Evaluating Mexican and Brazilian Residential Compact Fluorescent Lamp Programs: Progress and Unresolved Issues

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ABSTRACT

The evaluation experience from sixteen residential lighting demand-side-management (DSM) projects and programs carried out since 1990 in Mexico and Brazil is reviewed. A clear evolution both in the infrastructure and conception of what evaluation of DSM programs entails is evident. Early evaluation focused only on project impacts (energy and peak power savings and distribution system power quality). As projects progressed, more attention was paid to ascertaining marketing aspects of the DSM programs. Process evaluation was recently incorporated into program evaluation in Brazil but has yet to occur in Mexico. Future DSM program evaluations will need to adapt themselves to the changing reality of more privatized electric systems in these two countries. There will also be a need to define monitoring and evaluation protocols to guide the incipient evaluators.

Introduction

Mexican and Brazilian policymakers are intent on addressing the rapidly growing electricity demand of about 5-7% annually. The residential sector is beckoning, as it comprises about 25% of total electric consumption and an even larger portion of peak load demand (40% in Mexico Friedmann 1996; 36% in Brazil Jannuzzi 1994). As residential lighting is among the largest end-uses of household electricity and almost entirely done with incandescent bulbs, compact fluorescent lamps-CFLs are an attractive option to reduce future growth in peak load demand, defer electric sector investments, and reduce utility revenue losses due to (usually) subsidized residential tariffs.

We examine the objectives and methods used to evaluate fifteen residential CFL DSM projects and one nationwide program undertaken in Mexico and Brazil, since 1990. This overview provides almost a ten-year span of experience focused on one energy-efficient product. We expect CFLs will continue to be used to save energy both in these two countries as well as other developing countries. The data also allow us to track the evolution of evaluation in these two countries, as the efficiency programs themselves became more sophisticated.

Mexican Residential CFL Experiences

Since 1990, Mexico has promoted the replacement of incandescent lighting with CFLs. The residential CFL projects have been implemented by PAESE (Program to Save Energy in the Electric Sector; part of CFE, the main public electric utility) and/or FIDE (a private non-profit trust fund for saving energy initially in support of PAESE), and the Subdirectorate of Distribution of CFE. The Mexican residential CFL projects are briefly described in Table 1 (further descriptions of these projects can be found in: Blanc 1999; Friedmann 1996; Vargas 1999).

Table 1: Mexican Residential CFL Projects 1990 to Date

Project & Date Done	Program Description & Results	How Evaluated
Hermosillo I 5/90	150 homes (500-1000 kWh/mo.) direct-install 3 free 18Watt CFLs. Estimated savings of 9%. Users wanted quicker turn-on, more light, and willing to pay 50% of retail prices in bill installments.	Estimated savings from lamps replaced and bills. Surveyed 50 users for customer satisfaction.
Puebla 8/90	136 low income homes (< 100 kWh/mo.) direct install 3 free 18Watt CFLs. Saved 14% energy, 17% peak power and 3.4% power factor reduction. 6 users' bought appliances and/or became a commercial establishment, doubling electric use after CFLs. USA survey: 88% happy with CFLs due to savings, better quality of life & longer lifetime. 53% noticed lower bill. 23% disliked flickering. After 3 years: 30% no longer used, avg. savings 4.4%, used 3.9 hr/day. 22% couldn't find replacements, 17% didn't know where to buy. 77% willing to pay US$ 10, 8% US$ 20. Retailed for 7-10 $.	Metered savings at transformer banks. Further survey done by USA student in 1993 to see customer views on program and permanence.
Queretaro 3/91	100 homes (400+ kWh/mo.) direct install 5 free 9 Watt CFLs. Saved 16% energy, 9% peak, compared to control group; 14% energy savings metered. 34% initially refused CFLs due to low light output, 40% complained of interference.	Metered consumption, peak load and power factor at local transformer. Compared savings with those of control group.
Valladolid 10/91 - 5/92	Initial rebate redemption at CFE replaced with "aboneros" (house-to-house sales with financing). Sold 81% of the 9,100 CFLs via aboneros. 100 users that bought 5 CFLs each saved 20% of electricity.	Manual sales tracking. Survey (as sales dropped) led to aboneros. 100 user CFL permanence survey.
Chetumal 10/91 -11/92	Comites de Solidaridad sold/financed 25,000 CFLs. Varied rebate to discourage circular CFLs.	Manual sales tracking.
Hermosillo II 3/92 - 10/94	75% of 84,000 CFLs sold were circular 22-Watt as offered same rebate for all CFL models.	Computerized tracking of sales.
Guaymas 3/92 - 10/94	Sold 2,500 CFLs. Extension of Hermosillo II project.	Computerized tracking of sales.
Cozumel 3/94 -5/95	Sold 2,500 CFLs. Extension of Chetumal project.	Manual sales tracking.
Aguascalientes 1-4/95	41,000 CFLs sold or financed, with payments done via electric bills.	Computerized tracking of sales. CFL lab tests. Permanence survey.
Ilumex 4/95 - 12/98	2.5 million CFLs sold or financed over 2 years bill payments. Sales mostly at CFE offices. ~ 20% of cost for administration. 16% average participation rate.	Ex-ante lighting survey & CFL lab tests. Mid-way use patterns survey. Ex-post electricity, peak load & GHG emissions savings & benefit-cost.
Nationwide 1/96 to date	Plan to sell 6.1 million CFLs using Ilumex model. By 12/98 projects in 17 cities had sold ~ 2 million CFLs.	Measured & surveyed: peak load & electricity savings, benefit-cost, permanence & market changes.

