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Mapping

Mapping of the main stakeholders and processes affecting the selection of solutions (technologies and materials) for social housing projects – São Paulo, Brazil

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Mapping of the main stakeholders and processes affecting the selection of solutions (technologies and materials) for social housing projects

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Summary

This report highlights the results of the research, surveying and consulting of the Sustainable Social Housing Initiative (SUSHI) Project Team in Brazil, from October 2009 to March 2010.

The team's main objective in this report is to identify, map out and characterize essential technologies to be incorporated into the process of designing social housing units in Brazil, considering all agents involved, including consumers, suppliers and, especially, project developers.

In developing countries and especially in Brazil, the buildings and construction sector is a central part of the economy. The current rapid increase in natural resources consumption, the housing deficit, as well as the unique role that public housing developers play in transforming and shaping the construction industry provide contextual elements that introduce the issues to be addressed through SUSHI.

This report aims at providing an analysis of the current state of social housing projects in the State of São Paulo, in order to define concrete actions to remove barriers to the introduction of sustainable solutions, and select appropriate solutions considering the local priorities.

This report is divided in two parts: Chapters 1-2 are an introduction to the SUSHI project and to the methodology developed in Brazil. Chapters 3-8 highlight results of the assessment and mapping conducted in Brazil.

The analysis of the business-as-usual situation in social housing, combined with local (linked to the chosen pilot project) and national priorities related to natural resources, energy and policy, allowed to choose focus areas (or pilot functions) for the Brazilian approach. Although the environmental agenda in Brazil addresses consumption and production of several different natural resources, the SUSHI project team in Brazil chose to give priority to the issues of water and energy. To address water use, the team decided to focus on sustainable solutions for social housing that allow rational use of water and demand management, whereas to address energy use, the team chose to focus on thermal comfort and lighting, prevention of air conditioning use, and renewable energy use including solar energy.

The assessment of existing policies, available solutions, and previous experiences allowed to identify barriers to the uptake of sustainable solutions in social housing. The consultation with partner institutions resulted in the request for a more elaborate analysis of past experiments, which will be developed through a "Lessons Learned" report, with the Housing and Urban Development Agency (CHDU) of the State of São Paulo.

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Introduction

Worldwide, the civil construction industry is one of the most significant contributors to socio-economic development. However, this sector is also the largest energy and natural resources consumer, accounting for the use of a significant share of natural resources and for the generation of 40 to 50% of greenhouse gases and acid rain promoting agents (ASIF et al., 2005).

Therefore, the buildings and construction sector has a fundamental role in achieving sustainable development. A sustainable building seeks to continuously reduce the use of natural resources including water, energy and industrialized products. Building sustainably also implies avoiding long-distance transport, protecting environmental quality and natural resources that are essential for development and quality of life in the future (TABORIANSKI, 2009).

However, it is verified that in most cases, green building concepts are applied to high-standard buildings, both residential and commercial. Few or none of the sustainability concepts have been applied to social housing.

One of the reasons for this attitude is the idea that social housing units consume less energy than high-standard buildings and therefore there is no need for investing in energy reduction for this type of buildings. However, in developing countries, the increasing demand and limited supply generates important new construction activities, and especially a high quantity of low-cost housing units. Applying sustainability concepts to social housing may bring relevant savings of natural resources while also reducing the housing deficit.

Another common perception is that sustainability concepts can only be applied to high-standard buildings as they involve an important increase in construction and operation costs. However, there are solutions that can be applied in design, construction and operation of residential buildings that offer simplicity of implementation and do not necessarily lead to an increase in costs. These solutions may even reduce costs over the life cycle of the building.

Even facing the current economic crisis, Brazil has a rapidly growing real-estate sector. The social housing sector is particularly active, especially as the government plans to build one million social housing units in two years.

