECHANISM (CDM)

Christiana Figueres and Martina Bosi

November 2006

CONTENTS

CONTENTS	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iii
INTRODUCTION.....	1
1. POTENTIAL FOR GHG REDUCTION THROUGH EFFICIENT LIGHTING	2
2. PROGRAMS TO PROMOTE EFFICIENT LIGHTING.....	2
3. BARRIERS TO EFFICIENT LIGHTING	3
4. INTEGRATING THE CDM INTO EFFICIENT LIGHTING PROGRAMS	4
5. METHODOLOGICAL ISSUES FOR ASSESSING EFFICIENT LIGHTING PROJECTS UNDER THE CDM.....	5
6. EXAMPLES OF CDM IN EFFICIENT LIGHTING PROGRAMS	9
7. CONCLUSION	10
ANNEX I: OVERVIEW OF RESOURCES FOR THE ASSESSMENT OF EFFICIENT LIGHTING PROJECTS	11
ANNEX II: GLOSSARY OF CDM TERMS USED	12
REFERENCES.....	13

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 World Bank, its Executive Directors, or the countries they represent, or the view of the Carbon Finance Unit (CFU) or of the Participants in any of the carbon funds the CFU manages. They should in no way be taken to represent the official view of any institution with which the authors are associated.

ABSTRACT

Energy efficiency can help address the challenge of increasing access to modern energy services, reduce the need for capital-intensive supply investments as well as mitigating climate change. Efficient lighting is a promising sector for improving the adequacy and reliability of power systems and reducing emissions in developing countries. However, these measures are hardly represented in the CDM portfolio. The COP/MOP decision to include programs of activities in the CDM could open the door to the implementation of a large number of energy efficiency projects in developing countries. Since GHG reductions are essentially the emission equivalent of energy savings, the CDM can benefit from long established energy efficiency methodologies for quantifying energy savings and fulfilling CDM methodological requirements. The integration of the CDM into energy efficiency programs could help spur a necessary transformation in the lighting market.

ACKNOWLEDGEMENTS

The authors would like to thank the following experts and colleagues for their valuable input to this paper: Anne Arquit Niederberger, Brian Dawson, Johannes Heister, Peter Johansen, Benoit Lebot, Luiz Maurer, Michael Philips, Klaus Oppermann, Mahesh Sharma, Russell Sturm, Ed Vine, Paul Waide, and Stephen Wiel.

INTRODUCTION

The World Bank's "*Clean Energy and Development: Towards an Investment Framework*" (2006)¹ notes that 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. There is no silver bullet and a suite of measures and technologies will be necessary. However, improvements in energy efficiency, both at production and end-user level, 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 barriers.

In the medium term, what is likely needed is a planned 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. The CDM could help these projects overcome some of the barriers facing greater energy efficiency. However, the international emission reduction market has bypassed this opportunity to reduce emissions and contribute to sustainable development. Out of the 1,276 projects currently in the CDM pipeline, 174 are energy efficiency projects (mostly industrial efficiency), representing 9.7% 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 greater complexity of implementing and administering end-user energy efficiency projects that typically involve a large number of users in different sites, compared to the more common single-site CDM project activities that dominate the CDM pipeline. It may also be due to the CDM-related transaction costs and uncertainty regarding structuring/designing these activities as an eligible project activity under the CDM. Fortunately, the COP/MOP 1 decision to include "programs of activities" in the CDM, and the ensuing expected guidance from the CDM Executive Board, have the potential to open the door to the implementation of more energy efficiency (EE) projects in developing countries.

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, such as household appliances, air conditioning, heat and water pumps as well as buildings. This paper addresses the opportunity to use the financial leverage of the CDM to facilitate end-user energy efficiency projects. It focuses specifically on the efficient lighting sector as a promising sector³, given (i) the potential of national or regional programs to deliver the volume of GHG reductions necessary for a feasible CDM project; (ii) the possibility to monitor GHG reductions based on metered energy savings; and (iii) the broad applicability of efficient lighting projects throughout the developing world. The paper highlights the potential for GHG reductions from energy efficient lighting and notes how established efficient lighting methodologies and practices can be used to comply with CDM methodological requirements. The purpose of the paper is to show the complementarities and synergies between the implementation of energy efficiency measures and the CDM.

