SOLAR WATER HEATING AND RAINWATER TOWER / BRAZIL

Brazil has a large housing deficit, estimated at approximately 7 million units. Its population is permanently urban around 80% of the population lives in cities, and 63% of Brazilian households have a monthly average per capita income of more than half and less than two minimum wages (the minimum wage in Brazil is R$ 460, 00 corresponding to approximately U.S. $210). Despite being a country of continental dimensions, it has an agglutinated structure that does not allow the access to the land, contributing to the rural exodus and, in consequence, to the concentration of poor in the suburbs of large cities. The port of the population in general occupy the hills, areas of the city, or areas of permanent preservation such as commons and others. In these areas, they cause significant environmental impacts and their houses are almost always deprived of basic urban services such as water supply, sanitation and waste collection, as well as energy supply and urban transport. And even when these services are provided, they are generally incompatible with the income of these families.

In Brazil, about 44% of the electricity consumed is for the supply of buildings in general, being the residential demands around 22% of that percentage. In the housing sector the main end uses for the electric power consumption in the national rate is air conditioning (32%) and lighting (29%), corresponding to the use of refrigerators and heating and air conditioning equipment. The next major source of energy in the sector is air conditioning (32%) and lighting (29%).

The final uses of energy have regional differences since the country has various climates, and the use of water heating takes a most significant place in the south, southeast and center-west of the country. One promising solution for water heating is to use solar energy, a renewable source of energy which technology is easy to access and relatively low cost. The incorporation of this technology is an integrated way to the residences is not always possible because houses do not always have roofings with appropriate orientation and slope for the installation of solar collectors which will provide the best performance (i.e. to the best use during the winter, the collector should be turned to the north with a variation of less than 15 degrees and at the same slope of the local latitude plus or minus 10 degrees). To increase the use of this technology in the housing sector government programs have encouraged more flexible installations. As an example, it can be given where these collections were fixed at lightweight structures that allowed correctly positioning of the collectors. This solution, although, facilitates its portability and led to some cases of vandalism of the equipment.

Especially in low-income family settlements water is a resource that has limitations and is inversely proportional. This is one of the major problems of the housing sector in Brazil, where approximately 20% of the population have no access to potable water (wells). The dominant paradigm contributes to this shortage situation since we extract more water that is used also for non-potable uses. This accounts for about 47% of the water consumption of a residence, i.e. washing of bathroom fittings, irrigation of gardens and washing clothes and floors. This model does not consider the water required to irrigate a direct horticole resource that can be harvested near the place where it will be used, it is emphasized that the country presents regions such as south and southeast, with high and well-distributed rainfall, an ideal situation for the use of rainwater as an additional alternative water resource. In semiarid regions such as the northeast of Brazil, rain water can be used for ornamental purposes after treatment (with appropriate filtration).

The rainwater harvesting systems usually have built tanks for rainwater accumulation. These tanks, while keeping the temperature of the water cooler and providing a better use of space, have some disadvantages, such as difficulty of detection of leakage and infiltration, which can cause loss of water or damages to the quality of the stored water.
COMPONENTS OF THE TOWER

01 - Potable water reservoir
Designed with capacity for twice the daily household consumption (1000 L), reducing the need for potable water. It provides easy maintenance and sanitary safety. Durable water is supplied to the kitchen sink, the lavatory and shower. The rainwater collected on the roof is used for non-potable purposes, such as discharge of laundry, washing clothes and for garden irrigation. The solar heating water system supplies only a shower.

05 - Solar heating water system
This system consists of a thermal reservoir, with a capacity of 100 I, designed to meet consumption at all times, with a water temperature of 35 degrees Celsius. The thermal reservoir is equipped with a heat exchanger and a solar collector, providing the required water temperature. It stores water in a suitable pressure reservoir for the bath and is used to meet the demand for hot water.

05 - Area for maintenance
This area was designed to be added to the project, in order to provide easy maintenance, as it has the ideal location to store the water supply reservoir for the rainwater collection system.

05 - The rainwater harvesting system
Designed according to climatic conditions in order to recover water from the roof. It stores rainwater in a separate tank, with a capacity of 3000 L. The system also includes a rainwater storage tank, which can be used as a covering for the area of the washing tank.

04 - Area for washing tank
Supplied by an intermediate reservoir of rainwater and covered by the solar collector.

**Components**

- Potable Water Reservoir
- Solar Heating Water System
- Rainwater Harvesting System
- Area for Maintenance
- Area for Washing Tank
Quantum Change and Transferability

The main objective in the tower proposal is the concept of bringing together into a single structure solutions for energy efficiency and optimal use of water for the improvement of low income housing. This concept has a great transfer and versatility potential. Thus, the tower is appropriate for both new and existing homes in low and middle-income areas. This concept can be applied also for other types of buildings such as schools and multi-family housing. It can be applied both in urban and rural areas and can be built with a variety of materials such as cast-iron, reinforced mortar, steel and mixed masonry made of brick and reinforced concrete. Although the tower can be erected in a well-building system, the option of industrialization of light prefabricated pieces, such as reinforced mortar, provides a satisfactory economic viability when held in a high production scale.

