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**IMPLEMENTATION COMPLETION REPORT**

**Mexico**

**HIGH EFFICIENCY LIGHTING PILOT TRUST FUND**  
(GEF Grant No. GE -7492)

December 23, 1998

Mexico Country Management Unit  
Finance, Private Sector and Infrastructure Sectors Unit  
Latin America and Caribbean Region

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## CURRENCY EQUIVALENTS

Currency Unit = New Mexican Peso

New Mexican Peso 10 = 1US\$

Norwegian Krone 7.55= 1 US\$

## WEIGHTS AND MEASURES

1 Metric ton (mt or ton) = 1,000 kg

1 MW (Mega-watt) = 1,000 kW

1 MWh (Mega-watt-hour)= 1,000 kWh

1 GWh (Giga-watt-hour) = 1,000 MWh

## ABBREVIATIONS AND ACRONYMS

<b>BANOBRAS</b>	Banco Nacional de Obras y Servicios Públicos (National Bank of Public Works and Services)
<b>CFE</b>	Comisión Federal de Electricidad (Federal Electricity Commission)
<b>FCCC</b>	Convencion Marco de las Naciones Unidas sobre Cambio Climatico (United Nations Framework on Climate Change)
<b>FIDE</b>	Fideicomiso de Apoyo al Programa de Ahorro de Energía del Sector Eléctrico (Trust Fund for Energy Conservation)
<b>GEF</b>	Fondo Mundial para el Medio Ambiente (Global Environment Facility)
<b>GET</b>	Fideicomiso Mundial para el Medio Ambiente (Global Environment Trust Fund)
<b>GoM</b>	Gobierno de Mexico (Government of Mexico)
<b>ILUMEX</b>	Iluminacion de Mexico (Mexico Ligthing Project)
<b>IU</b>	Unidad de Implementacion (Implementing Unit)
<b>PCU</b>	Unidad Cordinadora del Proyecto (Project Coordinating Unit)
<b>STAP</b>	Panel de Asesores de Ciencia y Tecnologia (Scientific and Technical Advisory Panel)
<b>CETES</b>	Certificados de Tesoreria (Government of Mexico Treasury Bills)
<b>CO2</b>	Dioxido de Carbono (Carbon Dioxide)
<b>DSM</b>	Manejo de la Demanda (Demand Side Management)
<b>FLs</b>	Lamparas Fluorescentes (Flourescent Light Bulbs -Compact and Circular)
<b>IRR</b>	Tasa Interna de Retorno (Internal Rate of Return)
<b>LRMC</b>	Costo Marginal a Largo Plazo (Long-Run Marginal Costs)
<b>SO2</b>	Dioxido de Sulfuro (Sulphur Dioxide)
<b>NOx</b>	Oxido de Nitrogeno (Nitrogen Oxide)

Vice President : Shaid Javed Burki  
Director Country Management Unit: Olivier Lafourcade  
Director Sector Management Unit: Daniel Leipziger  
Task Manager: Enrique Vanegas

**IMPLEMENTATION COMPLETION REPORT  
MEXICO**

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**IMPLEMENTATION COMPLETION REPORT**  
**MEXICO**  
**HIGH EFFICIENCY LIGHTING PILOT TRUST FUND**  
**GRANT N0: GE-7492**

**PREFACE**

This is the Implementation Completion Report (ICR) for the High Efficiency Lighting Pilot Project (Mexico), for which Grant GE-7492 in the amount of SDR 7.3 million (approximately US\$10.00 million equivalent) was approved on March 14, 1994 and made effective on February 10, 1995. The project was closed on December 31, 1997. SDR 7.3 million was disbursed. The final disbursement took place in March 1997.

The project was co-financed by a Nkr 20.25 million (approximately US\$3 million equivalent) grant from the Kingdom of Norway.

This ICR was prepared by Messrs. Enrique Vanegas, Task Manager (LCSFP), and Gary Costello, consultant (LCSES). The ICR was reviewed by Richard Clifford, Infrastructure Sector Leader (LCC1C); Christine Kimes, GEF Coordinator (LCSES); Chaudra Sinha (ENV); and Maria Victoria Lister, Quality Assurance Officer (LCSFP).

Preparation of this ICR began during the Bank's final supervision/completion mission, August 16-26 1998. It should be noted that further revisions of operational and economic data was continued after the mission with the result that minor discrepancies exist between the Aide Memoire, which was signed on August 26, 1998 and the date of this ICR. The implementing agency contributed to preparation of the ICR by preparing a final implementation report which can be found in Appendix B. The implementing agency also provided comments on the draft ICR.

**United Mexican States  
Banco Nacional de Obras y Servicios Publicos  
High Efficiency Lighting Pilot**

**Grant Trust Fund No: GE-7492**

**Mexico**

**EVALUATION SUMMARY**

**Introduction**

1. The High Efficiency Lighting Pilot Project was the first of its kind to be funded by the GEF Trust Fund. Support to the Government of Mexico (GOM) was based on the desire to find ways to reduce the growth in demand for electric energy and the associated increases in gaseous emissions of thermoelectric power plants. Conversion of lighting from incandescent bulbs to high efficiency florescent bulbs (FLs), would complement Bank loans to implement programs to improve both supply-side and demand -side energy management. The Project would also complement ongoing energy conservation programs of the Comisión Federal de Electricidad (CFE) such as the installation of sodium vapor light bulbs in the public lighting system and sale of FLs in the Mexico City, Chetumal, Hermosillo, Querétaro, Puebla and Valladolid. The Government of Norway co-financed the Project. Project start up was delayed by one year due to problems associated with the execution of the Trust Deeds (Fideicomisos) and the contractual arrangements among the guarantor (SHCP), the recipient (BANOBRAS) and CFE . The project closing date was extended by one year in order to provide the GOM the opportunity to fully implement the project.

2. While the operation was expected to have an attractive rate of return, GEF participation was deemed necessary in order to increase the pace of technology adoption among consumers. The initial high cost of purchase (about ten times higher than incandescent bulbs) was a major barrier to purchase. An intensive marketing and education campaign was seen as essential to expanding FLs use. It was also expected that GEF support would help to establish a model for assessing the technical and economic viability of a new technology that could be applied throughout the developing world. The project was considered a STAP-designated priority area and the GEF's main demonstration project for energy efficient lighting technologies.

**Project Objectives**

3. The project objectives were to: (a) demonstrate the technical and financial feasibility of reducing emissions of greenhouse gases and simultaneously reduce local environmental contamination through the widespread installation of high efficiency lighting; (b) build institutional capacity for technological change and energy conservation; (c) provide a replicable model for demand-side-management (DSM) in Mexico and elsewhere in the developing world; and (d) strengthen the CFE capacity to practice DSM on a sustainable basis.

4. The project had a goal of replacing approximately 1.7 million incandescent bulbs with the higher efficiency FLs in Mexico's second and third largest cities, Guadalajara and Monterrey. CFE was responsible for the sale and distribution of the bulbs to customers. The Project was expected to generate global benefits associated with the reduction of greenhouse gas emissions, as well as other contaminants such as SO<sub>2</sub> and NO<sub>x</sub>.

5. The objectives were realistic and appropriate for the circumstance and the nature of the grant. They were also consistent with the governments overall energy development and management strategy, the Bank's development strategy for the country and the GEF's program priorities.

### **Implementation Experience and Results**

6. The project was implemented by the CFE. The design of the project placed heavy emphasis on the establishment of two implementing units (one for each city) financed through trust accounts (Fideicomisos) and BANOBRAS acting as the trustee. It was expected that this system would help keep costs low and allow CFE to introduce timely adjustments to ensure project success.

7. From the point of view of project monitoring and evaluation, the results were limited. CFE did not undertake an assessment of FLs usage and the demand coincidence factor until the last year of project implementation and the final results were not know until after project closing date. Consequently, the Midterm Review which took place at the end of June 1996 did not serve a useful purpose because no evaluation data was available. This was the time were project design could have been modified and improved.

8. The original closing date for the Project was December 31, 1996. In December 1996, The Bank agreed to extend the project for one year to December 31,1997 because the delay in effectiveness had caused disbursement lags. By closing date, full grant disbursement had been reached and 1,712,361 FLs had been sold surpassing the initial goal for sales of 1.7 million. As of July 1998, 2.5 million bulbs have been sold and installed. Also data related to energy consumption/savings and actual carbon savings based on installations and product use indicates that energy savings were close to estimates (911 GWh vs. 1014 GWh for the life of the FLs). Avoided CO<sub>2</sub> emission by the project (for the life of the FLs –9,000 hours) was 764,000 tons vs. 710,000 tons estimated at appraisal

9. Project costs and financing arrangements conformed well to SAR estimates. The total estimated costs for the project were US\$ 23.00 million of which GEF would contribute approximately US\$ 10.00 millions (SDR 7.3 million), the Kingdom of Norway approximately US\$ 3.0 million (NK 20.25 mill), and the CFE US\$ 10.00 million. As of closing date, total project cost was US\$ 25.95 due mainly to SDR and NK exchange rates appreciation against the dollar. The GEF Grant financed US\$ 10.7 million or 41 % of the total disbursed, the Kingdom of Norway provided US\$ 3.15 million or 12 % share, and CFE contributed US\$ 12.1 million (including reflows) or 47 % share.

## **Project Sustainability**

10. Project sustainability is likely. The project has continued beyond the completion date with financing from reflows and contributions from CFE. By December 31, 1998, CFE expects to install a total of 2.49 million FLs at a total cost of US\$ 33.82 million. For 1999 and 2000, CFE will support administrative offices in Guadalajara and Monterrey which will attend to customer needs including replacing defective FLs. Over the same period, CFE will collect all outstanding payments associated with the reflows or about US\$11.6 million. Throughout the life of the project and since project closing in December 1997, CFE has demonstrated the capacity to recover both the operational and direct costs of the lamps. CFE expects to use these funds to support its ongoing energy conservation initiatives including promotion of high efficiency lighting in other parts of the country. Based on these positive results, the prospects for project sustainability (FLs to be replaced by participants at the end of useful life) are good, but will depend on CFE's tariff policies and on the future market cost of FLs.

## **Bank Performance**

11. Bank performance during preparation and appraisal was for the most part *satisfactory*. However, the Bank preparation team should have considered including the specification of monitoring and evaluation indicators to measure cost effectiveness, environmental impact, and financial and energy usage target. Project monitoring and evaluation indicators (consultants reports, baseline surveys and participant surveys) which were included were appropriate but insufficient

12. Bank supervision, however, was *unsatisfactory*. Most Bank supervision reporting focused narrowly on the progress in achieving FL sales goals. Little attention was given to enforce the carrying out of technical studies and survey data, which was later produced by CFE. At the same time, however, the Bank could have done more in terms of providing guidance to CFE regarding monitoring and evaluation of energy demand particularly as relates to analyzing the project's impact energy consumption and CO<sub>2</sub> emissions, a most important rationale for Bank and GEF support. The Bank also failed in its fiduciary role with regard to the management and accountability of GEF and donor s' funds by not being more forceful with CFE that audit reports complied with Bank standards and project's financial controls strengthened. There was also high turn-over of task managers.

## **Borrower (Grantee) Performance**

13. CFE performance can be characterized as *satisfactory*. Project reporting was for the most part timely. However, project audit reports were not acceptable and submitted late and the CFE did not complete the final evaluation report by the agreed upon deadline of June 30, 1998. CFE has asked the auditors to correct any shortcomings in their reports so as to meet all Bank requirements. Regarding the M & E program, CFE bears some of the blame for not implementing it in a timely fashion as they failed to hire the specialized consultants agreed to during project appraisal.

## Summary of Findings, Future Operation and Key Lessons Learned

14. The project merits a *satisfactory* rating with regard to the achievement of its fundamental objectives. The performance of each of the project's components is also rated as *satisfactory*.
15. The project outcome is rated *satisfactory* as most development objectives were achieved and performance indicators attained. There were, however, some shortcomings such as a negative IRR for CFE, lower IRR (35% actual vs. 56% at appraisal) for the project, and lower value of the capacity postponed by the installation (33.7 MW actual vs. 100MW at appraisal). The main reason for these results was that the demand coincidence factor between electric system peak and efficient lighting usage was lower (.3 actual vs. .8 at appraisal)
16. As regard a future operation, there is no need for further Bank/GEF involvement in this sector. CFE has initiated a new high efficiency lighting project which will cover the entire country. A total of about 6.5 million FLs would be installed in four years. The project is being financed by CFE's own funds
17. Key lessons learned from implementation include:
- (a) in the case of Mexico where the implementation was carried out by an electric utility (CFE), the establishment of independent trust funds (fideicomisos) were a key factor in achieving sales and coverage goals. These fideicomisos were set up with BANOBRAS and have shown to be efficient, low cost and expeditious, since CFE was able to retain control of the project and introduced timely adjustments. It also guaranteed that the funds, including those resulting from the credit sales to the participants, were kept separate from those that entered into CFE's own treasury and that they were only used for the purposes of the project.
  - (b) high technical specification and reliability of FLs were important considerations in consumer acceptance.
  - (c) the price subsidy of FLs was important in overall marketing/sales strategy.
  - (d) a tariff policy which provides large subsidies to low income consumers acts as a disincentive to purchase FLs even when the price of the FLs are subsidized. Having a tariff policy which sets the electricity equal to the long run marginal cost (LRMC) will provide an incentive to consumers to purchase FLs
  - (e) the identification of appropriate project monitoring indicators and the regular collection of data by the implementing agency are essential steps in evaluating ongoing pilot project performance. Without rigorous monitoring, pilot projects' success or failure will be difficult to determine.
  - (f) decentralized Implementing Units (IUs) were a key factor in achieving sales and distribution goals.



# **IMPLEMENTATION COMPLETION REPORT**

## **MEXICO**

### **HIGH EFFICIENCY LIGHTING PILOT TRUST FUND (GE - 7492)**

#### **PART I : PROJECT IMPLEMENTATION ASSESSMENT**

##### **A. Introduction**

1. During the early 1990's, demand for electric energy in Mexico was high and increasing at a rate of over 5% a year. In 1992, it was estimated that Mexico would need to add 14,000 MW over a ten year period to meet this growing demand. The High Efficiency Lighting Pilot Project was designed as part of a larger Bank financed energy savings project (The Power Sector Project) and was fully consistent with Mexico's energy management and development strategies and priorities for reducing the demand for thermal generation and new energy investments. Although the Power Sector Project was not in the end funded, other earlier Bank supported energy activities in Mexico such as the Transmission and Distribution Project and the Hydroelectric Development Project were viewed as complementary as they addressed both supply and demand-side management issues.
2. In addition to addressing Mexico's energy conservation priorities, the High Efficiency Lighting Pilot Project was designed to address the problem of gaseous emissions associated with thermal generation. Due to the fact that about 80% of Mexico's installed generating capacity is thermal, gaseous emission levels are high. Carbon dioxide, sulfur dioxide and nitrogen oxide emissions have a deleterious effect on both the local and global environment. The introduction of energy saving technologies could contribute to reduced energy consumption thereby improving air quality and reducing greenhouse gas emissions.

##### **B. Project Objectives and Description**

3. The Project objectives were to: (a) demonstrate the technical and financial feasibility of reducing emissions of greenhouse gases and simultaneously reduce local environmental contamination through the widespread installation of high efficiency lighting; (b) build institutional capacity for technological change and energy conservation; (c) provide a replicable model for Demand Side Management (DSM) in Mexico and elsewhere in the developing world; and (d) strengthen Comision Federal de Electricidad (CFE)'s capacity to practice DSM on a sustainable basis.
4. The Project design included support for: (a) the acquisition of more energy efficient Flourescent Light Bulbs (FLs), (77 % of project cost; including contingencies); (b) the purchase of vehicles, metering equipment, computers, office equipment and sale stands (2 % of project cost including contingencies); (c) consultant services for canvassing, marketing and, testing, auditing and evaluation (4 % of project cost; including contingencies); (d) the cost of engineering,

monitoring, billing and accounting (8 % of project cost; including contingencies); and (e) the direct costs of project administration, including fully dedicated staff in both cities (9 % of project cost; including contingencies).

5. The Project included these design elements: (a) project benefits would be shared with participants through a rebate of approximately 63% of the total cost (including overhead costs); (b) participants would pay for FLs either in cash or under a deferred payment plan of 24 months, as part of their electric bill with an interest rate equivalent to the government treasury bills (CETES); (c) technical standards and specifications to allow FLs to operate properly and reach their projected lifetime; and (d) acceptable FL performance guidelines to be provided to the customer and CFE.

6. Project participation was restricted to residential customers. The project supported a marketing campaign which included specific targeting of low income/low consumption users. CFE expected that the cost savings to low consumption users associated with high efficiency lighting would help offset future tariff increases.

7. The Project did not include activities related to energy policy or institutional reforms. These areas were addressed in other Bank supported loans. The most significant of these policy reforms included in the Transmission and Distribution Project was that cross-subsidies among consumers would be reduced and that electricity tariffs would rise until they approached the long run marginal cost (LRMC). During Project preparation it was assumed that these reforms would move forward and therefore be complementary to the goals and objectives of the High Efficiency Lighting Pilot Project.

