

# **Improving Electricity Services and Reducing Energy Losses for the Urban Poor**

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## **ABSTRACT**

One billion people and growing at a reported rate of 5% per year live in poor urban and peri-urban areas, throughout the developing world.

This paper shares experiences and economic and social studies on innovative, socially responsible and cost-effective approaches, to expanding access to electricity services in these poor urban neighborhoods. The paper reviews worldwide lessons learned, with a particular highlight of the pilot project in the favela of Paraisopolis in Sao Paulo, Brazil, which was conducted by AES Eletropaulo, the U.S. Agency for International Development (USAID), and the International Copper Association (ICA) with local community and industry partners.





The focus of this project is on the safety and reliability of energy supply and use, and especially, the benefits of energy efficiency and renewable energy, as applied to residential and commercial buildings in poor urban areas, commonly called “slums”. Furthermore, the paper discusses the challenges, sustainability aspects, socio-economic conditions, financial analysis, regulatory and institutional factors, and technical solutions.

The total investment in the pilot project reached US\$1.8 million. The financial analysis concludes that the payback is a very attractive 1.5 years, making the business case for action.

## **Introduction**



Area: About 20,000 households in the middle of São Paulo



**•Area**


- 4,365 customers in **pilot project**
- 89% Residential
- 10% Commercial
- 1% Residential & Commercial

**• Population Data**

• < age 8	20%
• ages 9 – 17	18%
• ages 18 - 50	56%
• > age 50	6%

**• Earnings**

• 0 – 300 Brazil Real	7%
• 300 – 600 Real	50%
• 600 – 1000 Real	24%
• 1000 – 2000 Real	18%
• > 2000 Real	1%



Diretoria Regional Sul

Before project implementation in Paraísopolis, the second largest “favela” (poor urban “slum” area) in São Paulo, Brazil, the quality of electricity service was very poor: almost all the households and businesses had illegal electricity connections, were exposed to dangerous network and wiring conditions and did not pay for service. Households and businesses consumed, what are considered for this population, high amounts of electricity – on average 250 kWh/ month – due to the very poor condition of household appliances and electrical equipment (especially refrigerators and electric water heaters for showers), and the lack of price signal to encourage consumers to use electricity wisely.

## Global Development Alliance

Through a Global Development Alliance partnership with the International Copper Association (ICA), USAID and ICA teamed with AES Eletropaulo to develop, test, and evaluate customized approaches to regularizing electricity service in a target area of Paraísopolis. The pilot was the first to be launched under the USAID-ICA Slum Electrification and Loss Reduction (SELR) program, which was initiated in October 2005 on the theme of regularizing and improving electricity service to low income communities.

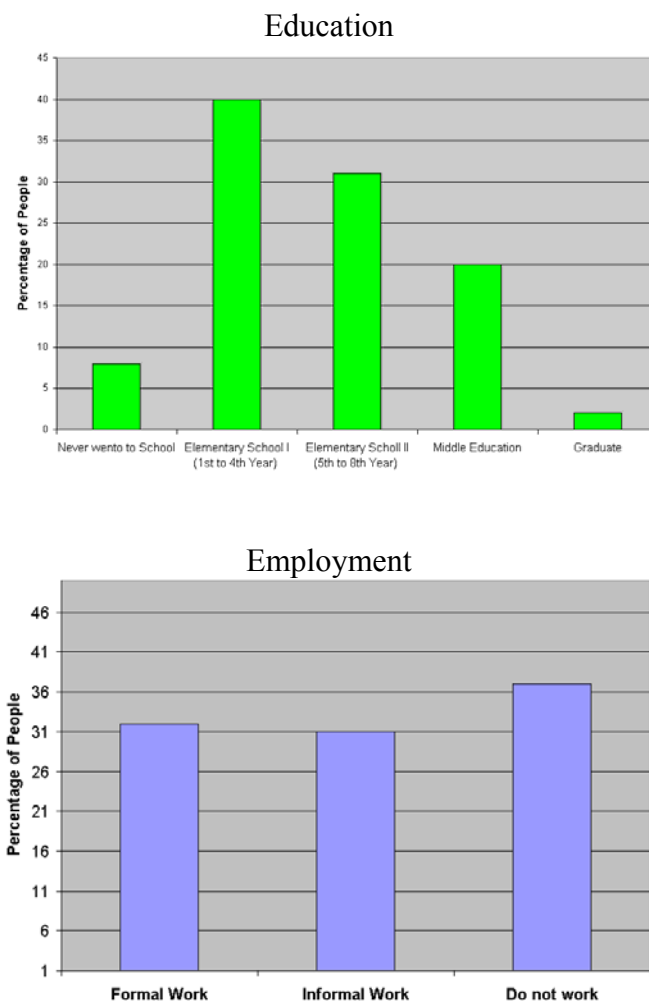
In addition to the pilot in Paraísopolis, a second is in the design phase in Mumbai, India and a third is being planned for Africa.

