Preface

For the past two decades, the World Bank Group (WBG) has been engaged in promoting energy efficiency. At the 2004 Bonn International Conference for Renewable Energies, the WBG committed itself to increasing financing for renewable energy and energy efficiency operations by 20 percent per year over the next five years. Since then, investment operations for energy efficiency have grown steadily, from US$177 million in fiscal 2003 to nearly US$1.7 billion in fiscal 2009. These projects have addressed the full range of end use and supply-side opportunities and have focused on removing institutional, regulatory, financial, and technical barriers. The WBG's commitment to energy efficiency is further reinforced through its key role in leading the global cooperative effort to reduce greenhouse gas (GHG) emissions through the Clean Energy Investment Framework and subsequent Strategic Framework on Climate Change and Development.

Energy efficiency remains as important as ever to the WBG and its client countries, in view of universal concerns over global energy security, competitiveness, and environmental protection. Although energy efficiency can alleviate pressures in all three areas, realizing large-scale energy savings is a significant challenge for the WBG's client countries. Questions persist on how best to identify, package, and finance many small, dispersed projects in a given market. Other informational, technical, financial, and behavioral barriers remain, thwarting efforts to convince end users to reduce their energy waste. Whereas some promising models from the developed world exist, difficulties lie in adapting them to fit the conditions and markets in the developing world.

In recent years, the WBG has been particularly active in responding to the growing demand for residential lighting programs as a means of reducing energy use, easing peak demands, mitigating environmental impacts, and easing the energy cost burdens to consumers. Since 1994, WBG-supported residential compact fluorescent lamp (CFL) programs have been completed or are ongoing in more than 20 countries, including the Arab Republic of Egypt, Bangladesh, Burundi, Ethiopia, Mali, Mauritania, Mexico, Morocco, Nigeria, Pakistan, the Philippines, Sri Lanka, Tanzania, Thailand, and Uruguay. These projects are expected to finance and install some 50 million CFLs globally.

With this experience, the WBG and its Energy Sector Management Assistance Program (ESMAP) concluded there was a critical mass of operational documents and experience that would aid the design of new CFL-based residential energy efficiency programs in additional WBG member countries. Thus, ESMAP developed this "CFL Toolkit" to compile and share important operational (design, financing and implementation) elements, documents, lessons learned, results, and other relevant data into a user-friendly format. The Toolkit does not seek to prescribe certain models or methods, but rather to share operational documents from past projects to help inform new ones. As such, the Toolkit includes key implementation/operational aspects, such as economic analysis and financial analysis (including carbon financing), elements of program design, methodologies and survey instruments for market assessment and potential, procurement guidelines, technical specifications, bidding documents, consumer surveys, awareness campaign information, environmental and safety issues related to CFLs, program evaluations, and associated Terms of Reference (TORs) for various project activities.

Acknowledgments

This report presents one of the major results of the project, Development of an Operational Toolkit for Energy-Efficient Lighting Program Design and Implementation (P114361), which was undertaken and funded by the Energy Sector Management Assistance Program (ESMAP) in the Energy, Transport and Water Department of the World Bank during 2008 and 2009. The other key product of this project is a Web-based Toolkit that is available on the ESMAP Website (http://www.esmap.org). The report was produced by Ashok Sarkar (ESMAP task team leader, now senior energy specialist in the World Bank's Energy Anchor Unit), Jas Singh (senior energy specialist within ESMAP), and Dilip R. Limaye (lead consultant and author), with support from the task team and other consultants, and with guidance and inputs provided by many others, inside and outside the World Bank.

The World Bank task team comprised of Bipulendu Narayan Singh, Samira Elkhamlichi, Abhishek Bhaskar, Xiaoyu Shi, and Isabel Lavadenz Paccieri. Major contributions to this report were made by Michael Philips, consultant (who drafted the CFL Program Matrix in the annex), Gerald Strickland, consultant (who drafted Chapter 5, Key Issues with CFLs), and Anne Arquit Niederberger, consultant (who prepared the initial drafts of the section on Carbon Finance Using CDM).

A number of WBG colleagues provided valuable guidance and important inputs at various stages, including peer reviewers Roberto Gabriel Aiello, Arun Banerjee, Anil Cabraal, and Christopher James Warner, and other specialists from across various regions and practices of the WBG, including Alexandra Le Courtois, Erik Magnus Fernstrom, Sunil Kumar Khosla, Luiz Maurer, Monali Ranade, Russell Sturm, Konrad von Ritter, Xiaoping Wang, and Saurabh Yadav.

The development of this work also benefited from advice and feedback provided by many experts from outside the World Bank. The task team remains indebted to Alexander Ablaza, Sabrina Birner, David Boughey, Peter du Pont, Felix Gooneratne, Wolfgang Gregor, Sohail Hasnie, Bernard Jamet, Stuart Jeffcott, Saurabh Kumar, Benoit Lebot, Dougal McInnes, Ramani Nissanka, Srinivasan Padmanaban, Nitin Pandit, Brian Parry, Mahesh Patankar, Shahab Qureshi, Melanie Slade, My Ton, Catherine Vallee, Harry Verhaar, Peter Watt, Uwe Weber, Zhihong Zhang, and George Zissis, for their comments, advice and inputs at various stages.

Special thanks to Rebecca Kary for editing the report, Nyra Wallace and Vonica Burroughs for providing administrative and contractual support, and Andres Londono and Agnes Biribonwa for developing the Toolkit website. Finally, the team would like to express their gratitude to Amarquaye Armar (ESMAP program manager) and Lucio Monari (Energy Sector Manager) for their strategic guidance and support throughout the study.

Any errors and omissions are solely the responsibility of the authors. Please address questions or comments to Ashok Sarkar (asarkar@worldbank.org).

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Jas Singh has worked on energy efficiency and sustainable energy issues for more than 15 years in more than 25 countries and currently serves as a Senior Energy Specialist within the World Bank's Energy Sector Management Assistance Program (ESMAP). Prior to 2008, he was a Senior Energy Advisor at USAID for four years. Before joining USAID, Mr. Singh worked in the World Bank's East Asia and Pacific Region for nine years on energy efficiency and other sustainable energy programs in China, the Philippines, Thailand, and Vietnam. Mr. Singh holds an M.Sc. in International Development from the University of Pennsylvania and a B.Sc. in Mechanical Engineering from UCLA.

1. Introduction

The power sector in many World Bank client countries is under severe stress because of generation supply deficits and high fuel costs. The electricity supply–demand gap in most developing countries is increasing rapidly as a result of the fast growing demand for electricity to meet economic growth, increasing urbanization, generation capacity deficits, high costs of new generation capacity, and fuel supply issues. At the same time, the electric power sector in most countries contributes substantially to both global level and local emissions. Therefore, the World Bank has increased its efforts to implement cost-effective supply and demand-side energy efficiency options that will reduce the need for electricity generation and peak capacities. From a menu of demand-side energy-efficiency measures, energy-efficient lighting technologies offer one of the most promising solutions to help bridge the supply-demand gap in many developing countries.

According to the International Energy Agency (IEA), lighting end uses consume 19 percent of global electricity consumption. In most developing countries, lighting is the most important use of electricity in the domestic sector, and the evening lighting loads contribute significantly to the local electric utility's peak load. Although the use of modern, energy-efficient lighting technologies has been increasing over the last several years, particularly in the commercial sector, most of the lighting in the domestic sector in developing countries continues to come in the form of ILs, which are very energy inefficient when compared to linear fluorescent tube lights (FTLs) and newer lighting technologies such as compact fluorescent lamps (CFL) and light-emitting-diode (LED)-based systems.[1]

During the last decade, many programs have been sponsored by such MDBs as the World Bank, the International Finance Corporation (IFC), Asian Development Bank (ADB), as well as such organizations as the United Nations Development Programme (UNDP) and United Nations Environment Programme (UNEP,) with support from the Global Environment Facility GEF,[2] to implement efficient lighting technologies and services in developing countries. Many of the programs are driven by the broader movement of the energy sector development toward climate change mitigation by reducing the energy usage, and therefore GHG emissions, associated with lighting. However, the primary objective in most cases has been to address the peak power shortages and improve reliability of supply. Most of these programs involve the replacement of conventional, energy-intensive incandescent lamps (ILs) with more efficient, high-quality CFLs (also referred to as "Energy Saver Lamps") that provide savings of more than 80 percent compared to ILs for the equivalent lighting output (measured in lumens); the CFLs last 5-10 times longer than ILs.[3] These energy-efficient lighting initiatives, based on large-scale deployment of CFLs, have provided substantial operational experience, demonstrated peak load and energy reduction impacts on the grids, and have been able to showcase how demand-side, energy-efficiency measures can be implemented at a much lower cost and in a shorter time frame compared to the requirements for adding new generation capacities. Developing countries can benefit from the lessons learned by improving how they plan for and structure their large-scale, energy-efficient lighting programs. This report summarizes the approaches, design issues, and lessons learned from World Bank-sponsored, as well as non-World Bank, programs.

Objectives of This Toolkit

As operational experience in designing and implementing large-scale, energy-efficient lighting programs using CFLs is being gained through projects sponsored by the World Bank and others in various countries, the Energy Sector Management Assistance Program (ESMAP) of the World Bank initiated an activity in 2008 to help practitioners benefit from these experiences. The objective is to develop good-practice operational models and templates or toolkits to help scale up the replication of large-scale, energy-efficient lighting programs. The overall goal of this toolkit is to review and synthesize the critical operational (design, financing and implementation) elements, including those related to carbon finance and GEF synergies from the experience of the Bank and other organizations, together in a user-friendly web-based format. The project is addressing CFL based programs primarily for the residential or small commercial markets.

Need for Energy-Efficient Lighting Programs

Lighting contributes significantly to energy as well as peak demand and is, therefore a good target for demand-side energy efficiency initiatives because of the prevalent use of inefficient lighting technologies especially in the residential sector. Energy efficiency initiatives targeting large-scale implementation of efficient lighting technologies can offer win-win solutions. From a national perspective, these programs enhance energy security by freeing up extra generation capacity and reducing the need for fuels, which itself is vulnerable to price variations and availability constraints. At the same time, they help offset the impact of higher tariffs. There are substantial benefits to consumers, utilities, and governments while the impact of energy consumption on the local and the global environment is reduced (see Table 1).

Table 1 - Benefits of Energy-Efficient Lighting

Benefits of Energy Efficient Lighting	
Customer	Energy savings, reduced bills, mitigation of impacts of higher tariffs
Utility	Peak load reduction, reduced capital needs, reduced cost of supplying electricity
Government	Reduced fiscal deficits, reduced public expenditures, improved energy security
Environment	Reduction in local pollution and in Greenhouse Gas (GHG) emissions

The benefits to residential customers include energy savings, reduced electricity bills, and mitigation of the impacts of higher electricity tariffs. Utilities benefit from energy-efficient lighting through peak load reduction, reduced capital needs for future generation expansion, reduced cost of supplying electricity, and reduced utility losses in supplying electricity to low-tariff or low-collection customers[4]. Benefits to governments include reduced fiscal deficits, reduced public expenditures, reduced energy price volatility, and improved energy security. In terms of the benefits to the local environment, energy-efficient lighting initiatives can help to reduce both local environmental pollution and global GHG emissions.

Despite these benefits, the implementation of energy-efficient lighting in developing countries has been very slow. While some residential consumers in most developing countries have switched from ILs to FTLs, most FTLs (more than 75 percent) use energy-intensive magnetic ballasts,[5] and the resulting energy savings are not as high as those achievable with CFLs. The penetration of more efficient CFLs (which can offer savings of 75-80 percent compared to ILs) is generally small -- no more than 10-15 percent in most developing countries Some of the reasons for the low penetration of CFLs are the poor quality (for example lower life, lower power factor or lower lumens per watt) of some of the CFLs on the market, and the relatively higher market price of the good-quality CFLs. Furthermore, in most developing countries, CFL prices are inflated by

VAT and customs duties, since local manufacturing is not available and these products are almost always imported. Even though using CFLs leads to reduced electricity bills and improved reliability, perceptions of poor quality and high prices especially in the 1980s and early 1990s, have made CFLs unattractive to many consumers, particularly amongst the low- and middle-income consumers. Furthermore, inferior-quality CFLs are eventually ineffective in helping the electric utility, since estimated potential savings in energy and peak load reduction are never actually achieved. There is therefore a need for energy-efficient lighting programs that assure high quality CFLs at a reasonable and affordable price to achieve large-scale implementation of this efficient lighting technology.

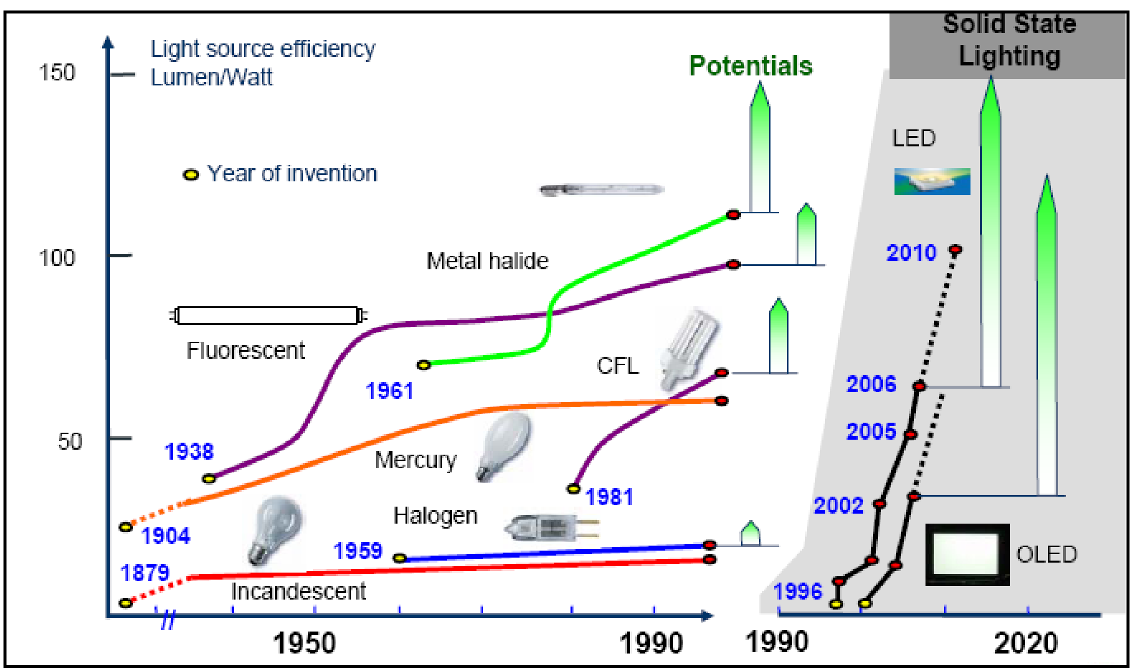
Efficient Lighting Technologies

Much of the developing world still uses the IL, which is a 100-year-old technology. However, there have been major innovations and improvements in lighting technologies over the last several decades (see Figure 1). As Figure 1 shows, the efficiency (efficacy in lumens per watt) of CFLs has also been increasing gradually, since these lamps became commercially available around the early 1980s.

Many of these technologies offer the potential for energy savings in various different lighting applications, such as street lighting, office and industry lighting, hospitality and retail spotlights, and household lighting (see Figure 2).

Of these, the technology option that is the most attractive to developing countries to make short-term substantial reductions in peak loads and derive other benefits to consumers, utilities, governments, and the environment is the replacement of ILs with high-quality CFLs. Box 1 provides a brief history of the CFL.

Figure 1 - Improvements in Lighting Technologies



Source: Wolfgang Gregor, "Towards a New Culture of Lighting", Presentation to the World Bank Energy Efficiency Thematic Group: Washington DC, January 2009.

Figure 2 - Energy Savings Potential in Lighting Applications

Application in general lighting	Energy saving through innovative lamp technologies			~savings / lamp / year*
Street lighting	Mercury vapor	~40%	High-pressure sodium lamp	220 kWh / 110 kg CO_2
Office & Industry Lighting	Fluorescent lp. w. halophosphate phosphor	~65%	New T5 fluorescent w/ electronic control & light management	180 kWh / 90 kg CO_2
Shop lighting	3 Standard Halogen lamps	~80%	New Ceramic metal halide lamps	500 kWh / 250 kg CO_2
Hospitality Spotlighting	Low voltage halogen reflector	~30%	Dichroic Halogen lamp with infrared coat technology	60 kWh / 30 kg CO_2
Household lighting (private)	Standard Incandescent	~80%	Compact fluorescent	50 kWh / 25 kg CO_2
		~30%	Halogen Energy-Saver	18 kWh / 9 kg CO_2
Lighting design	Low voltage halogen reflector	~50%	White LED Module COINlight OSTAR	45 kWh / 22 kg CO_2

* For typical usage / Energy-Mix 0,5 kg CO2/kWh

Source: Wolfgang Gregor, "Towards a New Culture of Lighting", Presentation to the World Bank Energy Efficiency Thematic Group: Washington DC, January 2009.

Box 1: A Brief History of CFLs

Peter Cooper Hewitt developed the parent to the modern fluorescent lamp in the late 1890s. The Cooper Hewitt lamps were not used in residences because of their poor light quality, but were employed in photographic studios. Edmund Germer, Friedrich Meyer, and Hans Spanner patented the first high-pressure vapor lamp in 1927.

George Inman teamed up with General Electric to create the first practical fluorescent lamp, which was first brought to market in 1938 and patented in 1941. In 1973, Edward E. Hammer, a scientist with GE, invented the modern CFL. While the CFL invented by Hammer met its design goals, it would have cost GE about US$25 million to build new factories to produce them, so the invention was shelved. The design plans for Hammer's CFL were eventually leaked and copied by other manufacturers.