8. The Project was not considered high risk nor complex. The main risks identified at appraisal were: (a) market penetration might be slower than expected which might result in higher project costs associated with additional program marketing; (b) the FLs might be installed in places where they are used less than four hours per day; (c) voltage fluctuations in the Mexico power system might be such as to significantly reduce the lifetime of FLs; and (d) the FLs might fail to reach their projected lifetime even if there were no excessive voltage fluctuations. The project's design attempted to deal with these risks through the development of extensive product marketing and promotion, strict purchasing specifications, laboratory testing and public awareness campaigns.

### **C. Achievement of Project Objectives**

9. Most project objectives were achieved. The Project was officially closed in December 1997. The original target for unit sales of FLs forecast at appraisal was 1.7 million. As of the project closing date of December 31, 1997 a total of 1,712,361 FLs were sold. The CFE commitment required that they continue to share savings with the project participants until all funds from both grants had been transferred to the participants in the form of rebates for the purchase of FLs and the balance of the reflow on funds (about US\$ 9.0 million) was completely exhausted. The additional sales were financed with funds accumulated from the payments made by the project participants and from CFE contributions. All grant funds have been disbursed : GET US\$10.7 (equivalent to SDR 7.3 mill) and Kingdom of Norway, as cofinancier, with US\$3.1 million (equivalent to NK 20.25 mill). The total project cost was US\$ 25.95 million. All contracts

to purchase FLs with GEF grant funds, including reflows, have been awarded (totaling approximately 2.49 million units) and all are expected to be sold by December 31, 1998 at a total cost of US\$33.82 million. The higher cost is due to SDR and NK/US\$ fluctuations.

10. Average cost of installed FL was estimated at US\$13.53 each at appraisal. The total number of FLs installed as of December 31, 1997, the official closing date of the project, was 1,712,361. As of December 31, 1998, the date when CFE will cease sales through the two trust funds, an estimated 2.5 million FLs will have been installed. Actual cost for the project as executed was US\$ 11.42 each (direct cost) or US \$ 13.92 total cost (including overhead). All sales were transacted through the CFE offices.

11. Approximately 51% of the sales occurred in Guadalajara which accounted for 58% of the contracts; 49% percent of the sales occurred in Monterrey. Brand preferences were different in the two cities. Participants in Guadalajara preferred General Electric and participants in Monterrey, Phillips. The FLs are of high quality and public acceptance has been very positive. A third bidding process was initiated for the sale of an additional 920,000 FLs which would be financed with payments made by project participants and from CFE contributions.

12. A successful DSM project would encourage customers to modify their energy consumption with respect to the timing and level of demand. The project only partly achieved this goal because complementary measures to influence the timing of demand such as time of use tariffs and direct load control were not implemented. Also the project assumed that tariffs would be raised to the long-run marginal cost (LRMC). CFE, however, simplified tariffs blocks in early project execution by reducing them from 7 to 3 categories. CFE was able to evaluate project impact in terms of energy savings (kWh savings) as well as the effectiveness of program design, marketing and delivery. The total amount of energy saved for the life of the FLs is 978GWh compared to 1,014 GWh estimated at appraisal.

13. From the point of view of project monitoring and evaluation, the results were limited. CFE did not undertake an assessment of FLs usage and the demand coincidence factor until the last year of project implementation and the final results were not known until after project closing date. Moreover some of the findings were revised and changed during the ICR mission. Survey results indicated that the FLs were being used less than 3 hours per day (compared to 4 hrs per day estimated at appraisal). This usage translated into a coincidence factor of .5, (compared to .8 estimated at appraisal). The coincidence factor was evaluated by the CFE and the Bank during the ICR mission and was lowered to .3. These results lowered the economic and capacity saving benefits of ILUMEX. The Bank was not forceful enough in demanding that CFE timely hire the specialized consultants to both monitor FL usage and assess its impact on energy conservation and the reduction of greenhouse gas emissions. The mid-term review was to be based on these findings. As these studies were not implemented during the first 18 months of the project, the mid-term Review mission was not carried out as designed at the appraisal stage. Moreover, at the time the mid-term mission took place at the end of June 1996, 77% of grant resources (US\$8.2 million) had been disbursed without the collection of project monitoring and evaluation data. Thus making any findings or recommendations from that mission largely irrelevant for project implementation purposes.

14. According to the project appraisal estimates, the project would reduce the need to install additional capacity generation by about 100 MW. The project was partially successful in reaching that goal by postponing the development of an additional 33.7MW of capacity. The lower than expected value is due primarily to a lower coincidence factor of use. This factor measures the ratio of FLs in use during peak hours vs. the total number of FLs installed. ILUMEX survey data of participants showed that FLs were used fewer hours than estimated at appraisal resulting in a coincidence factor of use of 30% vs. 80% estimated at appraisal.

15. The July 1996 supervision mission report stated that CFE had changed the fuel mix of power stations located close to Monterrey from heavy fuel oil to natural gas, resulting in a change in the level and composition of power plant emissions. In Guadalajara the fuel was changed to a low sulfur content fuel oil which also reduced greenhouse gas emissions. This meant that the net environmental benefits associated with the high efficiency lighting program were reduced. Economic benefits were also reduced, as previously mentioned, by the average time of use of FLs which was lower, 2.89 hours/day, than the 4 hours/day estimated at appraisal.

16. Data related to energy consumption/savings and actual carbon savings based on installations and product use indicates that energy savings were close to estimates (911 GWh vs. 1014 GWh for the life of the FLs). Avoided CO<sub>2</sub> emission by the project (for the life of the FLs – 9,000 hours) was 764,000 tons vs. 710,000 tons estimated at appraisal.

17. Another reason for the lower economic benefits was the drastic reductions in fuel prices which began in 1994. CFE's marginal cost of energy has decreased from .062 US \$/kWh in 1994 to US \$ .029 in 1998. From the national perspective, the project IRR was 35% (vs. 56% estimated at appraisal). For CFE, the project IRR was negative (vs. 32% estimated at appraisal). For the participants in the project, however, the project IRR was very high (248% vs. 151% estimated at appraisal). This was due to the impact of energy tariff increases imposed on the biggest residential consumers. Additional details and analysis of the economic costs and benefits of the project can be found in Annex C.

#### **D. IMPLEMENTATION RECORD AND MAJOR FACTORS AFFECTING THE PROJECT**

18. GEF supported pilot projects are expected to be: innovative, replicable, sustainable, incremental and include, where appropriate, participation and consultation. The performance of the Mexico High Efficiency Lighting Project in these areas has been mostly satisfactory.

19. Today CFE is implementing a variety of energy saving programs on a nationwide basis including; (i) thermal insulation of homes in hot climate areas; (ii) improving efficiency of motors for home and business use;(iii) improving efficiency of air conditioners; and (iv) the use of high efficiency lighting. In interviews with CFE staff during the ICR mission, they indicated that their experience with the GEF Pilot project played an important role in the design of nationwide energy savings programs, particularly : a) the establishment of internal management units as well as implementation units, or trust funds; b) the formulation of technical specifications and laboratory tests; and c) the undertaking of periodic technical and financial reviews.

20. Over the implementation period of the project the following changes occurred which positively affected overall project performance :

- the sales ceiling of 6 FLs per person was increased to 10 FLs
- the Fideicomisos were amended to increase geographic coverage to city suburbs and rural areas
- product price increases (in pesos) to keep pace with devaluation

21. These changes resulted in a larger number of FLs sold to a wider geographic population even though the discount was smaller (49%) compared to appraisal (63%).

22. Over the life of the project, the following occurred which negatively affected overall project performance:

- Initial poor quality of some FLs which required CFE to purchase and distribute replacements. 120v 15w doubleviac were replaced with 120v 15w tripleviac
- The peso devaluation also caused an increase in the price of FLs to consumers making purchases more difficult for lower income consumers
- CFE had difficulty in measuring CO<sub>2</sub> emissions and analyzing the environmental impacts of the Project. Also the monitoring and evaluation activities were not completed until after the project closing date
- Highly subsidized energy tariffs to low income consumers overrode the effects of steep price discounts for bulbs resulting in lower sales to this group
- One year delay in effectiveness due to various legal difficulties in establishing the Fideicomisos. It was assumed at appraisal that the condition of effectiveness could be easily complied. This turn out not to be the case. In accordance with the Bank legal counselor involved in the project, the fideicomisos did not provide any rigidities, once they were set up. It could therefore be deduced that the execution of the Trust Deeds and the contractual arrangements among the guarantor (SHCP), the recipient (BANOBRA) and CFE took longer than normal and this could be the main reason for the delay. There were additional factors such as a change in task managers and little oversight by the Bank. No explanation was found in project files.

23. Product use surveys undertaken by CFE indicated that FLs were used less than three hours per day (as compared to the original estimate of four per day). As was mentioned previously, consumer behavior caused a reduction in the project's economic benefits and a reduction in the energy capacity saved by the project.

24. The one year delay in declaring project effectiveness caused disbursement lags. No monies were disbursed in FY94, as compared to appraisal estimate of US\$650,000. In FY95, US\$ 2.2 million was disbursed or 35 % (US\$6.5 million) of appraisal, including Kingdom of Norway's contribution. However, by the end of FY96 procurement had accelerated and 161% of grant funds were disbursed, as compared to original timeline. In FY97, last disbursement was made, whereas appraisal assumed the project to be closed (see Table 4 of Statistical Annex).

### **E. Project Sustainability**

25. Project sustainability is likely. The project has continued beyond the completion date with financing from reflows and contributions from CFE. By December 31, 1998, CFE expects to install a total of 2.49 million FLs at a total cost of US\$ 33.82 million. For 1999 and 2000, CFE will support administrative offices in Guadalajara and Monterrey which will attend to customer needs including replacing defective FLs. Over the same period, CFE will collect all outstanding payments associated with the reflows or about US\$11.6 million. Throughout the life of the project and since project closing in December 1997, CFE has demonstrated the capacity to recover both the operational and direct costs of the lamps. CFE expects to use these funds to support its ongoing energy conservation initiatives including promotion of high efficiency lighting in other parts of the country.

26. In Guadalajara, a recent customer survey undertaken by CFE indicated that: (i) 90% of the participants of the ILUMEX project were satisfied with the product; (ii) over 80 % indicated that in the future they would purchase the bulbs without a subsidized price; and (iii) among non-participants only 51% did not know about the Project. In Monterrey, the ICR Mission found that: (i) 90% of the Project participants were newcomers; (ii) 66% were familiar with the project but did not participate; and (iii) 78% understand the economic benefits of FL use. In terms of coverage, 18.5% and 16% of households in Monterrey and Guadalajara, respectively, had participated in the Project. Based on these positive results, the prospects for project sustainability (FLs to be replaced by participants at the end of useful life) are good, but will depend on CFE's tariff policies and on the future market cost of FLs.

27. CFE has initiated a new high efficiency lighting project which will cover the entire country. A total of about 6.1 million FLs would be installed in four years. The project is being financed by CFE. While no discount will be given to the participants, lamps will be sold on terms with low interest rates. The project is using the same organizational structure as the ILUMEX project, including the executing agent, CFE, the financing agent, FIDE and the same operation guidelines utilized in the GEF project. CFE will finance the new initiative with its own resources 175,000,000 Mexican pesos (approximately US\$ 17.5 mill.) have been allocated for 1998.

28. The results of the ILUMEX project and the new program initiated by CFE will be disseminated at an international seminar to be held in Mexico scheduled for March 1999.

### **F. Bank Performance**

29. Bank performance during preparation and appraisal was for the most part satisfactory. However, the Bank preparation team should have considered including the specification of monitoring and evaluation indicators to measure cost effectiveness, environmental impact, and financial and energy usage target. Project monitoring and evaluation indicators (consultants reports, baseline surveys and participant surveys) which were included were appropriate but insufficient.

30. Bank supervision was unsatisfactory. Most Bank supervision reporting focused narrowly on the progress in achieving FL sales goals. Little attention was given to enforce the carrying out

of technical studies and survey data, which was later produced by CFE. At the same time, however, the Bank could have done more in terms of providing guidance to CFE regarding monitoring and evaluation of energy demand particularly as relates to analyzing the project's impact energy consumption and CO<sub>2</sub> emissions, a most important rationale for Bank and GEF support.

31. The Bank also failed in its fiduciary role with regard to the management and accountability of GEF and donors funds. When the first audit reports were issued for FY95, the Financial Management/Accountability Team stated that these reports were not prepared in accordance with Bank requirements and that the internal controls of the project were weak. Although this situation was communicated to CFE, the deficiencies persisted up until project completion.

32. Supervision efforts were hampered by numerous staff changes, but this was not the main reason for unsatisfactory performance. The task manager position was changed three times over three years, which reflected the high staff turnover in the LAC energy cluster. The main arguments for the Bank's unsatisfactory performance was the failure to be more forceful in demanding the execution of the studies to verify the project benefits and that appropriate changes could be introduced following the Midterm Review. Basically, for most of the life of the project, not a single Task Manager or a single unit of LAC felt responsibility for the project. In general, supervision missions were adequately staffed and generated satisfactory performance ratings on Supervision Form 590. While the number of staff weeks devoted to supervision was adequate (average two missions per year), the composition of the supervision teams should have been broader and included climate change experts. The overall Bank performance is rated unsatisfactory.

### **G. Borrower (Grantee) Performance**

33. CFE performance can be characterized as satisfactory. Project reporting was for the most part timely. However, project audit reports were not acceptable and submitted late and the CFE did not complete the final evaluation report by the agreed upon deadline of June 30, 1998. CFE has asked the auditors to correct any shortcomings in their reports so as to meet all Bank requirements. Regarding the M & E program, CFE bears some of the blame for not implementing it in a timely fashion as they failed to hire the specialized consultants agreed to during project appraisal.

34. The establishment of the fideicomisos in Guadalajara and Monterrey as implementing units contributed to the positive project outcome. The main reasons were : a) the fideicomiso were able to channel grant resources to beneficiaries without having to pass those resources through CFE's treasury department which reduced bureaucratic delays; (b) administrative guidelines agreed to with the Bank were well designed and efficient; c) hiring and firing of personnel is not subject to CFE personnel policy – no carrying costs after project completion; and d) procurement is done directly by the implementing units, and not through CFE.

35. CFE was supposed to organize an international conference to present and discuss project results in June 1997 following the preparation of the consultants reports. This deadline was not met. Despite these shortcomings, the Grantee eventually complied with the reporting requirements and will organize and implement the international conference in March 1999. National and

international experts will be invited. GEF and the Bank will review and comment on the proposed seminar agenda.

#### **H. Assessment of Outcome**

36. The project outcome is satisfactory. CFE has been effective in outreach to clients through sales stands and awareness campaigns. The executing agency showed a high level of ownership and commitment which contributed significantly to achieving and in some cases exceeding the targets for the project. One disappointing result, however, was the demand coincidence factor. In the feasibility study for the project prepared by an international consultant, it was estimated that the average number of FLs purchased and used by each participant of the program would be 3.0. Based on this assumption, the coincidence factor was estimated to be 80%. In hindsight, this factor was overestimated, however the Bank during supervision did not catch this over-estimate, as no data was available, as previously mentioned. In fact, the average number of FLs sold to each participant of the ILUMEX project was 10. A higher number of FLs in one home normally resulted in a lower percentage of FLs being used at any time. As a result, the actual coincidence factor was only 30%. Some other key outcomes included:

- Avoided CO<sub>2</sub> emissions (for the life of the FLs – 9,000 hours) was 764,000 tons, compared to 710,000 tons estimated at appraisal, plus the environmental benefits associated with lower power generation.
- The number of FLs installed during the official period of project implementation (1995-1997) was slightly higher than estimated during appraisal. The unit cost per FL was US\$ 13.92 (vs. US\$ 13.53), of which 18% or US\$ 2.50 was overhead cost (vs. 18.7%). This small variation in the total unit cost of FLs had no appreciable effect in the results of the project.
- A fully developed institutional capacity to implement high efficiency lighting projects at a national scale.
- A solid understanding on the part of CFE of the role of high efficiency lighting projects in the overall DSM program.
- A solid understanding of the economic dimensions of high efficiency lighting programs including the role of both tariff and price subsidies.

37. Another outcome of this project which merits mention is the fact that the Bank's Carbon Offset Unit has selected Mexico as a pilot for testing verification of carbon savings. The pilot will undertake a technical audit to validate project results in terms of the reduction of greenhouse gas emissions. The results of this audit will (1) strengthen the basis for the preparation and replication of efficient lighting and similar DSM projects, in particular Mexico, and (2) deliver input for the design of an approach to the verification and certification of GHG emission reductions.



Verification and certification of GHGs is required by Art. 12 Kyoto Protocol for projects that generate GHG emission credits under the so called Clean Development Mechanism.

38. **Economic Benefits of the Project.** The project's performance from the economic perspective was analyzed by both CFE and the Bank. A summary of the key findings is presented below. The detailed economic analysis can be found in Appendix C.

39. The expected economic benefits of the project as described in the Memorandum of the Director (MOD) were: (i) project participants will enjoy a comparable or higher lighting level at reduced cost; and (ii) the society at large and CFE will be able to postpone new energy investments because the project will reduce energy demand and, thereby, save fuel.

