Betim, Brazil

Solar heaters in low income housing: Energy and financial savings

ICLEI Local Governments for Sustainability

The Renewable Energies and Energy Efficiency Reference Centre (CRER) in Betim carried out a survey on the use of solar heaters in four housing estates for low income families in the municipality. Besides the benefits to the environment, the survey results show other benefits from the use of this type of renewable energy – both a reduction in energy consumption and in electricity costs, which represents a considerable increase in disposable household income.

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Abstract

The joint initiative by the City of Betim, Cemig (Minas Gerais Electricity Company) and Cohab (Minas Gerais Housing Department) resulted in the installation of 1,356 solar heaters in 4 housing estates for low income families in the municipality in the 2004-2007 period.

A survey was carried out by the Renewable Energies and Energy Efficiency Reference Center (CRER) of Betim in 2009 in these housing estates to compare the electricity consumption before and after the installation of solar heaters, and also to evaluate the level of approval among users of the solar heaters.

The solar heaters resulted in up to 20% savings of electricity consumption and up to 57% savings on the electricity bill for the average 3-4 member family.

The survey enabled a better understanding of the energy consumption profile at these housing estates. Based on the results obtained, some important proposals were put forward for more effective and appropriate actions.

Population / Land area
Approx. 435,000 / 346 km^2

Municipal budget
Approx. 1.15 billion BRL (2009)
(€ 520 million)

Local economy
Automotive industry, petrochemicals

Role of city in region
Fast-growing city within state capital metropolitan region

The importance of saving energy and follow-up surveys

Considering that over 80% of all the energy is consumed in cities, urban areas are responsible for about two thirds of global CO_2 emissions and the trend points to a further increase. It is estimated that between 60% and 90% of greenhouse gas emissions in cities are from fossil fuels used for energy generation and transportation.

The Betim context

Located 30 km from the state capital Belo Horizonte, the municipality of Betim is part of the metropolitan region of the capital of the state of Minas Gerais. Its strategic location and easy access is a strong attraction to companies and industries such as the automotive and petrochemical industries that are looking for low cost transportation and fiscal incentives.

Betim has the second biggest city budget in the state after Belo Horizonte, and is among the 18 largest city economies in Brazil. Its notable economic prosperity and the growth of the city's industrial park have resulted in considerable demographic growth due to the migration of workers looking for a more promising life.

LOCAL RENEWABLES
An ICLEI Initiative

ICLEI supports and strengthens local governments which promote the generation and supply of renewable energy and energy efficiency in the urban environment.

Consequently, the local environment has also been suffering. According to the 2002 greenhouse gas inventory, new industries and the high demographic growth are responsible for most of the emissions of greenhouse gases in the region. This growth is also responsible for the growing levels of contamination of the river that crosses the city as well as increased waste production levels.

Due to the population and industrial growth, the electricity consumption in Betim is extremely high (2.9 GWh/year). Therefore, the development of the sustainable energies sector is crucial so that the municipality can continue to grow, but in a more sustainable fashion.

In 2002, the city of Betim joined ICLEI's Cities for Climate Protection Campaign (CCP™), in the framework of which it developed its greenhouse gas inventory and undertook to stabilize and reduce the levels of emissions. Within the framework of the Campaign, it is in the renewable energy field that the city's actions have had greater emphasis, especially in relation to the progressive use of solar energy as a source of energy for low income communities. This leadership led the ICLEI Brazil team to select the municipality from among all the other cities that took part in the selection process to become the first Model Community for the Local Renewables project (Rede Elo in Portuguese) in Brazil in 2005.

Case Study

Solar heaters in housing for low income families: Energy and financial savings

One of the local government's housing policies is to provide homes for low income families. The municipality developed a specific program, in which it acquires the land and builds the necessary infrastructure with the objective of keeping the costs

Photo: Municipality of Betim

Solar water heaters have been installed in houses in Dicalino Cabral in Betim.

down and making the homes affordable to low income families. In order to reduce electricity consumption and, consequently, residents' expenditure on electricity rates, Betim sought a partnership with Cemig, the Minas Gerais energy company.

According to Brazilian Federal Law No. 9.991/2000, electricity providers must invest 1% of their net revenue on energy efficiency research and development, i.e. in actions which aim to combat electricity wastage within the framework of the Brazilian Energy Efficiency Program (Programa de Eficiência Energética).