The Mexican projects reflect four major shifts in the objectives and evaluation efforts of residential CFL projects in Mexico, as a learning curve process occurred among the implementing agencies. The learning curve was possible because of the close connections among the agencies involved, which allowed for the incorporation of lessons learned from past experiences to be incorporated into new projects. The projects culminated in the Ilumex project, where 2.5 million CFLs were introduced to homes, and the current FIDE nationwide program that aims to introduce another 6.1 million CFLs into homes by the end of 2000.

The four "eras" of project objectives and evaluation efforts were: (1) the verification of CFL technology as an energy saving option, (2) customer acceptance of CFL, (3) the need to ensure CFL marketability, and (4) the need to ensure maximum benefits while minimizing costs (including environmental impacts). Each era built upon the experiences of the previous one, and reflected changing attitudes as to what CFL programs objectives were and what they entailed. The evaluation strategies in these projects reflect the crucial monitoring and evaluation needs regarded in each "era".

Early Mexican CFL Programs Objectives and Evaluation Focused on Utility Concerns

The first two "eras", encompassing the first three projects (Hermosillo I, Puebla, and Queretaro) were spurred by an initial donation of CFLs by Philips Mexicana, who was manufacturing CFLs in Mexico, and wanted to see if there was a local market for CFLs. The utility wanted to verify Philips' claims that CFLs saved electricity and would be accepted by customers. Evaluation in these projects focused on estimating (using consumer self-reporting or installer data, and/or measuring at the local transformer banks), the electricity consumption and peak load power savings, and changes in the local grid power factor. Surveys were conducted in the three projects to ascertain customer views on the CFLs.

The results of the first two projects showed that measuring electricity savings at the transformer level was not enough to determine accurately the savings due to the CFLs, as users' baseline consumption patterns could change (e.g., due to purchases of appliances or population changes). This led to the use of a "control group" in the Queretaro project. Only homes on one side of a street were given CFLs, while the opposite side of the street homes served as a control group to mimic changes in household electricity use patterns and demand. The Queretaro project showed that projected savings were not being achieved. Engineering estimates of electricity savings were double what were measured (based on a comparison of participant and control group households), leading PAESE to suspect some consumers were taking out the CFLs. This indeed could be the case, as 34% of households initially refused to participate because of the low light output of the 9 Watt CFLs being promoted, and subsequent 100 homes survey results showed that customers in forty homes complained that the CFLs interfered with televisions and radios. CFE was promoting CFLs with the objective of maximizing its benefits, without understanding the need to cater to customer needs.