In recent years, CFLs have become the global symbol for efficient lighting, and sales of CFLs have steadily increased as more and more individuals, corporations, and nations embrace CFL technology as a means of reducing carbon emissions and combating climate change.

Source: Mary Bellis, The History of Fluorescent Lights, http://inventors.about.com/library/inventors/bl_fluorescent.htm.

2. Program Design Approaches

Overview

Large-scale implementation of CFLs can be accomplished in many different ways. Some of the approaches used by different countries are summarized below. Table 2 shows a comparison of the advantages and limitations of different program design approaches.

Table 2 - Comparison of Program Design Approaches

Design Approach	Advantages	Limitations
1. Bulk purchase and distribution	Bulk procurement lowers upfront CFL cost without subsidy. Distribution can achieve high penetration. Technical quality assured through tender specs. Relatively quick to implement.	Interferes with existing market channels. Raises concerns about market sustainability. Requires strong institutional and management systems.
2. Market-based approaches	Enhances existing market channels. Provides more options to customers. Lower implementation costs.	May not substantially reduce upfront CFL costs. Requires effective monitoring of market. Requires mature market with existing high quality CFL suppliers and retailers. Slower implementation rate.
2a. Coupons	More market-based approach with use of existing distribution channels to help ensure sustainability. Allows customers to choose products.	Need measures to protect against low quality products and fake coupons. Harder to ensure lower retail prices. Customers need good access to information to make informed choices.
2b. Branding	Allows customers to select outlets and products with simple branding. Some manufacturer negotiation can bring down upfront cost barrier. Allows manufacturers to target marketing efforts.	Branding alone may not be enough to overcome upfront cost barrier. Need for credible branding agency with strong informational component.
2c. Rebates and subsidies	Helps address higher incremental costs, participation can require trade-in of older models to ensure disposal. May fit well with carbon financing	May not be sustainable. Allocation of subsidies must be equitable. High potential for free riders.
2d. Agents	Can create market for proactive selling. Allows agents to determine best marketing approaches. Combines marketing with selling. Fits well with carbon financing.	Need to protect against possible collusion between agent and customer. Agents may 'oversell' products. Does not address higher upfront costs for customers.
3. Standards and labeling	Provide clear and credible information to customers. Low implement cost. Labeling creates platform for standards to eliminate low quality products and helps phase-out.	Does not address the higher upfront cost to consumers. When labeling is voluntary, participation may be low. Standards require considerable effort for proper testing and enforcement.
3(a). Phase-out policies	Effective mechanism for replacing inefficient ILs. Clear signal to suppliers and customers regarding CFL efficiency. Maintains and enhances existing CFL retail channels.	Requires national legislation or regulation. Affects existing market channels and local suppliers. Requires considerable time for implementation. Has led to some hoarding in Europe.

Source: Adapted from Jas Singh, Global Experience with Market Transformation Programs, ESMAP, The World Bank, February 2009

1. **Bulk Procurement and Distribution** - In many countries, large scale programmatic CFL programs have been implemented using the bulk procurement and distribution approach. Most such programs have been implemented by electric utilities. The planning and design of such programs may be performed by government ministries, donor agencies, and/or NGOs, but overseeing the purchase of the CFLs, their distribution to retailers or consumers, the provision of any subsidies or other financing, and the program monitoring is most commonly done by electric utilities. For a comprehensive discussion of the bulk procurement approach, click here.

2. **Market Channel Based Approaches** – The term market channel-based approaches has been used in this report for programs that utilize existing market channels to distribute or sell increased quantities of high quality CFLs that meet specified technical criteria. There approaches may be characterized by the implementation mechanisms utilized and include the following examples:

- **Coupon or Voucher Program** - In this approach the utility provides customers with a coupon or voucher for the purchase of a specified number of CFLs from existing retailers.
- **Branding and Promotion Program** - In this approach the utility works collaboratively with selected manufacturers or suppliers of high quality CFLs (who are generally selected competitively based on the quality and price of their products), to "brand" the CFLs and promote them for sale through existing retail channels.
- **Rebate Program** - In this approach the utility offers a rebate to customers who purchase high quality CFLs designated by the utility. Customers may purchase the CFLs at existing retail outlets.

It should be noted that some of the features of these approaches may be combined. For example a branding and promotion program may use coupons for rebates. Also, these approaches can be combined with utility financing of the customers' purchases of the CFL through the utility bills. This report includes a discussion and examples of market channel-based approaches.

Standards and Labeling: This approach involves establishing efficiency standards and/or labels to provide information to assist customer decision making. A comprehensive database on standards and labeling has been prepared by the Cooperative Labeling and Standards Program (CLASP), and is not discussed further in this report. An advanced approach now being used in many countries is *phase-out policies*, which eliminate ILs from the market through legislation or regulation. Many countries are moving toward this approach. An overview of phase-out policies implemented by a number of countries is provided in the next section. Substantial additional discussion of bulk procurement and market channel based programs is provided later in this report.

Phase-Out Policies

Recognizing that the IL technology is very inefficient and that higher-quality and lower-priced CFLs are becoming increasingly available and popular, a number of countries have enacted legislation or regulations in recent years to phase out IL technologies. A summary of the phase out policies and plans of selected countries is provided in Table 3 below.

Cuba was the first country to successfully complete the phase-out of ILs. Cuba banned the sale of incandescent lamps and implemented a program of direct substitution of ILs with CFLs in households. It is understood that this was completed sometime in 2007 making Cuba the first country in the world to have phased-out incandescent lighting. Another 10 Caribbean countries and Venezuela are reported to be implementing similar measures.[6] About 116 million ILs were replaced by CFLs in every household in the country, resulting in peak demand savings of about 4,000 MW and annual emission savings of more than 8 million tons of CO_2 equivalent.

Thailand has initiated an effort to voluntarily phase-out ILs through a national campaign to subsidize CFLs and to work with Thai suppliers to phase out the sale of ILs. Theb Thai government is providing THB 80 million (US$ 2.3 million) to reduce the cost of CFLs, which would help to voluntarily phase out the sale of ILs.

The GEF has launched a project to speed up the transformation of the market for environmentally sustainable efficient lighting technologies in the emerging markets of developing countries by phasing out ILs.

The global movement towards phasing out ILs is well-documented in a recent paper by CLASP. It has been estimated that the countries which are currently actively developing policy measures to phase-out incandescent lamps account for roughly half the global IL market and consume about 6.5 billion ILs per year out of a global market volume of approximately 12.5 billion lamps.

Table 3 - Incandescent Lamp Phase-out Policies of Selected Countries

Country	Date	Summary
Australia	February 2009	Phase out of General lamp service (GLS) bulbs
	November 2009	Phase out of Extra low voltage (ELV) halogen non-reflector lamps
	October 2010	Phase out of >40W Candle, fancy round and decorative lamps, Mains voltage halogen (MVH) non-reflector, and ELV halogen reflector
	October 2012	Phase out of MVH including halogen >25W Candle and decorative lamps
Philippines	2010	Phaseout of all incandescents by 2010
Cuba	2005	Cuba banned the import and sale of incandescents in 2005
US		Energy Independence and Security Act was passed in 2007. Requires that all general-purpose light bulbs that produce 310–2600 lumens of light be 30% more energy efficient than current incandescent bulbs by 2012 to 2014. The efficiency standards will start with 100-watt bulbs in January 2012 and end with 40-watt bulbs in January 2014
	2012	Phase out of 100W bulbs
	2014	Phase out of 40W bulbs
Argentina	2010	Sale and import of incandescents banned at the end of 2010
European Union	2009	Phase out of 100W incandescent bulbs
	2010	Phase out of 75W incandescent bulbs
	2011	Phase out of 60W incandescent bulbs
	2012	Phase out of 40W and 25W incandescent bulbs
Canada	2012	In 2007 the Federal Environment Ministry announced that Canada would phase out inefficient incandescent light bulbs by 2012

UK	2009	Phase out of 100W incandescent bulbs
	2010	Phase out of 40W incandescent bulbs

Source: Compiled from various sources, including the Proceedings of the Phase-out 2008 Conference.

Energy-Efficient Lighting Programs of the World Bank Group and Other Partner Organizations

During the past few years, the World Bank has stepped up its efforts to provide support to developing countries attempting to design financial incentive based programmatic approaches and to implement large-scale energy-efficient lighting programs. The implementation approach builds on the experience and best practices of the efforts led by the IFC and Bank with GEF support in the late 1990s to develop and implement large scale, energy-efficient lighting programs in Mexico, Poland, the Philippines, Thailand, and other countries that led to the establishment of the Efficient Lighting Initiative (ELI). These programs focused on CFLs as the primary technology targeted to replace ILs.[7]

Immediately following the success of the ELI-driven country programs, the World Bank successfully implemented a 1 million CFL deployment program in Vietnam (in 2004-2005) as a part of the Demand-Side Management and Energy Efficiency Project. Subsequent large-scale CFL deployment programs have been successfully implemented in several countries.

Examples of recent programs include in Argentina (25 million CFLs, under the Argentina Energy Efficiency Project), Benin (350,000 CFLs, under the GEF Benin Energy Efficiency Project) in 2006-2008, Central African Republic (80,000 CFLs, under the Emergency Power Response Project), Ethiopia (4.5 million CFLs, under the EEAREPII project of World Bank GPOBA), Rwanda (400,000 CFLs in two phases, under the UERP project), Senegal (1.5 million CFLs, under the Rural Lighting Efficiency Project), Uganda (800,000 CFLs, under the ERT project), and West Africa (under the GEF regional Strategic Program for West Africa (GEF-SPWA)).

In addition, many large efficient-lighting projects are being designed and implemented outside the World Bank's framework. For example, the ADB is initiating a major CFL program in the Philippines to procure and distribute 13 million CFL - more than 5 million CFLs have already been procured and are planned to be distributed in 2009. In addition, the ADB is also lunching CFL projects in Nepal and Pakistan. In 2005, the U.S. Agency for International Development (USAID) sponsored a market-based CFL program administered by the Bangalore Electricity Supply Company (BESCOM). Other large-scale efficient-lighting programs have been initiated in China, India, and South Africa. Also, in the nation of Mauritius, the Central Electricity Board has launched a CFL implementation program in cooperation with the UNDP. Recently, the UNDP, in cooperation with GEF, initiated large-scale CFL programs in Russia and China.

As discussed in the bulk procurement section most of these programs have included the bulk procurement of high-quality CFLs to assure the lamp quality and reduce the lamp price.

Box 2: The IFC/GEF Efficient Lighting Initiative (ELI): Transforming Markets for Energy-Efficient Lighting

What are the long-term impacts of sustainable energy market transformation projects? And what are the benefits of long-term engagement in a sector? Some insight into these questions can be gained from a current perspective on an IFC energy efficiency project completed several years ago, the Efficient Lighting Initiative (ELI), implemented from 1999 to 2003, that has had lasting impacts on both the WBG, the WBG's client countries, and international suppliers of efficient lighting products.

The ELI aimed to change consumer perception of CFLs, increase their availability in the market, and improve quality while reducing price. With US$15 million in grant funding from the GEF, ELI operated in seven countries with very different markets: Argentina, Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. Based on experience from several prior programs that relied largely on subsidies for short-term market stimulus, the IFC had good knowledge of the lighting market and technologies as well as the challenges to consumer acceptance of more expensive, but much more efficient CFLs. Avoiding subsidies, the ELI program aimed to sustainably transform local markets for CFLs, which at the time were not widely marketed or known to consumers and were sometimes of poor quality.

In 2005, the IFC and GEF contracted with the China Standard Certification Center (CSCC) to expand the program beyond the initial seven countries, and to increase manufacturer participation. The new ELI Quality Certification Institute is managed by the CSC, and is staffed by international experts from Asia, North America, and South America. The institute works with government agencies, international organizations, manufacturers and other stakeholders to accelerate the adoption of energy-efficient lighting. Products from local companies, such as Anhui Electron, and international manufacturers such as GE, OSRAM, and Philips are certified by the institute to meet high performance and technical standards that are used as criteria for procurement by energy service companies (ESCOs), national electricity utilities, and for projects financed by institutions such institutions as the WBG.

The program has been a success story, with both short-term and long-term impacts. An evaluation of the program's short-term impacts, undertaken at the close of the ELI, showed that the program had indeed transformed markets. New distribution channels brought CFLs to people who previously had no access to them. Prices dropped, consumer awareness and understanding grew and, as a result, CFL sales increased. For example, in Peru, annual CFL sales in 2003 were nearly 20 times greater than before the program began.

ELI has also become a cornerstone of the WBG's own procurement guidelines. ELI criteria and certified products have been used to inform procurement in a number of large-scale CFL projects, totaling some 50 million CFLs distributed in countries ranging from Argentina to Bangladesh, Mali to Mexico, and Rwanda to Vietnam. Cumulatively, the ELI-certified CFL distribution projects have had a significant impact on reducing GHG emissions.

In the longer term, the program's success is primarily a result of four factors of broad applicability. First, the results achieved during the program period helped build national awareness of the potential for energy and GHG reductions from energy-efficient lighting. Second, the ELI created and/or built capacity within institutions that continue to be effective advocates for energy-efficient lighting beyond the close of the program. Third, the ELI developed and nurtured local staff who went on to become national champions for energy-efficient lighting. Finally, ELI developed an internationally accepted quality standard that allowed demand to be aggregated effectively, by creating a joint standard used both by manufacturers and consumers of energy efficient bulbs, as well as by financiers such as the WBG.

Source: World Bank (2009), "Beyond Bonn: World Bank Group Progress on Renewable Energy and Energy Efficiency in Fiscal Years 2005 to 2009"

Illustrative Program Designs

Many of the recent CFL programs in developing countries have been implemented by electric utilities. Such programs can offer major benefits to utilities, including reduction of peak loads, reduced needs for capital investments in generation, transmission and distribution, and reduced cost of supplying electricity. In situations where electricity tariffs to residential customers are highly subsidized and are not sufficient to recover the utility's production costs, additional benefits include reduced losses and potentially higher margins if the save electricity can be sold to higher-paying customers.

Electric utilities have the natural advantage of having a business relationship with all electricity-consuming customers (except for those involved in power theft). Utilities can also finance CFL purchases with payments on the electric bills. A potential disadvantage of having the utility administer the program is that inefficiently-managed utilities or those with poor relationship with their customers may not do a good job of managing a complex CFL program. Also, some utilities have a poor public image and so may not have much public credibility in promoting CFLs.

The review of several efficient lighting programs from different countries points out that these programs have been designed to meet a range of objectives. The specific design approach selected is generally influenced by the objectives. Table 4 provides an illustrative overview of five different programs.

Table 4 - Illustrative Program Designs

COUNTRY	OBJECTIVES	DESIGN APPROACH
Vietnam	• Reduce impacts of high load growth • Contribute to market transformation	• Bulk procurement • Sale through utility distribution channels
Uganda	• Mitigate short-term supply shortage • Achieve load reductions quickly	• Bulk procurement • Free distribution
India – BESCOM	• Reduce need for new capacity • Reduce revenue loss • Utilize existing market channels • Facilitate customer participation	• Branding and cooperative marketing and promotion with suppliers • Financing through utility bills
India – Bureau of Energy Efficiency	• GHG reduction • Private sector implementation • Market transformation	• Developed CDM-POA • Encouraged private sector to implement programs

In Uganda, the Ministry of Energy and Mineral Development (MEMD), facing a severe short-term crisis in electricity supply, initiated a CFL program with assistance from the World Bank's Energy for Rural Transformation (ERT) project. The program involved bulk procurement and free distribution of CFLs to reduce the peak electricity demands of the utility (UMEME). A somewhat different approach was employed in Vietnam where Electricity of Vietnam (EVN) was interested in reducing the load impacts of both the high growth in electricity demands and the pronounced evening peak in demand from lighting use in the residential sector. EVN, using funds from the World Bank and GEF purchased one million CFLs using bulk procurement and sold the lamps to rural customers who contributed most to peak electricity loads.

Many North American utilities have used a rebate approach to promoting CFL implementation as a part of their demand-side management (DSM) programs under the direction and supervision of their regulatory authorities. A perspective on U.S. utility DSM programs addressing lighting is provided in a recent paper by EPRI, which mentions the role of such programs in the development and implementation of new lighting technologies.

In India, the Bangalore Electricity Supply Company (BESCOM) implemented a market-based approach in cooperation with selected CFL manufacturers (and with technical assistance from USAID) to increase CFL implementation. Through this new initiative, BESCOM promoted the use of CFLs in order to reduce the revenue loss that resulted from the subsidized sales of electricity to the residential sector and to lessen the need to invest in new generation capacity. This program called BESCOM Efficient Lighting Program (BELP) used a "branding and promotion" effort combined with a financing program through the utility billing mechanism.

Also in India, the Bureau of Energy Efficiency (BEE) has recently launched a major national program called the Bachat Lamp Yojana (BYL) to achieve market transformation in the domestic lighting market by utilizing carbon revenues (through the CDM) to offer CFLs to customers at a price equal to that of the ILs.

Bulk Procurement Programs

What is Bulk Procurement?

Bulk procurement refers to the purchase of a large quantity of energy-efficient lamps by the utility or a government agency, and distribution of such equipment to customers. Bulk procurement is generally conducted using a competitive bidding process wherein the purchasing entity defines the technical specifications of the lamps to meet energy-efficiency goals. The targeted customers are identified and lamps are then distributed to these customers. Depending on the program design, the customers may be charged for the lamps (at the cost of procurement and distribution or at a lower price based on a subsidy) or may receive them at no cost. The distribution of the lamps may be done by the utility or by contractors engaged by the utility.