Through the program, Cemig, Cohab (Minas Gerais Housing Department) and the City of Betim entered into a partnership. This joint action resulted in the installation of solar heaters on 1,356 houses in four housing estates for low income families between 2004 and 2007.

Renewable Energies Reference Center carries out survey on solar heaters

As a model community within the Local Renewables project, in 2007 Betim set up the Renewable Energies Reference Center (CRER) with the task of incorporating renewable energy (RE) and energy efficiency (EE) services into local development, to serve as an information centre and to promote renewable energy technologies and projects to inspire public policies and action in other cities in the region.

In 2009, the CRER-Betim team carried out a survey at these housing estates with the following objectives:

- compare energy consumption before and after the installation of the solar heaters;
- evaluate the level of satisfaction among solar heaters users; and
- evaluate the condition of solar heaters.

In order to carry out the survey, CRER's staff developed a multiple choice questionnaire which was read to residents of the four housing estates in a door-to-door fashion by the mobilization team of the environmental education unit of Betim's Environment Secretariat.

In total, 54% of the residents of the 4 housing estates (Dicalino Cabral, Celso Pedrosa, Itacolomi, and Vargem das Flores housing estates) were interviewed by the CRER and mobilization team between the months of July and August 2009.

Once the field work was concluded CRER staff worked with colleagues from the Environmental Secretariat to analyse the numbers. During this process, researchers ran into a few difficulties with the data. For example, in one of the housing estates, families only moved in when the solar heaters had been installed, therefore data on their bill before solar energy use was not available. Also, it was not rare that homeowners interviewed did not have their previous energy bills. In these cases, information was given from memory. Given these difficulties, CRER has learned how to better their field research in the future to collect more reliable quantitave information. In any case, CRER's research indicates that prior to the solar heater installation, the research project indicates that the energy consumption of a 3-4 member family was 98 kWh/month. After the installation the consumption dropped to 74 kWh/month, which represented a savings of 24 kWh or 25%. In financial terms, the electricity bill that used to be 79 BRL (35 EUR) dropped to 33 BRL (14 EUR), representing a savings of 45 BRL (20 EUR) per month for each household. Since there is a considerable tax exemption for homes that consume less than 90 kWh/month which is the case for most of the homes that began to use solar energy in Betim, most families had a greater financial savings, thus the high savings rate of 57%.

CRER's work in Betim

The Renewable Energy Reference Center (CRER) in Betim was established with a mission to incorporate renewable energy services in local development and be a center of information and dissemination of technologies and projects in renewable energy to inspire public policies and actions in other cities. CRER is a key element of Betim's involvement in the Local Renewables project.

For more information on the establishment of the CRER in Betim, please see ICLEI Case Study #105.

Although there are variances in numbers, CRER's research is in line with results from other studies that have been conducted in other cities by other reputable institutions such as the Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating (ABRAVA) and Green Solar, the solar energy study group from Católica Pontifícia University in Minas Gerais that points to tremendous savings. Their quantitative data, although not 100% based on precise sources is also confirmed by the qualitative research done in the field. 98% of homeowners indicated satisfaction. Such a high rate would not exist if homeowners were not benefiting from economic savings.

Results and impacts of the project in the community

The survey, especially the qualitative data, was highly praised by Cemig, which stated that they themselves were unable to carry out a survey with such a degree of detail, being that it is not viable since the company furnishes energy to many municipalities.

Photo: Municipality of Betim

Resident of Dicalino Cabral being surveyed about her solar water heater.

The CRER-Betim survey made it possible to know the effects of the use of solar heaters at these housing units. The survey showed that:

- the solar heater reduced power consumption by up to 25% in the majority of cases, maintaining an average consumption of 74 kWh/month for a 3-4 member household;
- when families consume less than 90 kWh/month, they are exempt from paying a 30% tax on the circulation of goods and services - the ICMS, allowing their financial savings to be greater since they not only reduce their bill by consuming less but also by paying less taxes;
- in general terms, the electricity bills were reduced by up to 57%;
- with this savings on the electricity bill, the use of solar heaters enables a considerable increase in disposable household income;
- 94% of those surveyed stated that there is enough hot water provided by the SWH for the whole family throughout the day;
- of those surveyed, 98% approve of the solar heaters; and
- of those surveyed, 96% would install a solar heater in another house.

Credit: Municipality of Betim

Resident being interviewed in Betim.