This offers a great opportunity to deal with sustainability issues in social housing. Reduction of energy and water consumption is a key challenge, and it should be addressed taking into account basic needs, comfort and quality of life of inhabitants. Addressing water and energy consumption also implies considering the economic and social implications of resource use, including the energy dependency of the country and scarcity or distribution issues (leading to black-outs for instance).

The SUSHI project aims at contributing to reflection and action in these areas, through the development of guidelines to apply the concepts of sustainable building to social housing projects. This report aims at analysing current social housing conditions in Brazil, identifying challenges and opportunities for inclusion of sustainable solutions, as well as conditions for successful implementation.

1. Preliminary considerations and approach

1.1 Defining sustainability

Sustainable development is defined as the development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." (WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, 1987).

This concept is based on the triple bottom line, involving social, environmental and economic dimensions, as illustrated in Figure 1.

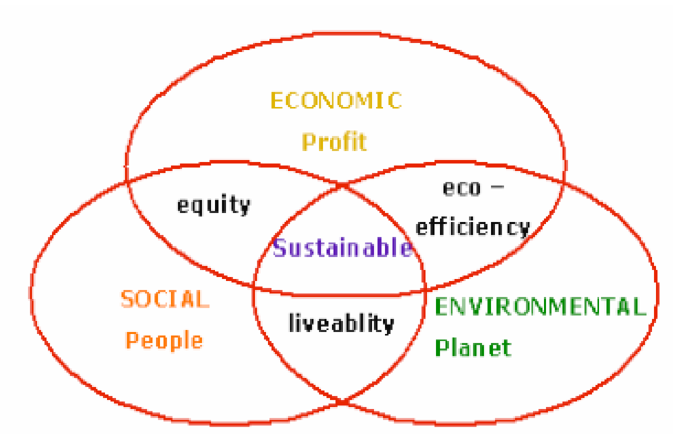
Therefore, to apply sustainability concepts to social housing, one should observe the following aspects in each of these dimensions:

Environmental dimension: the objective is to minimize the global environmental impact according to global and local priorities. This means that each country, region or housing project needs to identify its main environmental impacts, establish priorities (environmental agenda) and seek and develop solutions to minimize these impacts. Each project should conduct its own assessment and diagnostic. It is not appropriate to simply import solutions and knowledge generated in other contexts.

Social dimension: the main concern is to provide comfort and maximize quality of life. For housing projects, this refers more specifically to the quality of life of users, on-site construction workers and the surrounding neighborhood. Of course, housing per se – provided it has an adequate technical performance – is an important quality-of-life improvement. However, to truly integrate the sustainability dimension, the project should consider the workers and inhabitants quality of life, occupational health and safety and the impact of social housing projects on the neighborhood during construction and use of the houses.

Economic dimension: economic sustainability lies in the promotion of solutions that are economically viable throughout the life cycle of the building[1], in the real situation of use.

Figure 1 – Sustainability dimensions. Source: UNEP (2007)



1 The life cycle of a building defines its existence from cradle to grave including: extraction of raw materials, manufacture of building products, design, construction including transport, use, maintenance, deconstruction and disposal.

1.2 Economic, political and social implications of social housing

Stakeholders usually perceive sustainable building solutions as leading to an increase in the construction cost, although their use may lead to a reduction of use and maintenance costs. Many sustainable construction solutions have, indeed, a significant impact on costs. For example, solar water heating systems may lead to an increase of 5 to 10% in the construction cost of a generic social housing unit in Brazil.

In developing countries, for social housing projects financed by public resources, economic impacts have important social and political implications. The logical implication of an increase in the construction cost per housing unit is a decrease in the number of units constructed, therefore reducing the number of families who will benefit from the social housing programme.

Therefore, it is important to develop action models that allow to overcome this limitation, considering the potential distribution of costs and benefits among stakeholders, in the design, construction and operation of the building.

To address economic, political and social implications, the project team has considered:

- The need to find the appropriate solution according to the project budget;
- The need to reduce operation costs;
- The need for integrated resources management; and
- The potential availability of international resources.

