# Report on
# World Bank Appraisal Mission to Mexico,

# The GEF - ILUMEX Project

by

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# World Bank Appraisal Mission to Mexico, October 14 to 27, 1993
# The Global Environmental Facility's High Efficiency Lighting Pilot Project (The ILUMEX Project)

**Abstract**
This paper is written for the Norwegian Ministry of Foreign Affairs as a description of a practical demonstration project for possible future joint implementation schemes.

The paper gives a background and description of the ILUMEX project which has been considered and approved by the GEF participants meeting. It presents the objectives of the project and that of the Norwegian cofinancing, and discusses various elements of the project. These includes: The project costs and financing, the national and international benefits, the baseline scenario, incremental cost calculations, project sustainability and the aspects of monitoring and verification of effects.

The paper is not discussing the issue of crediting for possible future joint implementation projects.

## 1. INTRODUCTION

The Global Environmental Facility (GEF) of the World Bank (WB), the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) is established as a pilot program with donors, mainly from industrialized countries. The aim of the program is to give grants or concessional loans to developing countries or countries with economies in transition, to relieve pressures on the global environment. One of the priority areas of the GEF is to provide assistance to interventions for reducing or limiting greenhouse gas (GHG) emissions.

The United Nations Framework Convention on Climate Change (FCCC) is expected to enter into force in 1994. The objective of the Convention is to stabilize emissions of GHGs at a level which will prevent climate change. An important principle in the Convention is that measures to deal with climate change should be cost-effective to ensure global benefits at the lowest possible cost.

One of the mechanisms under the Convention is that developed country Parties may implement policies and measures jointly with other Parties. This clause has become known as the provision for "joint implementation". The Convention does not define the mechanism, but requires the first meeting of the Parties to decide on its criteria. To assist in this endeavor, the GEF and the Government of Norway have decided to support two projects, one in Poland and one in Mexico, to contribute to the process of defining such criteria.

The agreement between the cooperating Governments on the cofinancing of these projects is in no way prejudicial to the positions that they may take in the relation to the role of joint implementation under the FCCC.

This report is written by the two Norwegian members of the WB Appraisal Mission on the Mexican ILUMEX project as supplementary information to the Norwegian Ministry of Foreign Affairs. Some of the aspects of the project, had it been a joint implementation project (JI), are high-lighted. An analysis of these aspects goes beyond the scope of this report.

## 2. PROJECT BACKGROUND

Mexico is heavily dependent on fossil fuels for its electricity generation. Fossil-fuel fired power plants produced in 1992 roughly 100 terrawatt-hours (TWh) out of a total generation of 120 TWh. Oil, naphtha, coal and gas have a proportion of about 76, 13, 10 and 1% respectively. The hydrocarbon based electricity sector is estimated to account for roughly 70 mill. tons of carbon dioxide emissions per year.

The combustion of fossil fuel for power generation gives serious local pollution problems, which the Mexican authorities have started to address. The National Environmental Institute (INE) has introduced national standards and regulations also for the power stations of the Federal Electricity Commission (CFE). A shift towards more environmentally benign fuels, that is conversion to gas or lighter oil with less content of sulphur, is, however, expected to be slow. Elimination of cross-sector subsidies on

electricity may also help in reducing the impacts through lower growth in demand for electricity. Emissions in Mexico do not seem to cause transboundary air pollution of any magnitude.

Fossil-fueled power plants are projected to remain a major source for generating electricity in Mexico. CFE operates with an annual growth rate of 5,3 % in electricity demand, which means a need to add 14.000 megawatts (MW) to the power system over the next 10 years. Generating new electricity requires an average investment of US$ 1.000 per kilowatt, and massive investments, in the order of US$ 3 bill. per year for generation, transmission and distribution are needed to meet this demand. Mexico has implemented, with the assistance of the World Bank (WB), several energy conservation projects.

## 3. THE ILUMEX PROJECT

### 3.1 Objectives

The project-specific objectives are to:

a) demonstrate the technical and financial feasibility of reducing emissions of greenhouse gases (GHG) and reduce local environmental pollution through widespread installation of compact fluorescent lamps (CFLs);
b) build the institutional capacity for technological change and energy conservation through;
c) establish an organizational structure for replicating the project nationwide and as a learning experience for possible replication in other countries.

Of the least cost options to reduce the emissions of GHGs is probably investments in energy conservation. However, the technology of the ILUMEX project and the institutional and societal barriers to subscribe to this new technology has not been successfully demonstrated on a large commercial scale in developing countries.