## The Problem

The selected pilot area covers two neighborhoods (Antônico and Centro) within Paraísopolis, a favela with approximately 20,000 households in the middle of São Paulo. This target area includes 4,365 low income households and businesses (of which 60 households had small home businesses and 423 were stand-alone commercial enterprises of varying sizes and types of services/sales).

Like most other favelas, Paraísopolis is an informal community which lacks many municipal services and is home to families that migrated from rural areas over the years. Located in a large ravine, Paraísopolis has a physically challenging geography and is surrounded by middle- and upper-income residential areas.

## Socio-Economic Conditions



Although the land is publicly owned, the Paraísopolis households have occupied it for generations and the São Paulo city government is currently implementing a land tenure program to register residents and transfer title to them.

As a first step in the regularization program, AES Eletropaulo contacted community leaders to work with them on the scope and scale of the project. The utility then held a series of community meetings to educate residents about the program, bill payment, their energy consumption and measures that could be taken to reduce electricity usage.

Identifying, registering and numbering the individual households and businesses was sometimes a challenging task given the narrow, winding streets and alleys; the fact that multiple families often live in a single home; the lack of street names; and parallel registration efforts being made by the municipality and other service companies.

## **Community Involvement**

Fifteen community campaigns were carried out over several months and were supplemented by door-to-door visits by community “agents” hired by Eletropaulo, and by utility staff to each household both pre- and post- regularization. As residents previously did not have to pay for electricity (except in some cases to get their illegal connection), these campaigns were important to educate consumers on the importance of paying, understanding their electricity bill, and implementing efficiency measures that could be undertaken to reduce consumption and costs.



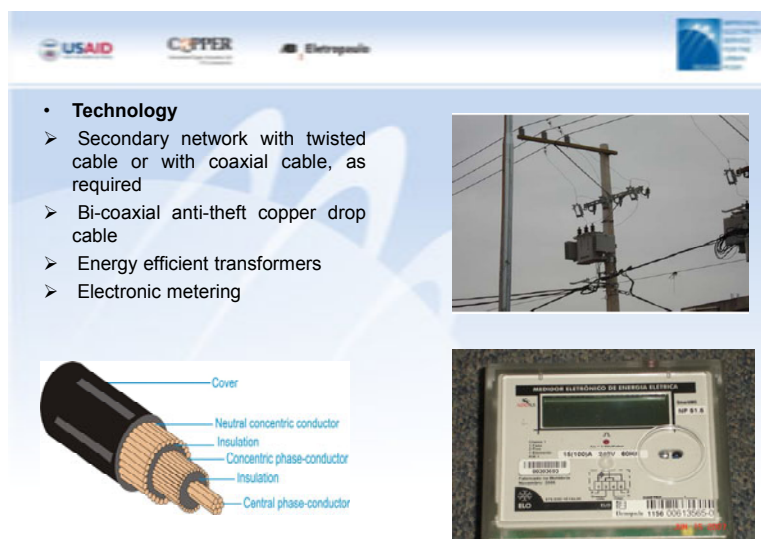
The electric utility Eletropaulo undertook the registration of all customers and numbering of the houses. Mini-audits were conducted by Technolight in more than 4,000 houses, and in 70 commercial enterprises, and finally a customer satisfaction survey took place.

## **Upgrading of the Distribution Network**

Under the project, the distribution network was upgraded and households and businesses were metered. The households were not charged a connection fee and any debts owed were forgiven. A key component of the SELR program was the use of new technologies and techniques to reduce theft and improve the energy efficiency and reliability of the distribution network. These included the following:

- Using bi-coaxial cable in the new service drop to each individual meter.

- Introducing electronic metering for large commercial consumers to allow easy disconnect or “social cutting” in the case of non-payment. 475 electronic meters with remote control were installed.
- Replacing 12 conventional and overloaded distribution transformers with energy efficient transformers.



