WORLD BANK GEF
Post-Implementation Impact Assessment

Mexico—Ilumex Project
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Post-Implementation Impact Assessment

MEXICO HIGH EFFICIENCY LIGHTING PROJECT

GLOBAL ENVIRONMENT FACILITY PROGRAM
THE WORLD BANK
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ACRONYMS AND ABBREVIATIONS

AI Activities Implemented Jointly
CANAME Cámara Nacional de Manufacturas Eléctricas (National Chamber of Electrical Manufacturers)
CDM Clean Development Mechanism
CFL compact fluorescent lamp
DSM demand-side management
DNV Det Norske Veritas
EE energy efficiency
ELI Efficient Lighting Initiative
GEF Global Environmental Facility
GHG green house gas
GWh Gigawatt-hours
Hg Mercury
IDB Inter-American Development Bank
ICR Implementation Completion Report
INEGI Instituto Nacional de Estadística, Geografía e Informática (National Institute of Geographic and Computing Statistics)
ICF ICF Consulting
IFC International Finance Corporation
JI Joint Implementation
LRMC Long Range Marginal Cost
NAFIN Nacional Financiera (National Development Bank)
NOx nitrogen oxide
OECD Organization for Economic Co-operation and Development
**Post-implementation Impact Assessment — Mexico — Ilumex Project**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>PAR</td>
<td>Performance Audit Report</td>
</tr>
<tr>
<td>PELP</td>
<td>Poland Efficient Lighting Project</td>
</tr>
<tr>
<td>PROFECO</td>
<td>Procuraduría Federal del Consumidor (Federal Consumer Protection Agency)</td>
</tr>
<tr>
<td>SOx</td>
<td>sulfur oxide</td>
</tr>
<tr>
<td>THD</td>
<td>total harmonic distortion</td>
</tr>
<tr>
<td>Tonnes CO\textsubscript{2}-eq</td>
<td>(Metric) tonnes of CO\textsubscript{2}-equivalent</td>
</tr>
<tr>
<td>TWh</td>
<td>terawatt-hours</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>USIJI</td>
<td>United States Initiative on Joint Implementation</td>
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**Notes:** All dollar amounts are U.S. dollars unless otherwise indicated.

For Mexico’s energy-related organizations’ acronyms, see box.
Executive Summary

Introduction

The World Bank – Global Environment Facility (GEF) team has embarked on a series of Post-Implementation Impact Assessments in order to better understand the long-term impacts of GEF projects, the sustainability of those impacts, the replicability of the projects, and the lessons learned.

The World Bank selected a cluster of four climate change projects in the energy efficiency thematic area for study:

- the Poland Efficient Lighting Project (PELP),
- Mexico — ILUMEX (Mexico High Efficiency Lighting Project),
- the Jamaica Demand-Side Management Project, and
- the Thailand Promotion of Energy Efficiency Project.

Le Groupe-conseil Baastel conducted the first study, an assessment of PELP, from April to September 2004. The second case study, the Mexico High Efficiency Lighting Project, known worldwide as ILUMEX, was conducted by Marbek Resource Consultants in association with Lightstream Energy; the field mission to Mexico City was conducted from November 29 to December 7, 2004.

ILUMEX was approved by the World Bank in 1994 and took place in the period 1995–1998. The project was co-financed by a GEF grant of US$10 million, about US$10 million from the Mexican government, and a grant of approximately US$3 million from Norway. The project mainly involved the promotional sale of high efficiency compact fluorescent light lamps (CFLs), of which 2.6 million were sold by the end of the project. The project was implemented by the Comisión Federal de Electricidad (CFE), Mexico’s main public electricity utility. Initially implemented in the cities of Guada-
lajara and Monterrey (Mexico’s second and third largest cities), the project eventually was expanded to cover the entire Mexican states of Jalisco and Nuevo León and parts of the adjoining states of Colima, Nayarit, Coahuila, and Tamaulipas.

Framework and Approach

The study assessed the success, sustainability, and attribution of the following outcomes and impacts:

- **Project Outcomes**: demonstration of technical and financial feasibility, increase in institutional capacity, and development of a replicable model.
- **Intermediate Outcomes**: replication of the model; additional increase in institutional capacity; consumer preference influenced; and improvement in capacity and confidence of manufacturers, distributors, and retailers.
- **Ultimate Outcomes**: transformation of the Mexican residential lighting market.
- **Impacts**: energy savings, reduced greenhouse gas (GHG) emissions, reductions of air pollutants of local concern, capacity savings, and financial benefits.

To identify and attribute impacts, the Study Team developed three scenarios: one scenario representing actual and forecast CFL sales (with ILUMEX) and two counter-factual scenarios representing a low and a high range of how CFL sales would have evolved in the absence of ILUMEX.

### Project Outcomes

In addition to the direct impacts of the CFL sales during the program, ILUMEX demonstrated the technical and financial feasibility of the technology and the approach and established a model for future programs. The key features of the ILUMEX model were:

- bulk purchases of high quality CFLs,
- CFL sales in local utility service centers,
- availability of low-interest financing,
- payment in installments on the electric bill, and
- subsidized prices.

### Intermediate Outcomes

The assessment concludes that ILUMEX has proven that the features outlined above have great replication value. The model was replicated in a nationwide program implemented by FIDE (Fideicomiso de Apoyo al Programa de Ahorro de Energía del Sector Electrónico or the Trust Fund for Electrical Energy) and in a program conducted by Luz y Fuerza del Centro (LyFC), Mexico City’s utility. The utility service center sales model was adapted and used in Efficient Lighting Initiative (ELI) programs in Argentina, Perú, and Costa Rica. Aspects of the program have influenced a broad range of programs from other demand-side management (DSM) programs in Mexico to a broad range of international initiatives.

ILUMEX helped develop a better understanding of the role and functioning of
DSM programs within CFE. The program confirmed the technical viability of using CFLs, including product quality, durability, and low impact on the electricity grid. The program also clarified the role of subsidies in promoting energy-efficient technologies newly on the market. ILUMEX contributed significantly to building a culture of energy efficiency programs within CFE and other government ministries and agencies. It also stimulated activity within a variety of government organizations and agencies; helped to refine visions, renew mandates, and clarify roles; and helped establish links among the various institutions. The result is that Mexico has one of the most well developed institutional structures for the promotion of energy efficiency. The economic analysis of ILUMEX clarified the financial implications for CFE of DSM programs. Unfortunately, the institutional incentives have not been realigned (i.e., lower electricity sales due to DSM causes a financial loss for the utility) and so the involvement of CFE as a promoter of energy efficiency continues to rely mainly on the utility’s broad interpretation of its public service mandate. Given that CFE is a public entity, making a profit is not as important as providing electric service.

Consumer awareness of CFLs and their preference for CFLs has grown substantially in the period since ILUMEX. ILUMEX and subsequent programs, such as FIDE’s CFL sales program, played an important role in achieving this outcome. ILUMEX succeeded by exposing consumers to the technology who otherwise would not have considered it, by putting a strong emphasis on product quality, and by making the case for the financial and energy benefits. Product quality has effectively been removed as a consumer concern, although there is a current trend toward lower-quality products on the market with low-price appeal. Most consumers have a good appreciation of the potential financial savings that can accrue from the use of CFLs and, as a result, roughly one third indicate that they intend to buy CFLs. The incentive programs have reached mainly middle- and higher-income customers.

Coinciding with ILUMEX, the worldwide market for CFLs — including the Mexican market — has grown substantially. ILUMEX and subsequent programs have played a significant role in expanding severalfold the Mexican market and attracting manufacturers and distributors to it. Because of the bulk sales generated by ILUMEX and FIDE, manufacturers and distributors felt confident enough of the sustainability of the market to invest in distribution channels and marketing. There is now healthy competition from a range of manufacturers, providing a range of CFLs of differing quality and price. Together with retailers, the manufacturers are experimenting with a variety of marketing approaches (including various methods of display and packaging in a broad array of stores).
Ultimate Outcomes

The key outcome has been transformation of the Mexican residential lighting market. When ILUMEX began, CFLs were expensive and hard to find, and had very small sales volumes. Today they are affordable, are visible in most retail outlets, and have a significant and growing share of the market.

- **Price.** Unit prices of CFLs have dropped from approximately US$15 prior to ILUMEX to less than $3 in 2004. Although international market developments played the largest role in this reduction, ILUMEX was important in establishing Mexico’s contribution to that worldwide market, and ILUMEX played a significant role in influencing consumer price expectations in the Mexican market.

- **Availability.** Before ILUMEX, CFLs were very hard to find in retail markets. Now they take up the majority of the lighting shelf space. The 2003 survey of the Mexican consumer association Procuraduría Federal del Consumidor (PROFECO) found 28 brands and over 250 different models in the country (PROFECO 2003. Although many factors influenced the increase in availability, the role played by ILUMEX and its successor programs in nurturing the Mexican market and in building capacity and confidence among trade allies suggests a relatively high attribution.

- **Sales.** CFL sales in Mexico are estimated to have risen from approximately 500,000 in 1995 to over 7 million in 2004. They are forecasted to continue rising to over 13 million per year by 2010. The increase in sales has been driven by higher electricity tariffs, reductions in the price of CFLs, greater consumer awareness and interest, and better availability and marketing. ILUMEX had no influence on the increase in electricity tariffs, but it had a moderate influence on CFL prices and a significant influence on consumer awareness and product availability.

ILUMEX has contributed modestly to mainstreaming certain aspects of climate change into national policy. However, such concerns remain secondary to energy security, economic, and local environmental concerns.

Sustainability

Following the completion of the project, concern was expressed by World Bank staff about whether a program that relies on subsidies to drive sales is sustainable. Although the concern is understandable, the evidence indicates that the program outcomes were sustained and continue to be sustained on several levels:

- **Subsidies and Replicability.** The multiple replication of the ILUMEX model (including its subsidy components) has shown that, under certain conditions (e.g., a public utility with a broad mandate), subsidies can be justified and maintained despite the financial cost. This is because CFE and FIDE recognized that, on a total resource basis and for their customers, the benefits
outweighed the costs and they accepted their public responsibility to invest in this outcome. Fortunately, over time, the need for the subsidy gradually disappeared. Successor programs were then able to succeed solely through the other aspects of the model. The need even for the successor programs is disappearing, and the sales of CFLs are becoming self-sustaining and market-driven.

- **Capacity Development.** The evidence suggests that the institutions, the knowledge, and experience — within the government, the utility, and the broader community of energy professionals — have reached a critical mass. This means that, even if particular individuals or institutions cease to be involved, there is sufficient dissemination of expertise and best practices to sustain the capacity in Mexico.

- **Market Transformation.** Provided that the broad features of Mexico’s energy market remain supportive (i.e., electricity tariffs remain high in relative terms), the changes that have taken place in terms of CFL availability, prices, manufacturer and retailer confidence, and consumer awareness and preferences are likely to be irreversible. This suggests that prices are likely to continue falling and sales are likely to continue rising.

**Lessons Learned**

The assessment suggests a number of lessons to be applied in future programs and, more broadly, in developing approaches to energy efficiency, including:

- Pilot programs like ILUMEX in selected markets are a good way to achieve significant market presence of a new energy-efficient technology at a reasonable cost. The success can then be replicated and exported to other markets. As energy efficiency markets evolve, the amount of public support for new technologies will diminish, making further new entrants cheaper to bring to market.

- Each of the features of ILUMEX mattered in determining the outcomes. These features were extraordinarily well suited to the circumstances and may be appropriate for a variety of future applications. However, replication of the program needs to take into account local conditions, including electricity tariffs, deregulation, market conditions, institutional capabilities, etc. Indeed, early pilot programs help mature an institutional capability to carry out further programs in the future, at lower cost and higher effectiveness.

- To be effective and sustainable, programs that rely on capacity building need a broad reach that includes a variety of government and private parties that have a role in the future evolution of the market. It is important to share program results widely among these entities to provide the maximum opportunity for replication and lessons learned. The ILUMEX experience was well communicated to both energy and other
government officials — making it easier to implement the programs that have followed and to overcome reticence by other government and private sector actors.

- It is important to align a program’s immediate economic objectives with the ultimate objectives of both the funding agencies and the implementing agencies. In this case, the World Bank and the CFE had slightly different objectives (global environmental objectives versus national socioeconomic objectives). However, the objectives were mutually compatible and this reinforcement added to the broad long-term success of the program.

- Although in hindsight some of the technical specifications may have been excessively stringent, the investment in high-quality CFLs was crucial to overcoming consumer concerns about CFL quality and to ensuring that quality never became an issue once ILUMEX began.

- It is necessary to establish a significant market presence in order to get critical mass for a technology such as CFLs. This justifies the focus on specific markets, such as residential medium- and high-income consumers, as well as the focus on selected cities.

- It is important to disseminate financial information along with technical information so that consumers can appreciate the savings offered and make their own judgments about reasonable paybacks.

- Marketing strategies need to be appropriate to the target customers’ needs. Thus strategies may vary among customer groups in differing income strata.

- Bulk purchases proved an effective feature of ILUMEX to stimulate the market and to provide lower unit CFL prices for the program.

**Impacts**

The CFL sales induced by ILUMEX and the associated increase in stock are estimated to have produced energy savings of approximately 1.4 TWh in 2004, and associated GHG emission reductions of 850 Kilotonnes (Kt) of CO$_2$-equivalent. Over the period 1995–2004, GHG emission reductions of 3.4 Megatonnes (Mt) were achieved and a further reduction of 9.0 Mt is expected to 2010. The following range of impacts are attributed specifically to the ILUMEX program:

- sales of 3.7 to 5.7 million CFLs in 2004,
- energy savings of 740 to 1,225 GWh in 2004,
- GHG emission reductions of 430 to 715 Kt in 2004,
- GHG emission reductions of 2.0 to 3.2 Mt in the period 1995–2004, and a further 3.3 to 6.3 Mt in the period 2005–2010,
- NOx emission reductions of 1.3 to 2.2 Kt in 2004,
- SO$_2$ emission reductions of 8.4 to 13.8 Kt in 2004,
- capacity savings of 190 to 300 MW in 2001 (the last year of capacity constraint),
- total resource net benefits of between $90 and $150 million over the period
1995–2010 (3.5 to 6.5 times the original investment),

- total net benefits to consumer participants of $140 to $245 million over the period 1995–2010, and

- total net costs to the utility of $45 to $85 million over the period 1995–2010.
1 INTRODUCTION

1.1 Background

The World Bank — GEF team has identified the need to assess the post-implementation results of projects, especially in terms of longer-term impact, sustainability, replicability, and lessons learned. In particular, there is a need to focus on lessons learned to better understand the extent of impacts and benefits, and the sustainability of these impacts, to determine how WBG operational programs’ long-term goals are being addressed.

This study is designed to support the Bank’s Monitoring and Evaluation policy (OD 10.70), which recommends that major impact assessments should be conducted on a selective basis several years after a project is completed to measure changes brought about by the project.

WBG selected a cluster of four climate change projects in the energy efficiency thematic area for study: the Poland Efficient Lighting Project (PELP), the Mexico ILUMEX (High Efficiency Lighting Project), the Jamaica Demand-Side Management Project, and the Thailand Promotion of Energy Efficiency.

This impact assessment deals with the second case study: the Mexico High Efficiency Lighting Project, known worldwide as ILUMEX.

1.2 Objectives

The study was intended to respond to the WBG’s need for long-term impact assessment. It contributes to the identification of factors that determine the sustainability of project outcomes and brings lessons to light that will help to improve design and implementation of Bank — GEF projects. The assessment issues addressed included the following:

- the project’s overall results at the outcome level,
- the project’s impacts on global environmental benefits,
• the project’s impacts on institutional development,
• the project’s impacts on beneficiaries,
  lessons learned for the sustainability of project impacts,
• the replicability of project outcomes achieved and the catalytic effect of the project,
• the lessons for improving the design and management of future activities (answering the question: how can it be done better?), and
• the extent to which the project contributed to mainstreaming global environmental concerns into the country’s national development and sector policies.