Finding the solution appropriate to the project budget and able to deliver the most effective impact on the project's sustainability performance.

Sustainable development involves searching for viable solutions that minimize environmental impacts and maximize social results. These solutions must be chosen according to the existing budget.

Many relevant measures to improve sustainability may be implemented without a significant direct impact on the construction cost of the unit, because they involve project and managerial measures, low-cost equipment or even negative cost equipment.

Some examples of possible low-cost measures are shown below:

a) Energy use reduction and comfort improvement through simple strategies improving ventilation, shading, or orientation for instance.

b) Reduction of construction materials losses. Losses of equipment and products are very common in Brazil. They may represent 5% of the unit construction costs.

c) Adoption of low-cost strategies to reduce water consumption, such as pressure reducers and tap aerators.

d) Segregation of construction waste on the construction site, with adequate disposal and if possible onsite recycling of the mineral fraction.

e) Use of cement with lower clinker content or concretes formulated with lower consumption of cement.

Operation cost reduction

Measures that improve energy efficiency and reduce water consumption result in a reduction in the costs of use and operation of the housing unit, benefitting users. That operation cost reduction will possibly mean a gain in the monthly income of the family, and an increase in the family's indebtedness capacity, which enables an increase in the construction cost via increase in the monthly installment paid by the families. However, in many countries including Brazil, the amount spent on energy is low, as houses do not have artificial air-conditioning and the cost of energy is subsidized for low income families. This reduces the economic benefits for users.

To better make the case for sustainable solutions, models that enable to estimate the cost savings to be obtained by families during the use phase of the building are needed. Factors such as number and demography of inhabitants, cultural issues and awareness of benefits, climate and micro-climatic aspects will decisively influence the actual water and energy savings. Therefore, the development of adequate models to quantify the benefits is an essential condition for the implementation of a sustainable social housing strategy.

Integrated resource management

Reducing energy and water consumption, reducing construction waste generation and improving waste management may generate savings for the government bodies responsible for the supply of those services. In Brazil, the generation of renewable electric energy (hydroelectric energy) requires investments exceeding US$ 1000 per kW generated (Tolmasquim, Guerreiro, and Gorini, 2007). This means that a 3.5 kW shower priced US$ 20 requires an investment exceeding US$ 3,500 for generation only, in addition to the transmission costs and environmental impacts associated to the plant construction.

In the Brazilian case however, for many projects such costs are already being supported by energy generating and distributing companies who, according to their contracts, have to invest in clean technologies that save electric energy.

International resources

International resources that promote energy efficiency, use of renewable energy and mitigation of greenhouse gas emissions are available, but their utilization potential has not yet been explored. Again, models that enable to estimate the concrete benefits of project actions to reduce consumption and emissions are required to define the return-on-investment.

1.3 Local agenda and project requirements

Specialized literature highlights a number of important actions that enable to improve the sustainability of a housing project. However, the set of solutions already identified is not all-inclusive and improving sustainability requires a local approach.

Some actions are universally proven to improve environmental impacts. However, the relative importance of these actions varies according to local characteristics: to address global problems, we need local solutions.

It is therefore necessary to establish priorities for each project, focusing on technically and economically viable solutions that bring greater environmental and economic benefits to the specific project.

This chapter will highlight the following local characteristics:

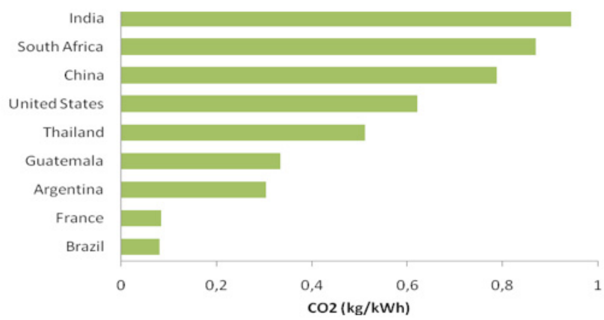
- The energy matrix of the country;
- Local environmental issues;
- Inhabitant income, needs and culture; and
- Business-as-usual practices.