## Actions to Reduce the Consumption of Costumers

- Replacement of 9.588 incandescent lamps, ranging from 40 to 200W, with Compact Fluorescent Lights (CFL)



- Replacement of 497 old high power consuming refrigerators to high energy efficiency models, among the poorest households. The old models consumed as much as 100 to 150kWh/month. The replacements meet Class A, the highest energy efficiency label based on the Procel standard, the Brazilian national electricity conservation program within Eletrobras, and are rated at 23kWh/month for a 300 liter volume. The average measured savings were 48kWh/month/customer. Old refrigerators were removed for recycling.





- 496 houses rewired to better-than-code sized wiring (in homes: 2.5mm<sup>2</sup> for supply, 4mm<sup>2</sup> for water heating). This saved on average 11kWh/month, but mainly guaranteed a safe supply of power.



Before

After



- 505 public lightning points, which not only contributed to reducing energy consumption in the neighborhood, but provided an improved sense of security.

Given the high level of consumption by households and the urgent need to reduce their usage and enhance the affordability of service, the project undertook a number of measures to increase household efficiency. These encompassed energy audits by Technolight of every household to identify energy efficiency opportunities, the replacement of three incandescent bulbs with efficient compact fluorescent bulbs in each home, the replacement of refrigerators in bad condition, and rewiring by certified electricians of homes with especially poor internal wiring in households that met low-income criteria. An audit of a sample of commercial customers provided the project with the information needed to make recommendations on the energy efficiency measures these customers could adopt to reduce their bills.

## Project Budget

USAID, AES Eletropaulo, ICA and its local affiliate, Procobre, worked closely to ensure a coordinated approach to project design and implementation. A 'responsibility matrix' was prepared which presented the project components and indicated the organization that was responsible for funding and implementing each task. AES Eletropaulo picked up the bulk of the project costs, including the distribution network upgrades, metering, consumer registration, and with ICA paid for new refrigerators; ICA arranged for the efficient transformers with the support

of the manufacturer Itaipu, for the coaxial distribution and service drop cables cost-shared with the wire and cable company Nexans, and the rewiring of households, as well as the preparation of a financial model; USAID covered the community campaign costs, audits of each household and selected commercial customers, purchase of CFLs (cost-shared with AES Eletropaulo), post-project survey, and efficiency recommendations to targeted commercial customers. Total project costs were about \$1.8 million at the average rate of exchange over the project period.

## **The Outcome**

Data on pilot project results are presented in the box on this page. A consumer poll, conducted after project completion and several months of billing, showed that a majority of the regularized families in the pilot area were highly satisfied with their better quality service and the assistance received in improving their household energy efficiency.

Of the 400 households surveyed, 62% rated their overall satisfaction with the project as a 9 or 10 on a scale of 1 to 10. Not surprisingly, this percentage increased to 98% for those who received a new refrigerator and were re-wired and to 80% for those who were only re-wired. The majority (88%) of the households considered the quality of the electricity service to be good or very good after project implementation compared to only 17% before the project. Eighty-nine percent of the households would recommend the program to other residents.

The energy efficiency measures taken in the households and distribution network are expected to yield annual energy savings of over 2 million kWh. Until recently, bills to households and businesses were capped at 150 kWh to help households transition to paying for service as well as to educate them about their actual consumption levels and charges once the cap is removed. It is expected that additional savings will accrue (but additional bad debt may also occur) when larger consumers start to experience the true cost of their consumption.

After project implementation, AES Eletropaulo began to collect a significant amount of new revenue from consumers who had not previously paid for their electricity consumption. Annual billing is expected to reach over \$920,000; currently, the bad debt rate is about 33%. This bad debt rate is relatively high and is due to the large number of commercial customers with high consumption levels that are unable or unwilling to pay. The bad debt rate is expected to decrease, based on experience in other areas, as AES Eletropaulo implements its 'social cutting' program and enforces collections.

However, while survey results show that nearly a third of households took a 'great effort' to pay their electricity bill, 56% said that if budgets were tight, they would select to forgo paying this bill. This is a challenge to project sustainability and needs to be taken into account by AES Eletropaulo as it rolls out of the SELR program to hundreds of thousands of additional favela households in São Paulo over the next two to three years. Therefore a sustained level of dialogue with and education of communities is planned.