Advantages of Bulk Procurement

Price Reduction

One of the major advantages of procuring CFLs in bulk is that by purchasing a large volume of lamps using a competitive bidding process, the cost of the CFLs is reduced substantially below market prices and the quality of CFLs is maintained vis-à-vis the technical specifications, thereby ensuring that energy savings are achieved.. Recent examples of bulk procurement programs have demonstrated the tendency for price reduction (see Table 5 below).

Most of these procurements used technical specifications based on the Efficient Lighting Initiative (ELI) to ensure that high quality CFLs were being procured. The Uganda and Vietnam procurements specified CFLs with rated lifetimes (defined as the time at which 50 percent of the CFLs are still operating) of 6,000 hours (as per the ELI specifications) while the ADB Philippines procurement specified even higher-quality CFLs, with rated lifetimes of 10,000 hours. The recent Bangladesh procurement had the strictest technical specifications.

The costs in Table 5 reflect only the procurement costs for the CFLs. Other program cost categories include administration, warehousing and distribution, marketing and promotion, and M&E. Typically these costs add about 40–50 U.S. cents per CFL to the costs of the CFLs. In Vietnam, for example, the total program cost was about US$1.50 per lamp, which included about US$1.00 for the lamp costs. If the program is being registered for CDM, there will be significant additional costs for validation, registration, and monitoring and verification

Table 5 - Examples of Cost Reduction from Bulk Procurement[8]

Program	Year	Procurement Size	Bulk Price
Vietnam - Phase 1	2004	300,000	1.07
Vietnam - Phase 2	2005	700,000	0.98
Uganda	2006	800,000	1.10
Rwanda	2008	200,000	1.00
Ethiopia	2009	4,500,000	0.87
Bangladesh*	2009	10,500,000	0.94 for 13-14W, 1.04 for 20-23 W
Philippines	2009	5,000,000	0.87

**Note - Bangladesh procured 3.3 million 13-14W and 2.2 million 20-23W CFLs. Additional 5 million CFL to be procured in 2010.*

Other Advantages of Bulk Procurement

In addition to the major advantage of price reductions, bulk procurement offers the following benefits:

- Significant load reductions are possible because a large quantity of CFLs are installed that replace existing inefficient ILs.
- The load reductions can be achieved rapidly through centralized procurement and distribution, thereby providing a quick response in load reduction.
- The technical specifications in the bulk procurement assure that high-quality CFLs are being installed.
- The programs can provide for better targeting of customers, since the CFL distribution is organized and conducted by the sponsoring agency or utility.
- Bulk procurement and distribution can simplify the acquisition of carbon credits using CDM.
- By injecting a large number of lamps into the target market, bulk procurement and distribution can have long-term positive effects on market transformation.
- The programs can provide immediate large net benefits to utilities, customers and society

Limitations of Bulk Procurement

It should be noted, however, that bulk procurement does have some limitations.

- The competitive procurement process and strict technical specifications may limit the number of competing manufacturers or suppliers, and the result of the competitive process will generally lead to the selection of a single supplier. It should be noted, however, that the recent Bangladesh bulk procurement allows for the selection of multiple suppliers

- The procurement process is also likely to limit the number of CFL types (for example size or color rendering) to a very small number (generally one or two), thereby limiting customer choice.

- The process also requires a substantial effort on the part of the utility or government agency for distributing the CFLs and ensuring that they will be used at homes to replace the ILs. Along with bulk procurement and deployment process, there is a need to have a comprehensive consumer awareness program.

- The distribution approach used in bulk procurement programs will generally not use existing market and distribution channels and may in fact be detrimental to existing CFL suppliers and retailers. This kind of distribution also entails additional costs for program implementation.

- Finally, utility or government distribution and installation or sale may be less sustainable in the long term, if appropriate measures are not adopted to ensure that high-quality and low or reasonable priced CFLs are available in the market in the future (after the utility-sponsored program is over).

Market Channel-Based Approaches

Market channel based approaches utilize the existing supply and distribution channels to promote and facilitate increased utilization of CFLs. Instead of one or two CFL types under the bulk procurement approach, the market channel based approach promotes the use of many CFL types and wattages provided they meet some predetermined technical quality specifications. The mechanisms used in these programs may include a combination of rebates, coupons, branding, cooperative advertising and promotion, and financing through the utility bills. These types of programs are best illustrated by two examples, the Sri Lanka CFL Program and the BESCOM Efficient Lighting Program (BELP).

Sri Lanka CFL Program

The Sri Lanka CFL Program was implemented by the Ceylon Electricity Board (CEB) as a demand-side management (DSM) program aimed at reducing system peak loads and improving the load factor (A Case Study of this program has been published by the World Bank as a part of the book on Financing Energy Efficiency,) The customers participating in the program were provided coupons to purchase CFLs from approved suppliers at a subsidized price. The subsidy was provided to cover import taxes and duties. Multiple suppliers were selected by CEB based on the quality of the CFLs offered and the warranties provided. Customers obtained the CFLs from the supplier's existing retail channels and were able to use their coupons to select a CFL of their choice provided that they were offered by participating suppliers. An aggressive marketing and promotion campaign was implemented by CEB in cooperation with the CFL suppliers. An important feature of this program was that customer payments for the lamps were recovered by CEB through electricity bills over a 12 month period at zero interest.

The program was implemented in three stages which took place between 1995 and 2000. The third stage included participation by Lanka Electricity Company (LECO) as well as the Energy Conservation Fund, which was responsible for public sector implementation. The program received wide public acceptance and transformed the CFL market in Sri Lanka. The number of CFLs purchased by customers outside the program (1,235,000) far exceeded the number of CFLs purchased by the program participants (261,000) as reported in the program evaluation.

BELP Program

A detailed case study of the BELP program is provided in this Toolkit. The program was launched by the Bangalore Electricity Supply Company (BESCOM), with technical assistance from USAID. The program aimed to develop a market-based mechanism to promote the use of CFLs.[9] BELP involved the branding of CFLs from selected suppliers and the development of cooperative advertising and promotion. BESCOM selected three suppliers using a competitive bidding process. BESCOM utilized technical specifications based on the ELI requirements and selected bidders based on product quality, price, warranty and existing retail network.

Eligible customers (with no arrears on electricity bills) were allowed to acquire CFLs from approved retailers and complete a sales voucher confirming purchase. BESCOM allowed two transactions options: (a) inclusion of lamp costs in the customer's electricity bills and repayment in monthly installments over 9 months; and (b) direct purchase from retailers without repayment through electricity bills.

In addition to cooperative advertising and promotion, BESCOM implemented an awareness-building program through its customer support centers which provided leaflets, posters, and other promotional materials. BESCOM also conducted intensive training programs for staff at suppliers' retail and wholesale distribution centers, for BESCOM staff at the customer support and billing centers, and for subdivisional and divisional officers.

The program evaluation results demonstrated that there was an increase in the sales of CFLs by the participating suppliers (175,000 additional CFLs) leading to a direct demand reduction of 11.3 MW. The evaluation also concluded that even nonparticipating suppliers experienced an increase in sales, although the actual sales increase and resulting load reductions were not documented.

Advantages of Market Channel-based Approaches

Market channel based approaches can be instrumental in enhancing existing market channels and providing customers greater choice in purchasing CFLs from various suppliers. They avoid the disadvantage of bulk procurement where generally only one supplier is (or a limited number of suppliers are) selected and the choice of CFL types is limited to one or two. In addition, these approaches do not have any detrimental effects on existing retailers and can be effective in reducing the number of poor quality lamps in the market that do not meet the established quality standards. However, retailers often stock low-cost, low-quality CFLs alongside the other CFLs, so the CFL program may need to include some design features to ensure that consumers buy the high-quality CFLs instead of the low-quality ones. Another advantage of the market channel based approach is that it does not impose the administrative burden of procurement and distribution on the sponsoring utility or government agency.

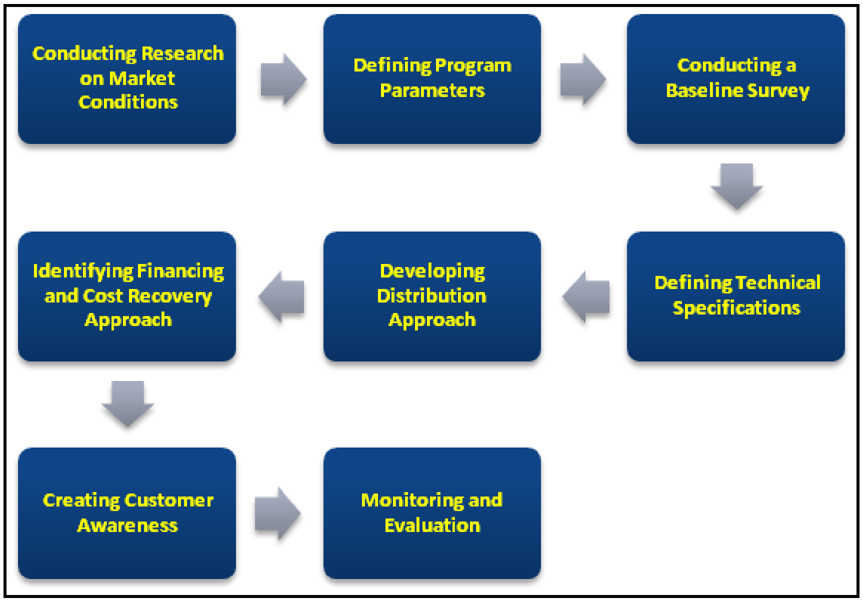
Limitations of Market Channel-based Approaches

One of the limitations of market channel based approaches is that they do not achieve the level of cost reduction possible through bulk procurement. Another limitation is that these approaches require the existence of multiple suppliers of high-quality CFLs, as well as existing retail channels where customers can purchase the lamps. Therefore, such approaches are more likely to be applicable in "mature" CFL markets where there are a number of existing suppliers and retailers or after there has already been a bulk procurement program. A third limitation is that consumer participation in the program may be lower, at least at first, compared to programs that provide the CFLs door-to-door or at utility bill paying centers.

3. KEY ELEMENTS OF PROGRAM DESIGN AND IMPLEMENTATION

There are several major steps in developing an appropriate CFL program design. These steps are shown in Figure 3.

Figure 3 - Key Elements of Program Design and Implementation

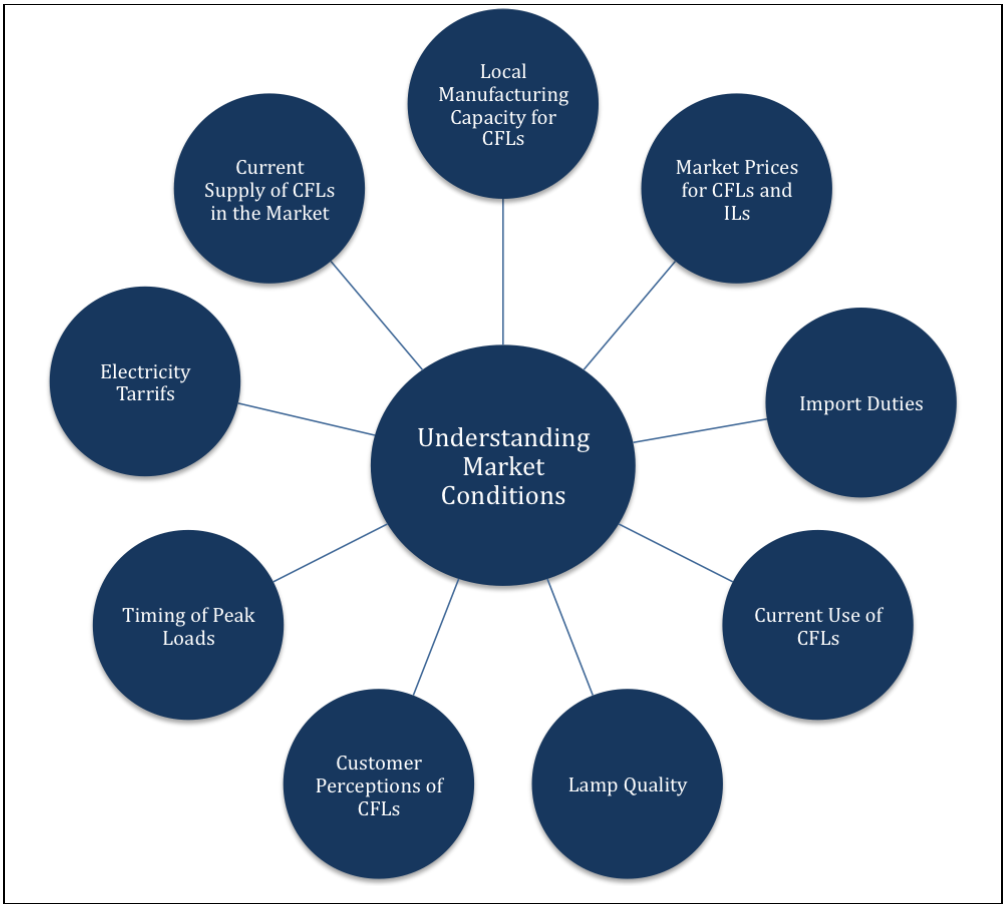


Source – Developed by the project team based on a review of prior programs

Understanding Market Conditions

When designing a program for CFL procurement it is important to first gain an understanding of pre-implementation market conditions. This step involves the collection of CFL-related data in the area of implementation. Key information and data required are shown in Figure 4.

Figure 4 - Understanding Market Conditions



Source – Developed by the project team based on a review of prior programs

Defining Key Program Parameters

This step involves outlining the key parameters of the CFL program. Key program elements that should be weighed in the outline include bulk procurement prices, rebates and coupons, CFL branding, and plans for cooperative marketing or promotion. During this stage of planning the program designer should also identify the target customers, and decide on an approximate total number of CFLs to be procured and number of lamps to be distributed to each customer.

Other important parameters to be considered during this stage include the following:

- Whether the CFLs are to be provided free to the customers or the costs (full or partial) of the CFLs should be recovered from the customers
- Whether existing retail channels will be used
- If utility distribution will be used, whether the CFLs will be delivered door-to-door to the customers by utility representatives or their agents, or the customer will have to pick up the CFLs at a utility office

- Whether customers will be offered the option of paying for the CFL over a period of time through their electricity bills.

Additional discussion of these design issues is provided later in this report.

Conducting a Baseline Survey

A baseline survey is important in determining local attitudes towards CFL technology. Information gathered via the survey is instrumental in shaping an appropriate marketing program and determining an appropriate number of lamps for procurement and distribution. If the CFL program is being considered as a CDM activity aimed at generating carbon revenues, the baseline survey is absolutely necessary. The sample size for such a survey depends on the number of different types of customers to be targeted and should be based on statistical criteria. CDM requires that the survey be conducted with 10 percent accuracy at a 90 percent confidence level. Information collected as part of the baseline survey generally includes demographic and household characteristics, current lamp usage (number, types, location, and hours of use), customer awareness and interest and interest in CFLs, availability of CFL in the current market, reasons for customer purchase or non-purchase, and willingness to pay.

Examples of baseline survey instruments are available from the following prior Bank CFL projects include:

- Uganda
- Rwanda
- Bangladesh
- Ethiopia

Key information items included in the baseline survey are as follows:

- Customer information
- Demographic characteristics
- Housing type and no. of rooms
- Current usage of lighting by room
  - Number of lamps
  - Types of lamps
  - Wattage
  - Type of fitting
  - Daily hours of use
  - Replacement period
- Usage pattern
- Knowledge and perception of CFLs
- Where lamps are purchased and at what price
- Why customer will or will not purchase CFLs
- Willingness to pay

This Toolkit includes examples of the following reports describing the results of the baseline surveys which include:

- Uganda
- Rwanda
- Bangladesh

Defining Technical Specifications

In order to ensure that the CFL program will promote an overall market transformation toward the use of high-quality CFLs, it is paramount to ensure high quality of CFLs distributed via the program. Therefore, before entering the competitive bidding stage, it is important to define technical specifications to ensure that bidders are able to provide CFLs not only at a low cost but of a high quality as well. Most bulk procurements have adapted the specifications prepared by the ELI program, which is consistent with the IEC and U.K Energy Savings Trust specifications for CFLs. The CFL technical specifications generally include lamp wattage, lumen output, rated lifetime, color rendering index, lumen maintenance over time, power factor, mercury content, safety, certification, and warranty. Of significance to the power systems in developing countries is the issue of fluctuating voltages and frequencies and which are also included in CFL technical specifications.

Examples of technical specifications are available from the following prior World Bank projects:

- Vietnam (Stage 1 and Stage 2 Procurement)
- Uganda
- Ethiopia
- Bangladesh

A brief discussion of the key technical parameters is presented below.

- **Lamp type -** The specifications include style of lamp (for example, unitary and self-ballasted), type of ballast (generally electronic), type of base (pin or screw type), voltage level, and lamp length.
- **Wattage -** The required wattage of the CFL is determined in the program design based on the wattage of the incandescent lamps to be replaced. The criterion for selection is that the CFL should provide at least the same lumen output as the IL being replaced.
- **Efficacy** - Efficacy refers to the light output of the CFL in lumens per watt. The efficacy level is generally between 45 and 60 lumens per watt.
- **Rated lifetime** - The rated lifetime of the CFLs is an important specification. Early programs such as those in Rwanda, Uganda and Vietnam used CFLs with 6,000-hour rated lifetimes. However, as CFL quality has improved, it may be desirable to consider 10,000 hour CFLs (the recent ADB-funded procurement for the Philippines and World Bank funded procurement in Bangladesh specified 10,000 hour lifetimes). The higher lifetimes may imply higher costs; however, with improvement in technologies the cost differentials have been coming down dramatically in recent years. The

ADB-supported bulk procurement of 10,000 hour CFLs in the Philippines achieved a price of $0.87 per unit, which is very close to earlier bulk procurement prices for 6,000-hour lamps.