Energy matrix

The energy matrix varies from country to country according to available energy sources and existing resources to finance energy generation through alternative sources. In addition, the energy matrix is directly connected to CO_2 emissions in the case of electricity production. Figure 2 presents the relation between the type of energy matrix adopted in some countries and CO_2 emissions for the production of 1 kWh of electric energy.

Figure 2 reveals that in countries where the use of fossil fuels prevails in the energy matrix, such as the United States and China, greenhouse gas emissions per kWh of generated electricity are particularly high.

Figure 2 - CO2 emission for generation of 1 kWh of electric energy (WRI, 2009).



The figure also shows that Brazil is one of the countries with lowest CO_2 emission per kWh of electricity generated. This fact is explained by the predominance of hydroelectric plants for electricity generation. More than 80% of electricity in Brazil is generated by hydroelectric plants (MME, 2008). The remaining 20% is generated by thermo-electric coal, natural gas, fuel oil, diesel oil, nuclear power plants and plants using alternative materials, such as firewood and sugarcane. It should be pointed out, however, that the Brazilian energy matrix is becoming "dirtier" with the incorporation of thermo-electric gas powered plants or other "dirty" sources.

Local environment

Environmental issues in a country can be caused by its climate conditions or by human activity. Challenges include scarcity of water, in countries of a dry and hot climate, or high consumption of energy in countries with very high temperatures in the summer or very low temperatures in winter.

Brazil has different climate zones, which require different solutions: in regions with a hot climate, the demand for water heating is low. As a consequence, the environmental and economic benefits of installing solar water heating systems are smaller; or in the worst case it can even increase the environmental impact and the project costs without delivering social benefits.

In addition, if a new housing project is located outside the urban perimeter, that location will require urbanization, which will extend the city area. In large cities, finding available areas for social housing is more and more difficult. The environmental problem will be very different compared to that of another similar project located in an existing urban area.

Inhabitant income, needs and culture

Cultural aspects should be considered as a priority to develop appropriate responses. Standard-unit projects may not fulfill the clients' needs, leading to customers' alterations or even home resale.

In some countries, the low-income population has the means to buy heating systems and even refrigeration systems. In others, the installation and operation cost is too high in comparison with the income of this population. Both situations require adequate solutions: in the first, design to reduce energy consumption of heating systems and in the other, seek to provide maximum comfort with bioclimatic strategies.

Education and awareness-raising are crucial. Technological solutions that change significantly the housing unit in its appearance or require behavior changes or user interaction in the operation and maintenance of devices will only be successful if they are socially accepted and understood. An example to be mentioned is the reuse of greywater. These systems require users – or condominium managers – to operate a simplified station. Small condominiums or individual residences will surely have more difficulty in assuming the operation of such a system. In addition, the reuse of greywater also requires periodical quality control of the treated water by a specialized laboratory that may not exist in a certain region. All these factors may render the adoption of that technology unviable.

Business-as-usual practices

The practices established for contracting, funding and sharing of technical responsibilities influence the final decision about the project. To reach sustainability in social housing it is imperative to involve all relevant stakeholders.

In Brazil, companies are selected for the project through competitive bidding, where cost is often the main criterion for the choice of the company. Different companies can share the responsibility for construction and operation, and each of them seeks to minimize its costs. Therefore, each stakeholder makes decisions based on short-term thinking and without considering life-cycle implications. Coordination is required to integrate sustainable solutions from cradle to grave.

Another common practice is the use of a generic design for housing units, which is applied to regions with different cultures, income levels and costumer needs. This practice may not respond to the expectations of the clients, and lead to a high rate of modifications in the unit during occupation, or even in resale of the unit.