Within the overall assessment framework, the study addressed the following specific issues:

• private sector impact and market development in the energy efficiency sector, including issues related to market growth such as product sales and industry structure, and
• the overall impact of ILUMEX on the lighting industry in Mexico.

The study also attempted to separate project-specific impacts from those due to other sources, including follow-up projects.
2

Project Background

In the early 1990s, Mexico carried out a series of small pilot projects in eight cities to encourage the use of fluorescent lighting in the residential sector. At that time, the utility was concerned about reducing residential consumption at peak hours; it wanted to test user response and acceptance of compact fluorescent lamp (CFL) technology, as well as the technology’s impacts on the grid. Positive consumer response and survey results led to the development of financing mechanisms, the most successful of which was a pay-on-the-bill scheme. Following these modest successes, Mexico sought the support of the World Bank for a more ambitious program that would test the concept more thoroughly and provide a model for future Demand-Side Management (DSM) initiatives. World Bank involvement was thought to be key for two objectives: (1) obtaining financing to increase the scale of the program, and (2) convincing professionals inside and outside the Mexican government of the financial viability of the program.

WBG approved ILUMEX in 1994 and the project took place in the period 1995–1998. The project was co-financed by a GEF grant of US$10 million, about US$10 million from the Mexican government, and a grant of approximately US$3 million from Norway. The project mainly involved the promotional sale of CFLs, of which 2.6 million were sold by the end of the project. The project was implemented by the Comisión Federal de Electricidad (CFE), Mexico’s main public electricity utility. The subsidy for CFLs was set so that the second-lowest, highly subsidized electric tariff users would see a two-year payback.

The program was implemented through the mechanism of “fideicomisos” (trust funds). The “FILUMEX-Jalisco” and “FILUMEX-Nuevo León,” as they were known, were established in the cities of Guadalajara and Monterrey (Mexico’s second and third largest cities and the largest cities served by CFE) to implement the ILUMEX project initially in those two cities’ households. Eventually
the program was expanded to cover the entire Mexican states of Jalisco and Nuevo León and parts of adjoining states of Colima, Nayarit, Coahuila, and Tamaulipas. By law CFE is not allowed to sell anything but electricity to its customers. The use of fideicomisos allowed for the promotion of CFLs, as the fiduciary trusts could use CFE’s offices for outreach and sales and CFE’s billing system for payment collection. The CFLs were sold in CFE’s service centers with customer financing available through paying on the electric bill.

The World Bank’s Implementation Completion Report (ICR) for ILUMEX was published in December 1998. It concluded that the project had exceeded its target for compact fluorescent lamp sales but had failed to achieve its financial objectives (particularly for CFE). The ICR also noted that project monitoring and reporting had been insufficient.

The World Bank’s Performance Audit Report (PAR) was completed in April 2001. This report concluded that the energy savings were in line with targets but that power capacity savings were only one third of the original estimates. Based on the energy savings, the PAR concluded that the project had an acceptable financial return (which would be enhanced further by consideration of the financial value of greenhouse gas emission reductions). The PAR also concluded that, although technical feasibility was demonstrated, the project failed to demonstrate financial feasibility because of the lack of sustainability of the CFL subsidy. It also noted that the project contributed modestly to the objective of power capacity building.
3  
Assessment Framework and Approach

3.1 ILUMEX Logical Framework

Because the ILUMEX project was initiated prior to the adoption of Results-Based Management tools within Bank, no explicit logical framework was developed at that time. Fortunately, the project goals and objectives, and the context in which it was designed and implemented, provide enough of an understanding of the results logic to allow the retrofit of a logical framework (i.e., ex post). Figure 3.1 illustrates the logic on which the impact assessment is based.

Figure 3.1 highlights the key "deliverable" or output of the project, which is CFL sales. Through these sales, the project was expected to: (a) demonstrate the technical and financial feasibility of reducing emissions of greenhouse gases and simultaneously reducing local environmental contamination through the widespread installation of high efficiency lighting; (b) build the institutional capacity for technological change and energy conservation; (c) provide a replicable model for energy demand-side management; and (d) strengthen CFE’s capacity to practice demand-side management on a sustainable basis.

CFE’s objectives for the residential lighting programs were to provide energy savings opportunities for its residential customers (as part of the public utility’s “public service contract”) and to avoid the need to construct more power plants by shaving peak consumption. Meanwhile, the World Bank’s project was implicitly seeking to transform the Mexican lighting market in the longer term and to generate sustainable energy savings, GHG emission reductions, and financial benefits. CFE carried out this mission by encouraging additional programs, influencing consumer preferences, and improving the capacity of trade allies. Furthermore, the program produced knowledge and capacity to transform the broader energy efficiency market in Mexico, and led to potential replication.
Figure 3.1: ILUMEX Logical Framework (ex-post)

**Activities**
- Supply CFL
- Market CFL
- Finance CFL

**Outputs**
- ILUMEX Sales of CFL

**Project Outcomes**
- Technical Feasibility Demonstrated
- Financial Feasibility Demonstrated
- Institutional Capacity Increased in Short Term
- Replicable Model Provided
- Model Replicated in Other Countries

**Intermediate Outcomes**
- Consumer Preference Influenced
- Trade Ally Capacity and Confidence Improved
- Institutional Capacity Increased in Long Term

**Ultimate Outcomes**
- Other Mexican Energy Markets Transformed
- Mexican Residential Lighting Market Transformed
- Global Env Concerns Mainstreamed in National Policy
- Development of Global Flexibility Mechanisms
- Replicable Model Provided
- Program Replicated in Mexico
- Energy Savings and GHG Reductions

**Impacts**
- Local Environmental Benefits
- Energy Savings and GHG Reductions
- Financial Benefits

**Outputs**
- ILUMEX Sales of CFL

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- Replicable Model Provided
- Program Replicated in Mexico
- Energy Savings and GHG Reductions

**Impacts**
- Local Environmental Benefits
- Energy Savings and GHG Reductions
- Financial Benefits
in other countries. A further benefit was the increased capacity and inclination of officials to consider global environmental concerns (e.g., GHG emission reductions) in national policies.

In addition, both Norway and the World Bank wanted to use the opportunity to build the global capacity to verify and certify emission reduction projects as a contribution to the development of global flexibility mechanisms.

### 3.2 Results Framework

Based on the logical framework, a series of indicators was developed that provides a basis for assessing results. These indicators are listed in Table 3.1.

<table>
<thead>
<tr>
<th>Result Statement</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Output: CFL Sales</td>
<td>• Units sold</td>
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<tr>
<td>Project Outcome: Technical Feasibility Demonstrated</td>
<td>• Lifetime of CFLs</td>
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<td></td>
<td>• Fixture compatibility</td>
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<td></td>
<td>• Lighting quality</td>
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<td>• Grid compatibility</td>
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<td>Project Outcome: Financial Feasibility Demonstrated</td>
<td>• Total resource cost and benefits</td>
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<td></td>
<td>• Customer participant cost and benefits</td>
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<td></td>
<td>• Utility cost and benefits</td>
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<tr>
<td>Project Outcome: Institutional Capacity Increased in the Short Term</td>
<td>• Lessons learned by CFE and other institutions</td>
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<td></td>
<td>• Experience gained by staff at CFE and in other institutions</td>
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<td></td>
<td>• Level of confidence of key players in ability to undertake similar programs</td>
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<tr>
<td>Project Outcome: Replicable Model Provided</td>
<td>• Identification of key features</td>
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<td></td>
<td>• Applicability of ILUMEX program design to rest of Mexico</td>
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<td></td>
<td>• Applicability of ILUMEX to other markets</td>
</tr>
<tr>
<td>Intermediate Outcome: Program Replicated in México</td>
<td>• Number, scope, and scale of efficient lighting programs since ILUMEX</td>
</tr>
<tr>
<td>Intermediate Outcome: Institutional Capacity Improved in the Long Term</td>
<td>• Levels of knowledge and ability to implement programs and policies at CFE</td>
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<td></td>
<td>• Levels of knowledge and ability to implement programs and policies in other government agencies</td>
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<tr>
<td></td>
<td>• Development and testing of methods for GHG verification</td>
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<td></td>
<td>• Existence of appropriate institutional structures</td>
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<td></td>
<td>• Existence of appropriate institutional incentives</td>
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<tr>
<td>Intermediate Outcome: Consumer Preference Influenced</td>
<td>• Awareness</td>
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<td></td>
<td>• Confidence in quality</td>
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<td></td>
<td>• Attitudes towards price and energy savings</td>
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<tr>
<td>Intermediate Outcome: Trade Ally Capacity and Confidence Improved</td>
<td>• Expertise of key groups</td>
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<tr>
<td></td>
<td>• Number of manufacturers and distributors</td>
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<tr>
<td></td>
<td>• Development of marketing networks, supply and distribution channels</td>
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<tr>
<td></td>
<td>• Size and distribution of retail network</td>
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(continued on next page)
3.3 Attribution

CFL sales were relatively small before ILUMEX started (at least an order of magnitude smaller than by 2004). But how much of the growth was due to ILUMEX, and how much to the worldwide CFL market transformation and other factors, is difficult to determine. The assessment used multiple lines of evidence to estimate the contribution of ILUMEX to various changes in the residential CFL market in Mexico.

The indicators in Table 3.1 describe the changes that have occurred since ILUMEX in Mexico’s residential CFL market. For each of these indicators, the report attempts to quantify or describe the change and the role of ILUMEX in that change.

To calculate the impact of ILUMEX on energy use and emissions, the report examines what has actually happened since the program (and what is projected in the near term) and assesses what would have happened in the absence of ILUMEX (counter-factual scenario). The difference between these two cases comprises the incremental impact of ILUMEX. As is common internationally, including in Mexico, historical and/or projected lighting sales data are hard to obtain. Furthermore, it is very difficult to project with any certainty what sales might be or could have been, since macroeconomic disturbances are hard to predict and their impacts can greatly affect sales, particularly in emerging economies such as Mexico. In addition, there are no other countries in the region that are similar enough to provide

Table 3.1. Results Framework (continued)

<table>
<thead>
<tr>
<th><strong>Result Statement</strong></th>
<th><strong>Indicators</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Outcome: Program Replicated in other Mexican Energy Markets</td>
<td>• Number, scope, and scale of similar programs</td>
</tr>
<tr>
<td>Ultimate Outcome: Program Replicated in other Countries</td>
<td>• Number, scope, and scale of similar programs</td>
</tr>
<tr>
<td>Ultimate Outcome: Development of Global Flexibility Mechanisms</td>
<td>• Knowledge and experience incorporated into CDM/JI (Clean Development Mechanism/Joint Implementation) mechanisms</td>
</tr>
<tr>
<td>Ultimate Outcome: Lighting Market Transformation</td>
<td>• Availability • Price • Sales</td>
</tr>
<tr>
<td>Impact: Energy Savings and GHG Reductions</td>
<td>• GWh saved • GHG emissions reduced, expressed as tonnes of CO₂-equivalent</td>
</tr>
<tr>
<td>Impact: Financial Benefits</td>
<td>• GW of capacity deferred • Total resource cost and benefits • Customer participant cost and benefits • Utility cost and benefits</td>
</tr>
<tr>
<td>Impact: Local Environmental Benefits</td>
<td>• Reductions in NOx and SO₂ emissions</td>
</tr>
</tbody>
</table>
a credible proxy for baseline CFL sales in Mexico.

Nevertheless, three scenarios were constructed to illustrate the quantitative implications.

- The *With ILUMEX* scenario incorporates all the available data on CFL sales and extrapolates these data to provide a complete time series of sales from the start of ILUMEX in 1995 through 2010.
- The *No ILUMEX — High Baseline* scenario sets a higher boundary on the range of estimates of CFL sales that would have happened in the absence of ILUMEX, and hence represents the lower boundary of the range of estimates of the incremental impact of ILUMEX.
- The *No ILUMEX — Low Baseline* scenario sets a lower boundary on the range of estimates of CFL sales that would have happened in the absence of ILUMEX, and hence represents the higher boundary of the range of estimates of the incremental impact of ILUMEX.

Although the scenarios (particularly the counter-factual scenarios) were necessarily based on “educated best guesses” and many assumptions, it was expected that by using a range of scenarios, as well as conservative assumptions, the results obtained would be useful and credible.

The assessment selected 2010 as the end year because it provides a reasonable period of time to allow for the differences between the scenarios to become evident. Projecting into the short-term future is more plausible than attempting to extend the analysis period, given the lack of available CFL market forecasts. It is anticipated that CFL market saturation will be achieved at approximately this time. Also, it is possible that new lighting technologies (such as white LEDs) might come to market and compete with CFLs in the medium term. It is likely that if extended further into the future, the “With ILUMEX” scenario and the two “No ILUMEX” scenarios would further converge as potential saturation in residential CFL sales is reached.

3.4 Methodology

The assessment methodology consisted of the following tasks:

- **Preliminary Documentation Review.** The Study Team reviewed the ILUMEX ICR and PAR (see chapter 2) in order to understand project activities, objectives, outputs, and immediate outcomes, and undertook an extensive literature review of numerous documents produced by or written about the ILUMEX program (see Appendix B, References).
- **Development of Draft Study Plan.** Based on the available information, the Study Team prepared an initial version of the ILUMEX logical framework and results indicators (see Table 3.1), developed a preliminary list of desired documents and potential informants to interview,
and prepared a preliminary interview protocol.

- **Initial Consultations.** Using the Draft Study Plan, team members interviewed a small number of key informants at World Bank and the Inter-American Development Bank (IDB) and reviewed the proposed approach with World Bank staff. The purpose of these discussions was to refine the framework and identify key informants (including contact information) and documents (including potential sources). Following these meetings, a revised Assessment Plan was produced.

- **Logistical Arrangements for Field Mission.** With the help of local Bank staff, the Study Team established contact with the key individuals involved at the CFE, and scheduled a series of meetings with informants within the utility, government departments and agencies, CFL suppliers, trade allies, university professionals, international agencies, and local and international energy consultants. The list of interviewees is provided in Appendix A. The list of interviewees and arrangements were greatly assisted by the services of Dr. Rafael Friedmann, who was familiar with the energy situation in Mexico and knew many of the key informants.

- **In-depth Document Review.** This involved a more detailed examination of the ICR and PAR as well as other documents obtained (from the World Bank and Dr. Friedmann) on both the project and the evolution of the lighting market in México.

The list of reference documents is provided in Appendix B.

- **Field Mission.** The field mission was conducted from November 29 to December 7, 2004. The Study Team was made up of Ms. Barbara Atkinson and Dr. Rafael Friedmann (first three days only). Activities included:
  - meetings with the local World Bank coordinator and an evening meeting with the Citizen’s Energy Roundtable (a broad group of professionals involved with the energy sector);
  - interviews with 40 people within 19 institutions, including 8 government agencies; 8 trade allies (manufacturers, consultant groups, associations); 2 universities; and 1 international aid agency (see Appendix A);
  - documents obtained from Procuraduría Federal del Consumidor (PROFECO or Federal Consumer Protection Agency) and interviewees; and
  - visits at Luz y Fuerza del Centro’s neighborhood office to discuss their CFL sales display. Lighting displays in a variety of stores in Mexico City were observed.

- **Analysis.** Upon completion of the field mission, the Study Team compiled its observations and reviewed additional documents to determine findings, including quantitative assessments of key indicators. The team reviewed the interview notes in order to estimate attribution and calculate the various impacts, and reviewed the entire body of findings to construct the three scenarios. The scenarios were mod-
elled using a spreadsheet to generate the corresponding CFL sales, energy savings, emissions savings, and financial results.