- **Voltage tolerance -** Since the power systems in many developing countries are subject to substantial voltage fluctuations, the technical specifications define the range of nominal voltages ±10 percent of rated operating voltage for the performance of the CFL without a reduction in the rated life. Higher voltage tolerance may imply higher costs, although the cost differential has been very small or zero, as observed in recent procurements. Better-quality CFLs with higher-rated lifetimes are also able to tolerate higher voltage fluctuations.
- **Correlated color temperature (CCT)** - The color of "white light" can be expressed by correlated color temperature (CCT) in the unit Kelvin (K). The CCT is defined as the temperature of the Planckian radiator whose perceived color most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions. Most World Bank technical specifications require compliance with IEC 60969. While warm color (yellowish) light entails lower CCT of around 2500 K, the pure white light (similar to that given by FTLs) could be 6500 K. There is slight reduction in efficacy of the latter compared to the warm color CFLs, and the price of pure white color CFLs may be slightly higher than warm color CFLs.
- **Color rendering** - Color rendering relates to the way objects appear under a given light source. The measure is called the "color rendering index" (CRI). A low CRI indicates than objects may appear unnatural under the source, while a light with a high CRI rating will allow an object's colors to appear more natural. For lights with a "warm" color temperature the reference point is an incandescent light. For lights with a cool color temperature the reference is sunlight. The requirement for color rendering is generally specified as >80.
- **Lumen maintenance** - The lumen maintenance refers to the degradation of light output over time. The requirement for lumen maintenance is generally expressed as a percentage of the luminous flux of a lamp at a given time in its life to its initial luminous flux while the lamp is being operated under specific conditions.
- **Power factor -** The power factor of an AC electric power system is defined as the ratio of the real power to the apparent power and is a number between 0 and 1. The power factor of CFLs may become an issue when large numbers of CFLs are being installed in a power system, because low-power-factor loads can increase losses in a power distribution system and result in increased energy costs**.** Additional discussion of power factor issues is presented in the section on Key Issues below.
- **Safety -** Lamps must be shown to be safe both in use, when installed and when they reach the end of their life. Most specifications require compliance with IEC standard 60968.
- **Harmonics -** In general, harmonics injected into the mains will distort the

waveform of the mains voltage and will increase the network losses. CFLs are generally required to comply with harmonic current limits set by IEC 61000-3-2. Additional discussion of harmonics issues is provided in the section on key issues in this report.

- **Mercury content -** Mercury is an important component of CFLs and plays an important role in their energy efficiency and also other parameters such as lifetime and warm-up times. However, the mercury content of CFLs is very small and poses much lesser environmental impacts than those created by the ILs it is replacing. Additional discussion of mercury issues related to CFLs is provided in the section on environmental issues in this report.
- **Test specifications -** The technical requirements include testing protocols and specifications. Generally, the purchaser will accept test data from prior testing (which may have been conducted in other countries) provided that such testing meets specified criteria for type of testing facility, test conditions, sample size, "burn-in" conditions, and longevity of test results. A list of certified testing facilities has been developed by ELI.
- **Warranty -** Most technical specifications for CFL procurement require the supplier to provide a warranty under which any lamps that fail during the warranty period are replaced by the supplier at no cost to the customer. Generally, such warranties are for a period of 12-18 months. Examples of such warranties can be seen in the TORs for bulk procurement used in Vietnam, Uganda, and Bangladesh.
- **Packaging -** The technical specifications will define the type of packaging including logos and other labeling to distinguish the CFLs being procured from others in the market.
- **Other requirements -** Other specifications may include lamp start time, rated operating temperature, and stabilized light output. (see, for example, the Uganda Technical Specifications)

Another useful information item is the estimated survival curve for the CFLs being procured. The survival curve defines the number of lamps expected to be surviving as a function of the number of hours of operation. Most major CFL manufacturers have such data available from their test results. A paper by Limaye and Niederberger provides illustrative data on CFL survival curves.

Selecting the Program Size

The primary criterion for selecting number of CFLs to be procured and distributed (program size) is the desired level of peak reduction and/or energy savings. Other considerations may include the following:

- Number of customers (households) in the target market.
- Number of lighting points per household.
- Wattages of existing lamps.
- Types of sockets.

- Number of high-use lighting points with the right socket type - CDM requires use of high-use lighting points (with usage of at least 3.5 hours per day).
- Number of CFLs to be provided per household.
- Non-participation and distribution considerations.
- Existing market for CFLs.

Selecting a very small program size will entail a lower program cost but may limit the effectiveness of the program. On the other hand, as the program size gets larger, it will have implications not only for cost but also on the existing market and distribution channels.

Developing a Distribution Approach

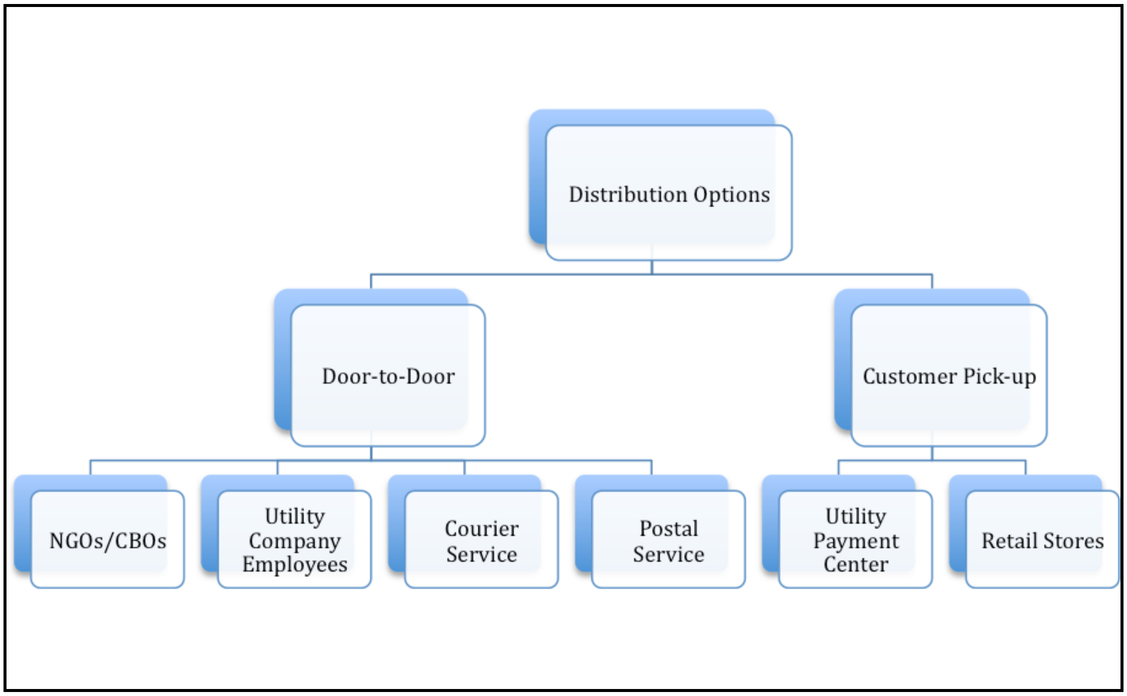
CFLs can either be delivered directly to consumers or made available for pick up at specified locations. If delivered to consumers, the delivery is generally performed through a door-to-door campaign using a utility representative, non-governmental organization (NGO) or an agent (such as a courier service. If the CFLs are to be picked up, they can be made available either at retail locations such as hardware stores, or at utility centers and bill payment stations. The options for distribution are illustrated in Figure 5.

Door-to-Door Distribution

One of the advantages or the door-to-door distribution is the relatively high penetration and deployment of CFLs, which can lead to higher participation. The questions related to such distribution include (a) selecting the appropriate distributing organization (b) deciding whether the CFL distributors should enter the home to install the CFLs (and remove the ILs), or whether to hand over the CFL(s) to (and collect the ILs from) whoever answers the door.

Distributing organizations have included utility employees, NGOs, and agents engaged by the utility. The utility may have field employees who are already working in residential areas (reading meters or delivering bills) and may be asked to distribute the CFLs. This approach was used in Vietnam. Alternatively the utility may contract for the services of an agent – in Uganda the utility engaged Yellow Pages (an organization that was already contracted to distribute utility bills) to distribute the CFL. In some cases, it may be preferred to use an NGO that is likely to be more trusted by the consumers than utility employees or agents. For example, in the Philippines, the Department of Energy is engaging local NGOs to distribute CFLs in the metropolitan Manila area.

Figure 5 - Options for CFL Distribution



Source – Developed by the project team based on a review of prior programs

If the distributing agent can enter the home to install the CFL (and remove the IL), there is increased assurance that the CFLs are installed in the right high-usage locations. However, cultural norms may in some cases preclude entry into the home.[10] In such situations, it is important to develop an approach to educate the customer to assure that the lamps will be installed in the right places within the household.

Customer Pickup

This approach requires the customers to pick up the CFL at designated locations. Such locations may include a utility office or payment center, or retail locations. A distribution system that relies on customers going to a certain location to pick up the CFLs is likely to get a lower penetration than a door-to-door system because, regardless of how well the program is marketed and promoted, some consumers will not "opt in" to participate. However the customer pickup approach is likely to cost less than door-to-door distribution. Programs that involve customers picking up the CFLs typically require that the customers trade a voucher (or coupon) or bring in a paid utility bill that shows the number of CFLs is they are eligible for under the program. Vouchers aren't needed with most door-to-door programs. The customer pickup programs may also require customers to turn in their ILs that are being replaced.

Another option is the use of existing retail stores as pickup locations. The main advantage of using such stores is that they already are already part of the lightbulb supply chain and a bulk purchase and distribution system is not needed. Instead, the program designers specify which CFLs qualify for the program's rebates or other subsidies. The retail stores then order and stock the approved CFLs and provide them to consumers in exchange for a voucher. The stores are paid by the CFL program for the vouchers and, when the CFL program ends, these stores may continue to benefit from prior participation in the program by retaining customer patronage

Collection and Recycling of ILs

The early CFL programs did not address disposal or recycling of ILs. Now, most programs attempt to do so, particularly if they are seeking CDM registration. Door-to-door distribution programs can easily facilitate IL collection, since the ILs may be collected as CFLs are being distributed. Under CDM, the ILs must be in working order. This is fairly easy to determine in door-to-door programs even if the CFL provider does not enter the house because most consumers do not have burned-out ILs in their possession. Programs that provide CFLs at bill-paying centers offer the next easiest IL collection approach. Consumers bring in working ILs in exchange for the new CFLs.

IL collection is most difficult in CFL programs that provide the CFLs at retail outlets. These programs require retailers to collect the ILs, check to ensure they are in working order, and provide storage space for the ILs. Often retailers require an incentive to participate in the IL collection. There is also a potential for dispute if the IL is not in working order. Retailers will not have much incentive to accurately document the working order of ILs unless they either receive an incentive payment only for working ILs or if there is a spot-check monitoring system. Both of the aforementioned methods may complicate and add cost to the overall program. One option is to offer small incentive payments for ILs brought to certain locations. Such an approach separates the IL collection from the CFL provision, which makes it easier for consumers to participate in the CFL program.

Once the ILs are collected and their working order documented, the next question is what to do with them. If a recycling program is to be established, decisions must be made about who will do the collecting (existing refuse collection services?), where the regional centers will be, and where the final destination(s) will be. A decision must also be made about exactly what is to be recycled – the entire bulb or just the metal base? The advantage of recycling only the metal base is that it has more value than the glass and is more easily transported than the entire bulb. Further discussion of recycling is provided in the section on key issues later in this report.

Cost Recovery and Financing

It has been argued that free distribution of CFLs may lead to market distortions and create problems with customer repurchase when the CFLs need to be replaced at the end of their useful lives. Some programs have therefore included provisions to recover some or all of the program costs from the customers. A potential benefit of requiring customers to pay for the CFL is that it decreases the likelihood that customers will attempt to resell the CFLs. Potential disadvantages of cost recovery include lower penetration rates, slower market response, and greater administrative burden/cost

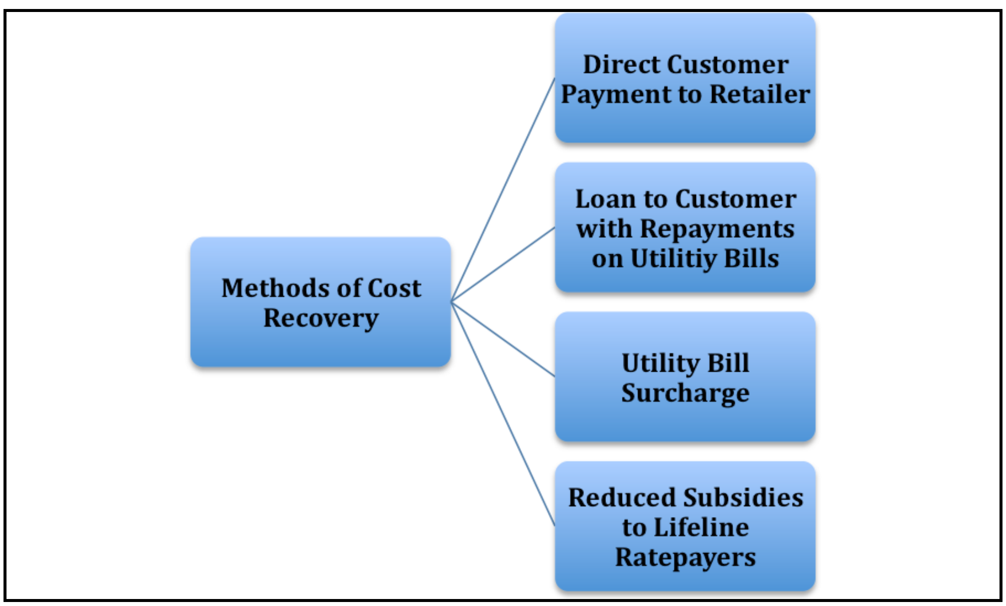
There are four basic approaches (see Figure 6) to recovering CFL program costs:

1. **Direct customer payment to retailer** – In this approach, the customer pays the retailer for the CFL. This approach can work in programs in which the market

price of CFLs has been reduced through bulk purchase or cooperative programs with suppliers.

2. **Loan to customer with repayments on utility bill** – The customer receives the CFL(s) at no upfront cost and signs an agreement with the utility to pay through the utility bill over a period of time. Since the typical paybacks are less than one year, the customer's payments will be lower than the cost savings from the reduced energy consumption. For examples, in the BELP program, the customer payback was about 7-8 months and the repayment period was 9 months.
3. **Utility bill surcharge** – In this approach the utility pays for the costs of the CFL through a surcharge on utility bills for all customers. The approach is easy to administer and does not require changing the utility billing system. However, it raises an equity issue related to increasing the electricity bills for nonparticipating customers. This approach was used for the recovery of DSM program costs in many North American utility programs.
4. **Reduced subsidies to lifeline ratepayers** – Where the electricity tariffs are subsidized to the extent that the utility is losing money on every kilowatt-hour sold, CFLs will reduce the electricity consumption and thus reduce the losses and cross-subsidies. The savings in the subsidy payments may cover the cost of the CFL program.

Figure 6 - Options for CFL Cost Recovery



Source – Developed by the project team based on a review of prior programs

Comparison of Giveaway, Cost Recovery, and Rebate Programs

CFL program designs have included giveaway programs (where the CFLs are distributed at no cost to the customers), such as in Rwanda and Uganda; cost recovery programs (in which some or all of the CFL cost is recovered from the customer), such as in Vietnam; and rebate programs (where a discount or subsidy is offered to the customer for purchasing CFLs to stimulate the CFL market), such as in many North American utility DSM programs. Table 6 provides a comparison of some of the characteristics of these three program types.

Table 6 - Comparison of Three Program Types

	Quality Control	Procurement Price	Price for Consumers	Disbursement Speed	Administrative Simplicity	Free Ridership	Long-term Sustainability	Fraud Potential	Monitoring Sales	Legislation Needed
Give-Away Program	Good	Low	Free	Quick	Simple	Very high	Poor	High	Easy	No
Cost Recovery Program	Good	Low	Market	Quick	Complex	Low	Good	Low	Easy	Possibly
Rebate Program	Moderate	Moderate (with supplier rebate); High (with consumer rebate)	Low	Slow	Complex	Moderate to High	Moderate to good	Low (with supplier rebate); High (with consumer rebate)	Could be difficult	No

Source – Developed by the project team based on a review of prior programs

Giveaway programs have several advantages and disadvantages compared to programs that seek to recover all or a portion of the capital and administrative costs of providing the CFLs. The main advantage of giveaway programs is that they achieve a greater participation rate and result in a greater penetration of CFLs in the market. This, in turn, means greater energy savings and carbon emission reductions during the period the program is in operation. A disadvantage is that they can be complex and expensive administratively. Another disadvantage of the giveaway programs is that they have potentially high "free ridership" effects. In the context of CFL programs, free riders are consumers who would have purchased and installed the CFLs without any utility or government program but will participate in the program to take advantage of the incentives being offered. The presence of free riders will lead to overstatement of the program benefits. (For additional discussion of free ridership in energy efficiency programs, see Office of technology Assessment, Energy Efficiency: Challenges and Opportunities for Electric Utilities). Also, as stated above, giveaway programs may have a detrimental effect on existing CFL suppliers and retailers. When a giveaway program ends and replacement CFLs become relatively expensive compared to ILs, consumers may revert to buying the low-cost ILs again.