<b>Summary of pilot results</b>	
<b>Measure</b>	<b># installed or completed</b>
Conventional meters and posts installed	4460
Remote meters	475
Pre- or post regularization door-to-door visits by community agents	8594
Community and school events (# events; # attending)	27 events with 4906 attending
Replacement of inefficient incandescent light bulbs with efficient compact fluorescent bulbs (CFLs)	9588 CFLs
Refrigerator assessments completed	2598
Inefficient refrigerators replaced with PROCEL A-rated ones as needed 2	497
Wiring safety assessments completed	2433
Rewiring of unsafe internal wiring and fixtures and replacement of electric water heaters3	496
Replacement of individual outside lights with public lighting	505 (472 in alleys, 33 in main streets)
Commercial audits and recommendations made	70

## The Business Case

The total investment in the pilot project reached about US\$1.8 million. The financial analysis, shown in the table below, concludes that the simple payback is 1.5 years, with a range, depending on optimistic and pessimistic projections of local conditions, from 1.4 years to 2.1 years.



Financial Analysis of Pilot Project – Paraisópolis			
Investments (in Brazil Real\$)		Revenues	
1-Assets (utility)		1- Billing (Collection)	Value R\$ - First Year
Customer registration	15,992	Annual post-regularization metered billing (collection)	2,255,439
Electrical project planning	14,722		
Primary distribution network (Poles, cross-pieces, etc)	79,437	Bad Debt rate	32.3%
Secondary distribution network (cables and accessories)	606,675	Minus: Annual Bad Debt	728,238
Contract work on distribution lines	529,492		
Efficient transformers	105,900	Minus: Collections before regularization (2% of billing)	64,443
Conventional transformers	6,310	<b>Net Revenues</b>	<b>1,462,758</b>
Public lighting	127,758		
Copper Co-axial cables	392,850	<b>2 - Subsidies/ Incentives</b>	
Meters (conventional)	185,947		
Meters (remote)	121,800		
Communication network for remote meters	15,000	Tariff subsidies for low income household, based on average consumption	219,176
<b>Sub-Totals</b>	<b>2,201,883</b>	<b>Additional Revenue</b>	<b>219,176</b>
<b>2 – Customers</b>		<b>3 - Capital Gain</b>	
Standard material for connection (box, grounding, fuses)	305,550		
EE Refrigerators (replacements)	298,200		
CFL Lights (material and labor)	79,421	Avoided costs due to saved energy (based on sell tariff)	659,939
Home re-wiring	383,134	<b>Sub-Total</b>	<b>659,939</b>
Door-to-door visits, community campaigns, lectures at schools...	62,134		
Mini household audits	40,280		
<b>Sub-Total</b>	<b>1,168,719</b>	<b>TOTAL REVENUES (First year)</b>	<b>2,341,873</b>
<b>3 – Other investments</b>		<i>Note: Total Revenues – 10 years</i>	<i>15,029,343 NPV: 12,877,462</i>
Commercial audits	57,630	<b>PAYBACK (years)</b>	<b>1.5</b>

<b>Financial Analysis of Pilot Project – Paraisopolis</b>	
Consumer survey	67,000
<b>Sub-Total</b>	<b>124,630</b>
<b>TOTAL INVESTMENTS</b>	<b>3,495,233</b>
<b>Total number of customers considered</b>	<b>4,365</b>
<b>Monthly energy savings</b>	<b>kWh/month</b>
Public lighting	19,258
Household CFLs	165,497
Refrigerators	23,856
Re-wiring	5,456
Efficient transformers	6,151
Showers	8,928
<b>Total monthly savings</b>	<b>229,146</b>

## Conclusion

It is clear from the outcomes and the financial analysis, even if conditions and bad debt would worsen, that the pilot project in Brazil shows that the approach to regularize the electrification of the slums, by involving the community, by addressing safety and energy efficiency, by creating a broad partnership of public and private stakeholders, is correct. It is therefore worthwhile replicating. In fact, the Brazilian regulator ANEEL has proposed a program to replace as many as 10 million inefficient refrigerators in the country.

The unique partnership created to develop and implement the pilot project, as described in this paper, could serve as a model for other communities, not just in Brazil, but throughout the world. AES Eletropaulo and other Brazilian utilities are continuing programs to properly electrify poor urban and per-urban areas, and to reduce the technical and commercial losses of electrical energy.

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– all presentations, also those reviewing other countries in Latin America, Africa, Asia,  
can be found on: [http://www.procobre.org/procobre/cobre\\_para\\_especialistas/  
improving\\_electricity.html](http://www.procobre.org/procobre/cobre_para_especialistas/improving_electricity.html)