The tower proposal presented to low-income housing is based on the potential replication, since it could be used with very few changes throughout the country. For this aim, it is very important a partnership with the CNEEM-BC, as an action scope as a live agent and to its transferability to other CNEEM’s in various regions of the country.

Among the possible adjustments to accommodate the use of this tower in different places, the tower’s volume can be modified using modular rings depending on the storage needs and on the local climatic regime.

According to the climatic region, the use of solar collectors can be dispersed at regions closer to the equator such as the north and northeast of Brazil. The tower was designed in a cylindrical shape in order to facilitate the creation of the solar collector to the top north, besides having its structural behavior optimized.

The solar heating system can also provide several constructive options and can be used with industrial materials or using alternative materials often recycled, such as PET. The heating pane attached to the tower can also be a precast piece of reinforced mortar or industrialized made of other materials such as PVC or ceramic.

This implantation would permit a better situation for low-income families, but in order to be applied in large scale it will be convenient through public policy.

It is suggested that this tower could be built in reinforced mortar, craft and prefabricated, or precast reinforced concrete.

Reinforced concrete - precast elements with an average thickness of 12 cm. This was the adopted solution in the design of the presented standard tower.

Craft reinforced - a material that can contribute to the affordable cost of this work, but is only suitable for the construction of equipment with the active participation of the users (this may be appropriate for volunteer housing or self-construction). One advantage of the usage of the material is that the tower can be built without the use of molds or scaffolding.

Precast reinforced concrete - these elements need to be sealed and may require machines (cranes) for the erection of the tower, due to the high weight of the parts. For this project’s transfer, training courses are being scheduled. In March 2005 we will participate in 54th Peresaba’s congress where the training of community leaders with self-construction technologies for sustainability. The course is organized by a Non-Governmental Organization and includes several technologies, such as alternative earthen collectors. We are also guiding a training in the community of “Mato da Corrida” located in the city of Monte de Cristo in Ponta do Ceará. During the training, workers from that community are building a tower in one of the residents’ houses. This training was sponsored by CNEEM-BC.

With the necessary resources, it would be possible to develop a research project to analyze the efficiency of the selected technology and also study alternatives to optimization of this concept. The tower’s design could also have a transfer potential to other developing countries, which presents similar conditions for its implementation.
Economic Performance and Compatibility

The project considers the social inclusion of families, giving access to the national use of resources in a legal and ratified manner, while contributing to the family economy. This tower can help to alleviate the housing deficit in a more sustainable way, with quality, and could also be used as a retrofit in existing homes.

The introduction and propagation of the strategies proposed in this project can contribute such standards - as those which treat solar heating and use of rainwater - as well as various cases of regulations that are emerging every day in this area.

In rural areas that are subjected to scarcity of available water, this tower could be modified and the overflow could, after appropriate disinfection, be used for human consumption.

The classification obtained in the first stage of the Holcim Awards Latin America competition allowed the project to win visibility and facilitate the concretization of the initial idea, that was to construct a prototype to be monitored. Also, many organizations have shown interest in this project.

The realization of the prototype is being concluded with the support of the Oxfam-Brasil, in the Favela Complex called Morro da Conceição, in the city of São Paulo.

The situation for the prototype implementation is very favorable in this community, because it is inserted in low-income homes, which are built in hemp plugs, but, with minimal access to create the implementation of the tower.

This location was chosen for the tower implementation for being a community, highly organized by local leaders, in which the authorities have easy access and thus it is thought to be easier the propagation of the technology in the community by training courses.

The implementation of the house implementation in this community also represents the reality of other regions, where the reproduction potential of the tower would be very high. The next step will be to monitor this first pilot to evaluate the reduction of water consumption and energy in real family. We will then evaluate the performance of the materials to be used in future towers.

The technological progress resulting from these studies should provide the improvement of the prototypes.

In a second moment, it will be expected a training program to be promoted in many communities, which will participate in the building or implementation of these prototypes and that from the appropriation of the technology could be used by the local leaders. Knowledge could be added for the improvement in a third moment. It would be ideal that an industrial process could be developed, which would contribute in the propagation of the concepts incorporated in this project. From this, support and partnership can be expected from governmental institutions and companies that work with elements that could be used in the tower.
Energy and water are the resources which are in evidence on the agenda of governments and societies. Being fundamental to the development and must be kept and used with rationality.

The Brazilian energy source is strongly based on hydroelectricity. About 80% of electricity consumed is generated by hydroelectric plants, being therefore a clean generation if compared to most countries. New thermals to meet the growing energy demand, thermal plants are being built.

Thus, a proposal that included including the use of rainwater in a large scale, by an alternative that uses a renewable energy generated at the consumption point (such as solar-heaters). Can contribute effectively to the reduction in consumption, family economy and the energy needs of the country.

Water is a limited resource, vulnerable and also essential to sustain life, development and the environment. It has been given the connotation of commodity. The main commodity of the 200th century - and the most important natural resource of the planet. But, above all, it is a public good of social interest and the access to it should be guaranteed, and universalized.