¹ Document produced by the World Bank in response to the Communiqué on Climate Change, Clean Energy and Sustainable Development resulting from the Gleneagles G8 Presidential Summit of 2005.

² Calculated based on CD4CDM website updated October 20, 2006 (<http://www.cd4cdm.org/>)

³ There are also other interesting energy efficiency opportunities in other sectors which need to be further examined.

1. POTENTIAL FOR GHG REDUCTION THROUGH EFFICIENT LIGHTING

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 2006). Annual emissions from the lighting sector currently reach almost 1,900 MtCO₂, equivalent to 70% of the emissions of the world's passenger vehicles and three times more than aviation emissions. Over the past decade, global demand for electric lighting increased at an annual rate of 1.8% in industrialized countries and 3.6% in developing countries. Over the next 25 years, demand will continue to grow. 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.

Hence, the International Energy Agency (IEA) concludes that there is a “very large cost-effective potential to reduce energy demand and GHG emissions through more energy efficient lighting” (IEA 2006). It estimates that approximately 735 TWh and 456 MtCO₂ could be reduced in non-OECD countries (or 385 Mt CO₂ excluding former Soviet Union countries) by 2020⁴, representing one half of the worldwide savings potential. At least part of these savings could be realized under the CDM.

The universe of lighting includes different markets: indoor lighting (domestic and commercial/industrial), outdoor lighting (street, external building, stadiums, etc.) and vehicle lighting (the latter not considered further in this paper). Lighting energy can be saved in many ways, including (i) improving the efficiency of the light source; (ii) improving the efficiency of the specific component of lighting system, typically the ballast; (iii) improving the efficiency of the luminaries; (iv) improving the efficiency of the control gear deployed; and (v) making better use of daylight inside built environment.

⁴ From the IEA World Energy Outlook's Reference Scenario (IEA 2004).

The general lack of implementation of these 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 2006). As further elaborated below, energy efficient lighting faces various barriers, some of which the CDM could help to overcome.

2. PROGRAMS TO PROMOTE EFFICIENT LIGHTING

Governments have been implementing EE lighting programs since the energy crisis of the 1970's. Multilateral institutions such as the World Bank, the International Finance Corporation (IFC), the Global Environment Facility (GEF), and the United Nations Development Program (UNDP) have promoted efficient lighting programs in developing countries. Today all industrialized countries and some developing countries have various sorts of EE programs for lighting, differing in nature, scope and effectiveness. The most common types are:

- Energy labels, ratings and certification schemes used to inform consumers about the energy use, energy costs and environmental consequences of their intended lighting purchase – by far the most widely spread type of EE program.
- Minimum energy performance standards (MEPS) that determine (voluntary or mandatory) minimum efficiency levels for lighting products sold in a particular country or region.
- Building codes that either set explicit lighting installation specifications, or indirectly include lighting in the general building energy performance specifications.
- Bulk procurement programs that seek to lower the information gathering and purchasing costs of large quantities of equipment and lighting systems.
- Financial and fiscal incentives in the form of either a rebate or a tax deduction, to motivate consumers to purchase energy-efficient lighting equipment.
- Performance contracts executed by energy service companies (ESCOs) that on the basis

of a mutually agreed energy baseline, assist their customers to reduce energy costs and share the savings.

- Market transformation programs that seek to positively influence consumer behavior and market trends on a voluntary basis through a combination of labeling, building certification, technical support, and incentive schemes.
- Utility driven EE programs.

3. BARRIERS TO EFFICIENT LIGHTING

The slow uptake of efficient lighting (and energy efficiency in general) is one of the most discussed ironies in the electricity industry. Technological developments over the past 30 years enable today's investments in efficient lighting retrofits to enjoy short payback periods and high internal rates of return. Compact fluorescent lamps (CFLs), for example, are now often sold in bulk for little more than one dollar apiece. In the face of rising oil prices and increasing power shortages in developing countries, EE in general, and efficient lighting in particular, are clearly cost-effective strategies. And yet, this economic rationale has not led to a mainstreaming of efficient lighting systems in practice.⁵ Traditional cost-benefit analyses are typically not applied to individual lighting decisions. Indeed, while rational economic behavior suggests that users would be better served by efficient lighting with lower life cycle costs, there are many reasons why this does not actually occur. Impeding factors and market failures differ by end-use sector, but they tend to fall into six broad areas that are well documented, and thus here only listed in Box 1. Moreover, it is 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, especially in cases.