### 3.2 Project description

The project will replace about 1,7 million ordinary light bulbs with compact fluorescent light bulbs (CFLs) in the two cities of Monterrey and Guadalajara. These CFLs can provide similar or better quality of lighting while consuming 75% less electricity and lasting 10 to 13 times longer. The project will be carried out by the CFE, while the borrower for Mexico will be Banco Nacional de Obras y Servicos.

The project concentrates on the residential sector. The electricity consumers will be offered the CFLs at an up-front rebate of approximately 46% on average. They may pay cash or over a periode of 2 years along with the electricity bill. The payment will show that the purchase creates a net positive cash flow to the consumer. It is estimated that this phase I of the ILUMEX project will be finalized in two and a half years after project start. The project is, however, structured to ensure that 50% of the original investment will be replenished by project revenues; that is: customers payment for the CLFs. The Ministry of Finance and the CFE have decided, if not budget constraints makes it impossible, to grant the other 50% for implementation of a similar size project (phase II) a second time in the areas of the two cities.

With the reflow of funds from the projects, the concept might expand further to the residential sector throughout Mexico. A revolving pool of funds may ultimately be used also to initiate replacement in the non-residential sector.

Phase I of the ILUMEX project will reduce electricity consumption by about 123 gigawatt-hours (GWh) per year. A later diffusion of the technology throughout Mexico is expected to result in even larger benefits. For every 10 million light bulbs replaced, this technology is estimated to save about 720 GWh per year in thermal generation.

A start in the commercial sector might provide larger economic benefits, due i.a. to longer operating hours for lamps in this sector. However, CFE gave several reasons for beginning with the residential sector: Other national institutions are focusing on energy conservation measures in the non-residential sector; this project will help reduce low income consumers costs at a time were subsidies are redused; it will improve CFEs public image; and they have already started work in this sector which they want to continue.

The project should prove itself as a simple and replicable set of demand side management measures that save resources and create national and global environmental benefits at little or no cost. A relatively rapid replication in Mexico is anticipated as the CFE operates nationwide and has the necessary skill and experience to carry out such a project. It is also expected that the project will demonstrate a viable concept to other developing countries. No policy or institutional reform is needed for project implementation.

**3.3 Project costs and financing**

The CFE has designed an administratively inexpensive structure for the project. The goal is to keep administrative costs below 10%. The projected cost per light bulb is US$ 10, but the actual cost will probably be lower. The cost calculation is presented in table 1 below.

Table 1, Costs of the ILUMEX project

| **Component** | **Percent** | **US$ mill.** |
|---|---|---|
| Purchase of the CLFs | 76 | 17,63 |
| Project equipment | 2 | 0,41 |
| Consultant services, monitoring, evaluation etc. | 5 | 1,01 |
| Engineering and project support | 8 | 1,93 |
| Direct project implementation | 9 | 2,02 |
| Total | 100 | 23.00 |

The total financing plan for the project is US$ 23 million, of which the local counterpart funding is US$ 10 million. The total amount of grant is US$ 13 million of which US$ 10 million is from the GEF and US$ 3 million as a cofinancing from the Government of Norway. The grant is for the Government of Mexico, represented by the Federal Electricity Commission (CFE), which will also be the implementing agency. Apart from the legal

arrangements between the World Bank and Mexico, a bilateral agreement will be made between the Governments of Mexico and Norway.

The grant funds would be used to finance the rebate to be made available to the participants, with is estimated to amount to US$ 10,6 mill. The difference, US$ 2,4 mill., will be used for the same purpose in a phase II of the project.

**3.4 Project benefits**

Apart from the significant global and national environmental benefits, there are also significant economic savings for the consumer as well as the utility and the Mexican society at large. Mexico is, a signatory to the FCCC. This means that the country, when the Convention enter into force, i.a. is committed to formulate and implement national or regional programs containing measures to mitigate climate change. Even if no quantification or qualification of commitments are mentioned, countries will have to communicate on their actions to the Conference of the Parties of the FCCC. This project may, in a political context, add favorably to the communication of the Government of Mexico to the Conference of the Parties of the FCCC.

**3.4.1 Global benefits**

It is calculated that phase I of the ILUMEX project will give a total direct reduction of carbon dioxide emissions of about 700.000 tons over the 6 years period that the CFLs are estimated to last, or about 120.000 tons per year over that period. The project will also give some reductions of methane emissions. This figures is likely to increase through the diffusion effect of the project.