- **Reporting.** A Draft Report was reviewed by World Bank staff. This Final Report incorporated those comments.
The World Bank assessed project outputs and outcomes shortly after project completion through the ICR and PAR. This chapter summarizes the key findings of those reports and adds the Study Team’s observations from its enquiries.

4.1 Project Outputs and Direct Impacts

Table 4.1 provides CFE’s estimates of the number of CFLs sold during the ILUMEX project, from 1995 to 1999. A small number of the sales in Table 4.1 may be circular fluorescents, which predominated in some of the pilot projects, but the large majority of lamps sold under ILUMEX were compact fluorescents, either integral or two-piece.

According to the ICR, 2.6 million CFLs were sold at an average price of US$13.92, with an average subsidy of 49 percent. Approximately 10 percent went to low-income customers. According to calculations at the end of the project, approximately 1 TWh of energy was saved, reducing GHG emissions by 764,000 tonnes, SO₂ emissions by 11,000 tonnes, and NOₓ by 2,100 tonnes over the life of the CFLs. Approximately 33 MW of capacity was deferred. While this was a relatively small savings, as shown in chapter 8, the long-term capacity savings that ILUMEX induced were much greater.

A total of 171,000 tonnes of GHG emission reductions were verified and certified by Det Norske Veritas/ICF Consulting in 1999 using conservative assumptions and covering the period from 1995 through 1998 only. These emissions savings were 28 percent
lower than those estimated by CFE, because of conservative assumptions, differences in methodology, and auditing resource limitations; also, stockpiling deferred some of the savings beyond the verification period.

4.2 Technical Feasibility

In order to demonstrate technical feasibility, ILUMEX set very high standards for CFL lamps, including:

- 10,000 hour lifetime,
- 1 year warranty,
- voltage variation +/− 10%,
- efficacy ranges by wattage,
- lumen maintenance > 90%,
- color temperature 2600–2800 K (warm white),
- color rendering index > 79,
- maximum length 20.32 cm, and
- maximum weight 350 grams.

Four of these factors were particularly important:

- **Impact on the Grid.** Early residential CFL DSM projects in Mexico were quite concerned with power factor and harmonics. As CFE gained more experience within Mexico and as other institutions in other country programs did more research (in Latin America and the United States), these concerns diminished. Two of the pre-ILUMEX pilot projects in the cities of Puebla and Querétaro had tested and found that CFLs did not significantly lower the power factor in the local grids. During ILUMEX, CFE realized that the added cost of requiring low total harmonic distortion (THD) was not warranted by impacts on the grid, especially in residential CFLs. Internationally, utilities noted that increased THD from other equipment, in all sectors, had much more impact than residential CFLs. The ILUMEX program maintained its high standards for power factor (PF) and THD to ensure that no grid-related problems developed. However, subsequent CFL programs in Mexico have relaxed these high PF and THD requirements.

- **Useful Life of the Product.** The intent of the project was to provide incentives to introduce a world-class CFL that could withstand voltage variations and last for several years. Imposing the 10,000 hour standard provided a way of overcoming consumer doubts about the durability and resilience of CFL lamps.

- **Fixture Compatibility and Ballast Characteristics.** Initially, there was concern that existing fixtures might not be compatible with CFLs. At the time, most CFLs had magnetic ballasts and were heavier, which could pose a short-circuit danger in fixtures where the incandescent bulb was simply hanging from the ceiling directly from the wire, with no protection. However, by the time the ILUMEX program began, magnetically ballasted CFLs had all but disappeared and were replaced in the market by lighter, smaller, electronically ballasted CFLs that met the specifications.
Similarly, concerns about fixture compatibility were quickly resolved as the size of CFLs continued to diminish and most were used in fixtures without size constraints.

- **Color Temperature and Rendition.** During pre-project surveys, consumers indicated a concern (based on experience with circular fluorescents) that the color of the lighting would be similar to an institutional setting rather than a home. By concentrating on high quality CFLs, ILUMEX sought to better meet consumer expectations.

The ICR noted some initial problems with the quality of some CFLs but ultimately both the ICR and the PAR concluded that feasibility had been well demonstrated. The PAR also noted that the project had demonstrated that bulk purchase was an effective way to obtain technical improvements and significant price reductions from manufacturers. Interviews conducted by the Study Team confirmed that technical feasibility had been demonstrated.

### 4.3 Financial Feasibility

Three benefit-cost tests are typically used to determine financial feasibility for energy efficiency programs:

- **Total Resource.** This test assesses the net benefits of the project from the perspective of the entire society. Considering the cost of the CFLs and the benefits (savings in purchase of incandescent bulbs, cost of capacity saved, cost of energy saved), the ICR calculated a positive internal rate of return (IRR) of approximately 35 percent.

- **Customer Participant.** From the perspective of participants, the ICR calculated an IRR of almost 250 percent, as the cost of the CFLs was subsidized and the energy savings were very large. This was partly because most participants were from higher economic strata than initially envisioned; given their very high electric tariffs, the energy savings were worth more in monetary terms.

- **Utility.** From the perspective of the CFE, the ICR determined that the IRR was negative (because the cost of foregone billings outweighed the reduced cost of generation).\(^4\) However, the ICR also noted that as inasmuch as there existed capacity constraints, the ability to sell the extra electricity that the project saved and the financial benefit of capacity savings could result in a return of 23 percent.\(^5\)

The ICR noted the importance of the price subsidy in the overall marketing and sales strategy, in part to counter the disincentive created by large electricity price subsidies, particularly for low-income customers. The ICR concluded that financial feasibility had been demonstrated based on IRR calculations using the Total Resource test.

The PAR recalculated the IRR under the Total Resource test at 29 percent. Assuming GHG emission reductions could be sold at US$10 per tonne, the PAR estimated this rate of
return would rise to 34 percent. However, given the negative return for the CFE, the PAR concluded that financial feasibility had not been demonstrated, a finding that has not been universally accepted. At the heart of the debate are the following questions:

- What level of subsidy is necessary?
- Under what conditions can a subsidy be justified?
- How could a subsidy be sustained?

These questions are considered in section 6.1.

4.4 Increased Short-Term Institutional Capacity

The ICR credited the project with having established a fully developed institutional capacity to implement high-efficiency lighting projects at a national scale, as well as a strong understanding on the part of CFE of the role of high-efficiency lighting projects in overall DSM programs. The ICR also found that CFE had gained a solid understanding of the economic dimensions of DSM programs, including the role of tariff and price subsidies. The PAR noted improvements in the institutional capacity for technological change and energy conservation and strengthened capacity for CFE to practice DSM.

The Study Team’s inquiries confirmed this increase in capacity and generated the following comments:

- Because of ILUMEX, many more professionals in the electricity sector began to work on DSM programs. During ILUMEX, this began with the CFE staff, followed by the staffs of the regional fideicomisos (FILUMEXs).
- Staff gained invaluable experience working with a successful program. As discussed below, this helped convince CFE management and other institutions of the viability of DSM programs to mitigate tariff increases and provide higher value services to customers.
- The same team who worked on ILUMEX worked on subsequent air conditioner and refrigerator early replacement energy efficiency programs.
- It was clear that the stakeholders interviewed in CFE and other institutions gained experience and confidence. Several of the staff had worked with earlier programs and transferred their experience to the ILUMEX program. Staff then transferred this knowledge into the next phase of CFL programs, expanding CFL sales nationwide.
- It was valuable for CFE and its related institutions to learn to calculate and verify the energy and environmental benefits of the ILUMEX program.
- ILUMEX also furthered the ability of Mexican institutions to develop and negotiate projects with international financial institutions. For example, the experience aided Mexico in obtaining a subsequent loan for electrical equipment technologies from the IDB.
4.5 Replicable Model Provided

The key features of the ILUMEX model are:

- **Bulk Purchases of High-Quality CFLs.** During ILUMEX, the FILUMEXs set specifications and issued large purchase orders, creating a demand for large quantities of CFLs. Their ability to issue a large purchase order gave them a lower unit price and allowed them to have a greater influence on product quality. This established a mechanism that would prove useful to future programs.

- **CFLs Sales in Local Utility Service Centers.** This allowed customers the convenience of buying the product at a time when they were unfamiliar with the technology and CFLs were not readily available in traditional sales outlets. This part of the model has been replicated in other countries, including the Efficient Lighting Initiative (ELI) program in Argentina (see section 6.6) and Costa Rica.

- **Low-interest Financing available at the Utility Service Centers.** This key feature enabled customers to purchase CFLs who otherwise could not afford the high initial capital investment. The low interest made the program more viable for customers with modest incomes. Some subsequent international programs, such as ELI Argentina, have offered zero-interest financing to promote CFL sales (see section 6.6).

- **Payment in Installments on the Electric Bill.** This mechanism for purchasing CFLs from the utility provided several benefits. It was convenient for the consumer, and paying in installments facilitated the financing option. CFE generated an automatic billing system that it could also use to track CFL sales and customer demographics.

- **Subsidized Prices.** ILUMEX successfully illustrated the use and value of a price subsidy to “jump start” the market for an emerging technology. CFL prices were still high in the early 1990s and potential customers had little awareness of or confidence in the potential advantages of the technology. Although the final average subsidy was lower than originally planned, it was enough to break through the high first-cost barrier. As the market grew, the economies of market (and accompanying improvements in technology) allowed CFL prices to decrease, and the need for a subsidy diminished.

The ICR did not comment on the replicability of the program, but noted CFE’s intention to extend the program to the rest of the country. The PAR concluded that failure to demonstrate financial feasibility meant that the program was not replicable.

Although the program may not have been replicable in all financial details, most of its features could be (and have been) replicated in Mexico. The extent of domestic replication that has occurred (and the lessons regarding subsidy programs) are discussed in section 6.1. Replication in other countries is discussed in section 6.6.
5.1 Energy Policy

ILUMEX occurred against a macroeconomic backdrop that both was impacted by, and affected, national energy policy. In 1995, following Mexico’s admission to the Organisation for Economic Co-operation and Development (OECD), the Mexican peso underwent a major devaluation (from 3 Mex$ per US$ to 10 Mex$ per US$) and the country was subjected to a deep recession. This caused the fall of real salaries and a rise in the value of imported goods, including CFLs. The Treasury implemented conservative fiscal policies, which lent support to proposals for privatization in the electricity sector, as well as other parts of the energy sector. Although public ownership is enshrined in the Mexican Constitution, a 1992 electric law redefined “public service,” allowing for the entry of independent power producers, self-generation, and other private power projects.

While much of the objection to privatization came from a concern about selling national patrimony, some professionals argued that energy efficiency and renewable energy were alternative resources that could significantly reduce the need for new power plants and private investment. Furthermore, some energy efficiency advocates argued against restructuring, stating that both demand growth projections and estimated cost of power plants were inflated, and with energy efficiency and conservation the government had sufficient resources to meet the need for new capacity. They also pointed out that the government was unprepared to provide appropriate oversight; for example, CRE (Comisión Reguladora de Energía or the Energy Regulatory Commission) had no authority or experience in regulating private power generation. The result was that CFE entered into a number of long-term purchase agreements called pidiregas that led to private sector investment in generation. There was considerable public opposition for full
privatization, however, as evidenced by demonstrations organized by the electricity sector unions and others. Ultimately, the strength of the opposition, aided by the bad experiences in California, Chile, and Argentina, as well as the major blackout in the northeastern United States, led policymakers to back away from full-scale privatization.

With the exception of a small amount of hydroelectricity, Mexico chose combined cycle natural gas (CCNG) turbine power plants to provide almost all new capacity in the last decade. A corresponding trend in the United States sent the natural gas price soaring from US$1–$2 per MBtu to US$4–$6 or more beginning in 2000. This reduced interest in investing in more CCNG power plants and increased the attractiveness of energy efficiency investments. To the extent that CCNG plants represented an increasing percentage of the supply, this contributed to lowering GHG emissions per KWh. As these plants become less affordable, GHG emissions can be expected to rise, unless offset by reductions in demand.

This natural gas price rise led the Treasury Department to increase residential electricity tariffs substantially in 2002, and real prices continued to rise in 2003 and 2004. The original plan to reduce subsidies to all tiers of residential consumers, including the lowest consumption tier, was moderated due to public opposition, but the two higher consumption residential tiers experienced considerable price hikes, as now all the consumption was charged at the marginal rate.

Higher prices have slowed overall growth in electricity demand, although some of this may also be due to structural change (e.g., electricity demand in many end uses may be saturated); as population growth slows, the country may also be moving from a more energy-intensive industrial mode to a less energy-intensive service mode.

When the economy picked up again in the late 1990s, the country faced severe electricity shortages, partly due to drought conditions for hydro plants and partly due to the quick increase in demand. However, as the Mexican economy’s growth slowed and electricity demand growth was lower than expected, the system ended up with a large excess of capacity. Also, the years since 2002 have had more rainfall, and the interconnected system reserve margin that had dipped to around 20 percent in 2000 had risen to almost 50 percent by 2005.

Thus, as ILUMEX took place, the country was still looking mostly at supply-side options and, given the size of these investments, considering opening the sector to foreign investment and ownership. At the same time, CCNG plants saw a significant reduction in cost, and Mexico (as well as other countries) focused almost all its supply growth on this technology. Yet when prices and availability of natural gas became problematic, the coun-
try found itself drawing upon the ILUMEX experience to try to provide customers with a price signal to reduce demand growth. Tariffs were increased significantly in 2002 together with a national promotion of DSM. This can be considered a legacy of ILUMEX.

5.2 Energy Efficiency

The box below outlines the major institutions involved with energy efficiency in Mexico. Other institutions not directly involved with energy but important for understanding the

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**Key Institutions Involved in Energy Efficiency in Mexico**

*ATPAE, Asociación de Técnicos y Profesionistas en Aplicación Energética (Association of Technicians and Professionals in Energy Applications), is composed of academics, federal legislators, and power sector individuals who meet periodically to discuss energy sector issues.*

*CFE, Comisión Federal de Electricidad (Federal Electricity Commission), is the national electricity utility of México. CFE serves most of the country, with the exception of México City and a few areas outlying the capital. CFE implemented the ILUMEX program.*

*CRE, Comisión Reguladora de Energía (Energy Regulatory Commission), is involved with energy regulation; however, its role in energy efficiency is limited.*

*Luz y Fuerza del Centro (LyFC) is the utility that serves Mexico City and some surrounding areas.*

*PAESE, Programa de Ahorro de Energía del Sector Eléctrico (Electricity Sector Energy Savings Program), was formed in 1989, essentially renaming the agency PRONURRE that began in early 1982. Its goal has been to foster energy efficiency opportunities among customers and also within the electric sector itself (supply efficiencies). However, PAESE has had a limited budget and currently concentrates mostly on analyzing energy savings projects within CFE itself. PAESE was the key promoter and coordinator of efforts to do residential CFL DSM projects. This work provided the background and infrastructure development for ILUMEX. Basically the PAESE program gave FIDE access to CFE resources (mostly in-kind).*

*FIDE, Fideicomiso de Ahorro de Energía Eléctrica (Trust Fund for Electrical Energy), was created in 1990 to help collect funds for PAESE-identified projects and eventually FIDE’s own projects. It was created after the Energy Secretariat established CONAE in 1989 to ensure that electricity efficiency stayed within CFE’s purview. FIDE learned from the PAESE experiences and then from ILUMEX to set up national residential CFL DSM projects. FIDE used CFE offices as sales offices and used CFE’s billing system to collect reimbursements for goods.*

*FILUMEX was a trust fund (fideicomiso) formed to implement the ILUMEX program. There was one FILUMEX for each of the two states, Jalisco (Guadalajara) and Nuevo León (Monterrey).*

*FIPATERM (Fideicomiso para el Programa de Aislamiento Térmico de la Vivienda en el Valle de Mexicali, Trust Fund for the Residential Thermal Insulation Program in the Mexicali Valley) began*

(continued on next page)
in 1989. Through low interest loans, it financed roof insulation, weatherstripping, high-efficiency air conditioners, CFLs, and residential energy audits.