40. The economic benefits were estimated based on project data and using the same methodology as in the MOD. All costs are expressed in constant terms as of September 1998. All taxes have been excluded, except for the analysis from the perspective of the participant as is explained below. Following the same methodology described in the MOD, the costs and benefits were calculated assuming that the FLs will not be replaced at the end of their useful life. If all or a percentage of the FLs are replaced as is expected, the economic benefits will be higher than shown below.

41. *The economic benefits to the nation were* (i) the value of the capacity postponed by the installation of the FLs (33.7 MW actual vs. 100 MW estimated at appraisal), valued at the LRMC (US\$ 126 vs. US\$ 132.5); (ii) the yearly value of the energy not generated because of the MW savings of the FLs (978 GWh total vs. 1,014 GWh) also valued at LRMC (US cent 2.9 per kWh vs. US cent 6.2 per kWh); and the value of the incandescent light bulbs not installed.

42. The internal rate of return (IRR) was calculated using data reported by CFE, which is based on project implementation information and market surveys. The IRR from the nation's perspective, as executed, was 35% vs. 56 % forecast at appraisal. The IRR did not reach the level estimated at appraisal because capacity postponed by the project was only 33.7 MW instead of 100 MW. The main reason for the lower capacity savings is related to the coincidence factor which was estimated at appraisal to be 80% but whose real value during implementation was 30%.

43. *The economic benefits for CFE were:* (i) the yearly repayment by participants of FLs sold on terms; and (ii) the cost of the capacity and energy saved by the project (same as for the nation). The CFE IRR was negative vs. 32% estimated at appraisal. The reasons for this result are: (i) the benefits for saved capacity were low, for the same reason explained above for the nation; and (ii) the cost of the energy saved by the project had a lower value for CFE, because the long run marginal cost of energy or LRMC has today a lower value than in 1994 when the project was appraised.

44. *The economic benefits for the project participants were:* (i) the value of the incandescent light bulbs not purchased because of the replacement with FLs; and (ii) the energy saved by the FLs, which reduces the amount of the monthly electricity bill to the participants. The present structure of CFE's residential tariffs changed, early in project execution, penalizing higher consumption of energy by higher rates. Although the saved energy by the participants is close to

the estimate of the appraisal, its value is higher because of the large participation of higher consumption users. As a consequence, the energy saved was valued at a higher cost, resulting in a higher amount than at appraisal.

45. The resulting IRR for the participants was much higher than estimated, because of the higher monthly savings on the electricity bill achieved by the participants. The IRR for the project as executed was 248% vs. 151% at appraisal.

### **I. Future Operation**

46. The Fideicomisos will cease sales on December 31, 1998. For calendar years 1999 and 2000 CFE will maintain a small administrative office in both cities, Guadalajara and Monterrey, which will deal with customer problems including FL replacement under the purchase guarantee. CFE will also continue to monitor different aspects of project impact including FL usage and purchasing patterns by socio-economic group and replacement purchases. CFE has initiated a new high efficiency lighting project which will cover the entire country. A total of about 6.5 million FLs would be installed in four years. The project is being financed by CFE and therefore there is no need for future GEF involvement in this sector.

### **J. Key Lessons Learned**

47. The above analysis of project implementation suggests that the key lessons learned from the project are:

- (a) In the case of Mexico where the implementation was carried out by an electric utility (CFE), the establishment of independent trust funds (fideicomisos) were a key factor in achieving sales and coverage goals. These fideicomisos were set up with BANOBRAS and were shown to be efficient, low cost and expeditious, since CFE was able to retain control of the projects and introduced timely adjustments. It also guaranteed that the funds, including those resulting from the credit sales to the participants, were kept separate from those that entered into CFE's own treasury and that they were used for the purposes of the project.
- (b) high technical specification and reliability of FLs were important considerations in consumer acceptance.
- (c) the price subsidy of FLs was important in overall marketing/sales strategy.
- (d) a tariff policy which provides large subsidies to low income consumers acts as a disincentive to purchase FLs even when the price of the FLs are subsidized. Having a tariff policy which sets the electricity equal to the LRMC will provide an incentive to consumers to purchase FLs
- (e) the identification of appropriate project monitoring indicators and the regular collection of data by the implementing agency are essential steps in evaluating ongoing pilot project performance. Without rigorous monitoring, pilot projects' success or failure will be difficult to determine.

- (f) decentralized Implementing Units (IUs) were a key factor in achieving sales and distribution goals.

**PART II : STATISTICAL TABLES**

**Table 1: Summary of Assessments**

<u>A. Achievement of Objectives</u>	<u>Substantial</u>	<u>Partial</u>	<u>Negligible</u>	<u>Not applicable</u>
	(✓)	(✓)	(✓)	(✓)
Macro Policies	<input type="checkbox"/>	<input type="checkbox"/>		✓
Sector Policies	<input type="checkbox"/>	<input type="checkbox"/>		✓
Financial Objectives	✓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional Development	✓		<input type="checkbox"/>	<input type="checkbox"/>
Physical Objectives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	✓
Poverty Reduction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	✓
Gender Issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	✓
Other Social Objectives	<input type="checkbox"/>	<input type="checkbox"/>	✓	<input type="checkbox"/>
Environmental Objectives	<input type="checkbox"/>	✓	<input type="checkbox"/>	<input type="checkbox"/>
Public Sector Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	✓
Private Sector Development	<input type="checkbox"/>	✓	<input type="checkbox"/>	<input type="checkbox"/>
Other (specify)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(Continued)

<u>B. Project Sustainability</u>	<u>Likely</u>	<u>Unlikely</u>	<u>Uncertain</u>
	(✓)	(✓)	(✓)
	✓	<input type="checkbox"/>	<input type="checkbox"/>

	<u>Highly satisfactory</u> (✓)	<u>Satisfactory</u> (✓)	<u>Deficient</u> (✓)
C. <u>Bank Performance</u>			
Identification	<input type="checkbox"/>	✓	<input type="checkbox"/>
Preparation Assistance	<input type="checkbox"/>	✓	<input type="checkbox"/>
Appraisal	<input type="checkbox"/>	✓	<input type="checkbox"/>
Supervision	<input type="checkbox"/>		✓
Outcome	Unsatisfactory		

	<u>Highly satisfactory</u> (✓)	<u>Satisfactory</u> (✓)	<u>Deficient</u> (✓)
D. <u>Borrower Performance</u>			
Preparation	<input type="checkbox"/>	✓	<input type="checkbox"/>
Implementation	<input type="checkbox"/>	✓	<input type="checkbox"/>
Covenant Compliance	<input type="checkbox"/>	✓	<input type="checkbox"/>
Operation (if applicable)	<input type="checkbox"/>	✓	<input type="checkbox"/>

	<u>Highly satisfactory</u> (✓)	<u>Satisfactory</u> (✓)	<u>Unsatisfactory</u> (✓)	<u>Highly unsatisfactory</u> (✓)
E. <u>Assessment of Outcome</u>	<input type="checkbox"/>	✓	<input type="checkbox"/>	<input type="checkbox"/>

**TABLE 2: RELATED BANK LOANS/CREDITS**

Loan/credit title	Purpose	Year of approval	Status
<i>Preceding operations</i>			
1. Power Transmission and Distribution (Mexico)		1990	Completed
<i>Following operations</i>			
2 Promotion of Electric Efficiency Project (GEF-Thailand)		1994	Ongoing
3. Efficiency Lighting Project (GEF-Poland)		1995	Completed
4. Demand Side Management Project (Jamaica)		1995	Ongoing

**TABLE 3: PROJECT TIMETABLE**

Steps in Project Cycle	Date Planned	Date Actual/ Latest Estimate
Identification (Executive Project Summary)		October 1991
Preparation		June 1992
Appraisal	August 1993	October 1993
Negotiations	December 1993	February 1994
Letter of Development Policy (if applicable)		
Board Presentation	March 1994	March 1994
Signing	June 1994	June 1994
Effectiveness	September 1994	February 1995
First Tranche Release (if applicable)		
Midterm review (if applicable)	September 1995	June /July 1996
Second (and Third) Tranche Release (if applicable)		
Project Completion	December 31, 1997	December 31, 1998
Loan Closing	December 31, 1996	December 31 1997

**TABLE 4: LOAN/CREDIT DISBURSEMENTS: CUMULATIVE ESTIMATED AND ACTUAL**  
(Includes Norwegian Grant – in millions of US\$)

	FY 94	FY 95	FY 96	FY97
Appraisal Estimate	.65	6.5	5.85	
Actual	0	2.2	9.4	2.2
Actual as % of Estimate	0%	34%	161%	
Date of Final Disbursement	March 1997			

Note: The actual GEF/Norway amount disbursed of US\$13.8 million exceeded the appraisal estimate of US\$13.0 million due to the variation of exchange rates (SDR and NKr) vis-a-vis the US\$.



**TABLE 5: KEY INDICATORS FOR PROJECT IMPLEMENTATION**

I. Key Implementation Indicators in SAR/ President's Report	Estimated	Actual
1. Accumulated Sales of CFLs	1,700,000	1,712,337
2. Marketing Survey	3 and 15 months after project start	Dec. 1994, Feb. 1996, Aug. 1998
3. Laboratory Testing	Fls first submitted as sample by all bidders, and subsequently a random selection from the first delivery made by the selected contractor	9 times over the life of project
4. Baseline Survey	At Project Start	1992
5. Sales and Participants Satisfaction Survey	3 and 15 months after project start	June 1996; July 1998
6. Survey on Hours of CFL Use	6 and 18 months after project start	July 1998

**TABLE 6: KEY INDICATORS FOR PROJECT OPERATION**

I. Key Operating Indicators in SAR/President's Report	Estimated	Actual
1. Semi-Annual Progress Reports	June/December	Bi-annually
2. Auditing Reports	Annual-December	Received annually
3. Mid-term Project Implementation Review	June 1995	June/July 1996
4. Final Project Evaluation	December 1997	August 1998
1. Bi-annual Supervision Missions	1-2 per year	2 per year

**Table 7: Studies Included in the Project**

Study	Purpose as Defined at Implementation	Status	Impact of Study
1. Baseline Survey	Baseline Data Collection	Completed prior to FLs sales	Provide reliable information for monitoring and evaluation
2. The market for Fluorescent and Incandescent Bulbs in Monterrey, 1995	To determine any shortcomings in the sale process	Completed during project execution	Assess market size
3. The market for Fluorescent Bulbs Among Consumers who use 15-400KWh every two months, 1996.	Consumer preference	Completed during project execution	Initiate 3 <sup>rd</sup> Bid
4. Participants Satisfaction Survey. 1996	Key project implementation indicators	Completed during project execution	Determine most popular Fls Voltage
5. Study of Non-participants from the Lowest and Intermediate Category of Consumers. 1997.	Key project implementation indicators	Completed during project execution	Understanding of factors contributing to non-participation
6. Tepic and Colima (state capitals) Market Study 1997	Key project implementation indicators	Completed in Dec/97	Provide more realistic estimates on bulb use in future projects.
7. Usage and Coincidence Factors in Monterrey 1998	To verify project appraisal estimates and estimate energy savings	Completed after project closing date	No Impact
8. Study of Participants, Non-participants and Specialized Stores 1998	Key project implementation indicators and to verify project appraisal estimates.	Completed after project closing date	No impact

**TABLE 8A: PROJECT COSTS**

Item	Appraisal Estimate (US\$M)			Actual/Latest Estimate(US\$M)		
	Local Costs	Foreign Costs	Total	Local Costs	Foreign Costs	Total
1. Lamps and Equipment	.2	14.2	14.4	0	21.8 <sup>1</sup>	21.8 <sup>2</sup>
2. Services	.77	.03	.81	0	.4	.4
3. Engineering and Management	1.5	0	1.5	1.2	0	1.2
4. Administrative Costs	1.6	0	1.6	2.5	0	2.5
5. Unallocated	1.0	3.6	4.6	0	0	0
<b>TOTAL</b>	<b>5,180</b>	<b>17,820</b>	<b>23,000</b>	<b>3.7</b>	<b>22.2</b>	<b>25.9</b>

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<sup>1</sup> This includes all budget formally designated as Unallocated

<sup>2</sup> This includes all budget formally designated as Unallocated

**TABLE 8B: PROJECT FINANCING**

Source	Appraisal Estimate (US\$M)			Actual/Latest Estimate (US\$M)		
	Local Costs	Foreign Costs	Total	Local Costs	Foreign Costs	Total
GEF Grant	0	10.0	10.0	0.	10.70	10.70
CFE	4.3	5.7	10.0	1.1	11.0	12.1 <sup>1</sup>
Kingdom of Norway	0	3.0	3.0	0	3.15	3.15
TOTAL	4.3	18.7	23.0	1.1	24.85	25.95

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<sup>1</sup> This figure includes US\$973,000 of reflows from sales of CFLs

TABLE 9A  
ILUMEX PROJECT  
ECONOMIC ANALYSIS  
(Price levels of August 1998)

Basic data for the economic analysis

Marginal cost of capacity (distribution level)	US\$/kW/year	125.8																	
Marginal cost of energy (distribution level)	US\$/kWh	3.3																	
Energy losses T&D	%	18.6																	
Capacity losses peak hours	%	23.5																	
Useful life of CFLs	Hours	9000																	
Useful life of incandescent light bulbs	Hours	750																	
Utilization	Hours/day	3.5																	
Peak coincidence factor	%	30																	
Average total cost of CFL	US\$	13.92																	
Cost of incandescent light bulb	US\$	0.35																	
CO2 avoided per kWh saved	kg/kWh 1/	0.7																	
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008				
Number of CFLs sold per year		445,204	685,767	581,390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of CFLs sold (cumulative)		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361
Number of CFLs in service		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,703,092	1,625,546	1,355,194	999,781	538,627	223,499	108,800	83,870	37,793				
Cost of CFLs per year US\$		9,724,000	12,380,000	1,732,065	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Payment by clients US\$ (with IVA)		1,667,595	4,821,647	4,573,631	2,068,154	746,939													
Payment clients US\$ (no IVA)		1,450,083	4,192,737	3,977,070	1,798,395	649,512													
Number of incandescent bulbs saved																			
Cost of incandescent bulbs saved US\$		230,501	621,757	1,086,857	953,053	953,053	947,894	904,734	754,263	556,450	298,672	124,393	60,616	46,680	21,035				
Capacity saved MW		4.2	15.2	27.8	33.5	33.5	33.3	32	27.4	20.9	11.6	4.9	2.4	1.8	0.8				
Net capacity saving MW		3.2	11.6	21.3	25.6	25.6	25.5	24.5	21.0	16.0	8.9	3.7	1.8	1.4	0.6				
Energy saved GWh		18.1	62.8	112.3	135.1	135.1	134.3	127.7	104.6	75.2	39.2	16.2	7.9	6.1	2.7				
Net energy saving GWh		14.7	51.1	91.4	110.0	110.0	109.3	103.9	85.1	61.2	31.9	13.2	6.4	5.0	2.2				
Cost of capacity saved US\$		421,160	1,487,938	2,681,171	3,228,784	3,228,784	3,211,307	3,065,087	2,555,318	1,885,161	1,011,850	421,423	205,356	158,144	71,261				
Cost of energy saved US\$		486,202	1,686,934	3,016,603	3,629,056	3,629,056	3,607,567	3,430,277	2,809,765	2,020,022	1,052,990	435,164	212,210	163,858	72,527				
Energy saved by clients GWh		18.1	62.8	112.3	135.1	135.1	134.3	127.7	104.6	75.2	39.2	16.2	7.9	6.1	2.7				
Cost of energy saved by clients US\$		922,108	3,898,313	8,859,395	9,343,097	9,343,097	9,288,292	8,829,755	7,231,151	5,200,405	2,708,549	1,173,800	544,490	419,309	188,946				
Total CO2 emissions avoided, tons		12,670	43,960	78,610	94,570	94,570	94,010	89,390	73,220	52,640	27,440	11,340	5,530	4,270	1,890				

Note 1/ Average emission factor based on avoided energy as follows:

Guadalajara, 100% avoided generation at Manzanillo power plant, 100% fuel oil generation (0.75 kg of CO2/kWh)  
Monterrey, avoided energy based on 48% fuel oil (0.75 kg/kWh) and 52% gas (0.55 kg CO2/kWh)

TABLE 9B  
ILUMEX PROJECT  
ECONOMIC ANALYSIS  
(Price levels of August 1998)