As it is a right of all citizens, in recent years changes have been observed in historical series that tend to show the projections reported by the IPCC (2007), indicating the increase in critical extreme situations related with great intensity and occurrence of long periods of drought.

The use of rainwater as an alternative an complementary water resource for non-potable purposes, proposed in this project, has greater feasibility of implementation in regions with a uniform distribution of rainfall throughout the year, such as Florianópolis. The use of rainwater presents difficulties in its implementation in areas subjected to long periods of drought, a situation that are required reserves of large volumes that can economically not viable.

With this project it is intended to improve our skills to anticipate, to cope, to resist and to recover ourselves from the impacts of climatic adversity. The proposed incorporates concepts of efficient use of energy and water, besides providing a rational use of space with easy maintenance and access to the equipment, concentrating on a single device - the tower - with multiple functions that contribute to enhance the sustainability of housing, especially some of social classes.
Contextual and Aesthetic Impact

The implementation of this tower would provide families access to essential resources such as water and energy, with a lower cost, enabling a sustainable economy without compromising the socio-economic development. This economic viability of this project, in order to validate its implementation in low-income homes, is associated with its application in large scale and with the implementation of light construction elements, such as prefabricated reinforced concrete units. In addition, the use of water resources in households, which are considered as public policy, with government encouragement, as the example of programs that are subsidized through CPMV in Brazil, this new model could save resources that would be needed to implement the infrastructure to meet the water and energy demands for low-income families.

To serve the Brazilian housing deficit (of about 7 million households) using the conventional technologies, electric showers and the use of potable water for non-potable uses; it would be necessary at least about 4.5 million electric showers and the loss of approximately 1.5 million m³ of potable water per day. In the case of this tower, on a large scale, it could be saved about 5% of drinkable water and 20% on the energy bill.

For the city of Florianópolis, considering a family of 4 persons in a house of 40 m² (area considered standard for low-income houses) the tower could have a potential economy of the total electrical energy bill of around 24%. This house implementation is in conjunction with a public policy for the exchange of refrigerators for more efficient equipment and also the exchange of incandescent lamps for energy efficient incandescent lamps that are already being adopted in some states. It will be possible to double energy savings in these houses.

Referring to water, it would be possible a saving of around 57% of drinkable water in this residence, which corresponds to the supply of about 78% of the non-potable water demand in a low-income residence in the city of Florianópolis. This economy may increase with larger consumption areas and also depending on the consumption habits of the user. The water economy obtained with the use of this tower also depends on the current pricing policy and regulatory boundaries. These are often barriers to the implementation of the minimum charged volume for low-income housing, which is independent of consumption. This attitude works as a disincentive to the adoption of measures for the efficient use of water. The economy also depends on the local pluvimetric regime, but in general it may be said that in the South, Southeast, Midwest and North of the country the pluvimetric regimes are favourable to the implementation of this tower.

Through other projects, in which two of the authors of this proposal are also involved, some of the equipment to be used in the tower were developed in an innovative manner in the building sector of self-construction, counting on the labor and a traditional heating system. The final cost is around R$ 5,000.00 (US $ 2,000.00). From this value, the water heating system corresponds to 17.2%, and the labor to 17.57%, which means 34.79% of the final value. Thus, for self-construction, the use of low cost solar panels and local labor could be considered, which would reduce it to around 30% of the value of the tower, reaching around R$ 4,000.00 (US $ 1,700.00).

The main goal of the tower for its wider dissemination is that it should be built in a traditional manner, so that the pilot project being built can be used to make it a future self-construction house. This proposal can reduce the private sector to produce such equipment in large scale and with great potential for the consumer market. At the same time, it follows consumers, especially those users of organized communities, to be trained, so that they can incorporate at their homes the concepts presented in this project.

One of the authors did an extensive experience in construction in craft tradition and also has contributed to the execution of feasibility studies for the use of light construction elements, such as those made of reinforced mortar. In these studies we conclude that the cost of include and equipment necessary for implementation of prefabricated elements for this type of tower is estimated in R$ 12,000.00 (US $ 5,000.00). The industrial model will provide a substantial reduction in the implementation costs of the tower, better quality and a quick installation.

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New houses are needed for the low-income segment of the population, and better conditions in the existing housing, where most of the current needs are not met by current technologies. A great opportunity to introduce sustainable concepts into the low-income context will be lost.

The proposal will contribute to improve the life quality of the population in this segment, where the search for solutions that improve the quality and comfort of services, mainly the sanitary water supply system, has led to improvements that degrade the aesthetic and environmental quality.

The tower proposal presents an alternative with a better functional quality, plastic and that gives innovation to a solution that is already taken for the one when building their improvised high-sanitary services. It provides an aesthetic improvement of the built environment and the project can be adapted to both new and existing homes, easily integrating it into the context of space, and emphasizing practical ways of proving important strategies for sustainability. This case provides positive impacts on the environment, contributing to the cultural dissemination of the concepts incorporated into the project, in the places where they are introduced. The tower must be a motive of pride for its beneficiaries.

Thus, the tower proposal will fill an existing gap in low-income housing offering a solution that will save energy, water and aesthetic improvement of the built environment.