The main advantage of cost-recovery program designs is that they require little or no grant funds. Although cost recovery programs will not be likely to achieve as high an initial penetration rate as giveaway programs, they can nevertheless achieve good penetration rates if the attractive financing terms are offered and program participation is simple and easy. Allowing consumers to pay for their CFLs over time on their utility bills can be a very effective mechanism for customers.

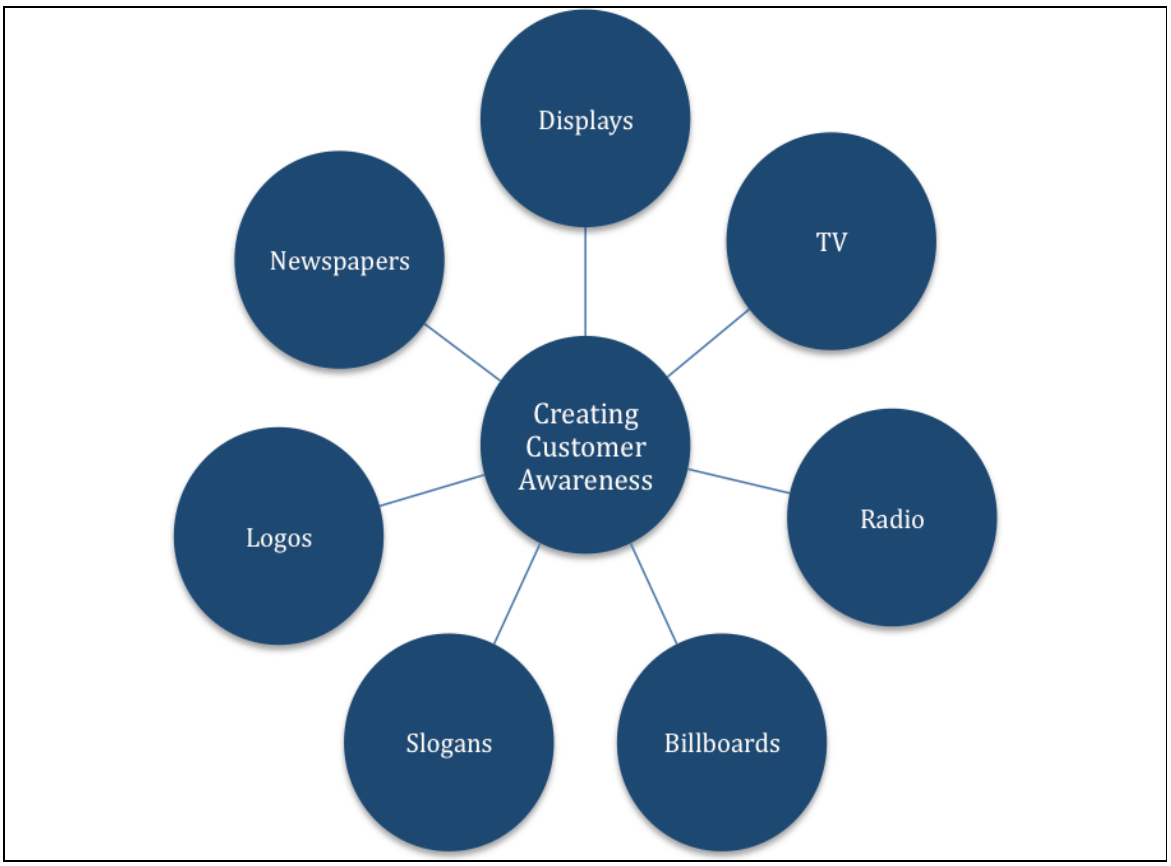
The question of whether or not to provide a subsidy also involves the question of what size subsidy to provide and in what form. With respect to the size of the subsidy, programs in the developing world have involved a broad range of bulb subsidy sizes. A review of programs in Asia found that 100 percent subsidies were provided in a quarter of the programs, 40-59 percent subsidies were provided in 42 percent of the programs, 20-39 percent subsidies were provided in 8 percent of the programs, and 1-19 percent subsidies were provided in a quarter of the programs.

The giveaway, rebate, and cost-recovery approaches can all be matched with either a bulk procurement program or the existing light bulb distribution and retail channels. Typically, giveaway and cost-recovery programs are tied to bulk purchases, while rebate programs use existing distribution and retail channels. Thus, in terms of administrative ease, the rebate approach has an advantage over the other approaches because the program staff do not have to worry about procuring the bulbs.

Creating Customer Awareness

A successful marketing program can substantially improve the success of a well-planned CFL program by improving customer awareness of CFL technology and ultimately may lead to the desired market transformation toward the use of CFL technology. A wide range of channels or mechanisms of advertising may be used to promote awareness of CFL technology. Examples from prior programs include advertising (radio, television, newspapers), billboards, slogans and logos, leaflets, bill inserts, designated "champions" who promote CFLs, branding, displays at utility offices, displays at retail outlets, etc. Some of the examples from previous World Bank programs are included in the CFL Toolkit. Figure 7 illustrates some of the options for creating customer awareness.

Figure 7 - Options for Creating Customer Awareness



Source: Developed by the project team based on a review of prior programs

An excellent source for information on marketing and promotion campaigns for CFLs in the European Union is the EnERLIn study sponsored by the European Union. This study reviewed and documented the CFL awareness and promotion programs from a number of European countries, and provides many examples of marketing and promotion materials used in these programs. Box 3 provides an overview of the EnERLIn project.

Box 3 – The European Union EnERLIn Project

In order to reduce CO2 emissions and combat climate change the European Commission carried out the European Climate Change Programme (ECCP), which endeavored to identify cost-effective means of reducing CO2 emissions. After initial data gathering, the ECCP identified residential lighting as an area with great potential for improvement. Researchers pointed out that in order to achieve considerable savings in this sector a coherent strategy was required to transform the lighting market. In order to effect this change EnERLIn developed a series of promotional campaigns and training programs aimed at raising awareness of CFL technology. One of the most important outcomes from the EnERLIn project was the design and testing of various CFL promotional campaigns.

The project activities included:

- Surveys of end users and retailers using specific questionnaires in order to identify barriers and evaluate promotional campaign approaches
- Development of various campaign scenarios adapted to different target populations
- Creation of attractive promotional materials and tools
- Review of results and analysis the impact for different campaign strategies.

Key lessons learned from the EnERLIn Study include:

- There are a number of barriers to the widespread adoption of efficient lighting technologies. These barriers vary from across demographic and regional characteristics. They can be identified through well-designed surveys and appropriate promotional campaigns can be designed to overcome them.
- A successful promotion should be customized to the target population group.
- Modern communication and information technologies (such as web, web TV, net lessons, e-learning, etc.) can be effectively used to address population at various levels.
- An important group targeted by EnERLIn was the young population, in collaboration with schools, because children are the “citizens of the future” and they will reproduce in the near future energy efficient behavior that they learn.
- Awareness of efficient lighting technologies can be increased significantly by using well designed promotional tools that address the identified barriers.

The project final report concluded that in several countries a significant increase was observed in the sales of energy-efficient technologies following the EnERLIn promotional campaigns.

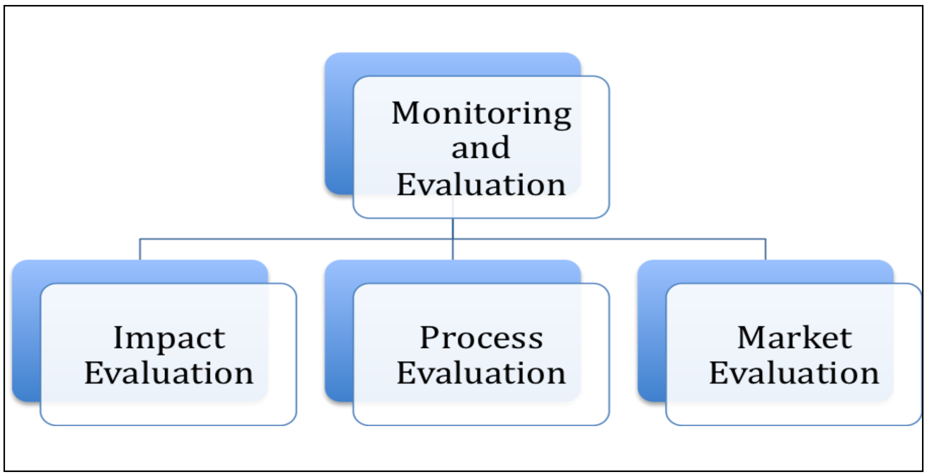
Source: Energy Efficient Residential Lighting Initiative, http://www.enerlin.enea.it

The World Bank has recently compiled a set of TOR for customer awareness and marketing-promotion campaigns for CFLs.

Monitoring and Evaluation (M&E)

An important element of program design is the M&E plan. Programs sponsored by the World Bank, GEF, or other donor agencies require a formal evaluation, and an M&E plan needs to be included in program design. The three types of evaluations generally included are shown in Figure 8.

Figure 8 – Three Types of Evaluation



In order to facilitate the program evaluation, it is important to design pre- and post-installation surveys that will develop the basic information needed to calculate the direct program impacts as well as the market impacts, and facilitate the process evaluation. Prior CFL projects (World Bank and others) provide examples of the TOR for program evaluation (from Vietnam), sample post-program survey instrument (from Uganda), and a program evaluation report from the Vietnam CFL program.

Also included are examples of completed program evaluation reports from Vietnam, Uganda and Sri Lanka.

Although CFL program evaluation is generally focused on energy savings (MWh) and peak load (MW) reduction impacts, CDM projects impose additional requirements for the evaluation to related reductions in GHG emissions, as a result of the lowered need for grid-based generation using fossil fuels. The two CDM methodologies commonly used in CFL programs (AMS-II.C vs. AMS-II.J) both specify the pre- and post-implementation survey requirements and the measurement procedures needed to calculate GHG emission savings. CDM projects also require an independent entity to verify and certify the emission reductions.

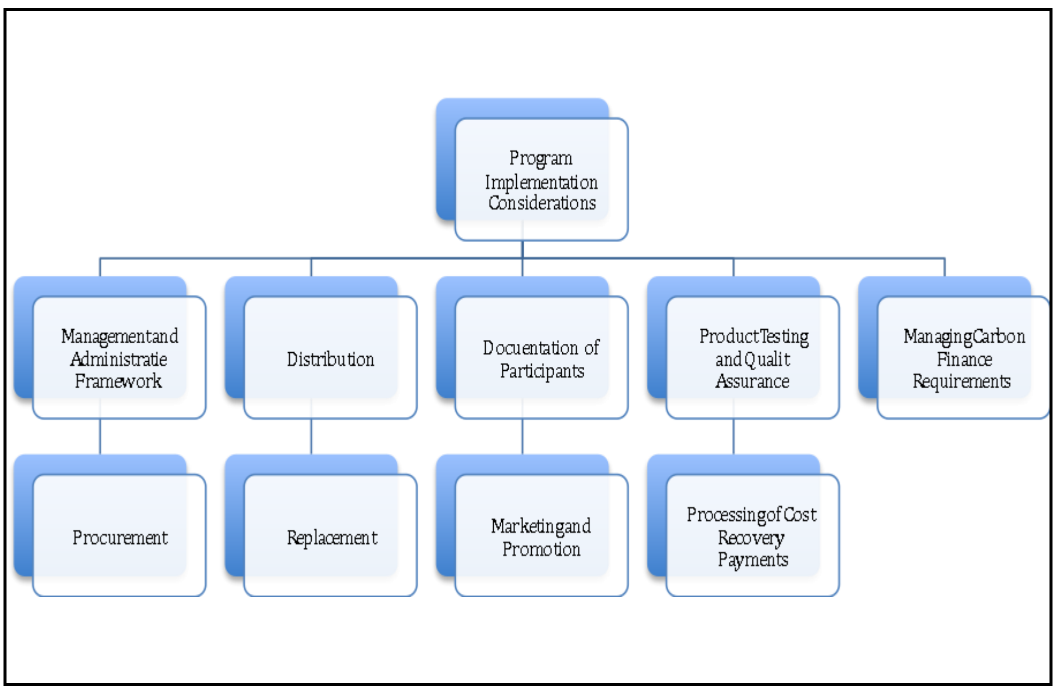
Program Implementation Considerations

The following are some important program design considerations:

- **Management and administrative framework**: The sponsoring government agency and/or utility needs to develop an appropriate framework for the management and administration of various program design elements. This is particularly important when bulk procurement and distribution of CFLs are involved. In many developing countries, there is likely to be little or no experience with such activities and within the government agency or utility, and therefore they may require The World Bank or other donors to assist it in developing a program management unit.
- **Procurement**: In the case of bulk procurement, a competitive bidding process needs to be employed for the selection of the CFL supplier. When World Bank or other donor funds are involved, there may be additional requirements imposed upon the procurement process. Most electric utilities are familiar with the competitive bidding process and therefore, bulk procurement is generally conducted by the utility. In some cases (like in Bangladesh and Pakistan), one utility takes the lead and does a consolidated procurement, while the actual distribution may be done by several different utilities. By consolidating the procurement, the prices of CFLs may be lower because of the larger size of the procurement, and a consistency in the quality can be maintained throughout the larger program, even though different utilities may be focusing on different regions and customer bases of the country.
- **Distribution** - There are many options for the distribution of CFLs to target customers (a discussion has been provided above). The sponsoring agency and utility needs to adopt a distribution approach most appropriate for the country.
- **Replacement of incandescent lamps** - One of the important program design elements is replacing the existing ILs with CFLs and assuring that the ILs are removed from the market. Again, there are several approaches for replacement and destruction of ILs (as discussed above) and an appropriate approach needs to be selected by the sponsoring organization.
- **Documentation of participants** - One major issue concerning implementation is monitoring the proper distribution of CFLs to the target audience. It is necessary to develop a formal documentation process to record the recipients of the CFLs distributed. This element is a requirement under CDM.
- **Marketing and promotion** - As indicated above because marketing and promotion are such important elements in the program design and implementation, the implementation process needs to devote sufficient attention to this.

- **Product testing and quality assurance** - The implementation process needs to assure that high-quality CFLs are being installed. This may require testing of the products in the marketplace. Additional discussion of the product testing and quality assurance considerations is provided in the section on CFL issues below.
- **Processing of cost recovery payments** - If the CFLs are being sold to the customers, the implementation process will include a mechanism for collection of customer payments. As discussed above, an attractive option is to collect the customer payments through the utility bills. If this option is selected, the utility needs to develop an agreement with the customer and modify or adapt its billing system.
- **Managing carbon finance requirements** - If the program design includes applying for carbon credits using CDM, the implementation process will need to address a number of critical CDM requirements, including a more rigorous baseline survey and a number of expost surveys to obtain information on lamp failure rates. A discussion of CDM methodologies and their requirements is provided later in this report.

Figure 9 - Program Implementation Considerations



Source: Developed by the project team based on a review of prior programs

4. Economics and Financing

Illustrative Economics of CFL

Table 7 illustrates the economics of a typical CFL program. The calculations are based on a hypothetical program to replace 1 million 60 watt ILs with 15 watt CFLs.[11] The table shows the key program design parameters, which are based on experience form several recent programs in developing countries. The table shows the program results in terms of the benefits and costs to the customer, utility, and nation.

The results are striking in terms of the beneficial impacts of the program. For example:

- The total program cost is $2.0 million assuming the CFL costs of $1 million, program administration, CFL distribution, and communication and awareness costs of US$500,000, and CDM costs of US$500,000.
- The total customer bill savings are more than 20 times the total cost of the program.
- The utility peak demand savings are 38.9 MW (assuming transmission and distribution losses of 15percent, coincidence factor of 85 percent, net-to-gross ratio of 90 percent, and power factor of 50 percent).
- The total utility capacity cost savings are US$37.9 million and total energy cost savings are US$31.6 million for total utility savings of US$69.5 million (net present value of US$48 million).
- The customer bill savings are US$44.8 million.
- In addition, assuming an emissions factor of 0.8 kg/kWh, the CFL program produces GHG reductions amounting to about 317,000 tons that would provide CDM revenues of about US$3.2 million.
- The NPV of national benefits (using a discount rate of 10 percent) is equivalent to more than US$50 million compared to the total program cost of US$2.0 million.