⁵ This is also true in the case of industrialized countries, where there is still significant potential for energy efficient improvements.

BOX 1. MAIN BARRIERS TO ENERGY EFFICIENT LIGHTING IN DEVELOPING COUNTRIES

1. Policy Barriers

- a Lack of institutional capacity, particularly at national level, to implement EE programs in the end-use sector
- b Energy efficient technologies, including lighting, is not given due consideration at the fiscal policy level
- c Lax, if any, Minimum Energy Performance for most end-use equipment.
- d Pricing of electricity below costs and poor recovery of electricity bills.

2. Finance Barriers

- a Price sensitivity of the lighting market
- b No financial incentive for manufacturers to invest in energy efficiency
- c Lack of financial incentives and mechanisms to promote EE products in the market
- d Financial misalignment or split incentives: those who make the decision on EE investments are often not the final users who pay the energy bill

3. Business and Management Barriers

- a Manufacturers uncertainty about market demand of high efficiency models
- b Lack of resources amongst small-scale manufacturers for developing and marketing energy efficient products

4. Information Barriers

- a Lack of awareness about residential sector energy end-use, and therefore the energy efficiency potential, amongst consumers as well as the policy makers
- b Lack of information about the precise energy saving potential from energy efficient lighting
- c Lack of information about state-of-the-art energy efficient design and manufacturing of energy efficient lighting system.

5. Technology Barriers

- a Limited access to the state of the art energy efficiency technology among manufacturers
- b Lack of EE driven applied R&D by the manufacturers as well as the government labs and research institutes
- c Lack of adequately equipped and staffed independent test labs for energy efficiency testing of lighting system
- d Limited experience of energy efficiency testing amongst engineers

6. Common Practice Barrier

- a Lack of trust of new equipment
- b Local customs and inertial behavior working to maintain the status quo in the design, selection and operation of energy-using equipment.

4. INTEGRATING THE CDM INTO EFFICIENT LIGHTING PROGRAMS

The CDM cannot overcome all these barriers, but as a financial instrument, the CDM can help meet some of the above financial and other challenges. In addition to the usual energy savings, the CDM provides energy efficiency projects with 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 would be benefited by 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. Under the CDM, projects consisting of programs of activities could enable the revenue flows of the CERs to go to the entity which implements the efficiency program in order to defray the costs of the program, while the consumer/end-user is, as usual, benefited by the energy savings. 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. Finally, (D) the up-front cost of setting up and running a labeling and testing program or implementing minimum energy performance standards would be covered by front-loading the payment of future CER flows. It is also important to recognize the contribution that CDM can make to a project in terms of hard currency. Experience thus far in

carbon finance highlights the fact that financial institutions may be more open to financing CDM operations if at least one income stream is in hard currency, as CERs are paid in US dollars or Euros (CDCF 2004). Thus by bridging the financial disconnect in a few ways, the CDM can help accelerate the implementation of efficient lighting programs in developing countries.

The COP/MOP 1 decision to include “programs of activities” (See Box 2) opens the door to integrating the CDM into energy efficiency activities.

BOX 2. PROGRAMS OF ACTIVITIES UNDER THE CDM

The inclusion of “programs of activities” under the CDM was decided at COP/MOP 1 in November, 2005. At its 27th meeting in November, 2006, the Executive Board of the CDM considered the following components for the definition of a program, with a final decision expected at its next meeting on 12-15 December 2006:

- *Multiple sites*: The program involves several project activities within a country or several countries.
- *Legal nature*: each individual project activity is voluntary. Mandatory GHG-mitigation options implemented by each project activity may be allowed if the policy or standard is not otherwise enforced.
- *Additionality*: each project activity has a direct, real and measurable impact on emission reductions.
- *Traceability*: each project activity must be identifiable at either the validation or verification stage, including by sound sampling techniques.
- *Coordinating entity*: the entity providing the technical or financial assistance can be private or public.
- *Actors implementing the GHG-reducing activities*: they are not necessarily the same as the coordinating entity, and they enter into agreements with the coordinating entity in order to prevent double counting.
- *Project types*: a program can involve various project types, as long as each project type applies an approved CDM baseline and monitoring methodology.