Marketing is Included as a Program Objective in Mexican CFL programs

CFE became interested in implementing a multi-million nationwide CFL residential program and began to examine marketing mechanisms for the CFLs (since giving away the CFLs to homes was unacceptable in the new conception of government as a facilitator of free markets). As CFLs were at least an order of magnitude more expensive than incandescent lamps, CFE's General Directorate gave US$400,000 to FIDE to sell 120,000 CFLs with a rebate of about US$ 3/CFL (half the retail price of the least expensive, 9-Watt CFL).

Marketing was the focus of the projects in Valladolid, Chetumal, Hermosillo II, Guaymas, and Cozumel. These projects taught CFE the importance of paying attention to customers' needs. This implied ensuring both availability (by signing agreements with manufacturers and retailers), and accessibility (by using simple procedures that made it easy for participants to pay: e.g., offering financing. A differentiated rebate (i.e., different for each CFL model) was tried to foster purchase of higher efficiency CFLs. Evaluation focused on CFL sales, and if sales lagged, figuring out why sales lagged and how to solve it.

The Valladolid project taught PAESE the importance of using locally accepted distribution channels, financing, and a differentiated rebate. An identical rebate for all CFLs, together with an accord with CFL vendors to sell CFLs at cost (no mark-up), was used to try to solve the initial cost hurdle. Yet the project almost failed due to the complicated payment mechanism initially used. Customers had to purchase the CFL at a participating store, then take the receipt, CFLs, and last electric bill to the local CFE agency. CFE used the customer's account number and located the five rebate coupons allocated to each customer. The customer signed the appropriate number of coupons and was paid the rebate. Sales did not proceed. CFE surveyed customers. The main problem was low income of users and high initial cost of CFLs, and to a lesser degree also apathy, communication problems and lack of information on the program. CFE decided to go to a house-to-house scheme using "aboneros" (local travelling salesmen who sell their wares on credit). The users received their rebates while paying their electric bill and the first of the two installments on the CFLs. The aboneros sold 81 percent of the CFLs. Customer preference for circular, less efficient but cheaper CFLs (86% of sales) showed CFE the importance of having a differentiated rebate. Energy savings were measured at the distribution transformer level (results are unavailable).

The Chetumal project (an expansion of the nearby Valladolid project) reinforced the concept of local, trusted agents as effective sales channels, and the need for a differentiated rebate. Eight local "Comites de Solidaridad" were used as the promotional agents. Since sixty percent of initial sales were circular 22-Watt CFLs, PAESE and FIDE instituted a differentiated rebate where circular CFLs only got a 7,000 peso (~ US$ 2.3) rebate while all other CFLs were rebated 12,000 pesos (~ US$4), to make circular CFLs less attractive. CFE still believed it could convince homes to use the CFLs that maximized electricity savings, instead of what consumers preferred. Initial billing analyses of 10 users showed average household savings of 8%. Also, there were some problems with availability (existence) of CFLs in this remote location.

The value of tracking CFL sales with a computer database was demonstrated in the Hermosillo II and Guaymas projects. Hermosillo was revisited to reduce residential electric consumption and high electric bills. Formal accords with manufacturers sought to avoid CFL availability problems experienced in Chetumal. The computer tracking allowed timely analyses of customer preferences and identification of areas requiring more outreach efforts. Because the rebate given was the same for all CFLs, about 75% of sales were circular 22-Watt CFLs. Measurements of electricity savings were done (results are unavailable).

The Guaymas and Cozumel programs were extensions of the Hermosillo II and Chetumal projects; being neighboring towns facing similar issues. The focus again was on selling CFLs. No information is available on whether these projects were evaluated beyond tracking CFL sales.