Therefore, the final decision on the actions to be adopted to promote sustainability must be based on the "Project agenda," whose purpose is to identify the relevant socio-environment aspects for the project in question, considering the resources available and user characteristics. The agenda is a result of a discussion between the applicant and his/her team and, if possible, direct and indirect clients. The final result of the project will depend on the quality of the agenda preparation process.

1.4 Developing a participative project

The consolidation of a sustainable development model will require deep changes in society, including in the different supply chains that are responsible for the direct impacts of society on the environment. Some advanced products, buildings or projects may serve as example and inspiration, but considered individually are in no condition to induce transformation.

The introduction of more sustainable standards of production in the social housing supply chain is not an easy task. The social housing construction industry is complex as it operates with public resources, brings together companies of different sizes and different technological backgrounds, and those companies have to work with public agencies, with often contradictory interests. The situation is worsened because the sector has no experience with innovation. As a consequence, implementation of sustainable solutions in the building sector will not only require the development and demonstration of viable and relevant solutions in different situations, but also specific public and industrial policies.

The capacity of a demonstration project such as SUSHI to influence a supply chain requires several actions, including:

- Qualified participative process: The engagement of the main stakeholders with decision-making power in the project implementation. These main partners include governments, building construction companies, designers, funders and academia. User participation is very important, but it may only be made viable when there are entities to represent users.

- Recognized unbiased technical leadership: The recognition of the project leadership by the sector and by the local community as an important reference in the sustainability theme. Preferably, the project leader should not have vested economic or political interests in the outcome of the project. Having a neutral leader reduces natural resistance to change and encourages the creation of a favorable environment to identify objectives that are common to all.

- Dialog for the future: The creation of an environment that is propitious to dialog for the building of objective solutions and actions, without debates or criticisms of the past.

- Search for a common vision: The development of a common vision oriented to environmental protection, improvement of quality of life for the population and building trust between the main stakeholders. It is necessary to identify the opportunities that the project brings in terms of business, image, savings, social-environmental benefits and recognition for each partner and thus to indentify the themes that mobilize all partners. Translating terms such as greenhouse gas emission, energy efficiency and rational use of water into the language of each one of the stakeholders also becomes an important factor in the search for a common vision.

- Knowledge as base for decision: the establishment of procedures for discussion based on knowledge established and validated for the local reality, avoiding discussions and decision-making based on opinions or knowledge developed for other situations. In that sense it is fundamental to understand the state of the art in academic knowledge and practical experience, whether positive or negative.

- Focus on innovation: Significant gains may be obtained from combining innovative financial, methodological, organizational and technological approaches, developed taking into consideration the specificities of each country or project.

- Investment in publicity: The project capacity to influence the market depends on the permanent publicity of ideas developed in the project.

2 Methodology and project site

The United Nations Environment Programme launched the SUSHI project in Brazil and in Thailand in 2008. In Brazil, the lead implementing organization, CBCS (Brazilian Sustainable Construction Council) brought together a network of multidisciplinary experts to assess existing challenges and propose solutions for sustainable social housing.

CBCS also partnered with institutions involved in the development and implementation of social housing projects:

- **State of São Paulo's CDHU** - Companhia de Desenvolvimento Habitacional Urbano (Urban Housing Development Company): a company connected to the State of São Paulo's Housing Department and the largest popular housing promoting agent in Brazil.
- **Caixa Econômica Federal (Brazilian Federal Savings Bank):** the main federal government's public policy agent responsible for about 70% of the social housing funding.
- **Universities:** USP – University of São Paulo's Poly-Technical School, UNICAMP (State University of Campinas) and UFSC (Federal University of Santa Catarina).
- **Other partners:** representatives of the materials industry, construction industry, building managers, academia, etc.