*CONAE, Comisión Nacional de Ahorro de Energía (National Energy Savings Commission)*, was created in 1989 and was part of the incoming administration’s program to improve the efficiency of government, including the energy sector. However, when FIDE came into existence in 1990, CONAE’s role shifted from programs directly impacting consumer end-use electric efficiency and focused more on non-electricity energy efficiency promotion. CONAE did retain the role of enacting building and appliance minimum energy efficiency standards and test procedures. Over 20 such standards (*Normas Oficiales Mexicanas, or NOMS*) exist; the standards for two-piece CFLs (lamp and ballast), air conditioners, refrigerators, and motors have the largest energy-savings impacts. CONAE continues to serve as a promoter and organizer of energy efficiency and renewable energy efforts, especially within and among public sector entities (from the municipal to the federal levels).

*SENER (Secretaría de Energía)* is Mexico’s Secretariat of Energy. It is in charge of national energy policy and planning.

*SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales)* is the government secretariat that focuses on environment. It is the lead Mexican government agency on climate change.

context of ILUMEX and its subsequent programs are defined in the text and/or in the acronyms list at the beginning of this document.

Because of the 1995 economic crisis, internal funding was not available for new programs throughout the years 1996–1998. ILUMEX went forward in spite of the stagnated economy due to the momentum the program already had. By the program’s conclusion in 1998, the economy was in better shape, and thus it was possible to begin a nationwide program. Meanwhile, CFLs were being used more and more internationally, which helped reduce their price and increase their availability. In the early 2000s, technical advances allowed bulb size to be closer to that of incandescent bulbs. As sales grew, production increasingly moved to China and large price reductions ensued (an example of the economies of market technology). ILUMEX was the first of similar programs in many other countries that eventually together helped transform CFL technology and its markets.
6

Assessment of Intermediate Outcomes

6.1 Replication within the Mexican Residential Lighting Market

As the first large-scale energy efficiency project in Mexico, ILUMEX was very influential in providing a successful model for DSM programs. The program model has been replicated both directly and indirectly in the years since ILUMEX. Direct replication in the form of lighting programs includes the following programs, whose estimated sales and characteristics are summarized in Tables 6.1 and 6.2.

FIDE CFL Sales. Immediately following ILUMEX, FIDE conducted a program of CFL sales in CFE offices throughout the country beginning in 1998; at the time of this report, the program was ongoing. By the end of 2004, FIDE had sold 8.6 million CFLs in CFE service centers, with a scheme of financing on the electric bill similar to that used in ILUMEX. During the first few years, the CFLs were partially subsidized, though at lower levels than ILUMEX. It is clear that the FIDE program was a direct successor to ILUMEX and would not have been implemented in the same way if ILUMEX had not occurred. In fact, the general view is that in the absence of ILUMEX, the FIDE program would probably have developed into a pilot-scale program similar to ILUMEX, but at a much more modest level. This would have had a direct impact on sales and, more importantly, would have removed a significant impetus for market transformation. In interviews, stakeholders indicated that the FIDE sales program will phase out in the near future. Consequently, for the purposes of impact calculation, it was assumed that sales last through end-2006, with reduced sales levels.

FIPATERM. Since 1989, FIPATERM has conducted a program to promote residential roof insulation, weatherstripping, and high-efficiency air conditioners. Beginning in 2000, FIPATERM added CFLs, and by end 2004 had sold almost 0.5 million CFLs, using the same utility bill financing mechanism as
ILUMEX. As of 2004, FIPATERM had virtually stopped selling CFLs, but at the end of 2004 had plans to include CFLs in their package again, using them as an incentive until approximately 2008 for people to participate in an appliance early retirement program. Although the FIPATERM program borrowed some elements from ILUMEX, the focus was on other technologies and it is difficult to make a credible attribution to ILUMEX. FIPATERM sales have very low attribution, as this program was focused on other technologies as well as CFLs. There appears to be no subsidy component to this program.

**CFE Rebate.** In 2002, tariff restructuring significantly reduced or eliminated the subsidy in the upper two tiers of the three-tier increasing rate residential tariff. Before 2002, the increasing rate structure was applied to consumption in each tier; therefore, a customer with high consumption still paid subsidized rates for the lower tiers. After 2002, a customer’s entire consumption was charged at the marginal tier rate. This significantly increased the bill for the second and third tier consumption levels (the middle- and upper-income classes). To offset the impact, CFE conducted a CFL rebate (bonificaciones) program together with the tariff changes. CFE allied with manufacturers and distributors, allowing customers to purchase up to 10 CFLs per customer over 10 months. This was advertised as a means to help lower electric bills. About 2.6 million CFLs with rebate coupons were sold. Only about 12 percent of the coupons were redeemed, perhaps because customers purchased the CFLs without an intention to claim the rebate and/or because the method of coupon redemption was unwieldy. The value of the coupon was about US$1 for higher-wattage CFLs and as little as US$0.25 for lower-wattage lamps. The evidence indicates that CFE would probably not have considered offering CFLs had they not known from previous ILUMEX evidence that efficient lamps would indeed reduce consumption appreciably, thus allowing the utility to offer relief to consumers when tariffs were raised. Thus the attribution to ILUMEX is very high; however, since most consumers who bought the CFLs did not claim the rebate, this feature turned out to be less of an incentive than anticipated.

**Luz y Fuerza del Centro (LyFC).** LyFC, the utility company serving Mexico City (and neighboring areas), has sold almost 0.5 million CFLs in its neighborhood offices. The LyFC program began in 2002 and is expected to continue until approximately 2008. In the LyFC program, customers pay cash for the CFLs at a subsidized price (10–15 percent below market) rather than having a financing option. The program is operated by a private company and the costs are shared with manufacturers (down to two companies from five initially). Professionals in Mexico City appear to be less familiar with this program than with ILUMEX; however, in the LyFC offices visited by the Study Team, the sales stand was highly visible as the cus-
Assessment of Intermediate Outcomes
tomer entered the door. The LyFC program is a direct extension of the ILUMEX program and probably would not have happened for several years without the encouragement, successful model, and infrastructure developed by ILUMEX.

Table 6.1 summarizes the principal programs that have been conducted in the Mexican residential lighting market. The fourth column provides the Study Team’s assessment of the attribution of these program results to the replication value of ILUMEX and is based on the Study Team’s interviews and experience. The final column provides the Study Team’s subjective estimate of a range of possible counter-factual scenarios in the absence of ILUMEX.

Table 6.2 presents the actual (1998–2003) and forecast (2004–2008) sales for each of the post-ILUMEX programs.

According to most observers the key aspects of the ILUMEX model that provided a basis for replication were (a) the ability to finance purchases through customer billing and (b) the initial provision of a subsidy.

Table 6.1 CFL Promotion Programs: Sales, Dates, Attribution, and Counter-Factual Scenarios

<table>
<thead>
<tr>
<th>Program</th>
<th>Subsidy Level</th>
<th>CFLs Sales (millions)</th>
<th>Year</th>
<th>Attribution to ILUMEX</th>
<th>Counter-Factual Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot Projects (pre-ILUMEX)</td>
<td>Varied a</td>
<td>1.1</td>
<td>1990–1995</td>
<td>Nil</td>
<td>No change</td>
</tr>
<tr>
<td>ILUMEX</td>
<td>49%</td>
<td>2.6</td>
<td>1995–1999</td>
<td>Complete b</td>
<td>Does not happen</td>
</tr>
<tr>
<td>FIDE (post-ILUMEX)</td>
<td>0–40%</td>
<td>8.1</td>
<td>1999–2006</td>
<td>High</td>
<td>Smaller programs, delayed 0–4 years</td>
</tr>
<tr>
<td>FIPATERM (Baja California)</td>
<td>Nil</td>
<td>0.5</td>
<td>2000–2008</td>
<td>Low</td>
<td>No change</td>
</tr>
<tr>
<td>CFE—rebated or eligible for rebate</td>
<td>5–20%</td>
<td>2.6 c</td>
<td>2002</td>
<td>Very High</td>
<td>Does not happen</td>
</tr>
<tr>
<td>Luz y Fuerza del Centro (México City)</td>
<td>10–15%</td>
<td>0.5</td>
<td>2002–2008</td>
<td>Very High</td>
<td>Does not happen</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>15.4</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

a The first three pre-Ilumux programs gave the CFLs away via manufacturer donation to CFE. Other pilot programs usually had a reduced price since manufacturers sold the CFLs at cost, retailers were convinced to reduce their profit margins, or financing was offered.

b While the attribution is described as “complete,” this model assumes 10 percent are free riders.

c Of these, only 325,000 claimed the discount.

The original CFL price subsidy planned in the ILUMEX program was about 63 percent. But because the program was extended to allow more sales, many of which were to higher-income customers, the actual subsidy was about 49 percent. As noted in Table 6.1, most of the post-ILUMEX programs retained some level of subsidy, albeit at a reduced level and for a limited time.

Overall, the evidence suggests that in Mexico: (a) some level of subsidy (or financial assistance) has remained useful to overcome barriers to efficient technology adoption, especially among the poorer sectors of society; (b) the level of subsidy necessary has declined significantly over time; and (c) the broader benefits have been sufficient to sustain the willingness of government institutions to provide these subsidies.

Most observers tend to credit the ILUMEX project with having demonstrated these lessons. FIDE, CFE, and CONAE (Comisión Nacional para el Ahorro de Energía), as well as manufacturers, all remarked that the CFL market has now been transformed and does not require further support via subsidies. However, all believe that the earlier CFL price subsidies helped accelerate the market evolution and transformation.

6.2 Improvements in Long-Term Institutional Capacity

Following ILUMEX, the capacity to implement energy efficiency programs spread to FIDE through its subsequent programs and expanded to the personnel of other energy and environmental institutions. The experience and its results helped convince others who had been sceptical of energy efficiency. While inspired by ILUMEX, not all of this change can be attributed to the program. Electricity tariff adjustments in 2002 and 2004 are cited as other key factors leading to increased interest in energy efficiency. Nevertheless, it is reasonable to conclude that, without ILUMEX, institutional capacity would have been much less developed and would have taken several years longer to mature. Without ILUMEX, it also would have been harder to implement these tariff adjustments.

Capacity within CFE and Institutional Incentives

Within CFE, ILUMEX brought increased recognition of the use of energy efficiency programs to mitigate the impacts of residen-
Assessment of Intermediate Outcomes

The success of ILUMEX helped convince management of the viability of DSM as a strategy. As discussed above, FIDE transferred this knowledge to their CFL sales program that directly followed ILUMEX. CFE also provided rebates for CFLs to help consumers reduce their bills when tariffs were increased in 2002.

Unfortunately, despite the success of ILUMEX, CFE still does not have explicit institutional incentives to carry out DSM programs. For the utility, energy efficiency does not pay unless the system is capacity constrained and the reduced consumption allows additional power plant construction to be deferred, which is less likely now with the private power plant option. The key problem is that CFE finances are subservient to the needs of the federal budget, and when the Treasury’s funds are low, it taps into the electric and oil sectors, leaving these public entities without profits for reinvestment. Since CFE operates as a public utility, there is still an opportunity to consider the public good but, without more tangible incentives (e.g., mandated investment), there will always be a temptation to invest where returns are positive rather than negative.

Capacity within Other Government Agencies and Institutional Structures

The Treasury (Secretaría de la Hacienda) defines many public policies regarding subsidies and rebates. In recent years, subsidies were seen as counter to the free market. ILUMEX demonstrated the value of subsidies in certain conditions, which were then replicated (at a lower level) in the FIDE CFL programs. This broadened the outlook of the Treasury and increased Mexico’s capacity to use a full array of public policy instruments to promote energy efficiency. ILUMEX’s success also led to an agreement between the Presidency and the Treasury to establish a credit line to support efficient equipment (CFLs, air conditioning, refrigeration, and building envelope measures) to offset the impact of 2002 tariff increases.

ILUMEX helped CONAE raise the profile of a variety of energy efficiency opportunities. Previously, CONAE tended to focus on technologies rather than markets and, during the period of greatest fiscal pressures, was not able to significantly advance the energy efficiency agenda. Following the success of ILUMEX, CONAE gained a renewed appreciation for the potential of energy efficiency/DSM programs and was able to more effectively promote these opportunities with decision makers.

Before the ILUMEX program began, CFE had the PAESE program in place at a modest level and FIDE was just starting up, but in general, there was little institutional capacity for energy efficiency. In contrast, Mexico now has among the most solid energy efficiency infrastructures in the world and is used by other countries as a model to emulate. Via the FILUMEXs, CFE was able to set up insti-
tutional structures to: manage the funding; manage the bulk purchase specifications, contracting, and purchasing; hire personnel; purchase equipment; set up sales points; and do social marketing. This same infrastructure was then used in the nationwide FIDE programs. This structure has solidified and is broadly considered to be a successful model by most stakeholders.

Capacity of Energy Professionals
ILUMEX and the programs that followed helped provide the momentum for existing professional energy efficiency groups such as ATPAE and the establishment of new ones such as the Asociación de Ahorro de Edificaciones, an association for (energy) savings in buildings. This type of network gives professionals a base for developing and sharing knowledge about technology improvements and best practices and helps ensure the sustainability of energy efficiency markets.

International Capacity for GHG Verification
ILUMEX provided a vehicle for the development and testing of methodologies for calculating, validating, monitoring, and verifying GHG emission reductions in the context of a developing international market. This was the first Activity Implemented Jointly (AIJ) project globally to be validated and then monitored/verified (by DNV under contract to the World Bank). It helped create expertise in this field among the consultants (LBNL, IIEC) as well as the funding agencies (e.g., World Bank, GEF, and IDB) and global climate change institutions such as the United Nations Framework Convention on Climate Change (UNFCCC) and the United States Initiative on Joint Implementation (USIJI).

6.3 Consumer Preference Influenced
Consumer purchasing intentions are influenced by a variety of factors, including:

- awareness,
- confidence in quality, and
- attitudes toward price and energy savings.

Consumer data from a 2003 survey conducted by PROFECO, the national, government-run consumer protection agency, address several indicators of consumer preferences. PROFECO performed a survey and published the results as part of an article on CFL availability, ratings, prices and consumer response in the October 2003 issue of its widely-read monthly magazine, Revista del Consumidor. PROFECO surveyed over 2,000 people in Mexico City, Hermosillo, Oaxaca, Tijuana, and Zacatecas, covering a wide geographical distribution. The relevant findings are included in the following discussion. Overall, the survey indicated that almost 30 percent of respondents were likely to purchase CFLs rather than incandescent lamps. (PROFECO 2003)

Awareness
CFE’s analysis of consumer attitudes toward CFLs prior to the ILUMEX project showed
that 74 percent of the population were unaware of the technology. In evaluations of the pilot programs that preceded ILUMEX, awareness ranged from 27 to 80 percent, and was higher for higher income groups. More people, however, were familiar with circular fluorescent lamps, which were widely sold before ILUMEX.

In 1996, a CFE survey found that about 65 percent of program participants thought the ILUMEX program was excellent or very good (CFE 1996).

The Study Team was unable to find any objective evidence concerning the evolution of levels of awareness. However, most people interviewed indicated that consumer awareness had increased substantially in the past five years, and this was also supported by anecdotal evidence of awareness in the general public.

The PROFECO survey did not directly address the level of consumer awareness or consumer acceptance of CFLs, but it did reveal that less than 10 percent of consumers considered themselves to be well informed before choosing a particular brand. This would appear to indicate that even if aware, consumers still have important information gaps concerning CFLs.