IRR CALCULATIONS														
Concept	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<b>POINT OF VIEW OF COUNTRY</b>														
<b>Costs:</b>														
Cost of CFLs	-9,724,000	-12,380,000	-1,732,065	0	0	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Incandescent bulbs saved	230,501	821,757	1,086,857	953,053	953,053	947,894	904,734	754,263	556,450	298,672	124,393	60,616	46,680	21,035
Cost of capacity saved	421,160	1,487,939	2,681,171	3,228,784	3,228,784	3,211,307	3,065,087	2,555,318	1,885,161	1,011,850	421,423	205,356	158,144	71,261
Cost of energy saved	486,202	1,686,934	3,016,603	3,629,056	3,629,056	3,607,567	3,430,277	2,809,765	2,020,022	1,052,990	435,164	212,210	163,858	72,527
<b>Benefits-Costs:</b>	<b>-8,586,137</b>	<b>-8,583,370</b>	<b>5,052,566</b>	<b>7,810,893</b>	<b>7,810,893</b>	<b>7,766,768</b>	<b>7,400,098</b>	<b>6,119,346</b>	<b>4,461,633</b>	<b>2,363,512</b>	<b>980,980</b>	<b>478,182</b>	<b>368,682</b>	<b>164,823</b>
<i>Internal Rate of Return (IRR)</i>	<b>29%</b>													
<b>POINT OF VIEW OF CFE</b>														
<b>Costs:</b>														
Cost of CFLs	-9,724,000	-12,380,000	-1,732,065	0	0	0	0	0	0	0	0	0	0	0
Cost of energy saved by users	-922,108	-3,899,313	-8,859,395	-9,343,097	-9,343,097	-9,288,292	-8,829,755	-7,231,151	-5,200,405	-2,708,549	-117,380	-544,490	-419,309	-188,946
<b>Benefits:</b>														
Payment of CFLs sold	1,450,083	4,192,737	3,977,070	1,798,395	649,512	0	0	0	0	0	0	0	0	0
Cost of capacity saved	421,160	1,487,939	2,681,171	3,228,784	3,228,784	3,211,307	3,065,087	2,555,318	1,885,161	1,011,850	421,423	205,356	158,144	71,261
Cost of energy saved	486,202	1,686,934	3,016,603	3,629,056	3,629,056	3,607,567	3,430,277	2,809,765	2,020,022	1,052,990	435,164	212,210	163,858	72,527
<b>Benefits-Costs:</b>	<b>-8,286,663</b>	<b>-8,911,704</b>	<b>-916,616</b>	<b>-686,862</b>	<b>-1,835,745</b>	<b>-2,469,418</b>	<b>-2,334,391</b>	<b>-1,866,068</b>	<b>-1,295,222</b>	<b>-643,709</b>	<b>739,207</b>	<b>-126,924</b>	<b>-97,307</b>	<b>-45,158</b>
<i>Internal Rate of Return (IRR)</i>	<b>Negative</b>													
<b>POINT OF VIEW OF CFE (Considering DSM)</b>														
<b>Costs:</b>														
Cost of CFLs	-9,724,000	-12,380,000	-1,732,065	0	0	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Payment of CFLs sold	1,450,083	4,192,737	3,977,070	1,798,395	649,512	0	0	0	0	0	0	0	0	0
Cost of capacity saved	421,160	1,487,939	2,681,171	3,228,784	3,228,784	3,211,307	3,065,087	2,555,318	1,885,161	1,011,850	421,423	205,356	158,144	71,261
<b>Benefits-Costs:</b>	<b>-7,852,757</b>	<b>-6,899,324</b>	<b>4,926,176</b>	<b>5,027,179</b>	<b>3,876,296</b>	<b>3,211,307</b>	<b>3,065,087</b>	<b>2,555,318</b>	<b>1,885,161</b>	<b>1,011,850</b>	<b>421,423</b>	<b>205,356</b>	<b>158,144</b>	<b>71,261</b>
<i>Internal Rate of Return (IRR)</i>	<b>16%</b>													
<b>POINT OF VIEW OF PARTICIPANT</b>														
<b>Costs:</b>														
Payment of CFLs	-1,667,595	-4,821,647	-4,573,631	-2,068,154	-746,939	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Incandescent bulbs saved	230,501	821,757	1,086,857	953,053	953,053	947,894	904,734	754,263	556,450	298,672	124,393	60,616	46,680	21,035
Cost of energy saved by users	822,108	3,899,313	8,859,395	9,343,097	9,343,097	9,288,292	8,829,755	7,231,151	5,200,405	2,708,549	117,380	544,490	419,309	188,946
<b>Benefits-Costs:</b>	<b>-514,986</b>	<b>-300,577</b>	<b>5,372,621</b>	<b>8,227,996</b>	<b>9,549,211</b>	<b>10,236,186</b>	<b>9,734,489</b>	<b>7,985,414</b>	<b>5,756,855</b>	<b>3,007,221</b>	<b>241,773</b>	<b>605,108</b>	<b>465,989</b>	<b>209,981</b>
<i>Internal Rate of Return (IRR)</i>	<b>277%</b>													

**TABLE 10A: STATUS OF LEGAL COVENANTS**

**Project Agreement**

Section	Covenant Type	Status	Original Fulfillment Date	Revised Fulfillment Date	Description of Covenant	Comments
2.08 (a)	5	C			Hold annual reviews of the progress of the progress of the project with the trustee not later than August 31 of each year.	An average of two supervision missions per year.
2.08(b)	5	C			Provide to the trustee one month prior to each annual review a progress report on the implementation of the project.	During supervision missions CFE submitted these reports to the Bank .
2.08(d)	5	C			Hold a midterm review with the Trustee not later than August 31,1995; particular attention will be given to the accomplishment of the sales targets set forth in the Monitoring and Evaluation Indicators and to the redesign of the Executing Arrangements in order to enable the project to reach its objectives.	Due to delays in declaring the project to be effective, the mid-term review was postponed until June /July 1996. Sales of CFLs reached targets set at Appraisal.
208(e)	5	Partial			Promptly take all such action, satisfactory to the Trustee, as shall be necessary for the efficient execution of the Project or the achievement of its objectives, if as a result of any such annual or midterm review, progress in the execution of the project or in the achievement of its objectives is not satisfactory to the Trustee.	The Fidecomisos were modified in order to increase the coverage of the project and to increase the purchasing level for bulbs from 6 to 10. The consultants to undertake evaluation did not complete the studies until after project closing date
2.08(f)	5	C				The report was delivered to the Bank on August 17,1998
2.09	5	Partial			Provide the completion report referred to in Section 9.07 of the General Conditions no later than June 30, 1998.	
		C			No later than December 31, 1997, or at such time as may be acceptable to the trustee, CFE shall hold a seminar for the Mexican and international community interested in the subjects of efficient use of electricity for lighting and the reduction of greenhouse gases on the basis of the results obtained.	CFE will hold the seminar in March 1999.
3.03	5	C				
4.01(a)	5	Partial			CFE shall take out and maintain with responsible insurers insurance against such risks and in such amounts as shall be consistent with appropriate practice.	CFE extended insurance coverage to cover inventories at all sales sites.
4.01(b i)	5				CFE shall maintain records and accounts adequate to reflect sound accounting practices.	CFE stated they will comply
					CFE shall have separate records and accounts and financial statements for each of the Implementing Units for each fiscal year audited, in accordance with generally accepted auditing standards and procedures, by independent and qualified	The auditing reports for fiscal year 1997 are not fully satisfactory. They are not fully consistent with the projects financial reports in



4.01(b ii)	5	C			<p>auditors.</p> <p>Furnish to the Trustee as soon as available, but in any case not later than six months after the end of each such year: (A) a certified copy of the financial statements for such year as so audited, and (B) the report of such audit by said auditors of such scope and in such detail as the Trustee shall have reasonably requested.</p>	<p>relation to fund flows. CFE has asked the auditors they prepare the financial reports to meet World Bank requirements.</p>
4.01(b iii)	5	C			<p>Furnish to the Trustee such other information concerning said records, accounts, and financial statements as well as the audit thereof, as the Trustee from time to time reasonably request.</p>	<p>In cases where CFE was unable to meet the agreed upon dates, the Bank was advised and extension of the deadline was granted</p> <p>CFE complied</p>

Covenant Type:

5 = Management aspects of the project or executing agency

**TABLE 10B: STATUS OF LEGAL COVENANTS**

Fund Grant Agreement

Section	Covenant Type	Status	Original Fulfillment Date	Revised Fulfillment Date	Description of Covenant	Comments
4.04	5	C			The Guarantor and the Recipient shall participate in the annual and midterm reviews referred to in section 2.08 of the Project Agreement.	They participated fully in both reviews.
5.01(a)	5	C			The Recipient shall maintain or cause to be maintained records and separate accounts adequate to reflect in accordance with sound accounting practices the resources and expenditures in connection with the execution of the project	Sound accounting practices are in effect. Records of expenditures were maintained.
5.01 (b)(i)	5	Partial			The Recipient shall have the records and accounts referred to in paragraph (a) of this section for each fiscal year audited, in accordance with generally accepted auditing standards and procedures consistently applied by independent and qualified auditors.	Audits completed but delayed in 1995 and 1996.
5.01 (b)(ii)	5	Partial			The recipient shall furnish to the Trustee as soon as available, but in any case not later than six months after the end of each such year, the report of such audit by such auditors, of such scope and in such detail as the Trustee shall have reasonably requested.	1995 and 1996 Audit reports delayed. Final audit did not fully comply with Bank guidelines. Auditors are revising audit report
5.01 (b)(iii)	5	Partial			The recipient shall furnish to the Trustee such other information concerning said reports and accounts as well as the audit thereof as the Trustee shall from time to time reasonably request	Auditors are revising audit report

Covenant Type:

5. = Management aspects of the project or executing agency

**TABLE 11: COMPLIANCE WITH OPERATIONAL MANUAL STATEMENTS**

Compliance with Operational Manual Statements is not applicable and thus not included

**TABLE 12: BANK RESOURCES: STAFF INPUTS**

Stage of Project Cycle	Planned		Revised		Actual	
	Weeks	US\$	Weeks	US\$	Weeks	US\$
Preparation to Appraisal					39	85.9
Appraisal-Board					20	49.1
Negotiations through Board Approval					10.4	25.3
Supervision					24.9	118.2
Completion					8	35.0
TOTAL					102.3	313.5

**TABLE 13: BANK RESOURCES: MISSIONS**

Stage of Project Cycle	Month/ Year	Number of Persons	Weeks in Field	Specialized Staff Skills Represented	Performance Rating		Types of Problems
					Implementation Status	Development Objectives	
Through Appraisal	1992	2	7.3	Operations Officer Environmental Spec Power Engineer	1	1	—
	August 1993	3	5.3				
Appraisal through Board Approval	July 1994	3	3.3	Operations Officer	1	1	None
Supervision	1995	1	.5	Power Engineer Economist	1	1	None Delays in receiving Audit Reports Delays in receiving Audit Reports
	April 1996	2	3.1		1	1	
	1997	2	2.4		1	1	
Completion	1998	2	2	Power Engineer	—	—	—



**MÉXICO  
PROYECTO ILUMEX**

**MISION DE CIERRE DEL PROYECTO  
Agosto 16 al 26 de 1998**

**AYUDA MEMORIA**

**1. INTRODUCCION**

1.1 El Banco Mundial envió a México una misión para el cierre del Proyecto ILUMEX, proyecto que fue financiado con recursos de CFE y con donaciones del GEF y del Gobierno de Noruega. La misión fue integrada por los señores Enrique Vanegas y Luis Luzuriaga y estuvo en el país del 16 al 26 de agosto de 1998. Se menciona que el Banco Mundial y CFE invitaron al Gobierno de Noruega para que envíe delegados a participar en la misión, pero no se pudo contar con su presencia. El propósito de la misión fue recibir de CFE la información final de los resultados obtenidos en la ejecución del proyecto y discutir el futuro del proyecto ILUMEX.

1.2 La misión deja constancia y agradece la colaboración y apoyo que recibió de CFE, de la unidad Ejecutora del Proyecto, de las unidades sectoriales de Jalisco y Nuevo León y de BANOBRAS. El Anexo 1 lista las personas que participaron en las reuniones de trabajo.

**2. PRINCIPALES FECHAS DE EJECUCION DEL PROYECTO**

2.1 La siguiente tabla muestra las fechas principales previstas y reales en la ejecución del proyecto:

	Prevista	Real
Terminación del estudio de factibilidad preparado por el IIEC	Diciembre, 1992	Diciembre, 1992
Misión de evaluación del proyecto (Banco Mundial y Gobierno de Noruega)	Octubre 13, 1993	Octubre 13, 1993
Informe del Banco (Memorandum and Recommendation)	Marzo 8, 1994	Marzo 8, 1994
Firma del Convenio de donación	Abril, 1994	Junio 10, 1994
Primera entrega de LFC de la primera licitación	Mayo, 1994	Abril, 1995
Constitución de los Fideicomisos de Jalisco y de Nuevo León	Junio, 1994	Junio 1994

Inicio de las ventas de LFC	Junio, 1994	Mayo 1995
Evaluación intermedia del proyecto (Mid-term review)	Junio, 1995	Julio 1996
Cierre oficial del proyecto	Diciembre 31, 1996	Diciembre 31, 1997
Seminario de difusión de resultados		Previsto: Febrero 1999
Informe de evaluación final preparado por CFE	Junio 30, 1998	Agosto 17, 1998
Informe final del proyecto (ICR) del Banco		Previsto: Septiembre 30, 1998

### 3. OBJETIVOS DEL PROYECTO

3.1 Los objetivos del proyecto fueron los siguientes: (a) demostrar la factibilidad de reducir emisiones gaseosas (GHG) nocivas mediante el uso masivo de lámparas de alta eficiencia lumínica; (b) fortalecer la capacidad institucional de CFE para implementar cambios tecnológicos que promuevan la conservación de energía; (c) desarrollar un modelo de control de demanda (Demand Side Management o DSM) que pueda ser aplicado en otras áreas de México y del mundo; y (d) fortalecer la capacidad de CFE para implantar programas de DSM en forma sustentable. En su Informe de Evaluación Final, CFE analiza la realización de estos objetivos.

3.2 El proyecto ILUMEX previó la instalación de 1.7 millones de lámparas fluorescentes compactas (LFC) a un costo total de US\$ 23 millones, equivalente a un precio unitario total de US\$ 13.53 por lámpara. A la fecha oficial de cierre del proyecto, Diciembre 31 de 1997, se instalaron 1,712,361 LFC, a un costo total de US\$ 23.83 millones, equivalente a un precio unitario de US\$ 13.92 por LFC. Se resalta que el proyecto ejecutado es esencialmente igual al programado y no hubo sobrecostos. La diferencia de US\$ 0.83 millones entre el presupuesto inicial y el ejecutado se debe al mayor número de lámparas adquirido.

3.3 Las unidades ejecutoras o Fideicomisos de Nuevo León (Monterrey) y Jalisco (Guadalajara) cesarán ventas en Diciembre 31, 1998. Para esa fecha, CFE espera haber instalado un total de 2,490,500 LFC, a un costo total aproximado de US\$ 33.82 millones, equivalente a un costo unitario de US\$ 13.58 por lámpara. En 1999 y 2000, CFE mantendrá una unidad administrativa reducida en Guadalajara y Monterrey, para atender los aspectos legales con clientes usuarios de LFC, incluyendo reemplazo de LFC dañadas y bajo garantía. Se estima que los saldos de LFC a Diciembre 31, 1998 serán cero. La recuperación de fondos del período 1998 al 2000, por concepto de LFC vendidas a plazo, se estima en US\$ 7.4 millones. El saldo remanente luego del pago del saldo de la tercera licitación, será utilizada por CFE en programas de ahorro de energía en los estados de Sonora y Sinaloa. Estos programas incluyen mejoras al aislamiento térmico de viviendas, modernización de sistemas de aire acondicionado residencial y lámparas fluorescentes compactas para vivienda. La utilización de la recuperación de fondos para este tipo de programas está permitida en las Guías de Operación del Proyecto ILUMEX.



#### 4. COSTO DEL PROYECTO

4.1 Según los detalles del Anexo 3, el costo total del proyecto ejecutado en el período 1994 a Diciembre 31, 1997 (1,865,133 LFC, incluyendo LFC no instaladas que quedaron en bodega) fue de US\$ 25,957,000, financiados en la siguiente forma:

Fuente	Monto y moneda	US\$ Equivalente
CFE		11,112,000
GEF	7,300,000 SDR	10,719,000
Gobierno de Noruega	20,250,000 NKr (coronas)	3,154,000
Recuperación de fondos (CFE)		973,000
Total		25,957,000

#### 5. CUMPLIMIENTO DE LAS CLAUSULAS CONTRACTUALES

5.1 A continuación se presenta el grado de cumplimiento de las principales cláusulas contractuales del Convenio Proyecto (Project Agreement) :

No de Cláusula	Condiciones Estipuladas	Cumplimiento	Comentarios
Sección 2.08 a)	Sostener reuniones anuales con el Banco acerca del avance del proyecto	Si	Las misiones se efectuaron en promedio 2 veces al año
(b)	Un mes antes de las reuniones arriba mencionada, CFE enviará un informe de avance del proyecto	Si	Durante las misiones de supervisión, CFE entregaba al Banco dichos informes
(c)	Incluir en dichos informes una comparación de lo real con los indicadores	Si	
(d)	Sostener una revisión a mediados del proyecto (mid-term) no más tarde del 31 de agosto de 1995; en dicha reunión se prestará especial atención al alcance de la cuota de ventas de acuerdo a los indicadores de gestión y rediseñar el proyecto en caso que fuera necesario	Si	Debido al atraso de un año en declarar efectivo el proyecto, se tuvo que posponer hasta julio de 1996. La cuota de ventas fue alcanzada.
(e)	Tomar rápidamente las medidas apropiadas, satisfactorias al Banco,	Si	Los fideicomisos fueron

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	cuando fuera necesario para la eficiente implementación del proyecto o para lograr el alcance de los objetivos		modificados para ampliar la cobertura del proyecto y se aumentó el techo de compra del usuario de 6 a 10 lámparas
(f)	Enviar el informe de terminación (ICR) referido en la sección 9.07 de las condiciones generales a más tardar el 30 de junio de 1998	Si	El informe fue entregado el 17 de agosto de 1998
Sección 2.09	No más tarde del 31 de diciembre de 1997 o cualquier fecha posterior, aceptable al Banco, la CFE celebrará un seminario para las autoridades mexicanas y la comunidad internacional interesadas en el tema de uso eficiente de energía para alumbrado y reducción de gases de efecto invernadero, basado en los resultados obtenidos del proyecto.	Si	CFE planea realizar dicho evento en febrero de 1999
Sección 3.03	CFE se compromete a tomar y mantener un seguro contra todo riesgo y en un monto consistente con las prácticas nacionales	Si	CFE amplió la cobertura del seguro de los inventarios en bodega a los sitios de venta
Sección 4.01 (a)	CFE deberá llevar los registros y cuentas separadas que reflejen los recursos y gastos del proyecto de acuerdo a principios de contabilidad generalmente aceptados	Si	
(b i)	Elaborar estados financieros para cada una de las unidades de ejecución por cada año fiscal, los que estarán sujetos a revisión por auditores independientes y calificados	Parcialmente	El informe de los auditores que refleje la relación evidente (cruce de cifras) entre el informe sobre los estados financieros del proyecto y los estados financieros de los fideicomisos, esta aun en proceso de integración.