2.1 Assessment methodology

The team developed an assessment of the processes and stakeholders affecting the selection of solutions for social housing projects through a 5-step methodology.

1 Identification of business as usual in the production of social housing in Brazil.

To define which sustainable construction concepts will have the highest impact on social housing, it was necessary first of all to identify the business as usual solutions used by companies responsible for construction of social housing units. To this end, interviews were conducted with the companies' technical professionals to reveal the initiatives that are already implemented and their history.

2 Development of a local agenda.

The local agenda for social housing was developed based on the local characteristics (as mentioned in 1.3) and considering the several interfaces of the participative project. The local agenda allowed defining the project's pilot functions, based on the specificities of the pilot site selected in Cubatão (cf.2.2).

3 Definition of pilot functions.

A Pilot Function is defined as a component or a function in a building that is used to test and demonstrate the project approach to include sustainable construction characteristics in social housing programs. Pilot Functions may be, for example, a building's lighting system, water supply or thermal performance.

The pilot functions defined for social housing within the SUSHI project context were reduced consumption of water (rational use) and energy (natural thermal comfort and energy efficiency) during the building's life cycle.

4 Identification of existing policies and sustainable solutions for buildings in Brazil.

The team identified existing solutions for water and energy supply and demand management in Brazilian buildings. This resulted in a spreadsheet (See Annex 5 for more detail) with solutions tentatively mapped according to:

- Acceptance by the users;
- Reliability;
- Resources required for implementation;
- Availability of product suppliers in the design, installation, and maintenance stages;
- Solution difficulty in the design, installation, and maintenance stages;
- Risks detected in the adoption of the solution;
- Risk origin;
- Risk mitigation capacity;
- Costs of implementation and during its use; and
- Possibility of measurement and verification of benefits achieved by solution implementation and use.

The solutions and policies mapped out provided a database of market-available alternatives for social housing. Some of these solutions have already been implemented by CDHU.

5 Selection of relevant solutions for the project.

The selection of relevant solutions to be applied in social housing projects requires an analysis of the solutions in the database, assessed against the environmental agenda, defined by the environment priorities, user cultural aspects and needs, availability of financial resources, and existing policies.

Based on the results of the 5-step assessment described above, completion of the interviews with the technical professionals and mapping of viable solutions for social housing, the team aims at developing a methodology to be applied in a pilot site. In the future such a methodology will help companies and government bodies acting in the construction of social housing. In addition, as project products, the team expects to disseminate the knowledge acquired by reports and books and propose innovative sustainable solutions to be tested in social housing.

2.2. Identification and presentation of the pilot site

The project team worked in cooperation with CDHU to identify a pilot site in the state of São Paulo (cf. Annex 4). The pilot site in Cubatão was used as a reference for the development of the market analysis, identification of key elements in the project agenda, as well as definition of pilot functions and alternative solutions.

The residential market, in Brazil, only serves 30% of the population, excluding many cities and the middle class that has an income of 5 to 7 minimum wages. A large share of this population invades lands for survival. Lands occupied by this population are often areas with fragile ecosystems. The Serra do Mar region is an area where development can be consolidated, since it does not represent a risk for permanent preservation and environmental recovery of the area.

The project selected is located in the socio-environmental recovery area of the Atlantic forest of Serra do Mar (see Annex 4). This project has several characteristics that make it interesting as a pilot project for the SUSHI project.

It is part of the largest and most advanced project of the CDHU in the area of urban settlements, the "Socio-environmental Recovery of the Atlantic Forest of the Serra do Mar - Serra do Mar State Park".

Several illegal settlements have been created in this region, and often present environmental and health risks for inhabitants. The objective of the project is to resettle the families that live in risk areas, namely in hillside areas, where landslides and erosion occur during heavy rains. Later the remaining urban infrastructure will be improved and adapted.