The following section highlights some of the key methodological issues that need to be

addressed by efficient lighting projects from the perspective of the CDM modalities and procedures, and suggests how current EE lighting practices can be used to comply with the CDM methodological requirements.

5. METHODOLOGICAL ISSUES FOR ASSESSING EFFICIENT LIGHTING PROJECTS UNDER THE CDM

At the core of the CDM modalities and procedures is the accurate quantification of emission reductions. Since in energy efficiency projects emission reductions are essentially the emission equivalent of energy savings, the CDM can benefit from long established energy efficiency methodologies for quantifying energy savings. Fortunately, “a wide range of evaluation methodologies has been developed and refined over the past 30 years to estimate energy savings with acceptable levels of precision. These evaluation techniques have featured many sophisticated methods to rigorously assess energy efficiency impacts, including quasi-experimental methods where program participants are compared to a comparison group of non-participants, direct measurements of ‘before and after’ energy use, estimation of ‘free riders’, utility bill analysis with adjustments for variations in weather and other factors where appropriate, accounting for the persistence of energy savings through measure retention studies and analyses of energy usage over time, and the analysis of program spillover and market transformation. All of these concepts are well established and widely used to estimate the energy savings of energy efficiency programs” (Vine et al. forthcoming).

Under the CDM, a number of project design and eligibility issues need to be addressed/reflected by projects seeking to be registered as programs of activities, as outlined in Box 2. The key methodological issues that need to be addressed by project activities seeking to reduce GHG emissions through improvements in lighting efficiency include (a) project boundary, (b) baseline, (c) additionality, (d) predictability, (e) free riders and positive spillover, (f) rebound effects and

suppressed demand, (g) double counting, (h) leakage, and (i) monitoring.

(a) Project boundary

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 spread over an area, a city, a region or the whole country, depending on the design of the program. 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 a region or country). In these cases, the targeted geographic coverage of the program (city, province or country) 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. cities where outdoor lighting is actually increased from 10 lumens per watt to 20, 50 or 100 lumens per watt) are 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 counterfactual baseline scenario is defined at the time of project validation. The calculation of the respective baseline emissions is based on a baseline ‘methodology’ - either an existing (already approved methodology by the CDM Executive Board⁶), or a new methodology developed specifically for the project (also requiring the approval of the CDM EB).

The lighting sector could include different types of energy efficiency project activities under the CDM; as a result, a single baseline methodology may not cover *all* types of lighting projects. Baseline methodologies for efficient lighting projects could reflect three different

⁶ A list and description of all approved CDM methodologies can be found on the UNFCCC website: <http://cdm.unfccc.int/methodologies>

markets: 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 is derived as is typically done for energy efficiency projects through an energy audit of existing conditions; 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). The additionality of a CDM project can be demonstrated in any of three ways: (i) economic/financial analysis (the project is not the least cost option/most attractive option); (ii) barrier analysis (without the CDM the project could not be realized due to lack of finance or non availability of technologies or other resources or due to lack of appropriate incentives or information), or (iii) an indication that the project is not common practice in the host country. 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 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.⁷ 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 lighting is the least cost option from the perspective of the eventual energy bill payer, it is clearly not the least 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). Once again, the efficiency industry has addressed this. “Energy savings projections now are much more accurate than they used to be, because we have decades of data from experience in the field. Also, with improvements in program design over the years, especially toward increasing market transformation and “spillover” effects, it is not at all uncommon for programs now to have realization rates⁸ in excess of 100%” (Vine et al, forthcoming). It remains to be seen how dependable energy saving projections turn out to be in the context of the CDM, but in any event, it is important to underscore that CERs are issued only after emission reductions have been actually verified (*ex-post*), and are thus independent of projections.

⁷ 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.

⁸ The realization rate is calculated as the *ex-post* estimate of net savings divided by the *ex-ante* estimate of net savings. Net savings refer to the program impacts over-and-above naturally occurring energy efficiency.