Table 7 - Illustrative Economics of a CFL Program

(Based on a hypothetical one million CFL program)

PROGRAM INFORMATION		
Number of CFLs Installed	Number	1,000,000
Capacity of CFLs	Watts	15
Rated Lifetime of CFLs	Hours	8,000
Capacity of Incand. Replaced	Watts	60
Cost of CFLs	$/CFL	1.00
Cost Charged to Customer	$/CFL	0.00
Distribution Cost	$/CFL	0.20
Program Management Cost	$	100,000
Marketing & Promotion Cost	$	200,000
CDM costs	$	100,000
Daily Usage	Hours/Day	3.5
Power Factor	%	50%
Coincidence factor	%	85%
Net-to-Gross Ratio	%	90%
CUSTOMER BENEFITS AND COSTS		
Annual Energy Savings	GWH/Year	57.5
Total Energy Cost Savings	Million $	44.8
Avoided Costs of Incendescents	Million $	2.1
Total Benefits	Million $	46.8
NPV of Benefits (Economic Analysis)	Million $	32.6
Customer costs	Million $	0.0
NPV of Net benefits	Million $	32.6
Net Benefits - Costs	Million $	32.6
Benefit/Cost Ratio	Ratio	N/A
UTILITY BENEFITS AND COSTS		
Capacity Savings - Generation Level	MW	38.9
Annual Energy Savings - Utility	GWH/Year	60.5
Avoided capacity Costs	Million $	37.9
Avoided Energy Costs	Million $	31.6
Total Utility Benefits	Million $	69.5
NPV of Benefits (Economic Analysis)	Million $	48.4
Program Costs	Million $	2.0
Revenue Loss	Million $	44.8
Total Costs	Million $	46.8
NPV of Total Costs	Million $	32.9
Net Benefits - Costs	Million $	15.5
Benefit/Cost Ratio	Ratio	1.5
NATIONAL BENEFITS AND COSTS		
Avoided capacity Costs	Million $	37.9
Avoided Energy Costs	Million $	31.6
CDM Revenues	Million $	3.2
Total National Benefits	Million $	72.7
NPV of Benefits (Economic Analysis)	Million $	50.6
Total National Costs	Million $	2.0
NPV of Total Costs	Million $	1.7
Net Benefits - Costs	Million $	48.8
Benefit/Cost Ratio	Ratio	29.5
GHG Impacts		
Total GHG reductions	Thousand Tons	316.9
Total CDM Revenues	Million $	3.2

Source: Calculated using the World Bank spreadsheet model for Economic and Benefit/Cost Analysis of typical CFL programs

Financing CFL Programs

The financing mechanisms utilized in residential CFL programs in developing countries include the following:

- Grants from the GEF or other donors.
- Loans from the World Bank or other multilateral development banks (MDBs).
- Grants from the World Bank's Global Partnership on Output-Based Aid (GPOBA).
- Self-financing by local utility or government.
- Private sector financing.
- Carbon finance using the CDM.

A brief discussion of each of these mechanisms follows:

GEF and Other Grants

The GEF, recognizing the substantial environmental benefits of large-scale implementation of CFLs, has provided grants for CFL programs to many developing countries. Many of the CFL programs implemented under the Efficient Lighting Initiative (ELI) received GEF grants. Examples include programs in Argentina, the Czech Republic, Philippines, and South Africa. GEF has collaborated with UNDP or The World Bank in funding most of these programs. Recent examples have included programs in Vietnam, Bangladesh and Pakistan (with the World Bank), and Russia and China (with UNDP).

World Bank and other MDB Loans

The World Bank and other MDBs have provided loans to a number of countries for implementing CFL programs. For example, the World Bank provided loan funds for recent CFL procurement and distribution activities in Rwanda (from the Urgent Electricity Rehabilitation Project) and Uganda (from the Energy for Rural Transformation Project). The ADB has provided a loan to the Philippines for the Philippines Energy Efficiency Project (PEEP) that includes a major CFL program.

GPOBA

The World Bank's Global partnership for Output-Based Aid recently provided a grant to the Ethiopian Electric Power Company (EEPCo) to fund the cost of connecting poor customers or 286,000 households in rural areas. The proposed one-off subsidy would pay for the costs to provide a five-year loan to poor customers to get connected to the electricity grid and the delivery of two CFLs per household to promote energy conservation and help the customers reduce their electricity bills.

Self-Financing by the Local Utility or Government

In some developing countries, the local utility or a government agency has financed the cost of a CFL program. One recent example is the CFL initiative of the Mauritius Central Electricity Board (CEB) in which the CEB purchased CFLs in bulk and sold up to 4 CFLs to customers at a low price. The objective of the CEB was to reduce electricity consumption and peak loads. The Bangalore Efficient Lighting Program (BELP), sponsored by the local utility BESCOM, is another example.

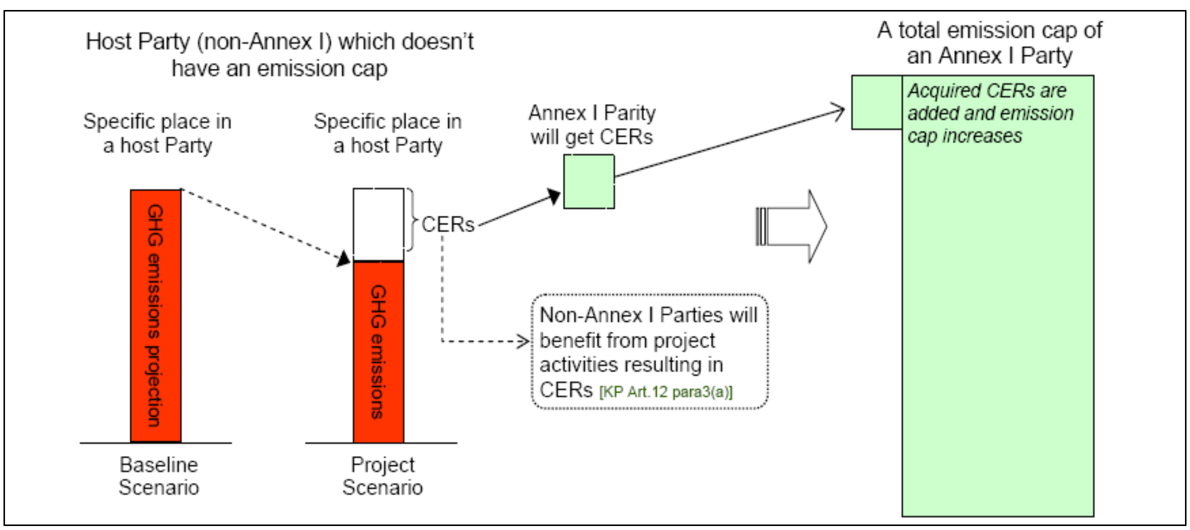
Private Sector Financing

The economics of CFL programs are very attractive and therefore may offer the private sector sufficient incentive to implement CFL programs, particularly if the potential revenues from the sale of carbon credits through CDM are also available. The Indian Bureau of Energy Efficiency, the national agency responsible for promoting energy efficiency, has encouraged private sector implementation of CFL programs in different regions of India by creating a Program of Activities (PoA) under the CDM provisions of the UN Framework Convention for Climate Change (UNFCCC). Additional discussion of the PoA mechanism is provided below. The Bureau of Energy Efficiency program provides a mechanism for the private sector to engage in CFL implementation and obtain the CDM revenues. As of November 2009, five projects (Projects 0079, 1754, 2457, 2476, and 2709) and one PoA (Reference number 2535) had been registered with the UNFCCC as can be seen from the CDM Projects Database.

Carbon Finance Using CDM

The Kyoto Protocol, a supplementary agreement to the 1992 UNFCCC, came into force on 16 February 2005. The treaty includes provisions for a Clean Development Mechanism (CDM), which gives monetary value to GHG reductions achieved through projects implemented in developing countries. The CDM allows industrial countries and authorized private entities to acquire credits in exchange for financing climate protection measures in developing countries that also contribute to the sustainable development of the host country (see Figure 10). The resulting credits (known as certified emission reductions or CERs) can be used by industrial countries to meet their climate protection obligations.

Figure 10 - Basic Concept of CDM



Source: CDM in Charts, V7.0 (February 2009)

Discussion of CDM and Carbon Finance

Economic Benefits of CDM

CFL programs typically have negative marginal GHG abatement costs, since savings in electricity costs rapidly pay for the additional up-front investment in the CFLs. Therefore, CDM programs make enormous economic sense from a utility or national perspective. Yet many CFL programs are giveaway programs, with no income stream, so CER revenues are essential for the projects to be viable, from a utility's financial standpoint. Similarly, end-users seldom make investment decisions that take into account the lifecycle cost of the technologies they buy. Rather, they consider the immediate capital outlay – and CFLs remain significantly more expensive in retail markets than ILs.

The economic benefits of carbon finance under CDM can be quite substantial. In the economic analysis example cited above, if carbon credits are valued at a market price of US$10.00 per ton, the total carbon revenues will be about US$3.2 million, or more than US$3.20 per CFL. However, as discussed below, CDM projects impose substantial survey, analysis and verification requirements, as described in a recent paper by Milestone Energy, and only five CFL projects and one Program of Activities had been registered for CDM as of November 1, 2009 (Projects 0079, 1754, 2457, 2476, and 2709 as listed in the UNFCCC CDM Projects Database, and Program 2535 as listed in the UNFCCC Programme of Activities).

CDM Methodologies

CDM projects must qualify through a rigorous public registration and issuance process designed to ensure real, measurable and verifiable emission reductions that are additional to what would have occurred without the project. The mechanism is overseen by the CDM executive board (EB). In order to be considered for registration, a project must first be approved by the designated national authority (DNA) for the country. To apply for carbon credits under CDM, a CFL project/program must apply a baseline and monitoring methodology that has been pre-approved by the CDM executive board[12] and request validation by the department of energy (DOE). At present, three approved methodologies applicable to CFL programs are available, one large-scale (AM0046) and two small-scale[13] (AMS-II.C. and AMS-II.J).

- AMS-II.C. – Demand-side energy efficiency activities for specific technologies (available since November 1, 2002)
- AMS-II.J. - Demand-side activities for efficient lighting technologies (available since August 2, 2008)
- AM0046 - Distribution of efficient light bulbs to households (available since February 16, 2007)

The latter two methodologies were designed specifically for residential CFL programs, whereas AMS-II.C is widely applicable to end-use electrical efficiency activities (yet it contains some provisions specific to CFL programs). Each of these methodologies faces limitations that have prevented its widespread uptake in the marketplace. As of November 1, 2009, only five CFL projects and one PoA had been registered for CDM as of November 1, 2009 (Projects 0079, 1754, 2457, 2476, and 2709 as listed in the

UNFCCC CDM Projects Database, and Program 2535 as listed in the UNFCCC PoA), despite the fact that AMS-II.C has been available since 2002. A comparison of AMS-II.C and AMS-II.J is provided in Table 8 below.

Some of the difficulties of project registration may be overcome with the emergence of the concept of programmatic CDM, also known as PoA which can combine several small projects (also called CPA) in a spatial and temporal (up to 28 years) scale, without defining more than one CPA in the beginning. The PoA concept can facilitate the implementation of large- scale CFL programs (which may be spread over several cities or municipalities or regions, each one of which can be considered as an individual CPA) that are easier to implement.

Additional information on the Program of Activities is provided here.

Table 8

Key Methodological Characteristics of AMS-II.C and AMS-II.J

Category	Key Methodological Characteristics
Ex-ante Survey & Implementation Planning	AMS-II.C: IL usage pattern; CFL penetration rate. AMS-II.J: IL usage pattern; CFL penetration rate; Net-to-Gross (NTG) ratio.
CFL Distribution and ILB Replacement	AMS-II.C: Direct installation and/or distribution at dedicated distribution points; no formal requirement on CFL process or replacement of defective CFLs AMS-II.J: Direct installation, minimal price charge for the CFLs (i.e. no give-away) or restriction of CFL distributed per household; mandatory replacement of defective CFLs
Monitoring	AMS-II.C: Sample group monitoring for daily lighting usage; ex-post CFL functionality check AMS-II.J: Deemed value for daily lighting usage; ex-post sample group monitoring for CFL functionality check.
Scrapping	AMS-II.C and AMS-II.J: Disposal of ILs to be documented and independently verified. The number of destroyed ILs to match number of distributed CFLs.

Source: KFW Bankengruppe, PoA Blueprint Book: Guidebook for PoA coordinators under CDM/JI, *Frankfurt am Mein, 2009*

There are some differences in the ex ante survey requirements of the two methodologies. Both AM0046 and AMS-II.C require monitoring of CFL hours of operation throughout the implementation period of the programs, which adds complexity, cost and uncertainty to projects that wish to apply these methodologies. The program design and monitoring provisions in AM0046 are particularly cumbersome. AMS-II.J, developed under World Bank sponsorship, draws on best practice in utility demand-side management program monitoring and evaluation, and relies on conservative ex ante estimation of energy savings. It was specifically designed to avoid the need to monitor individual CFLs during their operation. However, AMS-II.J requires several ex post surveys to be conducted to estimate the ex post lamp failure rates.[14]

CDM Implications for CFL Project/Program Preparation

If a CFL project or program is to be implemented under the CDM, it is imperative to consider CDM aspects early in the process of project preparation, since they are related to basic program design parameters that can be impossible or costly to change at later stages of project preparation. AMS II.J., for example, stipulates that the CFL project activity must be designed to limit undesired secondary market effects (for example, leakage) and free ridership by ensuring that replaced lamps are exchanged and destroyed. It goes on to require project participants to undertake at least one of the following measures: (a) direct installation of efficient lighting equipment; (b) charging at least a minimal price for efficient lighting equipment; or (c) restricting the number of lamps per household distributed through the project activity.

Two important CDM requirements relevant at the project design stage that are common to at least two of the approved CDM methodologies are additionality considerations and development of baseline information:

- **Additionality considerations**: A CDM project activity is considered "additional" if it reduces GHG emissions below those that would have occurred in the absence of the CDM project activity. Different rules for demonstrating additionality apply to large- and small-scale CDM. Demonstration of additionality for CFL programs should be relatively straightforward, particularly for CFL activities with no income stream other than CER revenues. However, if a CFL activity has already been announced with no mention of the CDM, it may be difficult to later claim that the activity is additional and would not have been implemented were it not for the CDM.
- **Baseline (ex ante) information**: The approved baseline and monitoring methodologies applicable to CFL projects and programs (except AMS_II.J) require some ex ante data collection through a baseline survey. AM0046 provides guidance on related statistical sampling techniques, which need to be taken into account when preparing and conducting the baseline surveys. One challenge of the CDM process is that even though a methodology may have been approved, it can still evolve through revisions, so it is imperative to use the current version of the respective methodology.

CDM Program of Activities

As discussed above, a PoA is a voluntary coordinated action plan by a private or public entity, which coordinates and implements any policy, measure, or stated goal (that is, incentive schemes and voluntary programs), and which leads to GHG emission reductions or increased removals by sinks via an unlimited number of CDM projects. UNEP has recently published a primer on CDM PoA. The PoA approach allows for the aggregation of benefits from a number small-scale CDM projects, and may therefore be useful in designing a national CFL initiative that is implemented as a series of small-scale projects in different parts of the country. In order to develop a PoA it is necessary to file the project design document for the PoA, (called the CDM-PoA-DD) and supplement it with a project design document for one already existing real CDM program activity (called the CDM-CPA-DD). The Bureau of Energy Efficiency in India has launched a national CFL program using the PoA approach. The PoA serves as an umbrella CDM project and has been registered with the CDM executive board. The individual projects in different Indian cities, designed to be in conformance with the umbrella project, are being added to the umbrella project as they are prepared.

The World Bank Carbon Finance Unit Project Cycle

Text Box 4 below following page defines the key steps in the project cycle used by the World Bank Carbon Finance Unit.

Box 4: Steps in the World Bank Carbon Finance Unit (CFU) Project Cycle

Project Idea Note (PIN): Potential projects are submitted to the CFU in the form of a PIN. The PIN consists of a 6-page form that is then quickly analyzed by the Bank.

Early Notification and Letter of Endorsement (LoE): In the case that a third-party project sponsor submits the PIN, the Bank will contact the host country to ensure that it is aware of both the project and the follow-up responsibilities required under the Kyoto Protocol.

Host Country Committee Memorandum of Understanding (HCC MOU): Signing an MOU enables a host country to join the HCC and attend members' meetings.

Carbon Finance Document (CFD): Formerly known as the Project Concept Note (PCN), the CFD is an intermediate document that provides enough information on the project that the Fund Management Committee is able to review and clear the project for further development.

Letter of Intent (LoI): By signing this letter, the project entity commits itself to repaying project costs if it does not proceed to negotiate an Emission Reductions Purchase Agreement.

World Bank Due Diligence: All projects are subject to an Integrated Safeguard Policies review and an Environmental Assessment (EA).

Baseline Study (BLS) and Monitoring Plan (MP): During this stage, the project entity is required to outline pre-implementation baseline conditions. Furthermore, the project entity must establish a means of monitoring savings earned during the project cycle.

Letter of Approval (LoA): The host country formally approves the project and confirms that the project assists the host country in achieving sustainable development.

Project Design Document (PDD): This document enables the operational entity to determine that the project has (a) met approval by all parties, (b) would result in emissions reductions, and (c) has an appropriate baseline and monitoring plan.

Validation: The CFU engages an independent validator who must agree that (a) emissions reductions are additional to the baseline, (b) the MP is sufficient, and (c) the emission reductions have a high chance of being certified under the Kyoto Protocol.

Pre-Negotiations Workshop: This event brings together all involved parties to ensure fairness in the process of negotiating a Host Country Agreement and an Emissions Reduction Purchase Agreement (ERPA).

Negotiations/Host Country Agreement/ERPA: The final terms of the ERPA are agreed between the CFU, project sponsor, and host country. The project sponsor then signs the ERPA, and the host country signs the corresponding Host Country Agreement.

Post-Negotiations Workshop: The CFU may use this workshop to share "best practices" learned from the project with a wider group of CFU constituents, as well as other host countries.

Initial Verification: The CFU contracts a verifier who confirms that the project is ready to generate certifiable ERs.

Monitoring: The project operator is responsible for implementing the MP, which allows the project entity to calculate the emissions reductions generated by the project.

Verification and Certification: The verifier will issue a certificate, which confirms that the ERs have been achieved in compliance with applicable CDM rules.

Transfer of Emission Reductions: The CFU will pay for ERs as agreed upon in the ERPA and the ERs are transferred in accordance with the ERPA and Host Country Agreement.

Source: World Bank, Carbon Finance, Project Cycle, http://go.worldbank.org/P3OAVIT6Q0.