In addition to the information on the heaters, the survey also showed that:

- despite the considerable reduction in energy consumption after the installation of the solar water heaters, many people do not know the best ways to use electrical appliances, i.e. they do not have a sustainable consumption standard, which would further reduce the consumption and expenses on electricity;
- the use of incandescent light bulbs, which use more electricity than fluorescent bulbs, is still high at these housing estates. For example, at the Itacolomi Housing Estate, 79% of those interviewed useincandescent light bulbs;
- a more efficient monitoring of the properties is necessary to follow up on the solar heaters' use.

Action proposals

Another positive aspect of the survey was that, based on the analysis of its results, CRER put forward some action proposals, and has been working closely with partners to enable the implementation of the following initiatives:

- maintain the solar water heaters policy for housing estates for low income families in partnership with Cemig;
- author a municipal decree that mandates the use of solar heaters in all new buildings;
- mandate the use of solar heaters in all homes of the federal government's 'Minha Casa, Minha Vida' (My Home, My Life) program in Betim;
- continue to hold CRER-Betim's already existing workshop on energy saving for housing estates' residents, with the objective of promoting sustainable energy consumption.

CRER is currently working with Cemig to resolve the problems of leaks, blockages, faulty parts, etc. with the heaters that were highlighted by the residents during the survey.

Lessons learned

One of the most important lessons learned was understanding **the importance of monitoring results** and basing future action on proven data instead of on assumptions. Monitoring may be said to not be a part of Brazilian culture, especially in local governments that work with limited resources. However, despite dificulties and lack of experience, CRER staff began to monitor their actions. Proper monitoring must be planned for before actions are initiated rather than at the beginning of the monitoring phase. If indicators are only determined once actions are drawing to a close, implementors will not always have collected and or measured as needed. This posed a challange for CRER that had not thoroughly planned for monitoring before implementing actions. But CRER staff soon began to see the importance of information obtained when monitoring, which can help them design future actions or obtain support from leadership and external parties.

It is important to **properly structure the survey** before carrying it out. It is necessary to clearly establish what is intended to be learned from this survey. It is also important to calculate risks and problems that may occur. The questions must be properly formulated, not leaving room for doubt.

Survey team members should undergo training, during which they receive instructions and recommendations on filling out the questionnaires, approach, etc. It is important to establish a work plan that includes enough time for a pre-analysis of the results being obtained in the field. It is also essential to use a survey team that is a manageable size. Having a multitude of people involved in order to obtain quick results may cause difficulties and low quality results.

It is important to **document answers in a direct manner, without any ambiguity** so that they can be compiled afterwards. Additional information could be very useful.

Building relationships with homeowners is of high importance in Brazil. Considering that the community did not have any previous connection with CRER, it is important to calculate time for them to get to know the Center and its objectives This phase is useful to inform the community, remove false stigmas about the research's objectives and to prepare them to provide more precise and reliable information. This way homeowners will be more willing to support the research project since they already receive CRER's support.

Develop a continuous plan of activities and not only an isolated effort in these communities. Since it was learned that homeowners rarely keep their energy bill, it is important to establish continuous contact through monthly visits or another determined period in order to document energy consumption, bill amount and any other changes such as the number of inhabitants per unit. This would ensure more accurate data collection.

The study's **results must be published in a clear and transparent manner**. It is important to highlight difficulties that emerged in the various phases of the project in order to better explain results. For example, it is not sufficient to state that certain data was not obtained. The reader must know why. In the case of this particular research project some information on consumption before the use of solar energy did not exist because homeowners only moved in when the houses were already equipped with the panels. If the results are not well explained through methodology and calculations, the reader may have doubts that could lead to questioning the study's reliability. Transparency not only increases

The Local Renewables project

The Local Renewables Model Communities Network (or Local Renewables project) aims to support and strengthen local governments in promoting sustainable energy and to become model cities in their national and regional contexts. This international project (2005-2010) connects leading cities to cooperate in sharing their expertise and experience in the fields of renewable energy (RE) and energy efficiency (EE). Thus, the project is a key component of ICLEI's Local Renewables Initiative.

Special support for participating model communities in India (Bhubaneswar, Nagpur and Coimbatore) and Brazil (Betim and Porto Alegre) was possible due to generous funding from the German Federal Ministry for Economic Cooperation and Development (BMZ) through the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

The European Resource Cities of Bonn, Freiburg, Milan, Växjö and Malmö have highly developed renewable energy and energy efficiency strategies which they were happy to share.