(b ii)	Proporcionar al Banco, en un plazo que no exceda de seis meses, después del final de cada año fiscal los informes de auditoría	Si	En casos de atrasos CFE solicitaba exenciones, las cuales fueron otorgadas
(b iii)	CFE proporcionará al banco información de los registros, cuentas y estados financieros relacionados con el proyecto, cuando sean requeridos por el Banco	Si	

## 6. DATOS PARA LA EVALUACIÓN ECONOMICA

6.1 El Anexo 4 muestra los parámetros básicos para la evaluación económica y ambiental del proyecto ILUMEX. En una columna se presentan los valores que fueron estimados en el documento de evaluación del Banco, y en la otra los valores reales alcanzados por el proyecto ejecutado hasta el 31 de Diciembre de 1997, que incluyó la instalación de 1,712,361 LFC.

## 7. RESULTADOS OBTENIDOS

7.1 El informe de evaluación final del proyecto preparado por CFE, incluye el cálculo y la evaluación de todos los costos y beneficios del proyecto, algunos de los cuales se muestran en el Anexo 4. La evaluación de la energía y potencia de punta ahorradas por el proyecto se basó en las encuestas realizadas para el uso diario de las LFC y el factor de simultaneidad del uso de las lámparas. Los principales resultados del proyecto son los siguientes:

<i>Concepto</i>	<i>Previsto</i>	<i>Real</i>
Tasa interna de retorno (TIR):		
Punto de vista de la nación	135% (probable) 56% (mínimo)	32.2%
Punto de vista de CFE	66% (probable) 32% (mínimo)	Caso 1, Negativo Caso 2, 58.0% Caso 3, 22.8%
Punto de vista del participante	151% (mínimo)	248.2%
Toneladas de CO <sub>2</sub> evitadas	709,800	763,692

7.2 La tasa interna de retorno (TIR) bajo el punto de vista de la nación fue inferior al estimado en la evaluación del proyecto, debido a que los beneficios de la energía ahorrada por el proyecto fueron muy inferiores, pues la caída del precio de los

combustibles causó una disminución de 50% de los costos marginales de energía (US¢ 6.2 estimados, vs US¢ 2.9 actuales). Bajo el punto de vista de CFE, (Caso 1), la tasa también fue inferior, por las mismas razones. Adicionalmente, el beneficio económico de los usuarios, que equivale a una disminución de ingresos de CFE, fue superior al estimado debido a que participaron en mayor proporción los usuarios con altos consumos. Se debe aclarar que los pliegos tarifarios de CFE penalizan altamente a los altos consumos (son desincentivadoras del alto consumo). El Caso 2 resulta en una tasa TIR de 58.0%, asumiendo que la energía no facturada por CFE (igual a la ahorrada por el usuario participante) es facturada por CFE a otros clientes no usuarios de LFC. En el Caso 3 se supone que CFE no se beneficia con la energía evitada a nivel de generación, y se tiene una TIR de 22.8%.

7.3 Estos casos son explicados en el informe de CFE. Con el objeto de verificar los cálculos de CFE y validar los resultados, la misión preparó un modelo de cálculo de la TIR, que se muestra en el Anexo 6.

## 8. EVALUACIÓN DE LOS BENEFICIOS AMBIENTALES

8.1 El informe de CFE presenta los beneficios ambientales del proyecto, cuantificando las emisiones de gases evitadas por el ahorro de energía del proyecto, los cuales se suman en el Anexo 4. En cuanto a dióxido de carbono (CO<sub>2</sub>), el ahorro de 978 GWh en la vida del proyecto, equivale a un total de 763,692 toneladas de CO<sub>2</sub> evitadas. Este valor fue determinado por CFE, basado en las fuentes de generación del proyecto: (a) 53% de la generación evitada proveniente de la central Manzanillo (Guadalajara), que consume 100% de combustóleo, que produce 0.73 kg de CO<sub>2</sub> por kWh generado, y (b) 47% de la generación evitada proveniente de la central Monterrey, que consume 49% de combustóleo y 51% de gas (índices de 0.96 y 0.69 kg CO<sub>2</sub>/kWh, respectivamente). El índice resultante es 0.7807 kg de CO<sub>2</sub> por kWh ahorrado.

## 9. PLAN PARA EL MONITOREO FUTURO

9.1 Conforme se indica más arriba, CFE cerrará las operaciones de ventas de LFC de los FILUMEX de Guadalajara y de Monterrey en Diciembre 31, 1998, fecha para la cual todas las lámparas compradas en las tres licitaciones internacionales (2,490,500) habrán sido vendidas. En esta forma, el Proyecto ILUMEX habrá sido concluido. CFE está satisfecho con los resultados del proyecto, los cuales han servido para el diseño de un nuevo proyecto de iluminación eficiente descrito más adelante. CFE espera realizar encuestas en el futuro en las áreas del proyecto ILUMEX, con el fin de determinar el grado de persistencia del proyecto, esto es, para determinar si el proyecto contribuyó a modificar permanentemente los hábitos de los participantes en el uso de energía eléctrica para iluminación, y qué porcentaje de los participantes de ILUMEX continúan reemplazando las lámparas al final de su vida útil. El Anexo 5 muestra el plan de CFE para monitoreo futuro del proyecto ILUMEX.

## 10. NUEVOS PROGRAMAS DE LÁMPARAS FLUORESCENTES DE CFE

10.1 Basado en la exitosa experiencia del proyecto ILUMEX, CFE inició en 1998 dos nuevos programas de ahorro de energía, basados en la sustitución de lámparas incandescentes por lámparas fluorescentes compactas y circulares, para usuarios residenciales. El primer programa sustituirá 783,000 LFC en las Divisiones de Distribución Centro Occidente, Centro Sur y Peninsular, y el segundo sustituirá las restantes para llegar a 6,100,000 LFC en todo el territorio nacional en el año 2001.

10.2 Los recursos iniciales para financiar el programa, \$ 175 millones de pesos hasta el año 1998, serán suministrados por CFE. El ente ejecutor es FIDE, Fideicomiso para el Ahorro de Energía. Las lámparas serán vendidas a plazos, sin descuentos. La recuperación de fondos será utilizada por FIDE para continuar financiando el programa en un futuro. El nuevo programa utilizará las Guías de Operación utilizadas en el proyecto ILUMEX. Se utilizarán los servicios de consultores para la supervisión periódica del cumplimiento de metas. También se utilizarán laboratorios independientes para asegurar la calidad de las lámparas. Al igual que el proyecto ILUMEX, luego de las evaluaciones periódicas, los programas regionales podrán ser modificados para cumplir con las metas anuales de ventas.

## 11. SEMINARIO DE DIFUSION DE LOS RESULTADOS DE ILUMEX

11.1 CFE organizará en febrero de 1999, un seminario internacional para la difusión de los resultados del proyecto ILUMEX. El seminario será en alguna ciudad del país a ser oportunamente seleccionada por CFE. Serán invitados a participar (a) los organismos y ejecutivos mexicanos involucrados en el tema de ahorro de energía, los ejecutivos de las Divisiones de Distribución de CFE, los ejecutivos de Luz y Fuerza del Centro; (b) los gerentes de empresas de comercialización de energía eléctrica de Latinoamérica; (c) organizaciones y universidades nacionales e internacionales involucradas en el tema de ahorro de energía. CFE preparará oportunamente el programa del seminario, que será remitido al Banco, al GEF y al Gobierno de Noruega para información. CFE cubrirá los costos de organización del seminario, y los asistentes pagarán por sus gastos de viaje y hotel.

## 12. INFORME FINAL DE EVALUACIÓN DEL PROYECTO PREPARADO POR CFE

12.1 Se deja constancia de que la misión recibió el informe de evaluación del proyecto, preparado por CFE, y de los informes de ejecución de las unidades ejecutoras de Monterrey y Guadalajara. El Anexo 2 lista los informes recibidos.

## 13. INFORME FINAL DEL BANCO (ICR)


13.1 Basado en el informe preparado por CFE, en el contenido de la presente ayuda memoria, en los documentos de archivo del Banco y en entrevistas con el personal de CFE y del Banco involucrados en el proyecto, el Banco preparará un informe final (Implementation Completion Report o ICR). El ICR llevará como un anexo el resumen

ejecutivo del informe de CFE. El ICR será enviado a CFE y BANOBRAS para sus comentarios antes de la emisión final.

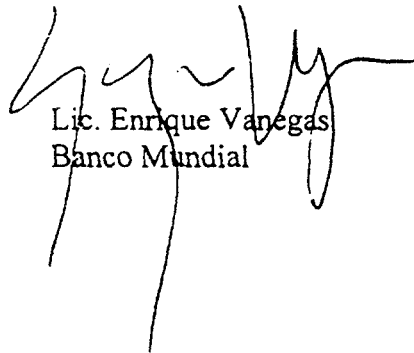
#### 14. INFORMACIÓN PARA EL GOBIERNO DE NORUEGA

14.1 Para dar cumplimiento a las condiciones del convenio de donación, CFE deberá enviar al Gobierno de Noruega, por intermedio de la Embajada en la ciudad de México, copias de todos los documentos principales relacionados con la ejecución del proyecto, incluyendo el Informe de Evaluación Final. Por su parte, el Banco enviará a Noruega copia del ayuda memoria y del ICR cuando haya sido completado.

México DF, 26 de agosto de 1998



Ing. Enrique Vargas Nieto  
CFE



Lic. Enrique Vanegas  
Banco Mundial

#### ANEXOS:

1. LISTA DE PERSONAS ENTREVISTADAS
2. LISTA DE INFORMES PRESENTADOS POR CFE
3. COSTO Y FINANCIAMIENTO DEL PROYECTO
4. DATOS PARA LA EVALUACIÓN ECONOMICA
5. PLAN PARA EL MONITOREO FUTURO DEL PROYECTO
6. TABLAS DE CALCULO DE LA TASA INTERNA DE RETORNO

**ANEXO 1**

**LISTA DE PERSONAS ENTREVISTADAS**

**CFE**

Ing. Enrique Vargas Nieto, Gerente Comercial  
Lic. Rita Saucedo Flores, Jefa del Departamento de Análisis  
Ing. Guillermo Ortega Rodríguez, Consultor de CFE

**FILUMEX NUEVO LEÓN**

Ing. Bonifacio Reyes Zapata, Gerente  
Lic. Sylvia Rodríguez, Subgerente Comercial  
C. P. Graciela Martínez Salinas, Subgerente de Administración

**FILUMEX JALISCO**

Ing. Antonio Macías Padilla, Gerente  
Ing. Francisco Rodríguez, Subgerente Comercial  
C. P. Ana Aída Castaño Meneses, Subgerente de Administración

**BANOBRAS**

C. P. Victor Herrejón, Subgerencia Fiduciaria  
Lic. Gabriel Penaloza, Subgerente de Proyectos

**BANCO MUNDIAL**

Enrique Vanegas, Task Manager  
Luis H. Luzuriaga, Consultor del Banco

**ANEXO 2**

**LISTA DE INFORMES PRESENTADOS POR CFE**

1. ILUMEX. Informe de Evaluación Final. Agosto de 1998  
ILUMEX. Informe de Evaluación Final. Agosto de 1998, Anexo Técnico.
2. FILUMEX NUEVO LEÓN. Informe de Resultados al 31 Diciembre 1997  
FILUMEX NUEVO LEÓN. Tiempo de Uso y Factores de Coincidencia.
3. FILUMEX JALISCO. Informe de Terminación al 31 de Diciembre 1997  
FILUMEX JALISCO. Tiempo de Uso y Factores de Coincidencia (2 volúmenes)  
FILUMEX JALISCO. Investigación de Mercado.



<b>PROYECTO ILUMEX</b>							<b>ANEXO 3</b>
<b>COSTO Y FINANCIAMIENTO FINALES DEL PROYECTO</b>							
<b>PERIODO 1995-1997</b>							
<b>(En miles de dolares)</b>							
Concepto	Costo		Financiamiento				
	Previsto	Real	CFE	Norway	GEF Recuperacion	Total	
<b>Lamparas y Equipos</b>							
Lamparas	18,703 1/	21,297	6,451	3,154	10,719	973	21,297
Vehiculos	162	192	192	0	0	0	192
Equipos de medicion	49	65	65	0	0	0	65
Equipos de computo	65	140	140	0	0	0	140
Modulos de ventas	32	36	36	0	0	0	36
Equipos de oficina	19	51	51	0	0	0	51
Sub-total	19,030	21,781	6,936	3,154	10,719	973	21,781
<b>Servicios</b>							
Encuestas de mercadeo	194	15	15	0	0	0	15
Promocion y publicidad	290	316	316	0	0	0	316
Monitoreo y evaluacion	163	39	39	0	0	0	39
Pruebas de laboratorio	97	84	84	0	0	0	84
Auditoria	65	39	39	0	0	0	39
Sub-total	809	493	493	0	0	0	493
<b>Ingenieria y Soporte de CFE</b>							
Ingenieria de CFE	158	125	125	0	0	0	125
Coordinacion y evaluacion	238	188	188	0	0	0	188
Soporte de oficinas centrales	26	21	21	0	0	0	21
Soporte de oficinas locales	1,126	891	891	0	0	0	891
Sub-total	1,548	1,226	1,226	0	0	0	1,226
<b>Costos Administrativos</b>							
Honorarios de BANOBRAS	23	177	177	0	0	0	177
Costos administrativos Fideicomisos	1,590	2,280	2,280	0	0	0	2,280
Sub-total	1,613	2,458	2,458	0	0	0	2,458
<b>Totales (1,865,133 LFCs)</b>	<b>23,000</b>	<b>25,957</b>	<b>11,112</b>	<b>3,154</b>	<b>10,719</b>	<b>973</b>	<b>25,957</b>

Nota 1/: Incluye contingencias (\$ 4,600,000)

Lamparas adquiridas	Previsto	Real
Total instaladas:	1,700,000	1,712,361
Total en bodegas a/:	0	152,772
Total lamparas adquiridas:	1,700,000	1,865,133
Precio medio por lampara (US\$/lampara):	13.53	13.92
(Costo de adquisicion en US\$/lampara):	11.00	11.42
(Costos indirectos en US\$/lampara):	2.53	2.50
(Costos indirectos en %):	23.0%	21.9%

Nota a/: Ya instaladas en 1998

**Costo total proyecto para 1,712,361 LFCs (1000 US\$): 23,836,065**

ANEXO 4			
PROYECTO ILUMEX DATOS PARA LA EVALUACION ECONOMICA			
Concepto	Unidad	Previsto	Real al 12/31/97
Lamparas adquiridas	Unidad	1,700,000	1,865,133
Lamparas instaladas	Unidad	1,700,000	1,712,361
Periodo de venta	Anos	2	2.7
Tiempo de uso de las LFC	Horas/dia	4	2.93
Factor de coincidencia	%	80	30
Potencia ahorrada por LFC	Watts	50.4	51.7
Vida util de las LFC	Horas	8,760	9,000
Vida util de los focos incandescentes	Horas	750	750
Factor de potencia de las LFC	%	0.9	0.95
Eficacia de las LFC	Lumen/watt	47	68
Costo directo de adquisicion por LFC	US\$	11.00	11.42
Costo indirecto por LFC	US\$	2.53	2.50
Precio unitario total por LFC	US\$	13.53	13.92
Descuento a otorgar	%	63	49
Costo marginal de capacidad	US\$/kW-ano	132.5	125.95
Costo marginal de energia de punta	USc/kWh	6.2	2.8942
Costo combustoleo	US\$/M3	90.3	84.3
Costo gas natural	US\$/M3	79.7	87.7
Tarifa media consumidor residencial	USc/kWh	6.65	5.00
Perdidas de energia en BT	%	18.0	18.6
Perdidas de capacidad en punta en BT	%	22.0	23.5
Potencia ahorrada por el proyecto	MW	100.0	33.7
Energia ahorrada por el proyecto	GWh/ano	169	114.3
Energia primaria ahorrada por el proyecto	TJ		10,753
Ahorro total de energia en la vida de LFC	GWh	1,014	978
Ahorro total de combustoleo vida de LFC	M3		187,066
Ahorro total gas natural vida de LFC 6/	mM3		83,450
Ahorro anual de carbon	Ton/ano	34,000	
Reduccion anual de emision de CO2	Ton/ano	118,000	89,234
Reduccion total de emision de CO2	Ton	709,800	763,692
Reduccion total de emision de NOx	Ton	205/yr	2,098
Reduccion total de emision de SOx	Ton	3,000/yr	10,920
Reduccion total de emision de CH4	Ton		23
Reduccion total de emision de CO	Ton		209
Reduccion total de emision de HC	Ton		746
Reduccion total de emision de particulas	Ton		5,345
Reduccion total de consumo de agua	M3		3,523,245

Notas:

1/ Igual al valor de las ventas de LFCs. dividido por el costo total de compra de las LFCs (excluye IVA)

2/ Energia ahorrada en el cuarto ano de funcionamiento del proyecto

3/ Previsto: 169 GWh por ano x 6 anos de vida de las lamparas = 1,014 GWh  
(Vida util=8,760 horas dividido para 365dias x 4 horas dia (1,460 horas) = 6 anos)

4/ Reduccion anual de emisiones en el cuarto ano.