5. Key Issues with CFLs

CFL Quality

The quality of CFLs has been a constant source of great concern for manufacturers, consumers and market surveillance authorities alike. Poor quality CFLs have in the past tainted the image of what is essentially a very efficient light source, by underperforming relative to consumer expectations of lifetime, lumen maintenance, light color, and aesthetics, such as shape and size. The newest generations of CFLs are much better-performing products compared with those put on the market in the past, although discontent lingers with some users, in particular concerning the perceived reliability of performance, as well as size and appearance.

Manufacturers need to keep tight quality controls on CFL manufacturing processes and suppliers are generally expected to maintain ISO9000 quality system standards. To meet product claims required by the CE mark (indicating that it complies with the relevant European "New Approach" product safety directives, which contain the essential requirements that a product must meet to be sold in the European Union (EU), or Energy Star in the United States, manufacturers are obliged to regularly audit manufacturing sites and maintain data reporting systems to evaluate long-term conformance. Energy-saving fluorescent lamps or their lamp packaging have carried conformance markings (such as CE-Mark and Energy Star) since the late 1990s.

CFL lamps have evolved to the point where good-quality lamps now are usually very similar in functionality to incandescent lamps. They last longer, and they will continue to get smaller, better, more efficient, safer, and less expensive. Energy-saving lamps from reputable manufacturers render a light quality that approaches very closely that of incandescent lamps. The CRI expresses the level to which colors are represented in its natural form, that is, as if lit by sunlight. Where an incandescent lamp has a CRI of 100, good-quality CFLs typically have a CRI value between 80 and 85, which is appropriate for most domestic applications and shop display lighting.

In addition to the EU legislation, several regional charters or specifications accounting for usage patterns and quality requirements in differing parts of the world lay out a variety of technical requirements for CFLs, of which the most commonly available are as follows:

- U.K. Energy Saving Trust
- EU CFL Quality Charter
- ELI (Efficient Lighting Initiative)
- US Energy Star standard
- Asia CFL Quality Charter

Health Issues

Efforts around the globe to phase out incandescent lamps have provoked large-scale cross-continent discussions fueled mainly by the press on possible health-related issues concerned with CFLs or fluorescent lighting in general. Some stakeholder groups (Lupus

UK, Eclipse Support Group, Spectrum (UK) and Lupus DK) have brought to public attention that some end users who are light sensitive are concerned that shifting to lighting sources other than low wattage incandescent lamps may affect their quality of life. The presence of flickering and electromagnetic fields is also causing concern to some stakeholders. In the European Union, the European Commission (DG SANCO) has given the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) the mandate to study these alleged effects. In September 2008 SCENIHR reported its findings on light sensitivity and other health-related issues.

Although data on CFL related health issues is limited, a number of evidence-based scientific studies and various position statements put forward by industry in various parts of the world have systematically provided answers that shed light on the alleged health impacts of CFLs. The conclusions are that energy- saving lamps are safe to use for consumers and workers alike.

In the EU, a range of stringent measures have been implemented to manage the alleged health risks arising from products such as lamps. Measures include the CE conformity marking, the EU General Product Safety Directive, and the EU Directive on the protection of workers from the risks associated with physical agents, as well as the Low Voltage Directive (LVD) and Electromagnetic Compatibility equipment directive (EMC) which relate to the protection of consumer safety. Lamps that bear the CE mark meet all the criteria of the relevant EU legislation, including health protection.

Voltage Fluctuation

Voltage fluctuation refers to the presence of any distortion on the network, including electronic disturbance to other appliances. Wide voltage fluctuation causes higher temperatures, which can cause circuits to burn out, leading to significant damage to the circuit as well as the equipment. Such disturbances have led CFLs in some cases to have shorter lifetime.

The primary cause of voltage fluctuations in the medium-and high-voltage grid (>1000 VAC) is the time variability of the reactive power component of fluctuating loads. In the low voltage grid (for example, 230/400VAC) it is the fluctuating load of active and reactive power. Also variations in the distributed energy resources) generation capacity can have an effect and, because the number of such installations will increase in the future, it can be expected that voltage fluctuations will increase accordingly. For lamps, the flicker that is generated significantly impairs vision and could cause general discomfort and fatigue. The permissible magnitude of light flicker is regulated by International Standards related to incandescent lamps (ILs), or so-called general lighting service (GLS) lamps.

For these ILs the permissible supply voltage variation (+/-10 percent) causes an incandescent lamp to deliver as little as 70 percent or as much as 140 percent of its nominal luminous flux. The same is true for other filament lamps that are directly operated by the mains (for example, mains voltage halogen lamps). Fluorescent lamps are less sensitive and will vary only +/-20 percent, and even less when they are operated by inverters with power factor controllers, for example, all electronic ballasts above 25 W. Voltage fluctuations cycle much faster in CFLs than in old tube fluorescents, so there is no perceptible flicker.[15]

In practical tests, lamp performances have been generally better in areas where the power quality is fairly stable. Voltage fluctuation could imply that the network supply is not stable, that is, that it is below 230 V or above 260 V. Most lamps that have been tested at the voltage variation of 6-10 percent have passed the test, thus functioning well within this tolerance level.

Power Factor

The power factor of an AC electric power system is defined as the ratio of the real power to the apparent power and is a number between 0 and 1 (see FAQs for Power Factor). Real power is the capacity of the circuit to perform its work in a particular time. Apparent power includes the reactive power that utilities need to distribute even when it accomplishes no useful work. *Low-power-factor loads can increase losses in a power distribution system and result in increased energy costs.*

Many electronic sources including CFLs are capacitive. In general the grid tends to be more inductive because of the high amount of motor loads and in industry, power factor compensation (PFC) capacitors are frequently installed. Incandescent lamps and electronic ballasts with power levels above 25 W have a power factor equal to 1, but electronic ballasts because an active PFC circuit is needed in order to satisfy the harmonic current limits of standard EN 61000-3-2 note that there is no direct limitation on the power factor itself in the standard but it is a consequence of the harmonic current requirement and the technology used.[16] Hence CFLs that capacitive are unlikely to create strong negative grid influences because they rather compensate inductive loads and are unlikely to dominate the total active power demand of the grid.

There is a general misconception that the low power factor of CFLs actually increases their energy consumption, and associated emissions, because of system losses. This is not true. An excellent discussion of power factor issues related to CFLs is provided in a report by the Electricity Commission of New Zealand.

Compared to incandescent lamps, CFLs with electronic ballast represent nonlinear loads for distribution networks. While the savings for consumers are related to lamp efficacy (lumens per watt), savings for utilities are somewhat compromised if replacement lamps' power factor is too low. In this case, the still high current needed to cope with peak demand translates into unnecessary distribution and network losses. The unused power, known as reactive power, is partially wasted in the process of being transferred and retransferred, and takes a toll on the infrastructure of the distribution system leading to overheating of transformers, cables and motors; premature aging of capacitors; and interference with telecom systems. CFLs with a high power factor (HPF) are an attempt to make up for the waste and stress on networks caused by regular CFLs. HPF CFLs mimic linear demands and so make up for conflicts between how power is supplied and how CFLs use power.

According to the technical studies conducted under the sponsorship of the European Commission to prepare for the regulation on household lamps, even if they have a poor power factor, CFLs are overall much more energy efficient than incandescent lamps. Moreover, the EU regulation on household lamps requires a minimum power factor for CFLs.

The European Council for Energy Efficient Economy (ECEEE) recommends that a few large-scale field tests with high CFL saturation should be set up and closely measured in order to settle the issue. The ECEEE also supports the European Commission's approach of gradually tightening the power factor requirements. ECEEE further believes that making HPF mandatory at this stage would be counter to the interest of consumers, manufacturers and society as a whole. HPF lamps should rather be introduced in the standard, not made mandatory. Households would not necessarily get any additional benefit from 0.85 PF lamps. It is the utility and the electricity distribution companies that will get the benefit out of the HPF lamps.

Harmonic Distortion

In many homes, energy suppliers have observed network pollution by harmonic interference originating from appliances such as televisions and personal computers. The replacement of conventional ILs with energy efficient electronic lighting equipment will result in a reduction of the load of the electrical network (mains). Electronic lighting equipment, however, is a nonlinear load that will inject harmonics into the mains. In general, harmonics injected into the mains will distort the waveform of the mains voltage, will increase the network losses (both generation and transport), and can lead to an overload of the PEN conductor in a three-phase "WYE" (or "Star") distribution network. CFLs provide low harmonic interference and some energy suppliers have discussed or claimed that the manufacturers should introduce an electronic compensation system in the CFL. Discussions of harmonics issues associated with CFLs can be found in a report by the Electricity Commission of New Zealand and in papers by Prof. Watson and Prof. Girdwood.

The limitation of the negative effects of the injected harmonics is safeguarded by IEC standard 61000-3-2 "Limits for Harmonic Current Emissions." The standard requires severe harmonics limitations for electronic lighting equipment with an active power (P) above 25 W. Reduction of harmonic emissions is, however, not obligatory for appliances with an active input power of less than 25 W. There is, thus, no regulation that requires compensation for CFLs. A comprehensive field test study carried out by the Community of the Austrian Electricity Suppliers,[17] including laboratory measurements and field measurements, proved that the extensive use of CFLs did not lead to negative effects on the voltage quality. It was concluded that remedial measures are not necessary. This is in accordance with the result of an inquiry made by the German umbrella organization ASEW, including six local energy suppliers, which showed that none of them had experienced any problems with harmonic interference caused by the use of CFLs (VITO).

Requirements of the internationally accepted IEC standard 61000-3-2 sufficiently safeguard the power quality of the mains. Therefore, no risks are to be expected of electronic lighting equipment that complies with this standard.

ENVIRONMENTAL ISSUES

Overall environmental impact

It takes approximately five times more energy to produce one CFL compared to one energy inefficient incandescent lamp. However, as CFL lamps last on average between 6 and 15 times longer than ILs, the amount of energy needed for the production of one CFL is comparable to the production of between 6 and 15 ILs. According to the technical study ordered by the European Commission to prepare for the regulation on household lamps the impacts of energy savings during the use of a CFL clearly outweigh the environmental impact of its production and its end-of-life. Therefore using CFLs in place of ILs reduces the overall energy use and the environmental impact of lighting. More than 97 percent of energy consumed during the lifecycle of a lamp is in the use phase and as CFLs are up to 80 percent more efficient than an average inefficient incandescent lamp, the savings are very large.

European legislation on Waste Electrical and Electronic Equipment (WEEE - 2002/96/EC) and Restriction of Hazardous Substances (RoHS – 2002/95/EC) are the two pieces of EU legislation regulating the use and disposal of environmentally sensitive substances, such as for instance mercury content in discharge lamps.

Mercury Content

Mercury is an important component of CFLs and plays a key role in their energy efficiency and also other parameters such as lifetime and warm-up times. No other material has been found to replace mercury and reach comparable energy efficiency. There are up to 5 mg (0.005 grams) of mercury contained in a CFL (compared to 0.5 g in dental amalgam filling or several grams in older thermometers). The 5 mg limit is set in the EU's Restriction of Hazardous Substances Directive (2002/95/EC).

Mercury is, however, present in CFLs in such a small amount that during their lifetime, a CFL will have saved more mercury emissions from electricity production in coal power plants (compared to the mercury emissions related to the incandescent bulbs' electricity need) than is contained in the CFL itself. According to the technical study ordered by the European Commission to prepare for the regulation on household lamps, even in the worst possible case that a CFL goes to the landfill, during its lifetime it will have saved more mercury emissions from electricity production in coal power plants (compared to the mercury emissions related to the electricity needs of the IL replaced) than is contained in the CFL itself, so the overall mercury pollution balance will be positive. See discussion of mercury issues in the FAQs published by the European Lamp Companies Federation.

CFLs have been widely used in European homes in the past decade. Most office and public buildings, and most streets have been equipped for the last 50 years with fluorescent and high-intensity discharge lamps containing mercury (often much more than CFLs).

According to European legislation governing the collection and recycling of waste electrical and electronic equipments (WEEE), mercury needs to be removed from the collected lamps through treatment, and their recycling should meet an 80 percent minimum target. Once consumers learn that they have to take back their burned-out CFLs to collection points just as they do with batteries, the mercury content will be recycled and not released to the environment. No mercury is emitted from lamps when in use, which is why they are safe, both in regard to human health and the environment.

Over the past 25 years, lamp manufacturers have developed innovative ways to increase lamp performance while minimising the use of mercury. The mercury content of lamps has therefore been reduced by more than 90%.

Waste & Recycling

The European Waste Electrical and Electronic Equipment (WEEE) Directive sets the requirements for the collection and recycling of all discharge lamps, and has been in effect since August 13, 2005. The exemptions include incandescent and halogen lamps, which do not need to be recycled because of the absence of environmentally sensitive substances and †he lack of any significant economic justification. Additionally, in line with producer responsibility, the WEEE directive requires each manufacturer to finance the cost of collection and recycling for the products they have put on the market in the EU.

Information on recycling of CFLs has also been published by the US EPA. The ADB has designed a waste lamp recycling program for the Philippines and has conducted a survey of lamp recycling facilities

Systematic collection ensures that the various materials, including mercury, are recovered and recycled or disposed of in an environmentally sound way. More than 80 percent of the material in lamps is recycled resulting in fewer resources needed to produce new goods.

The management of the collection and recycling infrastructure is carried out by qualified third-party experts. Specific to recycling great efforts have been made to adopt a method of high-grade recycling, which corresponds to the type and properties of the waste. This is guaranteed by the lamp manufacturers' contract partners certified or approved as a Specialist Disposal Company, as legally defined. The main objective of the WEEE directive is the recovery of unmixed materials in order to facilitate primary recycling. To encourage recycling, all spent WEEE lamps from homes can be returned to the manufacturer free of charge according to the national WEEE legislation in the different EU member states.

The lamp recycling process produces the following material streams: glass, ferrous and nonferrous metals, and fluorescent powders that contain mercury. Although most of these materials can be reused, almost all of them have practically no material value to the recycler. To stimulate more efficient use of the recovered material, it is essential to maintain ongoing cooperation between the lamp manufacturers and the recycling industry.

Improvements in product design are aimed at further reducing or eliminating altogether environmentally sensitive substances, minimizing the variety of materials used, and improving the ease of disassembly.

Testing, Certification & Market Surveillance

Lamps that bear the CE mark meet all the criteria of EU legislation, which relate to protecting consumer safety and ensuring product standards. The conformance marking acts as a "passport" into the single market, and demonstrates product compliance with the so-called 'new approach' directives. CFLs or their lamp packaging have carried a CE Mark since January 1998. The marking can be granted on the basis of a "self declaration" by the product manufacturers. As such, if market surveillance is not effective, it is possible for sub-standard products to be made and marketed without detection.

Unfortunately, not all lamp producers play by the rules. European citizens are faced with an array of lamps and lighting products that do not comply with the most basic requirements for product safety and functionality. Unfortunately they are not stopped from being placed on the market because of failures in market surveillance. Unless effective and timely market surveillance systems are implemented in Europe, free riders and substandard imports will continue to enter the European market in growing numbers to the detriment of consumers. It is crucial that remedies are therefore found – and quickly.

The European Lamp Industry has supported the creation of ICSMS – an Internet-Based Information and Communication System for Cross-Border Market Surveillance. This system enables the exchange of information and joint operations for all authorities involved in market surveillance (for example, market supervision ans customs authorities). It is also open to the public, so that consumers can gain access to information on certified products and identify rogue traders.

The system can also be used as a tool by distributors to help them comply with Directive 2001/95/EC on general product safety, in which they are required to act with due care to help ensure compliance with the applicable safety requirements and not to supply products they know that do not comply with those requirements.

A list of ELI certified test facilities is provided here.

6. Lessons Learned

The experience from CFL programs implemented in recent years demonstrates the major benefits of such programs in energy and demand savings. Table 9 below illustrates the results from some of the programs in peak load reduction, which has been one of the primary objectives of CFL programs.

Table 9 - Examples of Peak Load Reduction from CFL Programs

Country	No. of CFLs Installed	Reported MW Peak Reduction	Peak Reduction/ 100,000 CFL
Vietnam	1,000,000	33	3.3
Uganda	800,000	30	3.8
Sri Lanka	733,000	34	4.6
South Africa	2,700,000	90	3.3
India-BELP	300,000	13.5	4.5

Source: Assembled using information from various program evaluation reports

The experience from prior programs (as documented in the CFL Toolkit) concerning program design characteristics, implementation mechanisms, bulk procurement procedures, and survey instruments provides valuable information for the design and implementation of new CFL programs. It should be noted, however, that the experience clearly points out that there are significant differences across various countries among the customer characteristics, market characteristics, utility supply-demand situations, customer awareness and interest in CFLs, and other key factors influencing CFL program design and implementation. Therefore it is strongly recommended that, while the experience from prior programs documented in the toolkit and elsewhere provides useful guidance, the program design needs to be customized for local conditions.

The economic benefits of CFL programs are extremely high. As shown above, a typical 1 million CFL program costing US$2 million can provide load reductions of 38.9 MW, representing utility cost savings of more than US $69 million over the life of the CFL. The program also provides reductions in GHG emissions of over 300,000 tons of CO_2 equivalent.

Some of the other important lessons learned are summarized below:

- **Bulk procurement** - The bulk procurement and distribution approach can be very useful in providing quick results on peak load reductions (as well as reductions in energy use and GHG emissions). As indicated above, this approach can also lead to substantial reductions in the per unit costs of high-quality CFLs (as shown in Table 4 above). Other benefits of bulk procurement include the assurance of product quality (through the technical specifications for the procurement). Therefore, it presents a promising option for countries requiring short-term results.