Mexican Residential CFL Projects Reach Maturity

The Aguascalientes project was used by CFE to test the strategies contemplated for use in the Ilumex project (Blanc 1999). The project included computerized tracking of sales and, for the first

time, laboratory tests of CFLs. The project sold 40,000 CFLs in three months instead of the expected five months. The CFLs were sold on credit to be paid over one year in the electric bills. FIDE provided the credit. The CFL sales success of Aguascalientes was astonishing as it got underway in January of 1995, in the midst of a major macroeconomic crisis in Mexico. Aguascalientes showed that the technical and marketing aspects of residential CFL projects had been fine-tuned to the Mexican context.

The Ilumex project, the first large-scale residential CFL project in a developing country, drew upon the lessons learned both within Mexico and abroad. Its objectives were to sell 1.7 million CFLs, primarily to small, highly subsidized (over 50% subsidy) residential customers, to prove that CFL projects were a cheaper alternative for the future development of the electric sector, and an option for reducing power sector greenhouse gases (GHG) emissions. Initial plans called for sales taking place in the cities of Guadalajara and Monterrey. Customers would be allowed to purchase up to 6 CFLs whose price had a 49% average subsidy; the balance was to be paid in cash or financed for up to two years in the electric bill.

Ilumex was the first project that included an in-depth ex-ante evaluation, partly to conform to foreign sponsors' requirements. The World Bank, initially a potential financier, asked for an in-depth feasibility study that was paid for by USAID. The feasibility study examined technical aspects for the CFLs (including laboratory testing of CFLs), patterns of lighting use and demand in the homes (via a 1000 home lighting survey), and the economics of various rebate and financing schemes from the national, utility, and customer perspectives (Friedmann 1996). The World Bank did a further economic feasibility evaluation, which was part of the proposal for GEF Board of Director's approval (GEF 1994). The evaluation also examined the cost-effectiveness of GHG emissions reductions, an important consideration for the support from the Global Environment Fund (GEF) and the Kingdom of Norway.

The in-depth and continuous external evaluation effort using foreign consultants envisioned did not happen, apparently due to its high cost. CFE did monitor CFL sales, project expenses, and did a mid-project survey and direct measurements in 100 homes to verify patterns of use of the CFLs. Sales progressed as planned, because CFE expanded the sales area to the entire States of Jalisco and Nuevo Leon and parts of neighboring states. The maximum number of CFLs customers could purchase was increased to ten. Computer sales tracking showed that sales were mostly to the larger (and wealthier) customers. The survey showed that the increase to ten CFLs/home reduced the average hours of daily CFL use; reducing the yearly electric consumption and peak load savings per CFL, and negatively impacting the economic attractiveness of the project for the utility and yearly GHG emissions savings (Vargas 1999). To enhance sales to lower consumption customers, CFE added house-to-house efforts and sales outlets at large factories in the Guadalajara area, selling 10% of the CFLs in this area this way. This improved the proportion of small users participating. Participant-observers did informal and partial process evaluations of Ilumex (Friedmann 1996 & 1998; De Buen & Masera 1994).

The first major Mexican CFL permanence study was sponsored by FIDE in August and September 1998. It evaluated Valladolid, Aguascalientes, and Ciudad Juarez (one of the nationwide program cities). It found 33%, 70% and 72% of the CFLs in each city respectively, still in use (Buitron 1999). The main reason for missing CFLs was that they no longer worked. Up to 20% of respondents claimed to have purchased CFLs outside of the DSM projects. Daily average use was 2.7 hours, with a 33% peak coincidence factor. The study also examined retail market accessibility; a reflection of the increasing sophistication of evaluation in Mexico. CFLs were found in 88%, 60%, and 10% of the stores visited in Aguascalientes, Ciudad Juarez, and Valladolid, respectively.

In view of the CFL sales success of Ilumex, CFE and FIDE are carrying out a nationwide residential CFL project, which will introduce six million CFLs by the year 2000 (Urteaga 1999). Another 500,000 CFLs will be sold in the Mexicali area as part of a multi-facet residential efficiency program. All these projects will offer subsidized CFLs, sold in cash or financed with payments in the utility bill.