5/ Valor Previsto en el SAR: 1,014 GWh en la vida de la lampara, multiplicado por 0.78 kg/kWh ahorrado = 763,692 ton

6/: Ahorro adicional al combustoleo

## **ANEXO 5**

### **PLAN PARA EL MONITOREO FUTURO DEL PROYECTO**

CFE considera necesario seguir monitoreando el programa ILUMEX mediante las siguientes acciones:

- a) Estudios de persistencia en el uso de las LFC entre los usuarios que las compraron bajo el programa.
- b) Estudios de mercado de las LFC en las sedes del proyecto para ver la sustitución que se haya presentado al término de la vida útil de las lámparas que vendió el programa, así como la influencia que haya ejercido el mismo sobre el mercado libre.

TABLE 2 (Page 1 of 2)  
**ILUMEX PROJECT**  
**ECONOMIC ANALYSIS**  
 (Price levels of August 1998)

Basic data for the economic analysis

Marginal cost of capacity (distribution level)	US\$/kW/year	126.0																
Marginal cost of energy (distribution level)	USc/kWh	2.89																
Energy losses T&D	%	18.6																
Capacity losses peak hours	%	23.5																
Useful life of CFLs	Hours	9,000.0																
Useful life of incandescent light bulbs	Hours	750.0																
Utilization	Hours/day	2.9																
Peak coincidence factor	%	30.0																
Average total cost of CFL	US\$	13.9																
Cost of incandescent light bulb	US\$	0.3																
CO2 avoided per kWh saved	kg/kWh 1/	0.781																
		<b>1,995</b>	<b>1,996</b>	<b>1,997</b>	<b>1,998</b>	<b>1,999</b>	<b>2,000</b>	<b>2,001</b>	<b>2,002</b>	<b>2,003</b>	<b>2,004</b>	<b>2,005</b>	<b>2,006</b>	<b>2,007</b>	<b>2,008</b>	<b>Total</b>		
Number of CFLs sold per year		445,204	685,767	581,390	0	0	0	0	0	0	0	0	0	0	0	1,712,361		
Number of CFLs sold (cumulative)		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361			
Number of CFLs in service		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,703,092	1,625,546	1,355,194	999,781	538,627	223,499	108,800	83,870	37,793			
Cost of CFLs per year US\$		6,192,240	9,545,877	8,092,949	0	0	0	0	0	0	0	0	0	0	0	23,831,066		
Payment by clients US\$ (with IVA)		1,667,595	4,821,647	4,573,631	2,068,154	746,939										13,877,966		
Payment clients US\$ (no IVA)		1,450,083	4,192,737	3,977,070	1,798,395	649,512										12,067,797		
Number of incandescent bulbs saved		743,365	1,888,402	2,859,159	2,859,159	2,859,159	2,859,159	2,859,159	2,859,159	2,728,374	1,913,290	965,530	324,988	167,110	63,104	25,949,117		
Cost of incandescent bulbs saved US\$		252,744	642,057	972,114	972,114	972,114	972,114	972,114	972,114	927,647	650,519	328,280	110,496	56,817	21,455	8,822,700		
Capacity saved MW		4.2	15.3	27.9	33.7	33.7	33.7	33.7	33.7	32.0	22.2	11.1	3.9	2.1	0.8			
Net capacity saving MW		3.2	11.7	21.3	25.8	25.8	25.8	25.8	25.8	24.5	17.0	8.5	3.0	1.6	0.6			
Net energy saving GWh		14.5	52.2	94.8	114.3	114.3	114.3	114.3	114.3	108.6	75.8	37.9	13.1	7.1	2.7	978.2		
Gross energy saving GWh		11.8	42.5	77.2	93.0	93.0	93.0	93.0	93.0	88.4	61.7	30.9	10.7	5.8	2.2	796.3		
Cost of capacity saved US\$ (@ LRMC)		404,677	1,474,182	2,688,214	3,247,054	3,247,054	3,247,054	3,247,054	3,247,054	3,083,256	2,139,009	1,069,504	375,772	202,339	77,081	27,749,304		
Cost of energy saved US\$ (@ LRMC)		419,050	1,508,580	2,739,720	3,303,270	3,303,270	3,303,270	3,303,270	3,303,270	3,138,540	2,190,620	1,095,310	378,590	205,190	78,030	28,269,980		
Cost of energy saved by clients		853,377	3,723,157	8,597,986	9,091,108	9,091,108	9,091,108	9,091,108	9,091,108	8,641,477	6,026,844	3,012,247	1,043,555	561,140	217,287	78,132,610		
Total CO2 emissions avoided, tons		11,320.2	40,752.5	74,010.4	89,234.0	89,234.0	89,234.0	89,234.0	89,234.0	84,784.0	59,177.1	29,588.5	10,227.2	5,543.0	2,107.9	763,680.7		

Note 1/ Average emission factor based on avoided energy as follows:

Guadalajara, 100% avoided generation at Manzanillo power plant, 100% fuel oil generation (0.75 kg of CO2/kWh)  
 Monterrey, avoided energy based on 48% fuel oil (0.75 kg/kWh) and 52% gas (0.55 kg CO2/kWh)

**TABLE 2 (Page 2 of 2)**  
**ILUMEX PROJECT**  
**ECONOMIC ANALYSIS**  
**(Price levels of August 1998)**

**IRR CALCULATIONS**

<b>Concept</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>POINT OF VIEW OF COUNTRY</b>														
<b>Costs:</b>														
Cost of CFLs	-6,192,240	-9,545,877	-8,092,949	0	0	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Incandescent bulbs saved	252,744	642,057	972,114	972,114	972,114	972,114	972,114	972,114	927,647	650,519	328,280	110,496	56,817	21,455
Cost of capacity saved	404,677	1,474,182	2,688,214	3,247,054	3,247,054	3,247,054	3,247,054	3,247,054	3,083,256	2,139,009	1,069,504	375,772	202,339	77,081
Cost of energy saved	419,050	1,508,580	2,739,720	3,303,270	3,303,270	3,303,270	3,303,270	3,303,270	3,138,540	2,190,620	1,095,310	378,590	205,190	78,030
<b>Benefits-Costs:</b>	<b>-5,115,769</b>	<b>-5,921,059</b>	<b>-1,692,901</b>	<b>7,522,438</b>	<b>7,522,438</b>	<b>7,522,438</b>	<b>7,522,438</b>	<b>7,522,438</b>	<b>7,149,443</b>	<b>4,980,147</b>	<b>2,493,095</b>	<b>864,858</b>	<b>464,346</b>	<b>176,567</b>
<i>Internal Rate of Return (IRR)</i>	<b>34.7%</b>													
<b>POINT OF VIEW OF CFE</b>														
<b>Costs:</b>														
Cost of CFLs	-6,192,240	-9,545,877	-8,092,949	0	0	0	0	0	0	0	0	0	0	0
Cost of energy not billed to users	-742,067	-3,237,528	-7,476,510	-7,905,312	-7,905,312	-7,905,312	-7,905,312	-7,905,312	-7,514,328	-5,240,734	-2,619,345	-907,439	-487,948	-188,946
<b>Benefits:</b>														
Payment of CFLs sold	1,450,083	4,192,737	3,977,070	1,798,395	649,512	0	0	0	0	0	0	0	0	0
Cost of capacity saved	404,677	1,474,182	2,688,214	3,247,054	3,247,054	3,247,054	3,247,054	3,247,054	3,083,256	2,139,009	1,069,504	375,772	202,339	77,081
Cost of energy saved	419,050	1,508,580	2,739,720	3,303,270	3,303,270	3,303,270	3,303,270	3,303,270	3,138,540	2,190,620	1,095,310	378,590	205,190	78,030
<b>Benefits-Costs:</b>	<b>-4,660,497</b>	<b>-5,607,907</b>	<b>-6,164,455</b>	<b>443,407</b>	<b>-705,476</b>	<b>-1,354,988</b>	<b>-1,354,988</b>	<b>-1,354,988</b>	<b>-1,292,532</b>	<b>-911,105</b>	<b>-454,531</b>	<b>-153,077</b>	<b>-80,419</b>	<b>-33,835</b>
<i>Internal Rate of Return (IRR)</i>	<b>Negative</b>													
<b>POINT OF VIEW OF CFE (Considering DSM)</b>														
<b>Costs:</b>														
Cost of CFLs	-6,192,240	-9,545,877	-8,092,949	0	0	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Payment of CFLs sold	1,450,083	4,192,737	3,977,070	1,798,395	649,512	0	0	0	0	0	0	0	0	0
Cost of capacity saved	404,677	1,474,182	2,688,214	3,247,054	3,247,054	3,247,054	3,247,054	3,247,054	3,083,256	2,139,009	1,069,504	375,772	202,339	77,081
<b>Benefits-Costs:</b>	<b>-4,337,480</b>	<b>-3,878,959</b>	<b>-1,427,665</b>	<b>5,045,449</b>	<b>3,896,566</b>	<b>3,247,054</b>	<b>3,247,054</b>	<b>3,247,054</b>	<b>3,083,256</b>	<b>2,139,009</b>	<b>1,069,504</b>	<b>375,772</b>	<b>202,339</b>	<b>77,081</b>
<i>Internal Rate of Return (IRR)</i>	<b>22.8%</b>													
<b>POINT OF VIEW OF PARTICIPANT</b>														
<b>Costs:</b>														
Payment of CFLs	-1,667,595	-4,821,647	-4,573,631	-2,068,154	-746,939	0	0	0	0	0	0	0	0	0
<b>Benefits:</b>														
Incandescent bulbs saved	252,744	642,057	972,114	972,114	972,114	972,114	972,114	972,114	927,647	650,519	328,280	110,496	56,817	21,455
Cost of energy saved by users	853,377	3,723,157	8,597,986	9,091,108	9,091,108	9,091,108	9,091,108	9,091,108	8,641,477	6,026,844	3,012,247	1,043,555	561,140	217,287
<b>Benefits-Costs:</b>	<b>-561,474</b>	<b>-456,433</b>	<b>4,996,469</b>	<b>7,995,068</b>	<b>9,316,283</b>	<b>10,063,222</b>	<b>10,063,222</b>	<b>10,063,222</b>	<b>9,569,124</b>	<b>6,677,363</b>	<b>3,340,527</b>	<b>1,154,051</b>	<b>617,957</b>	<b>238,742</b>
<i>Internal Rate of Return (IRR)</i>	<b>248.2%</b>													

ILUMEX PROJECT ECONOMIC ANALYSIS (Price levels of August 1998)																
Basic data for the economic analysis																
Marginal cost of capacity (distribution level)	US\$/kW/year	125.95														
Marginal cost of energy (distribution level)	USc/kWh	2.8942														
Energy losses T&D	%	18.635														
Capacity losses peak hours	%	23.475														
Useful life of CFLs	Hours	9000														
Useful life of incandescent light bulbs	Hours	750														
Utilization	Hours/day	2.93														
Peak coincidence factor	%	30														
Average total cost of CFL	US\$	13.92														
Cost of incandescent light bulb	US\$	0.34														
CO2 saved per kWh saved	kg/kWh 1/	0.7807														
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Number of CFLs sold per year		445,204	685,767	581,390	0	0	0	0	0	0	0	0	0	0	0	1,712,361
Number of CFLs sold (cumulative)		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361
Number of CFLs in service		445,204	1,130,971	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,712,361	1,634,034	1,145,877	578,260	194,637	100,083	37,793	
Cost of CFLs per year US\$		6,197,240	9,545,877	8,092,949	0	0	0	0	0	0	0	0	0	0	0	23,836,065
Payment by clients US\$ (with IVA)		1,667,595	4,821,647	4,573,631	2,068,154	746,939										13,877,966
Payment clients US\$ (no IVA)		1,450,083	4,192,737	3,977,071	1,798,394	649,512										12,067,797
Number of incandescent bulbs saved		743,365	1,888,402	2,859,159	2,859,159	2,859,159	2,859,159	2,859,159	2,859,159	2,728,374	1,913,290	965,530	324,988	167,110	63,104	25,949,114
Cost of incandescent bulbs saved US\$		252,744	642,057	972,114	972,114	972,114	972,114	972,114	972,114	927,647	650,519	328,280	110,496	56,817	21,455	8,822,699
Capacity saved MW		4.2	15.3	27.9	33.7	33.7	33.7	33.7	33.7	32.0	22.2	11.1	3.9	2.1	0.8	
Net capacity saving MW		3.2	11.7	21.4	25.8	25.8	25.8	25.8	25.8	24.5	17.0	8.5	3.0	1.6	0.6	
Energy saved GWh		14.5	52.2	94.8	114.3	114.3	114.3	114.3	114.3	108.6	75.8	37.9	13.1	7.1	2.7	978.2
Cost of capacity saved US\$		408,562	1,476,368	2,691,249	3,246,888	3,246,888	3,246,888	3,246,888	3,246,888	3,081,258	2,144,015	1,067,194	374,229	204,859	80,089	
Cost of energy saved US\$		420,778	1,510,198	2,743,444	3,308,046	3,308,046	3,308,046	3,308,046	3,308,046	3,144,435	2,193,031	1,096,088	379,726	204,186	79,066	
Energy saved by clients GWh		11.8	42.5	77.1	93.0	93.0	93.0	93.0	93.0	88.4	61.7	30.8	10.7	5.7	2.2	
Cost of energy saved by clients US\$		853,377	3,723,157	8,597,986	9,091,108	9,091,108	9,091,108	9,091,108	9,091,108	8,641,477	6,026,844	3,012,247	1,043,555	561,140	217,287	
Total CO2 emissions avoided, tons		11,350	40,738	74,004	89,234	89,234	89,234	89,234	89,234	84,821	59,157	29,567	10,243	5,508	2,133	763,692
Note 1/ Average emission factor based on avoided energy as follows:																
Guadalajara, 100% avoided generation at Manzanillo power plant, 100% fuel oil generation (0.73 kg of CO2/kWh)																
Monterrey, avoided energy based on 48% fuel oil (0.96 kg/kWh) and 52% gas (0.69 kg CO2/kWh)																

**IMPLEMENTATION COMPLETION REPORT (ICR)**

**ILUMEX PROJECT**

August 26, 1998

**FEDERAL ELECTRICITY COMMISSION**  
***(COMISION FEDERAL DE ELECTRICIDAD – CFE)***

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**Executive Summary.** This final evaluation report has been provided in order to assist the World Bank in preparing its Implementation Completion Report (ICR). CFE was essentially pleased with the Project outcome. The objectives were achieved, bringing Mexico many benefits, and costs did not unduly exceed anticipated levels.

Over a period of 2.7 years, 1,712,361 high-efficiency fluorescent bulbs (FLs) were installed, resulting in 114.3 GWh in annual energy savings and 33.7 MW in capacity saved. From the environmental standpoint, 22,025 m<sup>3</sup> of fuel oil and 9.6 million m<sup>3</sup> of natural gas were saved, and CO<sub>2</sub> emissions were reduced by 88,600 tons.

A key benefit of the Project has been its catalytic impact in spurring the launch of similar, and more ambitious, programs. Businesses, hotels, and civil and church organizations have indicated their desire to participate. This enthusiasm was attributable largely to the high level of satisfaction reported by participants, who have also indicated that they will eventually replace the bulbs with similar ones.

FL manufacturers consider Mexico a potentially profitable market and, given the ILUMEX Project's success, international analysts view it as a pilot for demand-side management (DSM) programs. Furthermore, the participating institutions discharged their responsibilities successfully, paying constant attention to the key role of their employees' performance in achieving the stated objectives.

The evaluation process took three scenarios into account: Case 1 was based on the Project as originally designed. Case 2 excluded costs attributable to lower billings, since the electricity was sold to other users. Case 3 was based on the same assumptions as Case 2 and also excluded the economic benefit to CFE of the energy savings realized.