These calculations, made by the CFE, are based on assumptions about number of lamps replaced, average wattage reduced per replaced lamp, average usage of lamps of 4 hours a day, the fuel savings of the power plants most likely to be affected by the reductions in power demand, and several technical factors.

In addition to the emission reductions resulting directly from the project, the project will also have an indirect effect by speeding up the diffusion of efficient lighting technology in Mexico. This effect is difficult to quantify today. However, CFE has calculated that if the ILUMEX project was carried out successfully on national level, the reductions of emissions of carbon dioxide would total about 6.800.000 tons over the 6 year period or 1.140.000 tons per year. The revolving fund and the direct sales of CFLs from the company will directly and indirectly spur further diffusion of efficient lighting technology.

**3.4.2 National benefits**

The project will give national environmental benefits through reduced emissions i.a. of sulphur dioxide by about 3.000 tons annually or about 18.000 tons i the estimated 6 year lifetime of the CFLs. It vill also give reduced nitrogen oxides by about 205 tons a year or about 1.230 tons in the 6 year period, and finally reduced emissions of particulates by approximately 240 tons a year or 1.440 tons in the 6 year period. These reductions will improve the local air quality, give positive health effects and less damage to crops, vegetation and buildings. The reduction of emissions from the power plants in the project area will add favourably to the national initiatives to deal with these environmental problems.

The project will also give substantial economic benefits. These benefits applies to: (i) The

electricity consumers which will have a comparable or improved quality of light delivered at reduced cost; (ii) The utility which will be able to postpone investments by 100 megawatts and save the costs to produce and distribute 169 GWh of electricity annually. It will also help to reduce the impact of reducing subsidies on electricity for low income customers as the utility is committed to reduce the present cross subsidies among customers. The utility will further benefit from the institutional and technological learning derived from this project.

An unofficial economic evaluation of the project has been carried out. The result shows that the internal rate of return (IRR), exceeds 56 % for all events considered; for CFE the IRR will exceed 39% for all probable events, and for the participants the minimum IRR calculated was 62%. The project has thus very attractive internal rates of return for all parties involved, and the results are very robust even under pessimistic assumptions.

**3.5 Risks**

The total direct emission reductions caused by the project could be less than calculated for several reasons. The main risks lies in that CFE will not be able to sell all of the CFLs, or that CFLs will fail under the Mexican power system conditions, which has rather high voltage fluctuations. Delays in replacement or use of the CFLs less than 4 hrs. a day will only delay the emission reductions as long as the life time of the CFLs are not affected. The replacement may also cause behavior adjustments by the consumers, which could lead to diminished emission reductions. Due to lower costs, consumers may want to choose to burn lamps longer each day, instal lamps with greater light output and/or increase the number of lamps. There is also uncertainty about the long-term effects of the project, whether the consumers will continue to use CFLs in the future and buy them at full costs. Thus the total future net effect of the ILUMEX project on the GHG emissions are very difficult to calculate today.

**3.6 The baseline scenario**

To define the GEF contribution, it is necessary to agree on the baseline scenario or the reference situation. For this project, the baseline scenario is the emissions from the sector without the ILUMEX project. That is roughly 70 mill. tons of emissions of carbon dioxide annually. The ILUMEX project will reduce the projected increase of emissions by about 120.000 tons per year over the projected 6 year period of the project. However, it is possible that measures could be taken in the future to reduce emissions from the power plants. The fuel mix of the affected power plants could change in the future towards fuel with less carbon content. Plans and figures for this is not developed, and it seems unlikely that such changes will take place in the near future.

## 4. THE GLOBAL ENVIRONMENTAL FACILITY (GEF)

**4.1 The objectives and criteria of the GEF**

The GEF will, as an interim financing mechanism for the UN Framework Convention on Climate Change, provide funding for the "agreed incremental costs" of achieving agreed global benefits.

GEF interventions in the area of global warming are, by the Scientific and Technical Advisory Panel (STAP), classified in Type I and Type II categories. Types I are cost-effective

interventions, such as those related to energy efficiency, in which the economic rates of return to the country are good even if global concerns are ignored. Types II are interventions for which there are global benefits, but the national benefits are less than the national costs.

If it is possible to improve the competitiveness of non-conventional Type I technology and demonstrate its economical, technological and administrative feasibility, then such projects will satisfy the demonstration criterion and be a candidate for GEF consideration. Many Type I projects have significant global and national benefits, but may not be undertaken due to severe capital constraints in the country.