To the extent that awareness has improved, ILUMEX would certainly have played a major role in the cities where it was implemented. Beyond that, most believe that the FIDE program was a major factor and awareness would have benefited greatly from the ILUMEX precedent.

Confidence in Quality
Prior to ILUMEX, most people’s experience with fluorescents involved circular lamps. The common view was that fluorescent lamps were very large (in comparison with the incandescent lamps they replaced) and that the color was unappealing and “office-like.”

The Study Team found no direct data on consumer confidence in CFLs following ILUMEX. However, CFE’s assessment of mid-program consumer attitudes found that about two thirds of participants were satisfied, while almost one third were unsatisfied (though no reasons were recorded). Virtually all the people interviewed by the Study Team indicated that quality had ceased to be an issue with most consumers. Most also felt that the ILUMEX strategy of selling high-quality twin- or triple-tube compact fluorescents had helped dispel many of the concerns.

The ILUMEX program helped inspire consumer confidence in the two project cities. Several stakeholders stated that Mexican consumers tend to trust information imparted by people from their region as being pertinent to their needs. The local FILUMEX presence (in CFE offices) enhanced customer’s trust in the program.
Attitudes toward Price and Energy Savings

The PROFECO (2003) survey revealed that two thirds of consumers are still more likely to purchase incandescent lamps and that this ratio rises further as income decreases. This appears to indicate that factors such as the price premium as well as poor electrical service quality that affects product lifetimes are powerful disincentives. The price differential has decreased substantially in the years since ILUMEX.

Nevertheless, almost 30 percent of respondents in the PROFECO survey indicated a preference for CFLs, a major change from the situation pre-ILUMEX when few customers were aware of the technology outside of the pilot project areas. Of those who preferred CFLs, 90 percent were seeking to reduce their energy consumption or to reduce their electricity bill and 75 percent confirmed that they had actually noted a net cost savings. This indicates a strong awareness of the energy and financial advantages of CFLs, and helps explain the growing number of consumers who are able to overlook the initial price premium for CFLs. At the same time, the price premium is low enough that the investment becomes less major than it was during the pre-ILUMEX period.

According to the Study Team’s interviews, ILUMEX played a dominant role in changing the reluctance to invest in the expensive technology in the cities where the program operated. FIDE then spread this understanding to the rest of Mexico.

6.4 Improvements in Trade Ally Capacity and Confidence

The supply and marketing of CFLs involves the efforts of two main groups that each have a role in contributing to the evolution of the market: (a) manufacturers and distributors and (b) retailers.

Manufacturers and Distributors

Prior to ILUMEX, there were two main companies selling lamps in Mexico (Philips and Osram). These companies sold both the more common circular fluorescent tubes and the new CFL lamps, at a premium price.

During ILUMEX, the FILUMEXs set specifications and issued large purchase orders, creating a demand for large quantities of CFLs. This both provided a significant incentive for manufacturers to improve quality and contributed to worldwide demand that, in turn, helped generate economies of markets, technological improvements, and reductions in price.

Although not all manufacturers participated in ILUMEX (Osram declined to modify its products to meet the high quality specifications), the sales achieved convinced most manufacturers that the market in Mexico was expanding and was worth their attention. It also gave manufacturers a good understanding of the quality demands of that
market and helped them develop product distribution channels. In FIDE’s subsequent rebate program, a few of the more onerous and less important lamp requirements were relaxed and all the major lamp manufacturers (for example, Philips, Osram, and General Electric) participated.

FIDE has established alliances with participating manufacturers. The electrical manufacturers’ association CANAME (Cámara Nacional de Manufacturas Eléctricas) provided some of FIDE’s seed money, serves on its Board of Directors, and organized meetings with CONAE and SENER (Secretaría de Energía) to promote awareness and participation in FIDE programs. CANAME also strove to influence consumer’s awareness of consumer consumption and energy’s impact on the national level.

In the period since ILUMEX, major manufacturers such as General Electric and Panasonic, as well as a variety of distributors (including Sanalec, Electromag, MaxLite, Pepsi, and SLI) entered or increased their presence in the market to participate in FIDE programs, and are still operating in Mexico. CFLs entered established lighting-product distribution channels and were added to the product mix. CFLs expanded from this structure into supermarkets as well as large chain stores such as Costco, Sam’s Club, etc. Store brands and discount brands have also entered the market to sell lower-quality CFLs. In recent years, the introduction of mid-grade CFLs of 3,000–4,000 hours has provided medium-priced units with modest lifetimes, providing more consumer choices in terms of price and quality.

Worldwide manufacturing capacity to provide CFLs increased substantially during and following the ILUMEX program. Most of this manufacturing capacity developed in Asia with no new factories in Mexico. However, most observers believe that Mexico’s demand played a small but significant role in the worldwide growth of demand. Observers also agree that ILUMEX and FIDE played a significant role in giving manufacturers and distributors the confidence to enter the Mexican market and promote them in a serious way (this is clearly visible in the multitude and magnitude of CFL store displays).

Bulk purchasing for ILUMEX and the FIDE programs helped to signal manufacturers of the need to increase supply, allowed a lower unit product price, and provided leverage for the specifications for higher-quality CFLs. However, in one case — the 2002 CFE rebate program — manufacturers complained that overly optimistic goals caused them to produce and label more CFLs than the program ultimately sold. Since the rebate was not claimed by most customers, the manufacturers were left with many labelled products after the program had ended.

Retailers
The 2003 PROFECO survey noted that approximately 50 percent of CFL purchases
now take place in supermarkets and another 25 percent in specialized stores. Only 10 percent continue to be purchased through CFE offices.

In fact, retailer participation in the CFL market has increased dramatically. Before ILUMEX, the few CFLs sold in Mexico were made by Philips and Osram. Now, the large majority of residential light bulbs on display in chain stores (autoservicios), supermarkets, and hardware stores are CFLs. This widespread availability of the product is cited by many stakeholders as evidence of market transformation.

Stocking practices include prominent displays of a variety of CFL brands. In PROFECO’s 2003 survey in 21 diverse cities, over 250 models of CFLs provided by 28 manufacturers were observed. However, the number of available models varies widely geographically. Of the 26 models that replace 60 watt incandescent bulbs, the number of models on store shelves ranged from 15 (in six cities) to 1 (in one city). Manufacturers have not conducted many direct promotional campaigns in retail stores in Mexico, as was done more widely in other CFL programs such as the ELI program in Perú, with in-store displays and promotional product discounts.

Most observers agree that the increase in retailer participation has helped spread the CFL technology rapidly throughout Mexico. However, since ILUMEX did not focus on developing retailers as trade allies, it is difficult to assess how much of this to attribute to the program.

6.5 Program Replicated in Other Mexican Energy Markets

This assessment focused mainly on the residential lighting market. However, subsequent programs were identified as having been influenced in some way by the ILUMEX experience, although no attempt was made to quantify the attribution.

In 1997, FIDE received a US$23.4 million loan from the Inter-American Development Bank to conduct programs promoting several energy efficiency technologies, including motors and residential appliances. The Mexican experiences with energy efficiency, including the institutional strength of FIDE to carry out these projects, partly due to ILUMEX, led to IDB’s interest in pushing this loan to Mexico. The energy-efficient motors program is widely cited by stakeholders as very successful. In the residential sector, FIDE offered substitution programs for refrigerators and air conditioners, as well as residential insulation programs. The program included a modest subsidy for purchasing efficient refrigerators and air conditioners, and offered a three-year loan. The provision of a subsidy generally went against the philosophy of the program, but was seen (perhaps with the ILUMEX experience in mind) as a temporary measure to “jump-start” the market.
At the end of 2003, the Programa de Financiamiento para el Ahorro de Energía Eléctrica (Program to Finance Electric Energy Savings) was announced. The program was set up to counter the large increase in residential tariffs that was leading to customer complaints. Its partners are CFE, NAFIN (the National Development Bank), FIDE, and FIPATERM. Funds available are about US$322 million (3,225,000,000 pesos) in two credit lines from NAFIN. CFE administers the receipts, payments, and maintains the ties with the enterprises. About 100,000 refrigerators have been retired from service, resulting in large energy savings and impact on global climate change. The program also targets early retirement and destruction of air conditioners (central, window, and mini-split). The program also finances building envelope insulation. While NAFIN provides financing, CFE covers operational costs that it hopes to recover through the sale of carbon credits via the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

The Secretary of Agriculture and Water and Rural Financing was to start a program in 2005 for pumping and technology upgrades called FIRCO (Fideicomiso Riego Compartir), whose program implementation is similar to ILUMEX, but for the industrial sector. CFE, through FIDE, was to help with promotion only.

CONAFOVI (Consejo de Fomento de la Vivienda, Council of Housing Promotion) conducted a program in 2002 with FIDE to change the lighting in 1,800 houses (not focused on CFLs). CONAFOVI, as well as INFONAVIT (worker housing agency) have agreements with FIDE for financing of additional programs.

6.6 Program Replicated in Other Countries

ILUMEX was described by one stakeholder as the “Modelo Mexicano” (Mexican model) and dubbed the most successful DSM program in Latin America. Several informants credited ILUMEX as having influenced CFL programs in Central and South America, in particular, Costa Rica, Nicaragua, Argentina, and Perú. In addition, FIDE has had inquiries from Ecuador, Venezuela, El Salvador, and Colombia to discuss the Mexican experience with ILUMEX.

In Argentina, GEF and the International Finance Corporation (IFC) financed the Efficient Lighting Initiative, which took place between 2000 and 2004. It involved a CFL incentive program featuring sales in utility service centers with financing on the bill, similar to the ILUMEX scheme. Perú also implemented an ELI program; however, despite strong interest but because of regulatory hurdles, sales could not be financed on utility bills, and the program instead featured manufacturers selling CFLs for cash in the utility service centers.

In ELI, the next major GEF-funded project in Latin America, the managing entities were
private electricity distribution companies whose approach was to transform the lighting market by offering financing and convincing manufacturers to reduce prices, rather than providing direct subsidies to consumers to jump-start the market.
7
Assessment of Ultimate Outcomes

7.1 Transformation of Other Energy Efficiency Markets in Mexico

Section 6.5 described some of the energy efficiency programs that were implemented following ILUMEX. Identifying the results of those programs and assessing the state of other energy efficiency programs was beyond the scope of this study; however, it is clear that the market for energy-efficient equipment and buildings is changing.

For the moment, much of the change is still being led, or at least facilitated, by government agencies such as FIDE. For example, three of the country’s largest housing contractors have recently established agreements with FIDE to produce efficient housing. FIDE is also setting up a program (also financed by NAFIN) for small and medium enterprises to transform equipment markets, distribution chains, and financing chains through energy efficiency retrofits. This is accompanied by training and education to reduce misuse and snapback.

7.2 Global Environmental Concerns Mainstreamed in National Policy

As a result of ILUMEX and the other programs that followed, concern about energy efficiency and a culture of DSM is now prevalent in most government institutions. Furthermore, there is now a political interest in promoting energy efficiency as one of the objectives of Mexican policy. Energy efficiency continues to have a chapter in SENER’s annual Prospectiva del Sector Eléctrico (Electric Sector Prospective). In one interviewee’s opinion, energy efficiency could be considered the “theme” of the Fox presidency. However, the concern for energy efficiency is driven primarily by domestic energy security, economic considerations, and local air quality concerns rather than global concerns about climate change, and there is little evidence that concern about climate change itself has permeated national policy.

Nevertheless, based on the assessment interviews, ILUMEX appears to have had a
role in mainstreaming some aspects of the GHG reduction challenge in national policy. For example, whereas ILUMEX’s interest in GHG savings estimations was something new in Mexico, as were the discussions on how to get carbon credits, there is now broad awareness and interest in the calculation and certification of GHG emissions reductions, and this is making its way into government policy. The interest is driven primarily by the coming-into-force of the Kyoto Protocol, but it seems likely that ILUMEX played a significant role in establishing the knowledge base for mainstreaming this aspect of policy.

7.3 Development of Global Flexibility Mechanisms

ILUMEX was significant, both for Mexico and internationally, as a demonstration of joint action under the UNFCCC Article 4.2 that paved the way for the Kyoto Protocol’s “flexibility mechanisms.” Under Norway’s $3 million simulated carbon purchase, the project served as a vehicle for:

- the first energy sector project in the world to concretely demonstrate the concept of “joint implementation” (JI) under UNFCCC. It occurred five years before the adoption of procedures for the Clean Development Mechanism; previously only tree plantations had been proposed as JI demonstration projects;
- the first international workshop on Joint Implementation, organized by the World Bank in 1992 in Mexico City in collaboration with Norway and SEDESOL (the predecessor agency to the current Ministry of Environment). At this workshop, the then-advisor to the Secretary of SEDESOL, Edmundo de Alba, vigorously defended the benefits for Mexico of participation in the JI demonstration project against opposition by Raul Estrada (who later brokered the Kyoto Protocol agreement). Mexico to the present day remains a strong supporter of the Clean Development Mechanism (CDM) in UNFCCC and Kyoto forums;
- the first JI project globally to be validated and then monitored/verified (by DNV under contract to the World Bank). The evaluation was done under procedures that were eventually made operational by the Prototype Carbon Fund, and accepted and put into international practice by the CDM Executive Board; and
- along with the Poland project, the first project globally to illustrate concrete modalities through which GEF and the future CDM could work together.

7.4 Transformation of the Mexican Residential Lighting Market

As noted in chapter 3, market transformation was not an explicit objective of ILUMEX, at
least for CFE. However, the global impacts being sought by the World Bank depended on the strategy that customer awareness, manufacturer interest, and changes in government policies would ultimately transform the residential lighting market from a market focused exclusively on incandescent lamps to one increasingly relying on CFLs. The key indicators of market transformation are availability, price, and sales.

**Availability and Marketing**

In evaluations of the pilot programs that preceded ILUMEX, availability of CFLs was limited in the project cities, and many people did not know where to buy them. In one study, lighting shelf space devoted to CFLs was 5–30 percent (CFE 1999a).

In contrast, CFLs now take up the majority of the lighting shelf space. PROFECO’s 2003 survey conducted in 21 cities found 28 brands, all imported, in the Mexican market. As reported in section 6.4, there were over 250 different CFL models, although the number of models varied widely by city. The Study Team noted the availability of a multitude of brands and models in stores in Mexico City.

At the same time that availability has expanded, trade allies have also developed better marketing approaches. For example, the Study Team observed in some stores that 5-CFL blister (transparent plastic) packages were being sold at cheaper prices per bulb than for single units. Manufacturers reported that there was a large increase in sales when companies began selling these blister packages.

Although many factors influenced the increase in availability, the role played by ILUMEX and its successor programs in nurturing the Mexican market and in building capacity and confidence among trade allies suggests a relatively high attribution.

**CFL Prices**

The Study Team found several sources of estimates of CFL prices, all of which confirmed a substantial price reduction between pre- and post-ILUMEX years. The evidence suggests that the drop in price affected both long-life high-quality CFLs as well as shorter-life models. Furthermore, the price reduction seems to have been exclusively due to reductions in wholesale prices, as retailers have not lowered their margins.

Before ILUMEX, there were three product categories: (1) circular magnetic CFLs; (2) magnetically ballasted CFLs, which were more expensive; and (3) electronically ballasted CFL models, which were rare and even more expensive. The pre-feasibility study had found that magnetically ballasted CFLs cost about US$10, and electronically ballasted CFLs US$10–30. That study found that incandescent lamps were part of the *canasta basica* (basic basket of goods) and thus price controlled at about US$0.50.
CFE estimated that at the beginning of the program, the average market CFL price was US$6 – $14 while the incandescent price was US$0.20. During ILUMEX, CFE was able to get CFLs for about US$6.50–$12, with specifications of high power factor and low total harmonic distortion. In subsequent FIDE programs, when the PF and THD requirements were relaxed, the average CFL price came down substantially. (See Figure 7.1.)