The resulting internal rates of return were as follows: Case 1, negative; Case 2, 58%, and Case 3, 22.8%.

**A. Statement and Evaluation of Objectives.** The major objective of the ILUMEX Pilot Project was to demonstrate that investments in energy-efficient domestic lighting can both provide the capacity required to meet increased demand less expensively than building new power plants and simultaneously reduce emissions of greenhouse gases.

The target of the ILUMEX Project was to install 1.7 million compact fluorescent bulbs (FLs) in place of the incandescent bulbs household energy consumers traditionally use. The main results of the program were as follows:

- (a) Economic benefit: users were able to buy FLs at a cost-effective price;
- (b) Social benefit: users were made aware of the economic and environmental benefits of conserving energy;

- (c) Benefit to the electric power sector: maximum load was reduced, enabling the sector to postpone investments;
- (d) Social benefit: conservation of nonrenewable energy resources, i.e., fuel oil and natural gas;
- (e) Social benefit: reduced environmental contamination as a result of the lower power generation made possible by use of FLs.

**B. Achievement of Objectives.** With respect to the major achievements of the ILUMEX Project, the following results were achieved by the implementation units (the Jalisco and Nuevo León FILUMEX Trust Funds) over the sales period from May 1995 to December 1997:

- (a) A total of 1,712,361 FLs – slightly more (0.7%) than originally planned – were sold. Table 1 at the end of this document provides data on the number of bulbs sold by level of user consumption compared with the original figure.
- (b) Demand is expected to decrease by a maximum of 33.7 MW over the entire FL installation period (1998-2002), or 66% less than originally anticipated, since the actual coincidence factor recorded in field tests turned out to be lower than the figure estimated at appraisal (82%). Table 2 and Figure 2 show the reduced demand for each year of the Project.
- (c) It was estimated that annual energy savings would amount to 114.3 GWh from 1998 through the end of 2002, when savings would begin declining as the useful life of the original FLs ended. All the bulbs installed under the program will have reached that stage by 2008. The corresponding annual data appear in Table 2 and Figure 2 [TN: or should the reference be to Table 3 and Figure 3?]

Annual energy savings turned out to be lower than anticipated at appraisal, when daily usage was estimated at four hours and capacity savings at 50.4 W. Field tests, however, placed these figures at 2.93 hours/day and 51.69 W.

- (d) Total estimated savings amounted to 978 GWh. Table 4 and Figure 4 indicate the cumulative annual data for these savings.
- (e) Total fuel oil consumption fell by 187,070 m<sup>3</sup>, as shown in Table 5. The total decrease in natural gas consumption was 83.5 billion m<sup>3</sup> (also shown in Table 5). Emissions of contaminants also declined.

The potential for environmental benefits prompted CFE to encourage the substitution of natural gas for diesel and fuel oil in major cities; however, emissions of some contaminants did not decrease as much as anticipated.

With regard to user participation, sales of FLs under the Project's initial distribution plan were expected to be highest among low-consumption or intermediate-consumption users, since

one objective was to reduce subsidized sales to boost the economic benefit to the electric power sector. However, sales to low-consumption users turned out not to be as strong as expected.

**C. Major Factors Affecting the Project.** The major factors affecting this high-efficiency lighting pilot project were as follows:

**(I) Negative Impact on CFE's Image:** Some suppliers did not deliver the bulbs within the expected time frame, thereby temporarily halting sales. Some FLs were of poor quality, resulting in considerable failures and replacements. The price of the bulbs increased, primarily as a result of the 1995 devaluation. Users were dissatisfied because they were not permitted to buy more than six FLs. This number was subsequently increased to ten.

**(II) Negative Impact on Project operations and CFE's benefit-cost ratio:** The economic situation was such that fewer FLs than anticipated were sold to low-consumption users. The devaluation of the Mexican peso increased the purchase price of the FLs. It was difficult initially to coordinate the FILUMEX information system with CFE's internal marketing unit. Measurement of the Project's environmental impact proved difficult; this is an ongoing problem, primarily because emissions are not recorded at CFE's plants.

**D. Project Sustainability.** There is no guarantee that domestic energy users will continue to buy FLs, although they did seem to be very satisfied with this energy conservation method. Field studies have shown that the bulbs have remained in use since installation, evidence of the project's potential sustainability.

The market price of FLs has not decreased even though more bulbs are available now. Accordingly, the replacement rate – once currently installed bulbs have reached the end of useful life – is uncertain.

FIDE is developing similar projects to install over six million high-efficiency bulbs in various parts of Mexico.

**E. Bank Performance.** Bank personnel provided appropriate and timely advice to the parties concerned with project administration – CFE, BANOBRAS, and the Trust Funds (*Fideicomisos*) – during the project planning stage and as partial changes were introduced.

With respect to project financing, disbursements were made in a timely and expeditious manner. One minor difficulty, which had been anticipated, arose shortly before funds ran out, when not all of the invoices that were due could be paid. CFE had to pay the entire amount, thereby altering the proportion of matching payments under the grant.

This may be attributed to the devaluation of the peso against the dollar and to the price increase. As expected, the FLs ordered during the second bidding process were more expensive

than the initial batch, and the funds available for purchasing the agreed target of 1.7 million FLs were insufficient.

**F. Borrower Performance.** CFE took the following important steps in order to promote the success of the ILUMEX Project as fully as possible:

CFE established a Central Project Committee, a Project Coordination Unit, the Jalisco and Nuevo León Trust Funds, and a technical committee for each Trust Fund.

The utility arranged for the Jalisco and Nuevo León Distribution Units to support the respective trusts.

It established the procedures governing the CFE-BANOBRAS-Trust Funds resource stream with respect to capital contributions and collection of revenue (“reflows”).

CFE equipped its marketing unit (SICOM) to handle sales, invoicing, and trust revenue collection operations.

CFE kept the attention of its national branch offices focused on the Project. Personnel from its Accounting and Finance Departments, PAESE, and the Distribution and Marketing Departments supervised and evaluated the performance of the Trust Funds (implementation units).

One area where improvements may be needed is the international competitive bidding process. Because no single Mexican entity is in charge of the process, and bids require World Bank approval, the process took longer than was desirable.

**G. Assessment of Outcome.** Assessment of the outcome of the energy conservation program shows that households benefited considerably, the electric power sector benefited from the technical standpoint, and Mexico as a whole reaped definite economic and environmental benefits.

Broadly speaking, the program’s initial objectives were achieved. CFE benefited in terms of its image, as well as from the technical and environmental standpoint, although efforts to attract low-consumption users were not as successful as had been expected.

Mexico’s electric power sector continued its policy of adjusting household tariffs on a monthly basis and, as indicated in the appraisal report, CFE succeeded in mitigating the negative impact of this policy on its image, since program participants appreciated the fact that they were able to buy FLs at low cost and on deferred terms. This was borne out in participant surveys.

Additional user groups showed an interest in this program and similar ones, demonstrating that ILUMEX had served as an appropriate model for energy conservation in Mexico.

Table 6, which illustrates Case 1, presents the outcome for the main project parameters. However, the benefit-cost ratio was negative because so many high-consumption users participated.

In the evaluation of the Project from the alternative DSM perspective adopted for Case 3, the costs listed do not include CFE's reduced income attributable to lower billable sales, nor do the benefits reported reflect savings from energy not generated (see Table 7).

This was the case because sales to low-consumption users in Jalisco and Nuevo León were not as strong as anticipated; it had been assumed previously that electricity would no longer be sold at subsidized rates, a situation which turned out not to apply to this Project.

The results of a field survey on hours of use that measured consumption *in situ* provided an indication of bulb life and showed the coincidence factor for both peak demand periods and over a 24-hour period. Measurements were made during the summer as well as other seasons.

**H. Future Operations.** The Trust Funds can continue operating with financing from "reflows," as they are doing in 1998. However, FIDE has already begun to implement projects with similar objectives elsewhere in Mexico and, using the experience of the ILUMEX Project as a guide, the intention is to keep the structure of trust funds as small as possible beginning in 1999.

CFE believes that its financial contributions to FIDE and its assistance in terms of administrative support and experience are sufficient to allow the planned energy conservation policy to be sustained successfully.

In keeping with the original project design, the utility will, however, continue to do such things as replace defective bulbs, collect payments, record hours of use, and conduct sustainability surveys.

**I. Key Lessons Learned.** The key lessons learned during the implementation of this Project are set out below.

CFE gained valuable experience which is applicable to similar projects. It established internal management units as well as implementation units (IU), or trust funds; it formulated technical specifications and laboratory tests, sold merchandise, and collected "reflows." What is more, the utility simultaneously conducted technical and financial reviews of the Project from various perspectives. Quality and timely delivery were its watchwords as it negotiated with suppliers regarding price, delivery, technical specifications, laboratory tests, and the performance of purchased FLs.

The most impressive result was how rapidly the conservation measure gained acceptance, a factor that almost led to a shortage of FLs. However, this occurred at the same time that CFE's

local reputation was improving, since program participants were able to buy inexpensive compact FLs and pay for them over time.

The Project also paved the way for the implementation of similar projects through FIDE, thereby providing further opportunities to develop additional DSM methods.

**Table 1**

Distribution of FLs sold by level of user consumption (%)				
	Basic	Intermediate	High	Total
1995	5.7	24.9	69.4	100
1996	8.5	35.5	56	100
1997	13.8	31.2	55	100
Total	9.6	31.3	59.2	100

Planned distribution of FLs (%)				
Main Office	Basic	Intermediate	High	Total
Jalisco	34.3	49.7	16	100
Nuevo León	28.7	53.2	18.1	100

**“INFORME DE TERMINACION  
( ICR )  
DEL PROYECTO ILUMEX”**

26 de Agosto de 1998

**COMISION FEDERAL DE ELECTRICIDAD**

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**Resumen Ejecutivo. Este Informe de Evaluación Final servirá al Banco Mundial para la elaboración del Reporte de Implementación Completa (ICR). Centralmente, se desea afirmar la satisfacción de CFE con los resultados de este proyecto. Se consideran cubiertos los objetivos con un buen grado de beneficios para la nación y sin que se haya excedido su costo de manera inesperada.**

**Se instalaron 1 712 361 LFC en un plazo de 2.7 años, las que permitirán un ahorro de energía de 114.3 GWh por año, con una capacidad evitada de 33.7 MW. Desde el punto de vista ambiental, se ahorran por año 22,025 metros cúbicos de combustóleo y 9.6 millones de metros cúbicos de gas natural, con una reducción de 88,600 toneladas en las emisiones de CO<sub>2</sub>.**

**Entre los mejores resultados del proyecto, destaca la influencia que ha tenido para el inicio de programas similares de aún mayor envergadura. Comerciantes y hoteleros, así como organizaciones civiles y eclesiásticas, manifestaron su deseo de participar. A ello, ha contribuido el alto grado de satisfacción reportado por los usuarios domésticos participantes, quienes también manifiestan disposición a reponer sus lámparas por otras similares al término de su vida útil.**

**Los fabricantes de LFC ven al país como un mercado real y potencial, los analistas internacionales reconocen el éxito de ILUMEX como proyecto piloto en el marco de los programas de DSM, y las instituciones participantes cumplieron adecuadamente sus funciones, vigilantes siempre del buen desempeño de sus funcionarios para el logro de los objetivos marcados.**

**El proceso de evaluación incluyó tres enfoques: el primero, Caso 1, adoptado desde el diseño del proyecto; un Caso 2, que considera que no se tienen costos por la disminución de la facturación de CFE pues la energía se vende a otros usuarios; y un Caso 3 que implica la misma consideración del Caso 2 pero que, adicionalmente, no considera el beneficio económico del ahorro de energía a nivel de generación para CFE.**

**Los resultados obtenidos de la tasa interna de retorno ( IRR por sus siglas en inglés ) para cada caso son: Caso 1 : Negativo, Caso 2 : 58.0%, y Caso 3 : 22.8 %**

**A. Estado y evaluación de objetivos. El principal objetivo del Proyecto ILUMEX, que es un proyecto piloto, es demostrar que las inversiones**

**realizadas en medidas de uso eficiente de iluminación doméstica, permiten proveer la capacidad necesaria para la expansión de la demanda a costos inferiores a los de la construcción de nuevas centrales, al mismo tiempo que reducen la emisión de gases con efecto invernadero.**

La meta programada de ILUMEX es la instalación de 1.7 millones de lámparas fluorescentes compactas (LFC) sustituyendo los focos incandescentes tradicionales en uso actual por los usuarios domésticos de la energía eléctrica. Los principales resultados de este programa, son:

- a) Beneficio económico para el usuario al adquirir las LFC a un precio que asegura su rentabilidad económica.
- b) Beneficio social al hacer consciente al usuario de los beneficios económicos y ambientales del ahorro de energía.
- c) Beneficio para el sector eléctrico al posponer inversiones por la reducción de la demanda máxima del sistema.
- d) Beneficio social al conservar recursos energéticos no renovables, como son el combustóleo y el gas natural.
- e) Beneficio social al reducirse la emisión de contaminantes al medio ambiente, ya que propicia reducciones en la generación eléctrica por el uso de las LFC.

**B. Logro de objetivos. Con relación a los principales logros de ILUMEX, las acciones realizadas por las Unidades de Implementación (UI, Fideicomisos FILUMEX Jalisco y FILUMEX Nuevo León) durante el período de ventas -de Mayo de 1995 a diciembre de 1997- tenemos:**

- a) Se vendieron un total de 1'712,361 LFC, cantidad ligeramente mayor (0.7%) a la programada. La Tabla 1, al final de este documento, presenta los datos de lámparas vendidas por año para cada nivel de consumo de los usuarios, en comparación con lo planeado.
- b) La máxima reducción de la demanda se estima en 33.7 MW en el período de total instalación de las LFC (1998-2002), 66% menos de lo programado, ya que el factor de coincidencia real, obtenido de pruebas de campo, resultó menor a lo estimado en el estudio de factibilidad (0.82). En la Tabla y Figura 2 se presentan las reducciones en demanda en cada año del proyecto.
- c) Se calculó un ahorro anual de 114.3 GWh del año 1998 al final del 2002, cuando se iniciará la reducción del ahorro por terminarse la vida útil de las

primeras LFC vendidas; en el año 2008 se agota la vida útil del total de lámparas instaladas bajo el programa. Los datos anuales correspondientes se presentan en la Tabla y Figura 2.

La cifra de ahorro de energía anual es inferior a la estimada en el estudio de factibilidad, donde se suponía un uso diario de 4 horas y una capacidad ahorrada de 50.4 watts. Las pruebas de campo dieron las cifras de 2.93 horas/día y 51.69 watts.

- d) El ahorro total estimado es de 978 GWh. La Tabla y Figura 4 presenta los datos anuales acumulados de este ahorro de energía.
- e) La reducción total en el consumo de combustóleo es de 187.07 miles de metros cúbicos, como se presenta en la Tabla 5. La reducción total en el consumo de gas natural es de 83.5 miles de millones de metros cúbicos. (en la misma Tabla). También, se puede ver la reducción en la emisión de contaminantes.

Dado que la institución promovió la sustitución de diesel y de combustóleo por gas natural en las grandes ciudades, pues se involucró en cambios positivos hacia el medio ambiente, la reducción de algunos contaminantes es menor a la planeada.

Con relación a la participación de los usuarios, la distribución planeada del proyecto proponía que las ventas de LFC tendrían una alta participación de usuarios de consumo bajo e intermedio, ya que un objetivo era reducir las ventas subsidiadas para mayor beneficio económico del sector eléctrico, sin embargo, las ventas se distribuyeron con bastante menor participación de usuarios de bajo consumo.

### **C. Factores principales que afectaron el proyecto. Los principales factores que afectaron el proyecto piloto de iluminación eficiente, son:**

**I) Con efecto negativo sobre la imagen de CFE:** Incumplimiento de algunos proveedores en los plazos de entrega previamente convenidos, lo que provocó paros temporales en la actividad de venta. Mala calidad de algunas LFC, dando como resultado altos índices de falla y reposición. Se ajustaron al alza los precios de venta de las lámparas, sobre todo por la devaluación de 1995. Se puso un límite máximo de 6 LFC por usuario, lo que motivó insatisfacción, por lo que hubo de aumentarse posteriormente a 10.

**II) Con efecto negativo sobre la operación del proyecto y la relación B/C para CFE:** La situación económica motivó que las LFC no pudieran venderse entre los pequeños usuarios tan ampliamente como se había planeado. La

devaluación del peso mexicano incrementó los precios de compra de las LFC. Desajustes en la operación inicial entre el sistema de información de FILUMEX y el SICOM de CFE. La evaluación del impacto ecológico presentó dificultades que continúan, principalmente debido a la falta de medición de emisiones en las plantas de CFE.

**D. Persistencia del proyecto.** La persistencia de los usuarios domésticos de energía eléctrica en la compra de LFC no está garantizada, si bien se detectó un buen grado de aceptación de la medida de ahorro. En estudios de campo se detectó el uso continuo, desde la instalación, de las LFC, es decir, hasta ahora se persiste en su uso.

Los precios en el mercado abierto no han bajado, aún cuando ha aumentado la disponibilidad de LFC en el mismo; esto no permite asegurar el grado de remplazo que se presentará al agotarse la vida de las lámparas ya instaladas.