Improvements and Challenges to Future Mexican CFL Program Evaluation

The weakest area to date has been in formalizing an independent evaluation infrastructure that focuses not only on energy impacts and economic performance, but also on process assessment and improvement. Mexico has shown that "learning-by-doing" worked by using pilot-scale projects to better tailor the technical and marketing aspects of residential CFL programs to meet Mexican consumers' needs. What remains is to fine-tune the current scheme to optimize the subsidy given for CFLs. This will require some process evaluation.

Mexico is now considering privatizing its electric sector. At this time it is not clear what changes will occur nor when. Yet, it is conceivable that regardless of the final structure for the sector, there will be a need for energy efficiency projects and their careful evaluation.

Brazil's Experience in Residential Lighting Projects

Five projects were developed during 1993-98 by public electricity utilities from three States: the Energy Company of Minas Gerais - CEMIG, The Energy Company of São Paulo - CESP, the São Paulo Light and Power Co. - CPFL and the Energy Company of Ceará – COELCE. These projects had different underlying motivating factors, thus their objectives, implementation and evaluation schemes differed.

CEMIG faced concrete problems with electricity supply and financial constraints to expand its transmission system in a particular region (Vale do Jequitinhonha) where low-income households and electric consumption predominate. These aspects convinced CEMIG to use a CFL give-away program for the region. CEMIG's objective was to reduce 1.8 MW during peak period and increase residential energy consumption during off-peak hours, so that it would not loose revenues (residential customers pay only flat energy rates, which do not vary according to the time of use). The company would also improve its system load factor.

The project implemented by CESP was motivated by its interest in understanding consumer behavior with regards to the new CFLs. CESP's objective was to determine market response due to a marketing campaign and discount levels offered for the CFLs. Its evaluation procedure included a questionnaire with items such as customers' satisfaction with the lamps, the marketing campaign, reaction to the CFLs prices, and reasons for customer participation.

The two projects developed by CPFL were guided by the desire to promote conservation programs to extend the lifetime of their existing distributing installations (substations and transformers) in areas where continued demand growth would require significant and costly upgrades. CPFL's objective was to investigate the impacts (cost-benefits and energy savings) of different delivery and dissemination mechanisms. Project (I) tested 3 different rebate levels and project (II) offered financing via a monthly payment system for the CFL purchased.

COELCE was interested in promoting energy conservation in its residential market, especially amongst low-income households who receive heavily subsided tariffs. The utility was facing difficulties to meet the increasing demand and had limited resources to expand its transmission and

distribution lines. The utility wanted to test in a pilot scale a rebate and financing scheme and measure the amount of savings achieved and its cost/benefits.

Table 2 summarizes the main efforts of the four utilities during 1993-98. The projects can be considered modest in scale, especially if we compare them with international experience. The total number of lamps installed through each project varied from 2,000 to 90,000. Total costs varied from about US$19,000 to US$700,000. The delivery mechanisms tested by the utilities consisted of giveaway, rebate and monthly payment options.

Table 2. Description of Brazilian Residential CFL Projects

Characteristic	CESP	CPFL (I)	CPFL (II)	CEMIG	COELCE
Year done	1993	1994	1995/1996	1995/1996	1997/1998
Project type	Rebate	Rebate	Financing	Direct install	Rebate & financing
CFL user costs	US$11	US$4.8 to 29	US$10.4 to 25	None	US$12 to 18
CFL retail price	US$16	US$16 to 41	US$12.4 to 21	~US$8 [a]	~ 20% more
Participants	76,889	153,775	43,101	~52,000	4,173
Project costs [b]	US$19,270	US$670,00	Not available	~US$740,000	US$250,000
Lamp type	CFL	CFL, circular	CFL, circular	CFL	CFL, circular
Ballast type	Magnetic	Electronic & magnetic	Electronic & magnetic	Magnetic	Magnetic
CFL Wattage	9	15 to 32	15 to 32	9	15 to 25
Project duration	40 days	1 month or 10,000 sold	6 months	1 year	4 months

Notes: all financial values are in current US$ and refer to the year of the project;
[a] average cost per installed CFL;
[b] costs include: CESP: information campaign; CPFL: rebate, project administration, information campaign, implementation and evaluation; CEMIG: CFL and installation costs (estimated).
Sources: Jannuzzi, Dornelas, & Bittencourt, 1997; Jannuzzi et al., 1997.