Additional sources of price data include:

- three PROFECO studies (1993, 2000, 2003), which provide price ranges for CFLs and incandescent lamps, based on price surveys in several cities;

- a price survey conducted by FIDE in January 2004 of various CFL models sold in Mexico City autoservicios and department stores compared to the prices offered at LFyC customer offices. LFyC prices were lower in all cases, ranging from about US$3 to US$5.50, while market prices were US$4 to US$10 (FIDEa)9 However, these price observations are not weighted by sales volume for each model; and

- estimates by manufacturers themselves that the average 2004 CFL market price was about 31 pesos or US$2.75.

All of the available price data are consolidated in Table 7.1

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![Figure 7.1](image-url)

**Figure 7.1**

Average Residential CFL Prices, FIDE Programs

*Source: Adapted from FIDE 2004b. Pesos converted to US$ with exchange rates from June of each year.*
Although the most significant drop in price coincided with the ILUMEX program, most stakeholders believe that worldwide market changes were primarily responsible. For example, by the time ILUMEX began, electronic CFLs were already starting to gain market share and their prices were beginning to come down. However, it is also clear that Mexico played a role in the development of the world market and ILUMEX played a dominant role in determining local market conditions and attracting CFL manufacturer and distributor interest to that market. Overall, the Study Team’s assessment is that the price reduction has a moderate attribution to the ILUMEX program.

**CFL Sales**

Of all the market transformation indicators, CFL sales is the most important, particularly for estimating the impact on energy savings and GHG emissions. The Study Team was unable to find an official source of sales data for CFLs in the residential sector. To estimate

![Table 7.1 Summary of CFL Price Data (nominal US$)](image)
a time series of sales, the team used three information sources:

- annual CFL sales of various public programs as reported in Table 6.2 (historical data considered accurate);
- manufacturers’ estimates of total national CFL sales in 2003 and 2004 (data considered reasonably accurate);
- FIDE’s estimate that, of the total number of households, 20 percent now use CFLs and those households use an average of 5.5 CFLs each (estimate considered somewhat uncertain).

Manufacturers’ estimates of national CFL sales in 2003 are 13 million, and in 2004, 14.7 million. Based on the advice of manufacturers, the Study Team estimated that approximately 50 percent of the manufacturers’ reported CFL sales in 2003 and 2004 went to the residential market. Thus the estimate for sales of residential CFLs is 6.5 million in 2003 and 7.4 million in 2004, including sales from both market and program sources (using the program sales data summarized in Table 6.2).

For the years 1995–1998, it was assumed that ILUMEX accounted for the bulk of CFL sales, but that market sales contributed an additional 250,000 units in 1998. In order to estimate sales in other years, the Study Team first estimated the current size of the installed base. Using FIDE’s estimates and considering Mexico’s 23 million households, this would imply an installed base of CFLs of 23 million * 5.5 * 20%, or approximately 25 million CFLs.12

Thus to estimate total sales from 1999 to 2004, the Study Team made the following assumptions:

- sales from each of the promotion programs match the estimates shown in Table 6.2;
- total sales in 2003 and 2004 are 50 percent of manufacturers’ reported sales, as described above;
- the average CFL service life is five years, so the installed base at the end of 2004 is represented by sales from 2000 to 2004, and should add up to 25.3 million CFLs, as calculated above; and
- as indicated by manufacturers, total sales in 2002 (the year of the electricity tariff increase and the CFE rebate program) went up significantly over those in 2001, and rose more modestly in 2003 and 2004.

For 2005–2010, the Study Team assumed a steady growth rate of total CFL sales of 10 percent per year to reach market saturation in 2010. Market saturation was considered to be an average of 2.5 CFLs per household for an estimated 25 million households.13

The Study Team adjusted the time series of program and non-program sales to match these assumptions and produced Table 7.2. The interviews indicated that the FIDE CFL program would be phased out in the near
future, so the last program year was assumed to be 2006. The FIPATERM program has reduced its CFLs sales, but is retaining the CFL program to induce customers to purchase other technologies; these sales were assumed to last through 2008. The LyFC program began later than the FIDE program and is assumed to last through 2008.

ILUMEX had an important part in generating these sales through its effect on prices, consumer awareness, and marketing. Of course, ILUMEX was not the only driver for these changes; other significant factors included changes in electricity tariffs. The Study Team’s overall assessment of the attribution of the sales (other than those associated with incentive programs) to ILUMEX is presented in Table 7.3. These qualitative attribution statements are used in chapter 7 to generate the alternative scenarios (without ILUMEX) and subsequently to calculate the incremental impact of ILUMEX.

These four key factors were posited in the evaluation plan as the most likely influential factors on CFL sales. Based on stakeholder interviews, the Study Team ranked them in order of their influence. Electricity price, which jumped in 2002 and again in 2004, was seen as highly influential on the CFL market. Lower CFL prices, both from program inducement and market influences, had moderate influence, since high CFL prices were a major barrier to consumer purchase. Product availability, and consumer awareness, were seen as important, but relatively lower in influence than the first two factors.

The Study Team also used information from these interviews to assign the relative influence that ILUMEX had on each of these factors. The ILUMEX program did not influence tariff increases, which were induced by the economic and international pressures described above (although the increased CFL availability and lower relative price due to the program did allow CFE to allay public outcry about the tariff increases). ILUMEX affected CFL prices moderately, by offering subsidized products and financing and by contributing to international and domestic conditions that enabled price reduction, although a variety of other factors were working in parallel to reduce prices. ILUMEX had a strong influence on product availability, often cited as proof of market transformation. ILUMEX also contributed greatly to consumer awareness by making the product visible to consumers in the regions in which it operated. The composite attribution resulting from each factor’s influence on sales and ILUMEX’s influence on each factor resulted in assigning no attribution to electricity prices and moderate attribution to the other three factors.
Table 7.2 Estimated Annual Residential CFL Sales (millions of units)

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<td>CFE</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.60</td>
</tr>
<tr>
<td>Rebatable</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LyFC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.18</td>
<td>0.18</td>
<td>0.15</td>
<td>0.20</td>
<td>0.15</td>
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<tr>
<td>Market Sales</td>
<td>0.25</td>
<td>0.65</td>
<td>1.60</td>
<td>2.30</td>
<td>1.20</td>
<td>5.00</td>
<td>6.25</td>
<td>7.13</td>
<td>8.69</td>
<td>9.65</td>
<td>10.71</td>
<td>11.89</td>
<td>13.08</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2.13</td>
<td>2.72</td>
<td>3.30</td>
<td>5.39</td>
<td>6.51</td>
<td>7.38</td>
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<td>8.93</td>
<td>9.78</td>
<td>10.80</td>
<td>11.89</td>
<td>13.08</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.3 Influence of ILUMEX on CFL Market Sales

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Factor’s Influence on Sales</th>
<th>ILUMEX Influence on Factor</th>
<th>Composite Attribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Prices</td>
<td>Very High</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Lower CFL Prices</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Availability and Marketing</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Higher Consumer Awareness and Interest</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
To assess the impacts of ILUMEX, the Study Team needed a time series of sales for the past and near future (Table 7.2). Also needed was one or more counter-factual scenarios that represent hypothetical case(s) of how sales would have evolved in the absence of ILUMEX. Because of the significant amount of uncertainty involved, the Study Team developed two counter-factual scenarios representing a range of potential impacts:

Table 8.1 Counter-Factual Scenarios (No ILUMEX Program)

<table>
<thead>
<tr>
<th></th>
<th>High Baseline Sales—Low Impact</th>
<th>Low Baseline Sales—High Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILUMEX Sales</td>
<td>No sales except free riders.</td>
<td>No sales except free riders</td>
</tr>
<tr>
<td>FIDE Sales</td>
<td>FIDE Program takes the place of ILUMEX. Small-scale pilots. Starts at the same time as the actual FIDE program (1998) but only reaches 2/3 of actual FIDE sales levels. 25% subsidy for 5 years</td>
<td>FIDE Program takes the place of ILUMEX. Small-scale pilots. Starts five years later (2003) and only reaches 2/3 of actual FIDE sales levels. 25% subsidy for 5 years</td>
</tr>
<tr>
<td>FIPATERM Sales</td>
<td>No change.</td>
<td>No change.</td>
</tr>
<tr>
<td>CFE Rebate Sales</td>
<td>No sales except free riders.</td>
<td>No sales except free riders.</td>
</tr>
<tr>
<td>LyFC Sales</td>
<td>No sales except free riders.</td>
<td>No sales except free riders.</td>
</tr>
<tr>
<td>Other (Market) Sales</td>
<td>Three-year delay at start with gradual parity with ILUMEX scenario by 2010. Sales jump early in 2000 because of step reduction in market CFL prices and in 2002 because of significant tariff increase.</td>
<td>Seven-year delay at start, gradually achieving 2/3 of parity with ILUMEX scenario by 2010. Sales jump early in 2000 because of step reduction in market CFL prices and in 2002 because of significant tariff increase.</td>
</tr>
</tbody>
</table>
• No ILUMEX—High Baseline scenario that sets a higher boundary of the range of estimates of CFL sales than would have happened in the absence of ILUMEX, and hence represents the lower boundary of the range of estimates of the incremental impact of ILUMEX.

• No ILUMEX—Low Baseline scenario that sets a lower boundary of the range of estimates of CFL sales than would have happened in the absence of ILUMEX, and hence represents the higher boundary of the range of estimates of the incremental impact of ILUMEX.

These scenarios are defined on the basis of the interviews and the Study Team’s assessments of ILUMEX’s impact on subsequent programs (Table 6.1) and ILUMEX’s impact on overall sales (Table 7.3). The key features of these counter-factual scenarios are outlined in Table 8.1. Detailed calculation spreadsheets for the impacts are provided in Appendix C (available on line at www.worldbank.org/gef).

For the two scenarios, it was assumed that FIDE (or CFE) would have done some additional pilot CFL projects and that the FIPATERM program would have existed at actual levels. Because CFE would not have had as much experience with CFL programs, it would not have carried out the 2002 rebate program. It was also assumed that Luz y Fuerza del Centro would not have conducted a CFL sales program in Mexico City.

No estimates of free riders were developed for the various programs; however, most
Assessment of Impacts

observers indicated that levels should be relatively low, given the relative immaturity of the market. For the purposes of this study, it was assumed 10 percent of sales go to free riders for most programs, except the CFE rebate program in 2002. As noted in section 6.1, only about 12 percent of rebate coupons were redeemed. Even allowing for the possibility that many consumers who genuinely took part failed to redeem the coupons, it seems likely that the rebate program itself accounted for only a small percentage of the reported sales (for the purposes of this study, a 25 percent level was assumed). For the two counter-factual scenarios, the Study Team assumed that free riders still purchase CFLs at the same levels they did in the ILUMEX, CFE rebate, and LyFC programs in the “With ILUMEX” scenario.

These assumptions yield the sales scenarios illustrated in Figure 8.1. This figure shows the ILUMEX scenario, the two counter-factual scenarios, as well as the incremental sales under both counter-factual scenarios.

8.1 Energy Savings and Emission Reductions

To calculate the energy savings, the Study Team first calculated the stock of CFLs installed for each scenario in each year and multiplied this by the hours of use and the amount of energy saved per hour per CFL. An adjustment factor was applied for deviations from the average hours of use and lifetime, such as snapback, stockpiling, early removal, burnout, and spillover, as discussed below. The stock of CFLs that would still be in service was determined by the sales in the preceding years and the average lifetime of each CFL.

Key assumptions are as follows:

- **CFL Lifetime.** Average CFL lifetime was assumed to be 6,000 hours (see section 6.3). This is lower than the assumptions used for the ILUMEX program itself, where program specifications required a 10,000-hour lifetime (which the post-program evaluation by DNV and ICF Consulting estimated to be slightly lower). CFLs in the Mexican market have a range of lifetimes, from 10,000 hours or more for highest-quality products to less than 3,000 hours for low-quality bulbs. Persistence studies suggest that CFLs last more than five years in households, but the introduction of 3,000-hour CFLs into the Latin American market in 2001, as well as the presence of the patitos, provide a contrary influence on average lifetime. The Study Team chose 6,000 hours as a benchmark, matching the specifications for the FIDE CFL product quality seal.

- **Utilization.** As presented in section 6.3, the Study Team estimated the CFL operating hours to be three hours per day. This value was provided by FIDE as well as CONAE. It is slightly higher than the ILUMEX program estimate of 2.89 hours per day and congruent with the DNV/ICF
evaluation, which measured data for the ILUMEX cities and estimated an average a little under 3 hours/day.\textsuperscript{16}

- **Adjustment Factor for Snapback, Stockpiling, Early Removal, Burnout and Spillover.** Snapback is the tendency for consumers to use fixtures containing CFLs more than they would if they contained incandescent bulbs, since the wattage is lower. Stockpiling is the tendency of consumers to hold on to their CFLs and not to install them. Early removal and burnout affect the replacement rate of CFL in households. Spillover is the energy savings from people being more conscious and careful in how they use electricity. The Study Team found no data on the replacement rate of CFLs sold under ILUMEX and its successor programs. These studies were not carried out by CFE because, given the market maturation of CFLs in Mexico, they were not considered necessary. However, FIDE did conduct a study of CFL persistence in 1998 of three of the pilot program cities. The results showed that, of CFLs installed in one city in 1992, 33 percent were still installed six years later. Of those installed in another city in 1995, 70 percent were still installed three years later; early installations had higher failure and replacement rates. In the third city, 71.5 percent of the CFLs installed in 1997 were still in place a year later. The main reasons given for CFL removal were premature failure or breakage. Some CFLs were not installed (stockpiling), because they were given to someone else, saved as a replacement bulb, did not fit, or the customer forgot to install them. For comparison, the Study Team reviewed the PELP post-program evaluation performed by Navigant Consulting, in which snapback was estimated as 7 percent for first year and 26 percent for the second year; these were noted as comparatively high values, possibly because spaces had been underlit and there was shifting of usage to fixtures with CFLs. The PELP studies also estimated early removal rates to be 3 percent in the first year, zero in the second, and 6 percent in the third. In the absence of better data, the Study Team chose to use a constant factor of 15 percent to account for all of these effects combined.

- **Power Savings per CFL.** CFL wattage is typically between one quarter and one third of the wattage of the incandescent bulb it replaces. For its analysis, the Study Team used an average wattage difference of 50 watts. This value approximates the measured wattage differences between a variety of CFLs and the incandescent lamps they replaced in the DNV/ICF ILUMEX evaluation. It was assumed that these values are similar for all CFL replacements, whose choice should be based on nearly equivalent light output for each.

- **Transmission and Distribution Losses.** This factor identifies the amount of energy lost between generation and the lighting fixture, providing a basis for calculating the amount of energy savings at the generating
station. For the purposes of this study, the figure 18.6 percent was used, which is the same factor used by the ILUMEX ICR.

Based on these assumptions, the various scenarios and range of incremental impact are shown in Table 8.2 and Figure 8.2.

Based on these estimates, the use of CFLs resulted in energy savings of approximately 5.4 terawatt-hours (TWh) over the period 1995–2004, and will save an additional 15.9 TWh in the period 2005–2010. Of this total, between 3.1 and 5.0 TWh are attributable to ILUMEX over the period 1995–2004, and an additional 5.8 to 11.1 TWh are attributable over the period 2005–2010.