(e) Free riders and positive spill over⁹

For certain programs, it is possible that some of the individual actions implemented might not be additional even if the program 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 program of activities 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 efficiency projects 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 and that it varies among countries and socioeconomic income levels, 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 efficient lighting CDM projects the energy savings of lighting projects could be adjusted for the level of 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. At a December 2005 World Bank-organized expert workshop discussing CDM methodologies and issues associated with energy efficiency, it was largely felt that “since CDM is promoting sustainable development, meeting suppressed demand through an energy efficiency project activity should not be penalized.” (Quality Tonnes 2005). This would be consistent with the CDM modalities and procedures which stipulate that “the baseline may include a scenario where future anthropogenic emissions by sources are projected to rise above current levels...” (Para

⁹ For a more elaborate definition of these concepts, see, for example IEA 2003 (p. 160).

46 of the CDM modalities and procedures¹⁰), as well as the treatment of suppressed demand in the context of CDM methodologies for power generation projects using renewable energy (see Approved Consolidated Methodology ACM002¹¹ and Report of the 22nd meeting of the CDM Executive Board, Annex 2) where the activity level in the project scenario is used to determine the activity level in the baseline scenario.

(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. The avoidance of double counting must be checked by a Designated Operational Entity (i.e. the entity designated to validate proposed CDM project activities as well as to verify and certify emission reductions). In the case of two programs that overlap geographically, the first program to be registered must delineate its boundary. Any subsequent program wanting to claim credit for its actions within that boundary, must prove that it is additional and different to the first project, and does not claim ERs that occur due to the first program.

(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 others¹². 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.¹³ From this perspective the methodological challenge would be to structure the project such that leakage is minimized to ensure GHG reductions as a result of the CDM project activity but lamps are not destroyed. More research might be warranted to better understand substitution effects in a developing country context.

(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 can be done through statistically robust sampling techniques. A sampling plan can be used to select the sites to be monitored and to extrapolate the monitored results to the full program with an acceptable level of statistical precision. Sampling is already part of the approved CDM methodologies for some small and large-scale CDM project activities. Depending upon the measures implemented, the energy savings, and hence emission reductions, may be monitored by combinations

¹⁰ Text of the 2001 Marrakech Accords (FCCC/CP/2001/13/Add.1) can be found on the UNFCCC website (www.unfccc.int).

¹¹ ACM002 is the "consolidated baseline methodology for grid-connected electricity generation from renewable sources", which can be found on the UNFCCC website (<http://cdm.unfccc.int/methodologies/PAMethodologies/Approved.html>)

¹² Ensuring safe disposal could address the environmental problem associated with the mercury content of light bulbs and waste material created by the destruction.

¹³ On the margin, replaced equipment could replace even less efficient equipment.

of metering and calculations, billing analysis, and/or use of models, as has been credibly done by the ESCO community for years (Vine et al, forthcoming).

The vast experience with EE programs worldwide over the past fifteen years has produced a series of widely accepted monitoring protocols.¹⁴ 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)¹⁵ is perhaps the internationally preferred approach for monitoring and evaluating energy efficiency projects. The Protocol offers four options for calculating energy savings depending on the type of energy conservation measure. While the IPMVP is not detailed enough to serve as a CDM monitoring methodology, it does provide a common conceptual framework and terminology as a basis for the specific CDM methodology that must be developed for each type of EE measure.

6. EXAMPLES OF CDM IN EFFICIENT LIGHTING PROGRAMS

There is currently only one registered CDM project where efficient lighting is being used as a source of CERs. The Kuyasa energy upgrade project¹⁶ focuses on retrofitting existing low-cost urban housing in Cape Town, South Africa with energy efficient installations. The small-scale project has three components: insulated ceilings, solar water heater installation, and energy efficient lighting. In the lighting component, two incandescent lamps are replaced with two CFLs in each participating

¹⁴ See Hirst and Reed, 1991; Vine and Sathaye, 1999; FEMP, 2000; IPMVP, 1996-2004; ASHRAE, 2002; and TecMarket Works Framework Team, 2004.

¹⁵ <http://www.ipmvp.org>

¹⁶ See the UNFCCC CDM website: <http://cdm.unfccc.int/Projects/DB/DNV-CUK1121165382.34/view.html>

household, and income from the CERs is used to cover the cost of the replacement. The project uses an approved small scale CDM methodology (i.e. Demand-side energy efficiency programmes for specific technologies AMS-II-C) for the lighting component. The proponents are now considering upscaling this project to include 2 million homes.