One of the goals is to delimit the urbanized area by a ring road, as a physical obstacle, that will be regularly patrolled by the environmental police to avoid new invasions, appropriations and occupations. The border areas, from where houses will be removed, will be reforested with plants from the original Atlantic Forest biome.

The inhabitants will be settled in three new housing projects situated in the lowlands of Cubatão. These three areas conform to Cubatão's land use development plan and have been adapted to the steering plan of the municipality, which lacks areas to build social housing because of the mountains in the region. Therefore, CDHU agreed to use former construction dumps of the Immigrants highway that had been donated to CDHU in exchange for preserving the mangroves around them.

The sites were proposed by CDHU as a showcase for the change in the social paradigm for housing in Brazil. The Project follows the new standards for urban housing and for social housing in the state of São Paulo, which include:

- Health facilities;
- Education facilities and a school;
- Private and public green areas (partnership with the State Environment Agency); and
- Bicycle lanes.

CBCS also agreed to this project because of the phase-wise construction of these housing developments and the possibility of implementing a pilot project in these localities.

3 Business as usual in social housing production in brazil

Brazil has undergone massive urbanization since the nineteen forties, leading the country to attain an 82% urbanization rate. Today, the housing deficit is 6.3 million units countrywide. Table 1 shows the housing deficit in Brazil, in the State of São Paulo, and in the metropolitan area of São Paulo.

As shown in Table 1, the housing deficit in the State of São Paulo is of approximately 880,000 units. The largest part (84.1%) was concentrated in the metropolitan regions of São Paulo (620,000 units), Campinas, and Baixada Santista (Figure 3).

The government's social housing program, considered in the SUSHI project, now prioritizes the poorest population strata by giving subsidies to families who earn 1-3 minimum wages. However, the government also provides housing for the population earning up to 10 minimum wages.

Medium-income families may acquire their housing units through the SFH – Sistema Financeiro de Habitação Federal (Federal Housing Financial System), created by the Brazilian government to provide subsidies for up to 25 years for home building and acquisition.

Figure 3 – A typical example of social housing project in the State of São Paulo. Sources: Andrade; Pileggi (2005)

Brazilian citizens, who do not own their own house, may register with public bodies to participate in the social housing program, provided that the applicant:

- Does not own real-estate property;
- Is in the income class between 1 and 5 minimum wages (exceptions up to 10);
- Has an employment contract;
- Does not have debts;
- Has lived in the municipality for the last two years.

However, according to Andrade, Pileggi (2006), after receiving their own housing unit, with subsidized installments, borrowers have to bear housing costs, unknown problems for most of them:

- Those who used collected firewood will have an additional expense with gas;
- Those who come from 'favelas' (squatter settlements) where clandestine power connection is common will have an additional expense with electricity bills;
- Those who collected water from fountains, springs or used clandestine connection will have to pay water bills;
- Those who move to flats will have to bear condominium expenses for water, power and maintenance of common areas and equipment.

Because the vast majority of borrowers do not have a sufficient income to bear mortgage costs, gas, water, light, condominium and regular family expenses, subsidies to installment payments are not enough to solve the problem of access to housing.

Table 1 – Housing Deficit in Brazil and in São Paulo. Source: CDHU 2008

Region	Housing deficit		Area	
	Units	%	sq km	%
Brazil	6.300.000	100	8.514.215	100
State of São Paulo	880.000	14,0	248.209	2,92
Metropolitan Area of São Paulo	620.000	9,8	7.944	0,09

Without resources, borrowers first fail to pay CDHU, then the condominium, and finally water, gas and electricity utility companies. Condominiums frequently have the water supply suspended, and when dwellers have their gas supply suspended, they take gas cylinders to flats, which is an illegal procedure and generates risk to the community. There are no official statistics, but it is known that a large number of dwellers, pressed by lack of resources, sell their right to housing and return to squatter settlements (ANDRADE, PILEGGI, 2006).