The ICLEI offices for South Asia (Delhi), Brazil (Sao Paulo) and Europe (Freiburg) were giving continuous guidance and organized the exchange among the cities.

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the information's reliability, it also helps others to avoid problems in the future through lessons learned.

Surprising information became available: Some of the data collected during the survey was sent to Cemig due to difficulties in understanding it. For example, there were cases where some housing units that had a consumption of 30 kWh/month were paying a bill of 50 BRL, while a home with a consumption of 50 kWh/month was paying 40 BRL (sums for illustration purposes only). Cemig explained that in accordance with Brazilian Law No. 10.438/2002, all consumers with consumption lower than 80 kWh/month, or between 80 and 220 kWh/month registered in the Cadastro Único (Single Register) of the Federal Government Social Programs are entitled to the subsidy for the Low Income sub-class. This subsidy must be applied for. However, not everyone is aware of it. Therefore, CRER intends to notify the estates' residents about it.

Replication

The survey can be replicated in other housing estates that use solar water heaters, regardless of income level. Through the survey, it is possible to create a profile of energy consumption and, subsequently, draw up an action plan to promote sustainable consumption.

The results of the survey on energy and financial savings through the use of solar heaters should be made available to other municipalities, as it is an experience that can be replicated with guaranteed benefits. With this action plan resulting from the survey, it is possible to secure partnerships within the municipality and further afield in order to guarantee its implementation. Partnerships will not only result in better analytical work, it will also build capacity within CRER so that they may replicate it in the field in the future. Through this research project other opportunities to build partnerships have been established.

Local Renewables project materials

India

Bhubaneswar, Nagpur and Coimbatore City Completion Reports
Case Study # 108: Pioneering renewable energy and energy efficiency application in India's municipal health sector in Bhubaneswar
Case Study #109: Installation of energy efficient lighting at the Lord Lingaraj Temple in Bhubaneswar
Case Study # 110: Water sector audit enables efficient use of water and energy resources in Napgur
Case Study # 111: Reducing carbon emissions while improving Coimbatore's municipal public services

Brazil

Betim and Porto Alegre City Completion Reports
Case Study # 105: The Renewable Energy Reference Centre: Engaging stakeholders in renewable energy applications; Betim, Brazil
Case Study # 106: Cooking oil waste is used in community development with the Eco-oil Programme; Volta Redonda, Brazil
Case Study # 107: Turning pollution into profit: the Bandeirantes Landfill Gas to Energy Project; Sao Paulo, Brazil
Case Study # 112: Solar heaters in low income housing: Energy and financial savings in Betim
Case Study # 113: Stakeholder involvement groups for Local Renewables in Betim and Porto Alegre
Case Study # 114: Portuguese: Energia Solar é Incentivada em Lei sobre Compensação Vegetal em Porto Alegre
Case Study # 115: Portuguese: Cemig leva Eenergia Elétrica elétrica chega à a comunidade de baixa renda com apoio do CRER Betim

Global

Case Study #104: Freiburg, Germany: Long-term strategies for climate protection in Green City Freiburg
Case Study # 116: Växjö, Sweden: Becoming Fossil Fuel Free with citizen and stakeholder involvement
Case Study # 117: Milan, Italy: Improving the district heating system with RE and EE

Further case studies about energy efficiency and renewable energy in India, Brazil and the European Resource Cities, as well as city completion reports for the Local Renewables project are available on the project website. **www.iclei.org/local-renewables**

Individuals in academia, municipalities and the private sector have shown interest in working with CRER in the future. For example, CEMIG and a doctorate student have shown interest in helping CRER become involved in other research projects with a scientific base developed by professionals.

Furthermore, the promotion of the economic benefits from the use of thermal solar energy is still limited. One way to encourage the use of this type of renewable energy is to show its benefits. Compiling data using surveys is one way to show concrete results.

Budget and finances

In this particular case, no extra costs were incurred, as the surveyors were municipal employees and carried out the survey during their working hours.

According to CEMIG, the cost for acquiring and installing the solar water heaters donated by the company is on average 1,500 BRL per heater.

Sources

- interviews carried out in housing estates between July / August 2009;
- Research Paper: Solar Water Heaters in Betim, MG, Brazil Housing Estates, by Gabriela Maia e Silva;
- interviews with Cemig;
- interviews with staff from CRER Betim.

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