### 4.2 The rationale for GEF funding

The ILUMEX project has on the grounds of the above mentioned criteria been designated as a Type I project. It is considered economically viable from the country perspective, and is not normally eligible for GEF funding. The project has been considered and approved by the STAP and by the GEF participating countries.

The rationale for GEF funding is the perceived barriers to initiate and manage the project. The most important of these barriers are: (i) the lack of information about the technology and how it may work; (ii) the high initial investments; iii) the uncertainty of customers willingness to pay high initial costs, their consumption behavior; and (iv) national investment constraints imposed on CFE for macroeconomic reasons.

The preconditions for a successful project were in place - domination of hydrocarbon based electricity generation; rapid increase in electricity demand; a private sector looking for cost reducing options; increased national priority to reduce local air pollution; and a set of social benefits which could be included. The GEF and the WB would be able to show an economically sound option to reduce GHGs through less demand for thermal generation which could also be applicable to other developing countries.

For these reasons, participation from GEF seemed essential to a) realize the reductions of GHG and b) obtain the benefits related to reduction of local pollution and penetration of energy efficient technology.

## 5. INCREMENTAL COST CALCULATION AND JOINT IMPLEMENTATION.

### 5.1 The ILUMEX project

The GEF assistance will provide the incremental funding to either make projects with global benefits economically viable, or to modify already viable projects to enhance the capturing of such benefits.

The calculations show that the ILUMEX project is very profitable to Mexico. It is therefore not easy to define positive incremental costs related to reductions of greenhouse gases in this project. This implies that the demonstration value should be regarded as the major reason for financing the project from GEF funds.

This does not mean, however that the ILUMEX project could not be feasible in a joint implementation context. If this was to be a joint implementation project, the share of costs

would probably be subject to negotiations. The result would be influenced on how Mexico values the local benefits, and the reduction costs in alternative projects of reducing greenhouse gases in other countries.

The annual benefits related to penetration of energy efficient technology could be seen as bringing resource savings closer to the present, represented by the realization of savings caused by the project in one year. According to unofficial calculations, the present value of this accounts to US$ 5.7 million based on 10% real discount rate.

It is difficult to estimate the annual local benefits from reduced emissions of sulphur dioxide, nitrogen oxides, particulates and other air pollutants. An indication of the value of these benefits could be the costs of plans for further reductions of these emissions. One of the two large thermal plants in Monterrey have for environmental reasons switched from fuel oil to natural gas, the other is partly fueled by natural gas. In Guadalajara there are many small power plants, all fueled by oil. Emissions from the power plants do not cause acid rain in neighboring countries. According to CFE, there are possibilities for a further fuel switch from oil to natural gas, due to environmental reasons. The related costs are not known. Investments in scrubbers or filters etc. seems according to CFE to be unlikely due to high costs. The local environmental benefits can thus be estimated to be between zero and the cost related to emission reduction efforts that would otherwise be implemented, and is thus hard to quantify today.

The size of the total foreign grant is US$ 13 mill. The annual grant costs per ton of saved carbon dioxide emissions will then vary between US$ 21 and 27 depending on the discount rate. For other assumptions about the size of possible foreign grants and different discount rates, the figures are given in table 2 below.

Table 2, Annual grant costs per ton of reduced carbon dioxide emissions for different discount rates and assumptions of the size of possible foreign grants

| **Real rate of return** | **Annual costs per ton of $CO_2$ emissions in US$** | | |
|---|---|---|---|
| | **Possible foreign grants** | | |
| | **23 mill.** | **13 mill.** | **3 mill.** |
| 5% | 40 | 21 | 5 |
| 7% | 41 | 23 | 5 |
| 10% | 45 | 25 | 6 |
| 12% | 47 | 27 | 6 |

**5.2 Reduction costs in other countries.**

Costs of reducing carbon dioxide emissions in other countries could give an indication of the willingness to pay for reductions in Mexico. A study for some OECD countries has been made on the required carbon dioxide tax per ton to stabilize emissions at their 1988-level in

the year 2000. The taxes were assumed to be implemented in addition to existing taxes.

Table 3, Required tax rates in 1989 US$ per ton carbon dioxide i different countries to stabilize the emissions at their 1988-level in year 2000, and the suggested 1995 figures for a gradual increase up to the year 2000.

| **Country** | **1995** | **2000** |
|---|---|---|
| United States | 9 | 33 |
| Canada | 9 | 39 |
| Japan | 43 | 110 |
| Australia | 20 | 55 |
| Germany | 30 | 80 |
| France | 38 | 95 |
| Italy | 22 | 54 |
| United Kingdom | 7 | 20 |
| Sweden | 6 | 16 |
| Spain | 50 | 121 |
| The Netherlands | 18 | 46 |
| Greece | 27 | 69 |

Source: DRI/McGraw-Hill (1992): Economic effects of using carbon taxes to reduce carbon dioxide-emissions in major OECD countries.