Proyectos similares están siendo desarrollados por el FIDE para instalar más de seis millones de lámparas ahorradoras en diversos lugares del país.

**E. Desempeño del Banco.** Desde la planeación del proyecto y durante las revisiones parciales, el personal del Banco prestó orientación adecuada y oportuna a las partes involucradas en la administración del proyecto, CFE, BANOBRAS y los Fideicomisos.

En lo referente a la operación financiera, las ministraciones del proyecto se realizaron de manera oportuna y expedita. Aunque hubo un incidente menor, ya previsto, poco antes de que se agotaran los fondos, pues se presentaron facturas a cobro y no se alcanzaban a cubrir en su totalidad. CFE hubo de aportar el pago total, que ya no mantenía la proporcionalidad de pagos en contrapartida de la donación.

El alza en el tipo de cambio peso/dólar y el incremento en precios, motivaron esa situación; como estaba previsto, los pedidos de la segunda licitación resultaron más caros que los previos y ya no alcanzaban los fondos para adquirir 1.7 millones de LFC, como era el objetivo comprometido.

**F. Desempeño del prestatario. Para la realización, de la mejor manera posible, de las actividades que se tenían que llevar a cabo para lograr el objetivo del proyecto ILUMEX, la CFE realizó las principales acciones siguientes:**

**Creación del Comité Central del Proyecto, la Unidad Coordinadora del Proyecto, Constitución formal de los Fideicomisos Jalisco y Nuevo León, Creación del Comité Técnico de cada uno de los Fideicomisos.**

**El apoyo de las Divisiones de Distribución Jalisco y Nuevo León para cada uno de los Fideicomisos correspondientes.**

**Definición de procedimientos para regular el flujo de recursos CFE-BANOBRAS-Fideicomisos en el caso de las aportaciones patrimoniales y de la cobranza (recuperación de cartera).**

**Adecuación, por parte de CFE, de su Sistema Comercial (SICOM) para procesar las operaciones de venta, facturación y cobranza de los fideicomisos.**

**En oficinas nacionales, CFE mantuvo permanentemente la atención sobre el proyecto. Personas de las Gerencias de Contabilidad y Finanzas, del PAESE, de la Gerencia de Distribución, y de esta Gerencia Comercial, estuvieron supervisando y evaluando el desempeño de los fideicomisos (Unidades de Implementación).**

Una circunstancia a mejorar para el caso necesario, es lo relacionado con el proceso de licitación internacional, que por no depender de una sola institución nacional, y al requerir la aprobación del Banco Mundial, se llevó más tiempo del conveniente.

**G. Evaluación de resultados. La evaluación de los resultados del programa de ahorro indica que son muy favorables para los clientes domésticos, y que para el sector eléctrico son técnicamente ventajosos, mientras que para la nación son positivos en lo económico y lo ambiental.**

Atendiendo a los objetivos iniciales del programa, se puede afirmar que se alcanzaron en términos generales. Esto vale tanto en términos de imagen de la institución como en términos técnicos y ambientales, si bien no se alcanzó a penetrar de manera amplia en el sector de usuarios pequeños.

El sector eléctrico mexicano ha mantenido la política de ajustar mensualmente las tarifas domésticas, y tal como se planteó en el estudio defactibilidad, se ha paliado el efecto negativo de esa política sobre la imagen de CFE, ya que la clientela

participante ha reconocido el esfuerzo que se manifiesta al vender a precios bajos, y en plazos, las LFC. Las encuestas de participantes lo han mostrado así.

Otros sectores de usuarios se han interesado en el programa y en otros similares, por lo que ILUMEX ha cumplido sirviendo como ejemplo en el marco cultural del ahorro de energía.

La Tabla 6, correspondiente al enfoque del Caso 1, presenta los resultados de los principales parámetros para el proyecto, aunque la relación beneficio/costo del sector es deficiente por la más amplia participación de usuarios de alto consumo.

Evaluando el programa con un enfoque alternativo de DSM, correspondiente al enfoque del Caso 3, no se incluyeron entre los costos las reducciones de ingresos de CFE debidas a disminución en las ventas para facturación, ni se incluyeron entre los beneficios los ahorros por energía evitada en la generación, como se presenta en la Tabla 7.

Se hizo así por no haberse vendido las LFC entre los sectores de bajo consumo con la participación planeada para Jalisco y Nuevo León; la argumentación previa había sido que se dejaría de vender energía subsidiada, lo que no ocurre en el programa.

Adicionalmente, se tienen los resultados de un estudio de tiempo de uso que se hizo en campo con mediciones in situ, lo que permitió establecer el horizonte de vida de las lámparas, así como obtener el factor de coincidencia no sólo para la demanda en punta, sino para las 24 horas del día; las mediciones fueron realizadas tanto para la estación de verano como para la de fuera de verano.

**H. Operaciones futuras.** Con los recursos obtenidos de la recuperación de cartera, es posible mantener la operación de los Fideicomisos, tal y como se está haciendo en 1998; sin embargo, el FIDE se encarga ya de realizar proyectos con los mismos objetivos en otras áreas del país, para lo que está aprovechando la experiencia de ILUMEX, por lo que se tiene planeado reducir al mínimo la estructura de los fideicomisos a partir de 1999.

CFE considera que sus aportaciones económicas al FIDE y los apoyos que le brinda en términos de estructura organizativa y experiencia, son suficientes para mantener en un buen nivel la política de ahorro de energía que se ha trazado.

Sin embargo, y de acuerdo con lo planeado al diseño del programa, se mantendrán actividades como: reposición de lámparas falladas, cobranza, mediciones de tiempo de uso y encuestas de persistencia.

**I. Experiencias. Las principales experiencias obtenidas durante el desarrollo de este proyecto, son:**

La CFE obtuvo importantes experiencias válidas para esta clase de proyectos. Desde la organización de instancias de dirección internas hasta la organización de las Unidades de Implementación (UI) o fideicomisos; desde el establecimiento de las especificaciones técnicas y de las pruebas de laboratorio, hasta la venta de los productos y la recuperación de cartera. No puede dejarse de lado lo relacionado con la evaluación técnica y económica del proyecto, la cual se ha hecho sobre diversos enfoques simultáneamente.

En las negociaciones con los fabricantes sobre precios, abastecimiento, especificaciones técnicas, pruebas de laboratorio y desempeño de las LFC adquiridas, se buscó garantizar la calidad y oportunidad de las adquisiciones.

La mejor experiencia ha sido la aceptación rápida de la medida de ahorro, lo cual puso en peligro de desabasto al programa, aunque ello ocurrió al mismo tiempo que se mejoraba la imagen local de CFE, pues permitió, mediante este programa, facilidades para que los usuarios adquiriesen las LFC a bajo precio y con facilidades de pago.

Se abrió la posibilidad de implantar programas similares a través del FIDE, ampliando la capacidad de desarrollar otras medidas de DSM.

<b>Tabla 1</b>				
Distribución de LFC vendidas por Nivel de Usuario (%)				
	Básico	Intermedio	Excedente	Total
1995	5.7	24.9	69.4	100.0
1996	8.5	35.5	56.0	100.0
1997	13.8	31.2	55.0	100.0
Total	9.6	31.3	59.2	100.0

Distribución Planeada de las LFC (%)				
Sede	Básico	Intermedio	Excedente	Total
Jalisco	34.3	49.7	16.0	100.0
Nuevo León	28.7	53.2	18.1	100.0





## APPENDIX C

### MEXICO

#### HIGH EFFICIENCY LIGHTING PROJECT (ILUMEX)

##### Project Cost/Benefit Analysis

### I. Introduction

1. The ILUMEX project was financed by CFE and with grants from the Global Environmental Trust Fund and the Kingdom of Norway. It was completed in December 31, 1997. A total of 1,712,361 compact fluorescent lamps (FLs) (vs. 1,700,000 estimated at appraisal) were installed in houses and businesses in Guadalajara and Monterrey. The economic analysis presented in this report is based on information provided by CFE and compares these results with those estimated at appraisal and summarized in LAC's Memorandum and Recommendation of the Director (MRD) dated March 8, 1994 (Report No. 12448-ME).

### II. Main Parameters for Economic Analysis

2. The main parameters of the ILUMEX project as appraised and as developed are shown in Table 1 and are commented below. Data was collected from project participants in both cities. These parameters include:
- a. The number of FLs installed in the official period of project execution (1995-1997) is slightly higher than estimated. The unit cost per FL was US\$ 13.92 (vs. US\$ 13.53), of which 18% or US\$ 2.50 is overhead cost (vs. 18.7%). This small variation in the total unit cost of FLs had no appreciable effect in the results of the project.
  - b. The rebate or discount given by CFE was on average 49%. Participants paid on average US\$ 7.05 per FL, plus a sales tax or IVA of 14%.
  - c. Based on surveys of participants undertaken in both cities, the average use time for each FL was 2.48 hours. This is lower than the 4 hours estimated at appraisal. However, this variation reduces only slightly the amount of energy saved by the project, from 1,014 GWh for the life of the FLs estimated at appraisal to 977 GWh.

- d. The “coincidence factor” of use of FLs was only 30% vs. 80% estimated at appraisal. This factor is equal to the number of FLs in use at peak hours, vs. de total number of FLs installed. This variation reduces the amount of capacity saved by the project from 100 MW estimated at appraisal to 33.7 MW.
- e. Laboratory test results and the results of three years of project implementation demonstrate that the average life of the FLs is about 9,000 hours (vs. 8,760 hours estimated at appraisal).
- f. The energy savings for the project was calculated by CFE for the estimated number of FLs installed and in service in each year. For the period 1995 to 1997, the FLs in service was equal to the FLs sold to participants. For later years, CFE projected the number of FLs in service in accordance with the use time of each type of participant and the expected life of FLs (9,000 hours).
- g. The life of a typical incandescent bulb replaced by FLs is 750 hours and the unit cost is US\$ 0.34 (vs. US\$ 0.32).

### **III. Economic Benefits of the Project**

3. The economic benefits of the project as described in the MRD are: (i) project participants will enjoy a comparable or higher lighting level at reduced cost; and (ii) the society at large and CFE will be able to postpone new energy investments because the project will reduce energy demand and, thereby, save fuel. Based on the information collected by CFE and the expected future performance of FLs , those benefits were indeed perceived by all participants as explained below.

4. The economic benefits were estimated based on project data and using the same methodology as in the MRD. All costs are expressed in constant terms as of August 1998. All taxes have been excluded, except for the analysis from the perspective of the participant as is explained below. Following the same methodology described in the MRD, the costs and benefits are calculated assuming that the FLs will not be replaced at the end of their useful life. If all or a percentage of the FLs are replaced as is expected, the economic benefits will be higher than shown below.

#### ***Economic Analysis from the Perspective of the Nation***

- 5. *The cost* to the nation is the annual cost of the FLs needed to implement the project (total cost was US\$ 23.8 million vs. US\$ 23.0 million estimated in the MRD).
- 6. *The benefits* from the perspective of the nation are three:
  - a. The value of the capacity postponed by the installation of the FLs (33.7 MW actual vs. 100 MW estimated at appraisal), valued at the Long Run Marginal Cost (LRMC) (US\$ 126 vs. US\$ 132.5);

- b. The yearly value of the energy not generated because of the savings of the FLs (978 GWh total vs. 1,014 GWh) also valued at LRMC (US cent 2.9 vs. US cent 6.2); and
- c. The value of the incandescent light bulbs not installed.

7. The internal rate of return (IRR) was calculated using data reported by CFE, which is based on project implementation information and market surveys. (See final project evaluation report prepared by CFE :“ILUMEX. Informe de Evaluación Final. Agosto de 1998”). Table 2 shows the assumptions for the calculation and the results obtained. The IRR for the project as executed and the value forecast at appraisal are:

IRR Forecast at Appraisal	IRR for Project as Executed
56% (minimum)	35%

8. While the IRR for the project as executed is high, it did not reach the level estimated at appraisal because capacity postponed by the project is only 33.7 MW instead of 100 MW as expected. The main reason for the lower capacity savings is related to the coincidence factor which was estimated at appraisal to be 80% but who’s real value during implementation was 30%. At appraisal, little information was available on how households and businesses would use the new lighting. This was one of the main lessons learned through the ILUMEX project.

***Economic Analysis from the Perspective of CFE***

9. *The costs* to CFE are:

- a. The total yearly cost of FLs paid by CFE to execute the project, or, as described in the MRD. The cost to CFE is the rebate absorbed by CFE for the sale of FLs (cost of FLs minus the repayments by participants).
- b. CFE’s forgone income, as the energy saved by FLs is not consumed by participants, therefore reducing CFE’s income.

10. *The benefits* for CFE are

- a. The yearly repayment by participants of FLs sold on terms; and
- b. The cost of the capacity and energy saved by the project (same as for the nation)

12. The IRR calculations are:

IRR Forecast at Appraisal	IRR for Project as Executed
32% (minimum)	Negative

13. The reasons for this result are: (i) the benefits for saved capacity were low, for the same reason explained above for the nation; and (ii) the cost of the energy saved by the project had a lower value for CFE, because the long run marginal cost of energy or LRMC has today a lower value than in 1994 when the project was appraised. While in 1994, the LRMC was US \$ .062 per kWh, in 1998 the value is only US \$ .033 per kWh. This reduction in the LRMC is due to : (a) much lower prices for fuel oil today than in 1994; and, (b) the availability of lower cost natural gas which was not available for power generation in 1994.

14. The CFE also undertook the IRR calculation from the Demand Side Management perspective. It assumes that the energy saved by the participants does not cause a loss to CFE, but rather is billed to other higher use customers in the same area, as demand for power is high and CFE's reserves are relatively low. Under this scenario, the IRR for CFE would be 23%.

***Economic Analysis from the Perspective of the Participant.***

15. *The cost* to the participants is:

- a. the price paid for the FLs including sales taxes or IVA, as this was a real payment incurred by the participant when purchasing the FLs.

16. *The benefits* for the participant are:

- a. The value of the incandescent light bulbs not purchased because of the replacement with FLs; and
- b. The energy saved by the FLs, which reduces the amount of the monthly electricity bill to the participants. The average tariff charged by CFE at distribution level today is lower than in 1994 (US cent 5.0 per kWh vs. 6.65). The present structure of CFE's residential tariffs has changed, penalizing higher consumption of energy by higher rates. The first block of consumption (up to 75 kWh per month) pay a "basic" tariff of US cent 4.0 per kWh; the second block or "intermediate" pay US cent 4.6 for the excess over 76 kWh up to 200 kWh; and the third block or "excedent" pay US cent 14.2 per kWh for energy over 201 kWh. Although the saved energy by the participants is close to the estimate of the appraisal, its value is higher because the large participation of consumers of the third block. As a consequence, the energy saved was valued at a higher cost, resulting in a higher amount than at appraisal.

17. The resulting IRR for the participants was much higher than estimated, because the higher monthly savings on the electricity bill achieved by the participants. The results are:

<b>IRR Forecast at Appraisal</b>	<b>IRR for Project as Executed</b>
151% (minimum)	248%

18. In order to determine project benefits for all categories project participants, CFE made a detailed analysis in Guadalajara and Monterrey of the three blocks of consumption. All participants received benefits, however, as expected, the participants of the “basic” block had lower IRR than the ones of the higher blocks, because the higher kWh saved by the larger number of FLs purchased by these participants.

***Environmental Benefits.***

19. The amount of carbon dioxide emissions (CO2) avoided as a result of the ILUMEX project is now estimated at 763,681 tons for the life of the FLs, as compared to 709,800 estimated at appraisal. The updated value based on energy saved was calculated by CFE based on the regional dispatch of the power plants. The annual energy saved is: (i) 50% to the Manzanillo thermal plant (Guadalajara) which uses fuel oil (“combustoleo”) and has a thermal efficiency of 38%; and (ii) 50% to the Monterrey thermal plant which uses 48% of fuel oil and 52% of natural gas and has an average thermal efficiency of 29%. The resulting average index for the project is 0.78 kg CO2/kWh.

20. At present still there is no international consensus on the economic benefits of reducing CO2 emissions. For the purpose of comparing the benefits with those estimated at appraisal, the same indices used in the MRD were used to value the benefits of the project. These indices were estimated by Data Research Inc (DRI) (see MRD, Annex 4). The updated results are the following:

**ANNUAL BENEFITS IN US\$ MILLION**

<i>Index</i>	<i>Appraisal estimate</i>		<i>Updated estimate</i>	
	<i>Annual 1/</i>	<i>Life of FLs</i>	<i>Annual 1/</i>	<i>Life of FLs</i>
US\$ 23/ton (avg. 1995)	2.7	16.3	2.6	15.7
US\$ 26 (nominal rates)	3.1	18.5	3.0	17.8
US\$ 16 (effective rates)	1.9	11.5	1.8	10.9
Annual estimate is based for the years of maximum energy savings (third and fourth year)				

21. For a nominal rate of US\$ 26 per ton, the benefit attributed to CO2 reduction for the life of the ILUMEX project would be US\$ 17.8 million as shown in the table. This benefit is over and above the economic benefits described above.

22. Assuming the extreme case that the entire cost of the project (US\$ 23.8 million) would be assigned to CO2 avoided emissions, the unit cost would be US\$ 31.3 per ton of CO2 avoided.