At the time of writing, two other efficient lighting projects had been submitted for review: (i) an Efficiency Lighting Retrofit project in Ghana, that intends to replace incandescent lamps with labeled CFLs in 20,000 households, and (ii) the Green Lighting project in Shijiazhuang City, China, that intends to increase the penetration of CFLs by using the CER revenues to lower the purchase price of CFLs. Both of these projects are large-scale, and there is no approved large-scale CDM methodology for efficient lighting. Hence, each of the projects has submitted a proposed new methodology, currently under consideration on the part of the Methodology Panel and the Executive Board of the CDM. If they are approved they will provide helpful guidance on the methodological issues discussed above.

The upcoming guidance will affect the CDM's potential to stimulate GHG reductions through higher energy efficiency in lighting. Given the barriers facing EE lighting and the dispersed nature and often small individual size of the activities to be covered by lighting programs, guidance covering the following elements would likely be most helpful in paving the way for a potential take-off of EE lighting activities in developing countries under the CDM:

- Clear and practical implementation of the COP/MOP1 decision on Programs of Activities;
- Simple (without compromising environmental integrity) and broadly applicable (consolidated or standardized) baseline and monitoring methodologies, which can build on established efficient lighting methodologies and practices.
- Provisions to take into account - and not penalize - situations of suppressed demand for energy services.
- A practical means of addressing potential free-ridership, taking into account the often greater spill-over effect.
- Additionality assessment which takes into account the barriers and market failures

facing EE projects and the fact that traditional financial analysis of EE activities may not appropriately address the costs of these barriers and market failures.

7. 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 50% of energy-related abatement potentials identified in International Energy Agency analyses such as the World Energy Outlook (2004) and the Energy Technology Perspectives (2006). As discussed, the adoption of energy efficient options is not common practice because of well-documented market failures, and largely because they have thus far not received the same attention as renewable energy in government energy policies and in the lending portfolio of the multilateral banking system.

Energy efficient lighting could contribute to the long term objective of stabilizing greenhouse gas concentrations in the atmosphere, particularly if the global lighting market is transformed to high efficiency. The CDM cannot achieve this on its own, but it could jump start some of the programs that lead to the desired market transformation.

In the meantime, the greater complexity of implementing end-user energy efficiency projects, and the uncertainty as to their “fit” under the CDM prior to the inclusion of programs has kept the proportion of energy efficiency projects in the CDM pipeline very low. It is hoped that the new option of “programs of activities” in the CDM will open the door to the implementation of a larger number of 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.

ANNEX I

OVERVIEW OF RESOURCES FOR THE ASSESSMENT OF EFFICIENT LIGHTING PROJECTS

1- Standards and labeling programs:

Collaborative Labeling and Appliance Standards Program (CLASP) – An outgrowth of Lawrence Berkeley National Laboratory and supported by UNDP/GEF, CLASP is an independent global technical non profit institution that promotes efficiency standards and labels worldwide. The CLASP Handbook for Energy Efficient Labels and Standards is the leading guidebook on how to establish labeling and/or standard setting programs. Authored by Stephen Wiel, and James McMahon, *Energy Efficient Labels and Standards: A Guidebook for Appliances, Equipment and Lighting* is published by Collaborative Labeling and Appliance Standards Program, Washington DC, February 2005 and available for download at no cost. It is available in English, Chinese, Korean and Spanish.

Further information: www.clasponline.org

2- Certification of equipment:

Efficient Lighting Initiative (ELI) – Facilitated by the International Finance Corporation (IFC) with funding from the GEF, ELI is a voluntary international program that certifies the quality and efficiency of lighting products. It is operated by a non-profit organization, the ELI Quality Certification Institute, whose mission is to provide a transparent mechanism for certifying the quality and efficiency of lighting products sold worldwide. Lighting manufacturers can submit their products to the ELI Quality Certification Institute, and if the products comply with the ELI specifications, they may bear the ELI “Green Leaf” logo. So far the ELI Quality Certification Institute has developed technical specifications for self-ballasted compact fluorescent lamps, double-capped fluorescent lamps, and fluorescent lamp ballasts.