**GHG Emission Reductions**

Without running a dispatch model to see which plants would be curtailed, it was not possible to accurately estimate GHG emission reductions. However, the Asociación de Técnicos y Profesionistas en Aplicación Energética (ATPAE, Association of Technicians and Professionals in Energy Application) provided a historical and projected series of CO₂-equivalent emissions factors

Table 8.2 Estimated Energy Savings

<table>
<thead>
<tr>
<th>Year</th>
<th>Stock of CFLs with ILUMEX (millions)</th>
<th>Energy Savings per CFL (kWh)</th>
<th>Stock of CFLs w/o ILUMEX (millions)</th>
<th>Incremental Stock Due to ILUMEX (millions)</th>
<th>Estimated Energy Savings (Gwh)</th>
<th>Stock of CFLs w/o ILUMEX (millions)</th>
<th>Incremental Stock Due to ILUMEX (millions)</th>
<th>Estimated Energy Savings (Gwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>0.4</td>
<td>57.2</td>
<td>0.0</td>
<td>0.4</td>
<td>25</td>
<td>0.0</td>
<td>0.4</td>
<td>25</td>
</tr>
<tr>
<td>1996</td>
<td>1.1</td>
<td>57.2</td>
<td>0.0</td>
<td>1.1</td>
<td>65</td>
<td>0.0</td>
<td>1.1</td>
<td>65</td>
</tr>
<tr>
<td>1997</td>
<td>1.7</td>
<td>57.2</td>
<td>0.0</td>
<td>1.7</td>
<td>98</td>
<td>0.0</td>
<td>1.7</td>
<td>98</td>
</tr>
<tr>
<td>1998</td>
<td>4.0</td>
<td>57.2</td>
<td>0.8</td>
<td>3.2</td>
<td>180</td>
<td>0.0</td>
<td>4.0</td>
<td>229</td>
</tr>
<tr>
<td>1999</td>
<td>6.1</td>
<td>57.2</td>
<td>1.9</td>
<td>4.2</td>
<td>242</td>
<td>0.0</td>
<td>6.1</td>
<td>350</td>
</tr>
<tr>
<td>2000</td>
<td>8.4</td>
<td>57.2</td>
<td>3.2</td>
<td>5.2</td>
<td>298</td>
<td>0.2</td>
<td>8.2</td>
<td>471</td>
</tr>
<tr>
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<td>11.0</td>
<td>57.2</td>
<td>4.5</td>
<td>6.5</td>
<td>372</td>
<td>0.3</td>
<td>10.7</td>
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<tr>
<td>2002</td>
<td>15.8</td>
<td>57.2</td>
<td>7.6</td>
<td>8.2</td>
<td>470</td>
<td>0.9</td>
<td>15.0</td>
<td>855</td>
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<tr>
<td>2003</td>
<td>20.0</td>
<td>57.2</td>
<td>9.8</td>
<td>10.3</td>
<td>586</td>
<td>2.2</td>
<td>17.8</td>
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<tr>
<td>2004</td>
<td>25.2</td>
<td>57.2</td>
<td>12.3</td>
<td>12.9</td>
<td>739</td>
<td>3.8</td>
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<td>15.6</td>
<td>890</td>
<td>5.6</td>
<td>25.5</td>
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<tr>
<td>2006</td>
<td>37.4</td>
<td>57.2</td>
<td>20.1</td>
<td>17.3</td>
<td>987</td>
<td>7.9</td>
<td>29.5</td>
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<td>2007</td>
<td>42.4</td>
<td>57.2</td>
<td>24.2</td>
<td>18.1</td>
<td>1,036</td>
<td>11.1</td>
<td>31.2</td>
<td>1,785</td>
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<td>48.9</td>
<td>57.2</td>
<td>30.5</td>
<td>18.5</td>
<td>1,056</td>
<td>14.6</td>
<td>34.4</td>
<td>1,965</td>
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<tr>
<td>2009</td>
<td>55.6</td>
<td>57.2</td>
<td>38.2</td>
<td>17.4</td>
<td>994</td>
<td>19.1</td>
<td>36.5</td>
<td>2,087</td>
</tr>
<tr>
<td>2010</td>
<td>62.9</td>
<td>57.2</td>
<td>48.1</td>
<td>14.7</td>
<td>843</td>
<td>26.5</td>
<td>36.4</td>
<td>2,080</td>
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<tr>
<td>Total</td>
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<td></td>
<td></td>
<td></td>
<td>8,882</td>
<td></td>
<td>16,008</td>
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</tr>
</tbody>
</table>
for each year between 1995 and 2010 for the national interconnected grid. From this, the Study Team used a simple average between the peak values and the average values, since the peak coincidence factor is 0.5 (see section 8.2). The results are shown in Table 8.3 and Figure 8.3.

Based on these estimates, the use of CFLs resulted in GHG emission reductions of approximately 3.4 megatonnes (Mt) of CO₂-equivalent over the period 1995–2004, and additional reductions of 9.0 Mt are estimated to 2010. Of this total, between 2.0 and 3.2 Mt are attributable to ILUMEX over the period 1995–2004, and an additional 3.3 to 6.3 Mt are attributable over the period 2005–2010. In 2002, the incremental reduction of 300–600 Mt represented approximately 0.025 percent to 0.05 percent of Mexico’s total emissions from electricity.

**Local Environmental Benefits**

In addition to the global benefits of reduced GHGs, the electricity savings have also reduced emissions of air pollutants that have significance at the local level. Emission factors for NOx (1.81 tonne per GWh) and SO₂ (11.3 tonne per GWh) are average national values calculated from Mexico’s 2002 plant level emissions prepared for the North American Commission for Environmental Cooperation (CEC 2004).

Based on these estimates, the use of CFLs resulted in SO₂ emission reductions of ap-
Table 8.3 Estimated GHG Reductions

<table>
<thead>
<tr>
<th>Year</th>
<th>High Baseline—Low Impact Scenario</th>
<th>Low Baseline—High Impact Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GHG Reduction Factor (t/GWh)</td>
<td>Estimated Energy Savings (GWh)</td>
</tr>
<tr>
<td>1995</td>
<td>665</td>
<td>25</td>
</tr>
<tr>
<td>1996</td>
<td>664</td>
<td>65</td>
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<td>890</td>
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<td>987</td>
</tr>
<tr>
<td>2007</td>
<td>555</td>
<td>1,036</td>
</tr>
<tr>
<td>2008</td>
<td>563</td>
<td>1,056</td>
</tr>
<tr>
<td>2009</td>
<td>576</td>
<td>994</td>
</tr>
<tr>
<td>2010</td>
<td>554</td>
<td>843</td>
</tr>
<tr>
<td>Total</td>
<td>8,882</td>
<td>5,257</td>
</tr>
</tbody>
</table>

Figure 8.3
GHG Emissions Avoided

- With ILUMEX
- High Baseline
- Low Baseline
- Impact - Low
- Impact - High
approximately 16.3 Kilotonnes (Kt) in 2004, of which 8.4—13.8 Kt are attributable to ILUMEX. The Study Team calculated total reductions of approximately 61 Kt over the period 1995–2004, and an additional 180 Kt in the period 2005–2010. Of this total, between 35 and 56 Kt are attributable to ILUMEX over the period 1995–2004, and an additional 66 to 125 Kt over the period 2005–2010.

The use of CFLs resulted in NOx emission reductions of approximately 2.6 Kt in 2004, of which 1.3 to 2.2 Kt are attributable to ILUMEX. The Study Team calculated total reductions of approximately 9.7 Kt over the period 1995–2004, and an additional 28.8 Kt in the period 2005–2010. Of this total, between 5.6 and 9.0 Kt are attributable to ILUMEX over the period 1995–2004, and an additional 10.5 to 20.0 Kt over the period 2005–2010.

The emission reductions represent approximately 0.05 to 0.075 percent of electricity-related emissions of SO₂ and NOx in Mexico.

8.2 Capacity Savings and Financial Benefits

Capacity Savings

To calculate capacity savings, the Study Team used ICR estimates of the peak coincidence factor (0.5) and peak capacity losses (23.5 percent). PAESE also confirmed the peak coincidence factor during the field interview.

Based on the interviews, the Study Team estimated that Mexico was capacity constrained between 1995 and 2001, but has had excess capacity since that time (and is likely to continue to have excess capacity to 2010). These estimates imply that the use of CFLs resulted in capacity savings of approximately 300 Megawatts (MW) in 2001 and 700 MW in 2004. Of this total, between 190 and 300 MW are attributable to ILUMEX in 2001, and 360 to 595 MW in 2004.

Financial Impacts

To determine the financial impacts, the Study Team applied the same three tests as the ICR, i.e., total resource benefits and costs, benefits and costs for the consumer participants (i.e., beneficiaries), and benefits and costs for the utility, as follows:

- **Total Resource Benefit-Cost =** Cost of Incandescent Lights Saved + Cost of Energy Saved + Cost of Capacity Saved (until 2001 only)\(^{17}\) + Value of GHG Emission Reductions — Cost of CFLs
- **Consumer Participant Benefit-Cost =** Cost of Incandescent Lights Saved + Cost of Energy Saved — Cost of CFLs

To complete these calculations, the Study Team used the energy savings calculated
earlier and the following cost information:

- **Cost of Lamps.** The sources of unsubsidized prices of both CFLs and incandescent bulbs are discussed in section 6.3.1 and summarised in Table 7.1. The life span of incandescent bulbs is assumed to be one year; therefore the entire stock rolls over each year.

- **Electricity Prices.** Consumer Electricity prices, shown in Table 8.4, are from SENER (2002, Figure 11, and 2004). These real prices were converted to nominal prices in 2002 centavos/kWh using Mexico’s consumer price index from the Banco de Mexico and LatinFocus calculations. These were then converted to US cents/kWh using the exchange rate for early June of each year. In the absence of an official price projection, it was assumed that the nominal electricity price would remain constant from 2003 to 2010.

- **Long Range Marginal Cost (LRMC) of energy and LRMC of capacity.** The Study Team was unable to obtain updated values and therefore used the values from the ICR. The LRMC of energy at the distribution level is US $0.03/kWh and the LRMC of capacity at the distribution level is US $126/kW/year.

- **Value of GHG Reductions.** The Study Team assumed a value of $10/tonne of CO₂-equivalent reductions, a typical value used for estimating the value of GHG reductions.

Using these estimates and a discount rate of 12 percent, the Study Team calculated the Total Resource Benefit-Cost of CFL use over the period 1995–2010, as follows:

- total benefits: $337 million (see Figure 8.4 for sources of the benefits),
- total costs: $145 million, and
- net benefit: $193 million.

The breakdown of the benefits and costs is shown in Figures 8.4 and 8.5.

Total costs and benefits for CFL use over the period 1995–2010 are shown in Figure 8.6. Figure 8.7 provides the low end of the range of incremental impacts attributable to ILU-MEX, and Figure 8.8 provides the high end of the range attributable to ILUMEX.

- **Total Resource Benefit-Cost.** The total benefits of CFL use over the period 1995–2010 have a net present value (NPV) of $193 million, representing a rate of return of approximately 50 percent. Of this, $90–$155 million is attributable to ILUMEX.

### Table 8.4 Residential Electricity Prices (nominal US cents/kWh)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>3.3</td>
<td>4.2</td>
<td>4.8</td>
<td>5.7</td>
<td>6.4</td>
<td>7.0</td>
<td>7.3</td>
<td>7.7</td>
<td>8.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Assessment of impacts
• **Consumer Participant Benefit-Cost.** The total benefits to consumer participants over the period 1995–2010 result in an NPV of approximately $320 million. Of this, $140–$245 million is attributable to ILUMEX.

• **Utility Benefit-Cost.** For the utility, there is a net cost, but over the period 1995–2010 there is a positive NPV of approximately $120 million. Of this, $45-$85 million is attributable to ILUMEX.

These calculations demonstrate the financial viability of ILUMEX, even using conservative assumptions of the program’s long-term impacts.
Figure 8.7
Costs and Benefits Attributable to ILUMEX: Low Impact Scenario

Figure 8.8
Costs and Benefits Attributable to ILUMEX: High Impact Scenario
9
Conclusions and Lessons Learned

In addition to the direct impacts of the CFL sales during the program, ILUMEX served as a model that was replicated in several other DSM efforts, and it contributed to the transformation of the residential lighting market as a whole. The key features of the ILUMEX model were:

- bulk purchases of high-quality CFLs,
- CFL sales in local utility service centers,
- low-interest financing available at the utility service centers,
- payment in installments — on the electric bill, and
- subsidized prices.

The evidence indicates that ILUMEX (and the programs that replicated the ILUMEX model) played a significant role in raising consumer awareness and increasing consumer acceptance. The project also played a significant role in improving availability and marketing, and a modest role in lowering CFL prices, all of which, when combined with other domestic and international market influences, contributed significantly to a large increase in CFL sales and a corresponding increase in the installed base of CFLs, energy savings, emission reductions, and associated financial benefits.

When ILUMEX began, CFLs were expensive, hard to find, and had very small sales volumes. Today they are visible in most Mexican retail outlets selling lamps for the residential market and occupy shelf space at least equivalent to that of incandescent lamps.

9.1 Replication

The main conclusions are:

- ILUMEX has proven that the features outlined above have great replication value. The program was replicated in the nationwide FIDE program and by Mexico City’s utility. The utility service center sales model was adapted and used in ELI programs in Argentina and Peru, and
aspects of the program have influenced other programs ranging from other DSM programs in Mexico to a broad range of international initiatives.

The lessons learned are:

- Subsidies should not necessarily be ruled out on ideological grounds. ILUMEX has shown that they can be economically and practically justified in certain circumstances, particularly in immature markets, where the electricity cost savings from the efficient technology can allow the electric utility to increase tariffs by reducing subsidies while keeping customer bills unchanged or even lower.
- Pilot programs like ILUMEX in selected markets are a good way to achieve significant market presence at a reasonable cost. The success can then be replicated and exported to other markets.
- Each of the features of ILUMEX mattered in determining the outcomes. These features were extraordinarily well-suited to the circumstances and may be appropriate for a variety of future applications. However, replication of the program needs to take into account local conditions, including electricity tariffs, deregulation, market conditions, institutional capabilities, etc.
- It is important to publicize program results widely in order to provide the maximum opportunity for replication and lessons learned.

9.2 Capacity Development

The main conclusions are:

- ILUMEX helped develop a better understanding of the role and functioning of DSM programs in CFE. The program confirmed the technical viability of using CFLs, including product quality, durability, and low impacts on the electricity grid. The program also clarified the role of subsidies in promoting energy-efficient technologies newly on the market. It taught the engineers managing the program the importance of addressing customer needs. Thus technical issues gave way to customer issues as key determinants of success.
- ILUMEX contributed significantly to building a culture of energy efficiency programs within CFE and its related institutions. The program’s success raised the profile of energy efficiency in government institutions such as SENER and SEMARNAT. As such, ILUMEX helped develop a knowledgable and experienced cadre of energy professionals within the institutions directly involved as well as among academics and private industry. It helped establish links among the various institutions, both public and private, facilitating future efforts in energy efficiency.
- ILUMEX stimulated activity within a variety of government organizations and agencies and helped to refine visions, renew mandates, and clarify roles. The result is that Mexico has one of the most
well-developed institutional structures for the promotion of energy efficiency.

- The economic analysis of ILUMEX clarified the financial implications for CFE of DSM programs. Unfortunately the institutional incentives have not been realigned (i.e., DSM does not pay) and so the involvement of CFE as a promoter of energy efficiency continues to rely on the utility’s broad interpretation of its public service mandate.

- ILUMEX helped develop and test approaches for validating and verifying GHG emission reductions, thereby building international capacity.

The lessons learned are:

- The design of DSM programs must take into account the institutional incentive structure that is dependent on the model of energy regulation in place in the jurisdiction (i.e., public utility versus deregulated market or something in between). In some situations, it may not be possible to rely on the utility to champion DSM programs.