These tax rates should be corrected for the rate of inflation up to 1993 to make them comparable with possible annual reduction costs in the ILUMEX project. There may be single projects in each country with a lower cost of reducing a ton of emissions of carbon dioxide than the tax rate. These tax rates, however, give an indication of the differences in marginal costs of reducing carbon dioxide emissions between the countries. Some of the required tax rates in 1995 are lower than the calculated costs in the ILUMEX project, when US$ 13 mill. grant is assumed. However, most of the tax rates in year 2000 are higher than these costs.

Research projects in Norway have calculated the required tax in the year 2000 to stabilize the Norwegian carbon dioxide emissions at 1989-level in the year 2000 at approximately US$ 184 per ton. A stabilization of the carbon dioxide emissions from the OECD-countries as a whole will require a carbon dioxide tax at about US$ 60 in the whole OECD-area. These taxes are higher than the calculated costs in the ILUMEX project.

The annual marginal costs per ton carbon dioxide reduction in the Polish Coal to Gas Conversion project was calculated to about US$ 32 and US$ 69 for the to facilities respectively.

**5.3 Existing taxes.**
It is interesting to compare costs with existing carbon taxes. Below is shown the total nominal tax rate, i.e. carbon dioxide tax plus energy tax on fossil fuels, and nominal and effective carbon dioxide tax rates in 1993 for the Nordic countries in US$ per ton carbon dioxide. Effective tax rate is defined as average tax paid on all emissions, and is lower than the nominal tax rate due to exemptions for some sectors and fuels.

Table 4, Carbon dioxide tax rates, US$ per ton emission of carbon dioxide

| **Country** | **Total Nominal Rate, 1993** | **Nominal $CO_2$ Rate, 1993** | **Effective $CO_2$ Rate, 1993** |
|---|---|---|---|
| Denmark | 36 | 15 | 7 |
| Finland | 40 | 4 | 4 |
| Norway | 63 | 56 | 27 |
| Sweden | 100 | 55 | 33 |
| EC proposal | n.a. | 25 | n.a. |

Source: OECD Environment monographs No.78 1993: A comparison of carbon taxes in selected OECD countries.

The total nominal rate is the most relevant tax to compare with cost of reducing carbon dioxide emisions in other countries. It could be seen that these taxes are higher than the calculated costs in the ILUMEX project, assuming a grant of 13 mill. USD or lower.

**5.4 Verification and monitoring of results**
A monitoring and reporting design will be an integral part of the project. Because of the demonstration character of the project, it will probably be reviewed by GEF participant countries for potential replicability. It is therefore important that the project should have a comprehensive monitoring and evaluation program to evaluate project impacts and benefits. Such a program should be established in accordance with international procedures and requirements. The program should include pre- and post-evaluation of GHG emissions and other air pollutants. Recognizing the importance of this activity for producing verifiable project results, CFE should establish an independent monitoring and evaluation team. The process should be transparent and open to verification.

## 6. CONCLUDING REMARKS

Defining a baseline scenario has been easier in the ILUMEX project than in the Poland Coal to Gas Conversion project. A possible future switch of fuel from oil to natural gas is the most uncertain factor in this respect. Such a switch seems unlikely to be implemented in the near future because of high costs and the need for additional gas pipelines.

There is, however, a large uncertainty concerning the future net emission reductions caused directly and indirectly by the project. The diffusion effect of the project could be substantial, but will be hard to calculate. However, there are also possible effects in the form of behavior adjustment by the consumers resulting in a higher consumption. It is also uncertainty related to whether the electricity consumers will continue to by CFLs, but at full costs. The size of such effects is very difficult to predict. Should these effects, which is only possible to determine after some time, be counted in a joint implementation context, the definition of carbon dioxide credits for donor countries must be adjusted through an evaluation several years after the formal completion of the project.

Because of the high profitability of the project, there is no incremental costs related to it. This indicates that in a broader joint implementation context it would be very difficult to rank projects from the size of their incremental costs. The project could despite of this fact, however, be considered as a joint implementation project. The share of costs would then most probably have to be subject to negotiations between the parties.

It could be argued that subsequent high-profitability projects should not be financed through GEF, but rather through other WB grants/loans or development assistance resources.

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