In CEMIG the implementation of the full scale program was preceded by a pilot project. The CFLs were installed in homes with monthly energy consumption up to 50 kWh. CFLs were purchased by the utility, and local technicians were hired to install the lamps. The project distributed only one type of CFL.

CESP's project was essentially based on a marketing and information effort and a 30% discount given by the manufacturers. A discount coupon was included with the electricity bill. One type of CFL was offered, and no limit was placed on the number of lamps purchased. The project took place in four cities of the State of São Paulo (Atibaia, Franco da Rocha, Ubatuba e Campos do Jordão). Although four lamp manufacturers participated in the program, only one type of product was marketed (9 watt lamp) with small differences in lamp-ballast design.

The CPFL project (I) used three different rebate levels (30%, 60% and 70%) in three different cities (Americana, Marília and Franca) and the same information and marketing campaign. The rebate coupon was mailed directly to the customers. Thirteen different types of lamps were marketed. The project was based on reduced prices and allowed customers to purchase a maximum of three lamps. The utility limited the total of 10,000 CFLs for each city (see Jannuzzi & Santos 1995).

The CPFL II project was implemented in two cities (Botucatu and Valinhos). A small discount of US$2.00 that could be paid in up to four monthly installments was offered. In addition a marketing and information campaign was developed and used in the two cities. This project marketed seven different

types of CFLs and there was no limit on the number of lamps purchased by the consumer. A total of 50,000 CFLs were available for CPFL (II).

The COELCE program had two rebate levels for the low-income segment and a financing scheme applicable to all households living a specific portion of the city. The initial target was to sell 30,000 efficient lamps and acquire enough experience to eventually expand the program to the rest of the city, if it proved to be cost-effective to the utility and well accepted by customers.

Results of Brazilian CFL projects

Table 2 shows the results of the five projects. Except for the give-away project, the highest participation rates (5-9%) were achieved by the CPFL (I) project, but it is important to highlight that this project limited the maximum CFLs per customers. In the other projects participation rates were not used by the utility as an indicator of participation performance. The number of lamps per participating customer varied from 1-2 (CEMIG), an average of 1.7 (CESP) and 2.5-2.9 for the CPFL (I) project (this project had a limit of 3 lamps/customer).

Prices are an important parameter impacting CFL purchases. In CPFL (I) the best selling CFL was the cheapest: a circular, magnetic ballast lamp which replaced a 60 W incandescent lamp.

Several lessons were learned from these projects. The give-away strategy led to a high participation rate and a lower CFL price; the program was also targeted to areas were the utility had particular interest in electricity savings. On the other hand, this strategy did not include the participation and interaction of all actors in the lamp market (vendors, consumers, lamp manufacturers) and provides a passive customer behavior towards energy efficiency. It is, however, very suitable for emergency supply/distribution situations.

The other projects sought the participation of the utility, lamp manufacturer, vendors and customers. It was also possible to analyze the effects of the marketing and information campaign and consumer preference. It must be observed that there were problems with the supply of CFLs during the program, and indications that lamp manufacturers had their own strategies to market and commercialize the products. Another important aspect was that for the first time, utilities had to provide a different service to their customers, involve different areas of their companies, and hire outside experts.

Brazilian Project Evaluation Methods

Table 3 shows the types of evaluation efforts undertaken. CEMIG and COELCE were the only utilities to perform ex-ante measurements. CEMIG used the information collected previously to design its implementation strategy. Its ex-ante evaluation included a household survey (collecting data on appliance ownership and consumption habits) and electrical measurements in appropriate transformers and substation feeders. It also performed an ex-post evaluation 90 days after end of the CFL installation, administering survey questionnaires to collect information on customer satisfaction, and performing new measurements to detect actual electricity demand and use savings accrued from the project.