- To be effective and sustainable, programs that rely on capacity building need a broad reach that includes a variety of government, private, and other parties that have a role in the future evolution of the market.

- It is important to align a program’s immediate economic objectives with the ultimate objectives of both the funding agencies and the implementing agencies. In this case, the World Bank and the CFE had slightly different objectives (global environmental objectives versus national socioeconomic objectives). However, the objectives were mutually compatible, and this reinforcement provided a means to overcome the short-term financial disincentives faced by CFE.

9.3 Consumer Awareness and Preference

The main conclusions are:

- Mexican consumers’ awareness of CFLs and their preference for CFLs has grown substantially in the period since ILUMEX. ILUMEX and subsequent programs, such as the FIDE program, played an important role in achieving this outcome.

- ILUMEX succeeded by exposing consumers to the technology who otherwise would not have considered it, by putting a strong emphasis on product quality and by making the case for the financial and energy benefits.

- Product quality has effectively been removed as a consumer concern, although there is a current national (and worldwide) trend toward lower quality to reduce prices.

- Most consumers have a good appreciation of the potential financial savings that can accrue from the use of CFLs and, as a result, roughly one third are now intending to buy CFLs.
The lessons learned are:

- Although in hindsight some of the specifications may have been excessively stringent, the investment in high-quality CFLs was crucial to overcoming consumer concerns about CFL quality and to ensuring that quality never became an issue once ILUMEX began.
- It is necessary to establish a significant market presence in order to get critical mass for a technology such as CFLs. This justifies the focus on specific markets, such as residential medium- and high-income consumers, as well as the initial geographic focus on selected cities.
- It is important to disseminate financial information so that consumers can appreciate the savings offered and make their own judgments about reasonable paybacks.
- Marketing strategies need to be appropriate to the target customers’ needs. Thus strategies for low-income customers may need to differ from those used for other groups.

9.4 Manufacturers and Distributors

The main conclusions are:

- Coinciding with ILUMEX, the worldwide market for CFLs has grown substantially. Although most CFLs are now manufactured in Asia, the growth in Mexican demand has been a part of the expanding world market. ILUMEX and subsequent programs have played a significant role in expanding severalfold the Mexican market and attracting manufacturers and distributors to it.
- Because of the bulk sales generated by ILUMEX and FIDE, manufacturers and distributors felt confident enough of the sustainability of the market to invest in distribution channels and marketing. However, this confidence was tested during the 2002 CFE rebate program, when overoptimistic goals and incorrect signals produced an oversupply of improperly labelled products.
- There is now healthy competition from a range of manufacturers, providing a range of CFLs of different quality and different prices. Together with retailers, these manufacturers are experimenting with a variety of marketing approaches (including various methods of display and packaging in a broad array of stores).

The lessons learned are:

- Bulk purchases proved an effective feature of ILUMEX to stimulate the market and to provide lower unit CFL prices for the program. It is important to work with manufacturers on the procurement process. It is also important to give realistic estimates of sales, especially for a one-time program, to avoid producing excess product.
- High quality specifications may be appropriate when the CFL technology is new and unproven. Specifications, especially for power quality, may be relaxed.
Conclusions and Lessons Learned

as the technology matures. However, such specifications may still be needed to prevent poor-quality CFLs from entering the market.

- DSM programs should assess their impacts on social indicators such as employment in order to determine whether measures can be taken to encourage local sources of energy-efficient products and services.

9.5 Ultimate Outcomes

The key outcome has been transformation of the Mexican residential lighting market. When ILUMEX began, CFLs were expensive, hard to find, and had very small sales volumes. Today they are affordable, they are visible in most retail outlets, and they have a significant and growing share of the market.

- Price. Prices per CFL have dropped from approximately $15 prior to ILUMEX to less than $3 in 2004. Although international market developments played the largest role in this reduction, ILUMEX was important in establishing Mexico’s contribution to that worldwide market, and ILUMEX played a significant role in influencing consumer price expectations in the Mexican market.

- Availability. CFLs now take up the majority of the lighting shelf space. PROFECO’s 2003 survey found 28 brands and over 250 different models. At the same time that availability has expanded, trade allies have also developed better marketing approaches. Although many factors influenced the increase in availability, the role played by ILUMEX and its successor programs in nurturing the Mexican market and in building capacity and confidence among trade allies suggests a relatively high attribution.

- Sales. Residential CFL sales in Mexico are estimated to have risen from under 500,000 in 1995 to over 7 million in 2004. They are forecasted to continue rising to over 13 million per year by 2010. The increase in sales has been driven by increases in electricity tariffs, reductions in the price of CFLs, greater consumer awareness and interest, and better availability and marketing. ILUMEX had no direct influence on the increase in electricity tariffs (although it allowed CFE to soften the economic blow to customers), but it had a moderate influence on CFL prices and a significant influence on consumer awareness and product availability.

ILUMEX has contributed modestly to mainstreaming certain aspects of climate change into national policy. However, such concerns remain secondary to energy security, economic, and local environmental concerns.

ILUMEX made a significant contribution to the demonstration of joint implementation mechanisms under the UNFCCC and helped frame the CDM/JI mechanisms under the Kyoto Protocol.
9.6 Sustainability

Concern was expressed in the PAR about whether a program that relies on subsidies to drive sales is sustainable. Although the concern is understandable, the evidence indicates that the program outcomes were sustained and continue to be sustained on several levels:

- **Subsidies and Replicability.** The multiple replication of the ILUMEX model (including subsidy components) has shown that, under certain conditions (e.g., public utility with broad mandate), subsidies can be justified and maintained despite the financial cost. This is because CFE and FIDE recognized that, on a total resource basis and for their customers, the benefits outweighed the costs and they accepted their public responsibility to invest in this outcome. Fortunately, over time, the need for the subsidy gradually disappeared. Successor programs were then able to succeed solely through the other aspects of the model. FIDE considers that the need for these programs is also disappearing, and the sales of CFLs are becoming self-sustaining and market-driven.

- **Capacity Development.** The evidence suggests that the institutions, the knowledge, and experience—within the government, the utility, and the broader community of energy professionals—have reached a critical mass. This means that, even if particular individuals or institutions cease to be involved, there is sufficient dissemination of expertise and best practices to sustain the capacity in Mexico.

- **Market Transformation.** Provided that the broad features of Mexico’s energy market remain supportive (for example, electricity tariffs remain high in relative terms), the changes that have taken place in terms of CFL availability, prices, manufacturer and retailer confidence, and consumer awareness and preferences are likely to be irreversible. This means that prices will continue falling, and sales will continue rising. The market may, in fact, have entered a virtuous cycle phase, where increased sales help increase awareness and confidence and reduce prices, which in turn lead to increased sales.

9.7 Impacts

The CFL sales and the associated increase in stock are estimated to have produced energy savings of approximately 1.4 TWh in 2004, and associated GHG emission reductions of 850 Kt of CO₂-equivalent. Over the period 1995–2004, GHG emission reductions of 3.4 Mt were achieved and a further reduction of 9.0 Mt is expected by 2010.

The following range of impacts are attributed specifically to the ILUMEX program:

- sales of 3.7 to 5.7 million CFLs in 2004,
- energy savings of 740 to 1,225 GWh in 2004,
- GHG emission reductions of 430 to 715 Kt in 2004,
Conclusions and Lessons Learned

- GHG emission reductions of 2.0 to 3.2 Mt in the period 1995–2004, and a further 3.3 to 6.3 Mt in the period 2005–2010,
- NOx emission reductions of 1.3 to 2.2 Kt in 2004,
- NOx emission reductions of 5.6 to 9.0 Kt in the period 1995–2004, and a further 10.5 to 20.0 Kt in the period to 2005–2010,
- SO₂ emission reductions of 8.4 to 13.8 Kt in 2004,
- SO₂ emission reductions of 35 to 56 Kt in the period 1995–2004, and a further 66 to 125 Kt in the period to 2005–2010,
- capacity savings of 190 to 300 MW in 2001 (the last year of capacity constraint) and 360 to 595 MW in 2004,
- total resource net benefits of between $90–$155 million over the period 1995–2010 (approximately 3.5 to 6.5 times the original investment),
- total net benefits to consumer participants of $140–$245 million over the period 1995–2010, and
- total net costs to the utility of $45 to $85

**Stakeholders Interviewed by Institution Type**

**Government Agencies**

**CFE**
Ing. Enrique Vargas Nieto, Comercial Manager
Miguel Genel, Distribution Subdivision
Dr. José Antonio Rojas, Advisor to Management of Economic Studies
Mat. Luis Felipe Bazua, Submanager of Electrical Energy Prices
Ing. Francisco Aldana
Ing. Guillermo Ortega, Advisor, Generation Subdivision

**FIDE**
Ing. Jose Antonio Urteaga
Ing. Emilio Fernández, Manager, Large Scale Programs

**PAESE**
Ing. Horacio Buitrón, Manager
Ing. Adrián Valera, Submanager of Internal Projects

**CONAE**
Ing. Carlos Domínguez, Director General
Ing. Diego Arjona, Executive Secretary
Dr. Guadencio Ramos, Technical Coordinator
Ing. Fernando Hernández, Coordinator of Standards and Electricity Demand
Arq. Mónica Ortiz Pérez, Consultant
Ing. Israel Jáuregui, Director of Entailment and Program Development

**SENER**
Ing. Ubaldo Inclán, Director of Financing and Environment
María Elena Sierra
CRE (Comisión Reguladora de Energía, Energy Regulatory Commission)
Dr. Francisco Barnés, Commissioner

PROFECO
Lic. Arturo Velazco, Coordinator of Innovation
Lic. María de los Ángeles Jasso, Director of Conciliation
Virginia Castillo, Coordination of Promotion of Consumer Associations

ANCE
Ing. Martín Flores, Director of Operations

Private Sector
Ing. Alex G. Ramírez, Genertek, Technical Manager
Ing. Javier Villaseñor, Philips Mexicana, Executive Vice President
Ing. Luis Hurtado, Osram, Senior Manager Public Relations
Andrés Blanc (formerly PAESE, CFE)
Flor Martínez de Blanc (formerly CFE)
Ing. Odón de Buen, ENTE (Energía, Tecnología y Educación), formerly CONAE
Ing. Salvador Palafox, CANAME, General Director
Ing. Manuel de Diego Muñoz, Consultores en Energía
Ing. Manuel de Diego Olmedo, Consultores en Energía
Ing. Rubén Torres, CYSTE (Consultoría y Servicios en Tecnologías Eficientes)
Mark Oven, PA Consulting Group, Washington, DC

University
Dr. David Morillón, PUE (Programa Universitario de Energía), UNAM (Universidad Nacional Autónoma de México), Coordinator
Dr. Juan José Ambriz, UAM (Universidad Autónoma Metropolitana-Iztapalapa), Professor/Researcher, Chief of Area of Energy Resource Engineering

Non-governmental Organizations
Ing. Jorge Landa, USAID (Agency for International Development)

Professional Organizations
Mesa Cuidada de Observación de la Energía (Citizens’ Energy Observation Roundtable):
Lidia Zetter, formerly CFE
Dr. Victor Rodríguez, UNAM
Jean Hugues De Keyser, CFE

People Contacted for Information
Mirian Amaro López, PROFECO, PROMECABISE
Psic. Rafael Reglo, PROFECO
Lic. Raull Berrum, Osram, Submanager of Products
Lic. Rita Saucedo, CFE

People Interviewed in Washington D.C.
Ing. Enrique Vanegas, World Bank
Gary Costello, consultant to World Bank
Stephen Fischer, Economist, Interamerican Development Bank
### Organization Websites

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Appendix B: Bibliography


CFE/PAESE/FIDE. Guadalajara, Jalisco. April.


APPENDIX C: DATA ANALYSIS

Available online at www.worldbank.org/gef
1. All prices in US$ unless otherwise noted.
2. Norway’s contribution was at least partly aimed at demonstrating the feasibility of Activities Implemented Jointly (AIJ) under the United Nations Framework Convention on Climate Change (UNFCCC). AIJ was the precursor to the Kyoto Protocol flexibility mechanisms.
3. This is the approach used by Navigant (1999) in evaluating the Poland Efficient Lighting Project. In that case, the baseline scenario was based on CFL sales data for the entire Central and Eastern European region (a reasonable proxy for Poland without the program).
4. Apparently, this calculation did not account for the savings to be gained by sales to highly subsidized ratepayers.
5. The interviews suggested that the system was capacity constrained until approximately 2001 and that, generally, the system oscillates between periods of overcapacity and constraint as the country struggles to estimate the need for investments in new large plants.
6. There is some current concern about the influx of lesser-known brands of lower quality, usually made in Asia, locally termed marca patitos, from unfamiliar or unknown manufacturers. One manufacturer estimated that these lamps had grown to 40 percent of the self-ballasted CFL residential market. However, this estimate may be high, as there is less of a financial incentive for a black market than in some other Latin American countries, since import taxes are not as high in Mexico. Many program stakeholders stated the need for a national quality standard to keep these products from swamping the market. CONAE held a meeting in early December 2004 on a proposed standard (Norma Oficial Mexicana), but there was initial disagreement among manufacturers on the proposed efficacy levels.
7. Prior to ILUMEX, Philips and Focos had operated one factory that produced CFL lamps.

8. Snapback is the tendency by consumers to use an efficient technology more than the technology it replaces; see section 8.1.

9. Source: The exchange rate from January 7, 2004 was used to convert to US$.

10. Mexico’s statistical agency, the Instituto Nacional de Estadística, Geografía e Informática (INEGI)’s annual data cover all fluorescent lamps (in categories of less than 20 watts and greater than or equal to 20 watts), but not all of those lamps are CFLs, and CFLs fall into both categories, which makes it impossible to estimate the sales of residential CFLs.

11. According to FIDE, households used to have 3.5 CFLs each. Programs currently sell approximately 10 CFLs/household, and homes have reached a cumulative average of 5.5 CFLs/household.

12. Some stakeholders thought that FIDE’s penetration estimate might be too high, while others thought its estimate was low. Post-project evaluation studies of the pilot projects (before ILUMEX) showed a penetration in households of 25 percent in cities reached by the program. Furthermore, the manufacturers’ sales figures for 2003 and 2004 (even at 50 percent) would account for more than half of the estimated base. If it is assumed that CFLs are used on average 3 hours/day, and have an average lifetime of 6,000 hours (conservative estimates in this analysis), this means they are replaced about every five years. So sales from 2000 to 2004 would comprise the installed base in 2005. Assuming that total annual CFL sales occurred in 2000–2002 in quantities almost as high as in 2003–2004, this can be assumed to amount to an installed base of 2030 million CFLs.

13. Given the current average of 5.5 CFLs per households that already use CFLs, the figure of 2.5 CFLs per household for all households represents a conservative estimate. Navigant (1999) Le groupe-conseil Baastel, in its reassessment of the Poland Efficient Lighting Project (PELP) study (Evaluation of the IFC/GEF Poland Efficient Lighting Project CFL Subsidy Program, Navigant, August 1999), found that the estimate of 2.5 made by Navigant was significantly underestimated and, in fact, had already been exceeded.

14. The remaining 75 percent are not true “free riders” because they did not take advantage of the incentive. However, they do represent an overestimation of the impact of the rebate program and, therefore, they are treated as free riders for the purposes of calculating the impact.

15. The DNV/ICF report estimated that 20 percent of the CFLs would last 8,000 hours and the remainder would last for 9,300 hours. As reported, this latter assumption is conservative, since CFE’s lab tests showed that 80 percent of the CFLs had lasted over 9,300 hours, the manufacturer’s specified lifetime.
16. Data were based on a small number of monitored CFLs.

17. Capacity constraints only lasted until 2001 with excess capacity beginning in 2002 (see section 5).