  It should be pointed out, however, that, while some bulk procurement projects (such as in Vietnam) have stimulated the overall market for CFLs in the country, this approach may have negative impacts on existing retail channels, particularly when there are multiple suppliers of high-quality CFLs in the market. Also, if the lamps procured under bulk procurement are given away at no cost to the consumer, it is unclear whether the program would be conducive to long-term sustainability of the CFL market.

- **Long-term strategy** - When implementing the bulk procurement strategy, it is important to keep consider the implications of such a strategy for the long-term sustainability of the market. While the bulk procurement and distribution approach can provide quick results, it is important to recognize that such a strategy is not sustainable and a transition needs to be made to traditional retail channels for distribution and sale of CFLs. Such a transition will need to be adapted to specific local market conditions (for example number of manufacturers, number of retail outlets, market prices, quality of lamps in the market, and government policies and regulations). A key element of such a strategy is the determination of how price reductions obtained through bulk procurement may be sustained.

- **Market channel-based approaches** - Market-based programs involving coupons or rebates may be more appropriate for mature markets where there are many suppliers of high-quality CFLs. Such programs can stimulate the market and provide benefits not only to the customers and utilities but also to the CFL suppliers and retailers, and strengthen existing market channels, thereby contributing to an expanded long-term sustainable CFL market.

- **Market transformation** - Properly designed CFL programs can have substantial beneficial effects on market transformation resulting from the increased customer awareness and interest and the documentation of the benefits of the high quality CFLs. In the Vietnam CFL program, the program evaluation concluded that, while the direct peak load reductions from the program were 33 MW, the indirect effects resulting from the market transformation were as high as 250 MW.

- **Marketing and promotion** - Program evaluations have pointed out the importance of the marketing and promotion campaigns in influencing the customers decisions on the purchase and installation of CFLs. It is difficult to generalize which particular marketing and promotion approaches are most effective because these are highly influenced by customer and market characteristics. In the design of any new programs, careful attention needs to be devoted to developing effective communication and outreach efforts for promoting CFLs.

- **Assuring product quality** - In most developing countries, there is a wide range of quality in the CFLs available in the market. The bulk procurement and/or market-based strategies, combined with marketing and promotion of high quality CFLs provides the first important step in creating customer awareness of CFL quality. However, other actions may also be needed to assure product quality in the market. Examples include standards and labeling of CFLs, elimination of taxes and duties on imports of high-quality lamps (and possibly higher taxes and duties on low-quality lamps), and long-term customer education and awareness campaigns stressing product quality, establishment of testing laboratories and random testing of products in the market, etc.
- **Phase-out of incandescent lamps -** Many countries are moving toward banning (or have already banned) incandescent lamps, so as to force the customer into buying CFLs. While such regulatory or legislative phase-outs of incandescents will definitely lead to a rapid and large-scale implementation of CFLs, the issue of CFL quality becomes even more important in such situations. Any phase-out needs to be combined with measures to assure that only high-quality CFLs are available in the market.
- **Carbon finance** - CFL programs provide substantial savings in GHG emissions and can therefore benefit from carbon finance through CDM. As shown in the economic analysis, the carbon credits available from CFL programs can be worth more than the entire program cost. However, as pointed out in the discussion above on carbon financing, CDM imposes considerable time and cost requirements (for surveys, project development and verification) that may delay the achievement of the peak load reductions.

7. CASE STUDIES

Vietnam Case Study

Case Study Report

Annex 1 - Phase 1 CFL Pilot

Annex 2 - Bidding Document – Stage 1 Procurement

Annex 3 - Bidding Document – Stage 2 Procurement

Annex 4 - CFL Program Implementation Plan

Annex 5 - TOR for Monitoring and Evaluation

Annex 6 - Program Evaluation Report

Post-Installation Survey Instrument

GEF Project Appraisal Document

SEIER Project Appraisal Document

GEF Grant Agreement

Uganda Case Study

Uganda Case Study

Annex 1 - CFL Technical Specifications

Annex 2 – Tender for CFL Procurement

CFL program Concept Note

Presentation on Short-Term Approaches to Address Electricity Shortages

Survey Report - Pre-Installation Survey

Survey Instrument - Post-Installation Survey

Monitoring and Evaluation Report

BESCOM Case Study

Case Study – Bangalore Efficient Lighting Program (BELP)

Annex 1 – Program design and RFP for Supplier Selection

Annex 2 – BELP Program – Design, Implementation and Evaluation

Post-Program Survey

BELP Evaluation Committee Report

India Bachat Lamp Yojana

India's Bureau of Energy Efficiency has launched a comprehensive national CFL program. See the brochure on the Bachat Lamp Yojana.

ANNEX – SUMMARY OF CFL PROGRAMS

Country	Program Name	Primary Program Administrator	Implementaion Period	Targeted Market Segment(s)	CFL Market Maturity (Low - Medium - High)	No. of Lamps Procured / Distributed	Free vs Cost Recovery	Cost Recovery (Loan) Program	Financial Incentive / Subsidy	CFL Distribution Approach	Source(s) of Program Funds	Carbon Finance? (Y/N)	Savings (Verified or Projected)
Argentina 1	Efficeint Lighting Initiative	EDESUR	March 2000 - November 2003	Residential	Low		Market driven	0% loan with repayments on utility bill				No	Post-implementation survey conducted
Argentina 2	Energy Efficient Lighting Programme	CAMESSA (the national wholesale electricity market administrator)	July 2009 - December 2011	Residential	Low/Medium	25 million (projected) 8.5 million distributed as of Nov. 2009	2 free CFLs per household in exchange for 2 Ils	None	None	Direct distribution to households by utilities	GEF and National government	Yes	
Bangladesh	Efficient Lighting Initiative Bangaldesh	Rural Electrification Board (REB) and other utilities	2010 - ongoing	Residential	Low	10.5 million (projected)	2 free CFLs per household	None	None	tbd	IDA	Yes	350 - 400 MW peak demand reduction (projected)
Benin	Benin Energy Efficiency Project	Energy-efficiency unit of the Energy Directorate	2009 - ongoing	Urban residential		350,000 (projected)	Subsidized		4 CFLs for the price of 1 IL		GEF		9.8 MW and 18,000 MWh per year (projected)
Bolivia			2008 - 2009			8.5 million							
Brazil													
China 1	Shijiazhuang Green Lighting Project, Hebei Province		2007 - ongoing			600,000/year (projected)					GEF?	Yes	20 MW/year (projected)
China 2	China Green Lights Programme	National Development & Reform Commission	2008 - 2012	Residential and Commercial		None - marketing & promotion only - in conjunction with IL phase-out	na	None	None	na	GEF		7.5 TWh/yr & 7.5 million tons carbon (projected)
Cuba	Energy Revolution		2006 - 2007	Residential	Low	9 million - virtually all Ils replaced	Free	None	None	Direct distribution to households	Government	No	
Czech Republic	IFC/GEF Efficient Lighting Initiative	International Finance Corporation	2001 - 2003	Residential	Medium	None - marketing, promotion, & labeling only	Market driven	None	None	Existing retailers	IFC/GEF	No	
Egypt			2009 - ongoing	Residential, Government, Commercial, Industrial	High		Cost recovery	CFLs paid for on utility bill					
Ethiopia	Electricity Access Rural Expansion Project	Ethiopian Electric Power Corporation (EEPCo)	2008 - ongoing	Residential		First phase: 350,000; Total program: 4 million	4 free CFLs per customer	na		Local utility offices	World Bank		

Country	Program Name	Primary Program Administrator	Implementaion Period	Targeted Market Segment(s)	CFL Market Maturity (Low - Medium - High)	No. of Lamps Procured / Distributed	Free vs Cost Recovery	Cost Recovery (Loan) Program	Financial Incentive / Subsidy	CFL Distribution Approach	Source(s) of Program Funds	Carbon Finance? (Y/N)	Savings (Verified or Projected)
Kenya		Kenya Power & Lighting Company	2009 - ongoing			1,250,000 (projected)				Designated points for IL collection and CFL distribution			49 MW (projected)
Mali	Mali Energy Support Project	Unit within Ministry of Energy	2009 - ongoing	Residential	Low	1 million	Free	None	None	tbd	IDA	Yes	na
Mexico	Illumex	Comision Federal de Electricidad (CFE)	April 1995 - Oct. 1997?	Residential and Low-income residential	Low	Yes		24-month lease-purchase through utility		Utility offices & special booths at factories		No	
Nepal	Nepal Energy access and Efficiency Improvement Program	Nepal Electricity Authority	2009 - ongoing	Residentil	Low/Medium	1 million	Free to Lifeline; Buy-one-get-one-free to others	None	None	Through CFL suppliers	ADB, Govt. of Nepal	No	10 MW, 23 GWH/yr (projected)
Pakistan 1 (World Bank)		Four local electric utilities	2009 - ongoing	Residential	Medium/High		Free	None	None		IBRD		
Pakistan 2 (ADB)	Pakistan Energy Efficiency Investment Program	Pakistan Electric Power Company (PEPCO)	2009 - ongoing	Residential	Medium/High	30 million (projected)	Free	None	None	Direct distribution to households by utilities	ADB, AFD, & Govt. of Pakistan	Yes	1,094 MW, 2,132 GWH/yr (projected)
Philippines 1	IFC/GEF ELI Philippines	CEPALCO & MERALCO (utilities)	May 2000 to Oct 2003	Residential Commercial Institutional Industrial	Mature market, but largely low-cost, low-quality CFLs	n/a				Existing retailers	GEF		
Philippines 2	Philippines Energy Efficiency Project	Philippines Department of Energy	2009 - ongoing	Residential	Medium/High	13 million (projected)	Free	None	None	Multi-sector (Government, Utilities, NGOs)	ADB, Govt. of Japan, Govt. of Philippines	Yes	350-450 MW, 534,000 MWH/yr (projected)
Poland	Poland Energy-efficient Lighting Program (PELP)		1995-1998?		Low		Manufacturer/supplier subsidy			Existing retailers	GEF	No	Post-implementation survey conducted
Russia	Transforming the Market for Efficient Lighting		2009 - ongoing								GEF		
Rwanda	Rwanda Electrogaz CFL Distribution Project	Electrogaz	2008 - ongoing	Residential	Low	Pilot phase: 50,000; 2nd phase: 150,000; 3rd phase: 200,000; Future 4th phase: 400,000	Free	None	None	Utility bill-paying centers	IDA	Yes	na

Country	Program Name	Primary Program Administrator	Implementaion Period	Targeted Market Segment(s)	CFL Market Maturity (Low - Medium - High)	No. of Lamps Procured / Distributed	Free vs Cost Recovery	Cost Recovery (Loan) Program	Financial Incentive / Subsidy	CFL Distribution Approach	Source(s) of Program Funds	Carbon Finance? (Y/N)	Savings (Verified or Projected)
Senegal	Senegal Rural Lighting Efficiency project	Senegalese Rural Electrification Agency (ASER)	2008 - 2013	Newly electrified rural households & buildings		1.5 million		None			IDA?	Yes	45 GWh/year (projected)
S. Africa 1	A) IFC/GEF ELI South Africa - Medium & Upper LSM Market Program	Bonesa - a JV of ESKOM, Africon Engineering, & Umongi-Karebo	January 2000 - March 2003	Residential	Low						24% from GEF; 76% from ESKOM (utility)	No	1,344 GWH/year projected; 61.7 MW projected peak reduction
S. Africa 2	B) IFC/GEF ELI South Africa - EBSST Pilot Projects	Bonesa - a JV of ESKOM, Africon Engineering, & Umongi-Karebo	January 2000 - March 2003	Low-income residential	Low	3,000	2 free CFLs per low-income household			Direct distribution to households	24% from GEF; 76% from ESKOM (utility) - mostly GEF for this program	No	.2 GWH/year projected; .1 MW projected peak reduction
S. Africa 3	C) IFC/GEF ELI South Africa - RDP Housing & New Electrication Program	Bonesa - a JV of ESKOM, Africon Engineering, & Umongi-Karebo	January 2000 - March 2003	Low-income residential	Low		1 free CFL per low-income household			Direct distribution to households	24% from GEF; 76% from ESKOM (utility)	No	2.7 GWH/year projected; 1.2 MW projected peak reduction
S. Africa 4	D. IFC/GEF ELI South Africa - Rural low LSM residential market program	Bonesa - a JV of ESKOM, Africon Engineering, & Umongi-Karebo	January 2000 - March 2003	Low-income rural residential	Low	120,000				Existing retailers	24% from GEF; 76% from ESKOM (utility)	No	9.6 GWH/year projected; 4.4 MW projected peak reduction
Sri Lanka	CEB CFL Program	Ceylon Electricity Board	1994-1998	Residential	Low	Initiallly 100,000	Cost recovery	12-month interest-free loan repaid on utility bill	Subsidy provided by utility	Existing retailers	utility	No	46 MW and 64 GWH
Thailand	EGAT DSM Program	Electric Generating Authority of Thailand (EGAT)	Phase I: 1996-1999; Phase II: 2000 - present	Residential	Low	Periodic bulk purchases by EGAT	na	None	None	Existing retailers	utility	No	Phase I: CFL sales increaed 23%; Phase II: 7-fold sales increase 2003-2005
Uganda	Uganda Efficient Lighting Project	Ministry of Energy and Mineral Development (MEMD)	2006-2007?	Residential	Low	800,000	3 free CFL's per household	None	None	Direct distribution to households		No	20 MW peak savings total
Venezuela			2007 - present			72.3 million					government		
Vietnam	EVN CFL Program	Electricity of Vietnam (EVN)	2004-2006	Rural residential	Low	1 million	Cost recovery	Customer payments collected	None	Local utility offices and community cooperatives	GEF/ IDA	No	Total program savings of 30 MW and 243 GWH

Endnotes

[1] LED for household lighting is still about 3 to 4 years away from achieving commercial maturity, as suggested by industry practitioners and analysts. On the other hand, FTLs, especially with electronic ballasts, are more efficient than ILs and have penetrated many developing country markets. The focus of this document is in CFLs which is considered an ideal technology to replace the incandescent lamps, and is more efficient even as compared to FTLs.

[2] In recent years, there has also been a move to incorporate other financial incentives such as those available in the carbon market through the Clean Development Mechanism (CDM) and dedicated climate mitigation related funds like the Clean Technology Fund (CTF).

[3] Quality CFLs may be 5 to10 times more expensive than ILs, but have much longer lifetimes (6,000-10,000 hrs compared to 1,000-1,200 hours for ILs) and higher efficacy (in lumens output per watt input power). At typical residential electricity tariffs of about 7 US cents/kWh, CFLs have a payback period of well under one year if they replace ILs which are being used for over 3 hours/day.

[4] For instance, life-line consumers whose bills are highly subsidized

[5] Magnetic ballasts themselves consume about an extra 15-16 W per lamp, thus offsetting the efficiency gains of FTLs (38 W) over incandescent lamps (60 W). A switch over to electronic ballasts helps achieve increased savings.

[6] It has been claimed that about 116 million ILs have been replaced by CFLs using the Cuban model, resulting in peak demand savings of about 4,000 MW and annual emission savings of more than 8 million tons of CO_2 equivalent. See Roberto Gonzales, The Replacement of Incandescent Bulbs—The Cuban Experience, op cit.

[7] World Bank sponsored programs have generally relied on ELI-based specifications and procurement of CFLs through ELI-certified manufacturers which ensures high quality CFLs at low cost. In addition to encompassing robust technical parameters (which pertain to developing country requirements, such as poor quality of power in terms of low voltages), these ELI-based specifications also allow for 1-year warranty, wherein if CFLs procured through these programs fail within one year they are replaced free of charge by the supplier.

[8] This table was compiled by the authors based on various country-specific reports and discussions with World Bank TTLs. Note that the CFL wattage ratings and specifications are not the same for all these procurements

[9] The program also included efficient Fluorescent Tube-lights (FTLs).

[10] In some countries (such as China), it may be inappropriate for a stranger to enter a home, even if he/she is a utility company employee.

[11] With changing technologies and improvement in efficacy of CFLs, the equivalent wattages are coming down. For instance, the CFL replacement for a 60W UL which given equivalent lumens output (minimum 715 lumens) is now commonly available in the range of 13 to 14 watts also.

[12] Project proponents may also propose new methodologies, but experience points out that it takes a substantial amount of time and effort to get approval for a new methodology.

[13] As per CDM rules, a small-scale CDM activity is the one defined by energy savings of less than 60 GWH per year. Projects bigger than this threshold are considered large scale CDM activities. The small-scale CDM methodologies have simplified procedures. Additional information on these methodologies is available at the UNFCCC website.

[14] AMS-II.J specifies that *ex post* monitoring surveys are to be carried out at the following intervals: either (i) Once every 3 years; or (ii) once for every 30% of the elapsed rated lifetime of the lamp

[15] A major manufacturer reports that an incandescent class A 230V 100W lamp supplied with 240V will provide 17.5% more luminous flux, have 50% less life time and 6.6% more power consumed with the burning risk through overheating of the cap in the socket. On the contrary, an incandescent *class A 240V 100W lamp supplied with 230V will provide 15% less luminous flux*, will convert from energy class E to F but the life time will be 80% longer. The influence described above might explain why some customers complain about to short life time of their lamps. (VITO)

[16] Supratim Basu and T.M. Undeland, PFC Strategies in light of EN 61000-3-2, EPE-PEMC 2004 Conference in Riga, LATVIA, September 2004. (copy not available at time of publication)

[17] Brauner G, Wimmer K.,"Netzruckwirkungen durch konpaktleuchtsofflampen in Niederspannungsnetzen", Verband der Elektrizitätswerke Osterreich, 1995. (copy not available at time of publication)