The evaluation process performed by CESP focused on verifying items directly related to some specific objectives, such as campaign recall, CFL sales, lamp usage patterns, consumer satisfaction, consumer's reaction to lamp prices, and a socio-economic profile of program participants and non-participants. A household survey was performed 180 days after the program ended, but no information was collected before the program was implemented. Energy and demand savings were inferred from CFL

sales. In the case of CESP the evaluation procedure of the program was defined after the program had finished.

Table 3. Results of the Brazilian Residential CFL Projects.

Characteristics	CESP	CPFL (I)			CPFL (II)	CEMIG	COELCE
Rebate level	None	30%	60%	70%	None	none	~ 20%[g]
Type of evaluation [a]	I (ep)	I (ep), C	I (ep), C	I (ep), C	None	I[f],M	I[f],P,C,M
Total CFLs	2,232[b]	5,700	11,050[c]	10,058	not available	~ 89,000	12,027
Participation rate[d]	~1.7 %[e]	5%	9%	5%	not available	~100%[e]	2.3%
Savings estimate KW (peak) MWh/yr	 69 324	 203 325	 357 602	 352 593	 not available	 1,845 857	 190 557

Notes: [a] I = impact, P = process, C = cost-benefit, M = measurement, (ep) = ex-post.
[b] after the project sales were over an additional 881 CFLs were sold over the following month;
[c] more than 10,000 CFLs were sold due to accounting problem during the last day;
[d] participation rate: participating households/potential participants;
[e] authors' estimates.
[f] ex-ante and ex-post evaluations were made.
[g] A US$ 4 or US$ 8/CFL was offered to low income, subsidized tariffs, households.

Sources: Same as Table 2.

CPFL (I) developed an evaluation method to assess the participant rate, information campaign, lamp usage patterns, customer satisfaction with the CFLs and the program, and costs and benefits to the customer and utility. The energy and demand savings were estimated from lamp sales and customers declarations. CPFL (II) administered a questionnaire to households when they came to the stores to purchase the lamps. A second set of questionnaires was administered to samples of participating and non-participating households when the lamp sales period ended, but these results are not available. No ex-ante information was collected in the case of CPFL (I) and (II).

COELCE included a more detailed evaluation procedure compared to the previous programs. The program design contemplated data collection for evaluation purposes during its implementation and time and resources were budgeted for the effort. It is the first Brazilian program to present a process evaluation that included the participating lamp manufacturers, retail shops, program coordinators and staff. The impact evaluation consisted of ex-ante and ex-post impact evaluation, including end-use measurements and special surveys in several parts of the city to measure spillover effects.

Policy Implications for Programs in Developing Country Contexts

The reality of trying to introduce CFLs for mass-acceptance by households in Latin America is that two markets exist: the affluent who can purchase these outright, and the overwhelming majority of homes whose incomes make the CFLs prohibitive due to their high first cost and lack of credit or financing possibilities. This means that at least two approaches are needed for further dissemination

and promotion of the CFLs: (1) information campaigns for all customers; and (2) programs combining a subsidy in the price of the CFL (could be a direct rebate to customers or to manufacturers/distributors) with a financing scheme (payments made in the electric bills) for the income-constrained households. It is important that evaluation accompanies these programs to verify program effectiveness and to provide guidance on what modifications are most appropriate. Evaluation in the Latin American context must seek to improve the program implementers' understanding of end-users electricity consumption patterns and attitudes. Such base-data collection will not only provide a better baseline for project evaluation, but will also provide guidance for future projects design and improve the capability to build scenarios for future residential sector evolution.

We expect that most energy efficiency projects and programs will continue to be implemented by public entities, either directly or by mandating private parties to promote energy efficiency. This indeed is already the case in Brazil, where the law privatizing the public utilities has a clause that forces the concessionaires to spend 1% of yearly revenue (about 200 million dollars) on energy efficiency actions (at least 1/4 of this with end-users). Evaluation will be crucial to ensure that these funds are spent wisely and that the policy is well implemented. As efficiency programs increase in size, it will be imperative to ensure that other energy and/or fiscal policies in place promote, or at least do not discourage energy efficiency. Evaluation can be used to highlight changes to current policies to design new policies. For example, evaluation can point to the benefits of moving from DSM to more market transformation approaches in Mexico and Brazil. In view of the cultural bias against recognition of mistakes, policies can be enacted to require evaluation of all efficiency projects above a certain size.