Further information: www.efficientlighting.net

3- Monitoring and verification:

International Performance Measurement and Verification Protocol (IPMVP) – The most preferred approach for monitoring and evaluating energy efficiency projects. It is the result of approximately 20,000 hours contributed by over 300 experts worldwide over an eight-year period. North America’s energy service companies have adopted the IPMVP as the industry standard approach to measurement and verification. Translated into 10 languages, it is used in over 30 countries as the basis for quantifying, monitoring and verifying energy savings, the ultimate purpose of energy efficiency programs. The IPMVP centers around two components: (1) verifying proper installation and the measure’s potential to generate savings; and (2) measuring actual savings. The protocol offers four options for calculating energy savings depending on the type of energy conservation measure.

Further information: www.ipmvp.org

ANNEX II

GLOSSARY OF CDM TERMS USED

(as defined by Methodology Panel and approved by the Executive Board of the CDM)

Baseline: The scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity.

Baseline Methodology: A methodology is an application of a baseline approach, defined in paragraph 48 of the CDM modalities and procedures, to an individual project activity (reflecting aspects such as sector and region).

Certified Emission Reductions (CER): A "certified emission reduction" or "CER" is a unit issued pursuant to Article 12 and requirements there under, as well as the relevant provisions in these modalities and procedures, and is equal to one metric tonne of carbon dioxide equivalent, calculated using global warming potentials defined by decision 2/CP.3 or as subsequently revised in accordance with Article 5 of the Kyoto Protocol.

Designated Operational Entity (DOE): An entity designated by the COP/MOP based on the recommendation by the CDM executive board as qualified to validate proposed CDM project activities as well as verify and certify reductions in anthropogenic emissions by sources of greenhouse gases. A designated operational entity shall perform validation or verification and certification.

Issuance of Certified Emissions Reductions: Issuance refers to forwarding the CERs to the registry accounts of project participants involved in a project activity.

Leakage: The net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.

Monitoring methodology: A monitoring methodology refers to the method used by project participants for collection and archiving

of all relevant data necessary for the implementation of monitoring plan.

Small scale project activities: There are three types of small scale project activities:

- *Type I:* Renewable energy project activities with a maximum output capacity of 15 MW (or an appropriate equivalent);
- *Type II:* Energy efficiency improvement project activities, which reduce energy consumption, on the supply and/or demand side, by up to a maximum of 60 GWh per year (or an appropriate equivalent);
- *Type III:* Other project activities that result in emission reduction of less than or equal to 60 ktCO₂e annually.

Small scale project activities follow simplified modalities and procedures as defined by Decision 21/CP.8.

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.
- California Public Utilities Commission (CPUC). California Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals, San Francisco, CA, 2006.
- Community Development Carbon Fund (CDCF), *Annual Report 2004*, 2004 (www.carbonfinance.org)
- 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 2006
- 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 2004*, Paris, France. 2004
- OECD/IEA, *Energy Efficiency Case Study in Emission Baselines: Estimating the Unknown*. Paris, France. 2000
- Quality Tonnes, *Expert Workshop on CDM Methodologies and technical Issues Associated with Power generation and Power Saving Project Activities*, prepared for the World Bank Carbon Finance Unit, December 2005.
- 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.
- Wiel, S. and J. McMahon, *Energy Efficient Labels and Standards: A Guidebook for Appliances, Equipment and Lighting*, Collaborative Labeling and Appliance Standards Program, Washington DC, February 2005.
- World Bank, *Clean Energy and Development: Towards an Investment Framework*. 2006
- www.apec-esis.org International CFL Harmonization Initiative
- www.ashrae.org American Society of Heating, Refrigerating and Air-Conditioning Engineers
- www.carbonfinance.org Carbon Finance Unit of the World Bank
- www.cd4cdm.org Capacity Building for the Clean Development Mechanism
- www.clasponline.org Collaborative Labeling and Appliance Standards Program
- www1.eere.energy.gov/femp Federal Energy Management Program
- www.efficientlighting.net The Efficient Lighting Initiative

www.eu-greenlight.org European Union Green
Light

www.gefweb.org Global Environment Facility

www.ipmvp.org International Performance
Measurement and Verification Protocol

www.undp.org United Nations Development
Programme