Lessons Learned in Mexico and Brazil

In Mexico, evaluation has become increasingly more complex in scope and depth as a response to the evolution of perceptions amongst implementing parties as to what aspect of a project was crucial to the success of CFL sales and subsequent energy and peak load savings. Learning-by-doing has been possible because of the continuous involvement of the same implementing agencies, using previous experiences to refine the design of new projects. Evaluation has progressed from only examining energy impacts to examining marketing accessibility and availability to ensure sales, and finally, examining the cost-effectiveness of the strategies, including environmental aspects. The cost-effectiveness aspects have in part mimicked the increasing economic-technocracy within government during the last 16 years. The attention to environmental impacts also reflects the increased awareness of environmental issues both within Mexico and abroad. What is still lacking is in-depth process evaluation, which is understandable in view of the cultural antipathy to public acknowledgement of mistakes.

The Brazilian experience differs from Mexico in that the residential CFL programs were done by different utilities. Each utility faced different challenges and contexts. Thus, the objectives of the CFL programs differed among the utilities, and the evaluation methods were also different. There was less opportunity to learn-by-doing, as the projects were for a limited period and, with the exception of the CPFL utility, have not led to further efforts. The more active participation of PROCEL in the COELCE project was important to ensure a more comprehensive and sophisticated evaluation procedure. PROCEL has been working with experts from Brazilian universities and North-American utilities in order to develop "in-house" know-how. This is consistent with the perceived importance of more rigorous evaluation methods in order to be able to assist the National Electricity Regulatory Agency to review the privatized utilities' annual DSM plans.

The results in both countries do show that CFLs can be sold to homes and that this will result in reduced demand for electricity consumption and peak load. The projects have shown the importance of ensuring availability (in both quantity and types of CFLs) and accessibility (by providing a mix of purchasing and/or financing options) in the marketing of CFLs. The programs have corroborated the existence of two distinct residential markets: (1) one comprising the vast majority of households, of limited economic means and few CFL opportunities/home; and (2) the other comprised of a minority of households, generally very wealthy and with many CFL opportunities/home. Program marketing needs to differ for each segment to ensure the economic cost-effectiveness of programs. Finally, the results show that CFL projects can be tailored to both, address the target audiences and the specific government and utility objectives.

Conclusions

The Mexican residential CFL programs have progressed consistently from pilot-stage to large-scale, mature programs. The Brazilian programs are just moving from the pilot-scale to larger programs, with a recent shift in evaluation methods and program design.

In both countries, however, we noticed a reticence to do in-depth evaluation and admit mistakes publicly. This may change in the future, especially in Brazil with the requirement for privatized utilities to invest in energy efficiency programs, which implies that some accountability and reporting will need to take place. The most recent project, done by COELCE with support from PROCEL, shows the concern for a more thorough evaluation and its importance to improve the design of more cost-effective programs. Mexico also shows an interest in more thorough evaluation as is evident in the Ilumex and nationwide CFL programs.

One aspect of program evaluation that needs further consideration is the dynamic aspect of energy markets in most developing countries. Circumstances can arise and/or change much faster than in developed countries. These can significantly alter the marketplace for energy efficiency (e.g., currency devaluation). The use of pilot-scale projects, for example, to learn more about potential customers and establish links among market actors seems to be born out by the Mexican and to a lesser degree by the Brazilian experience. Pilots can eventually lead to major scale efforts. Learning-by-doing (with adequate evaluation) seems to be the most effective way of implementing energy efficiency in developing country contexts. Having a central repository of project experiences is crucial to ensure that the lessons learned are applied in future projects.

Evaluation is crucial to: (1) show that efficiency programs do indeed work and are cost-effective; and (2) collect baseline market data for use in future endeavors. Evaluation will also be needed if utilities are privatized and then required to spend public service funds, to ensure that the programs and projects undertaken are effectively carried out.

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