Therefore, more sustainable social housing projects that bring the following benefits should be implemented:

- **Environmental benefits:** reduce natural resource consumption and waste generation;
- **Economic benefits:** reduce water, electricity, and gas bills, allowing borrowers to save money and repay their debt to social housing construction companies; and
- **Social benefits:** reduce the return of the low-income population to squatter settlements, and provide comfort and better quality of life to families. Better conditions may improve the children's and youngsters' learning skills and the adults' work and income generating capacity.

3.1. Social housing funding and construction

At present, social housing projects in Brazil are executed by the federal, state, and municipal governments and private initiatives. Some of them are described below:

- **Federal Government:** The nationwide project called «Um Milhão de Casas» (A Million Homes) was launched by the current government and aims at building 1 million social housing units through the Ministry of Cities. The financial management is conducted by the Caixa Econômica Federal (Federal Savings and Loans Bank), that coordinates the funding of social housing projects in all 27 Brazilian states, managing a R$ 34 billion budget. The target group is families earning one to ten times the minimum wage, with priority for those earning one to three times the minimum wage.
- **State Government:** Most social housing projects are carried out through building construction companies that usually sub-contract private companies to design and build that type of housing units. The State of São Paulo's government conducts social housing projects through its own building construction company, CDHU. It also has budget resources available to build social housing units. Since 1990, a State Law (Law 6556/89) allocates a minimum of 1% of the total ICMS[2] resources (applied to all commercial transactions) to social housing projects.
- **Municipal Government:** It normally operates in collaboration with the State Government or with the Federal Government. The City of São Paulo's government has its own social housing construction company (COHAB SP).
- **Private Companies:** Some private companies finance the construction of housing units for low-income population, especially those earning between 5 and 10 minimum wages.

2 ICMS (Value-Added Tax) The city of São Paulo accounts for 1/3 of all state tax collection. Its ICMS collection totaled R$ 78.6 billion last year, a 2.8% growth as compared to 2008 (Source: SALLES, 2010)

3.2. Common practice in selection of social housing site and design

In the past, the goal of social housing companies was to eliminate the housing deficit by building family units, but there was not specific consideration of the environmental and social aspects, or of the incorporation of units in the urban environment.

An important part of social housing units were built on land that was not regularized by public bodies, as the regularization process was quite long. However, this hampered utility companies' ability to control the consumption of users and to take action when bills were not paid. Nowadays all lots must be regularized before keys are delivered to the owners.

Important aspects in site selection, design, building construction defects and housing quality level, building construction materials, and waste management are described below.

Site selection

Site selection depends on the availability of land for construction. The land cost was usually the most relevant aspect considered by local authorities and building construction companies. Although cost is still the main criteria, since 2004, characteristics such as neighborhood and distance were also considered, as well as the specific needs and lifestyle of target families.

The governments of small and medium-sized cities normally offer the land at no cost. In these cases, the construction company conducts a technical appraisal of the soil, mainly in its legal and urban aspects. If the piece of land is accepted by the company, the municipal government donates the land to build social housing units. The land donation increases project feasibility as the unit cost is reduced.

In other cases, the company acquires the land on the market. In large cities, such as São Paulo, the land cost is higher than in small and medium-sized cities. Therefore, the required investments are much higher and make it difficult to balance implementation costs, family payment capacity and governmental subsidies. This restrains the production of social housing projects in large cities.

In areas with a high land cost, companies prefer to build multi-family units, to reduce the unit cost. Where the cost of land is lower, as in inland cities, companies would rather build individual housing units.

Another important aspect is that the commuting distances for residents tend to be longer in large cities, and the cost of transportation spending may increase, which may compromise citizens' capacity to bear the housing funding costs.

Design

In the past, companies planned real-estate developments with their own designers and engineers. Due to the large volume of building construction, this started changing in 2000. Today most design tasks, construction, and management are sub-contracted or outsourced. CDHU, for example, is in charge of design and construction in new real-estate developments.

Most social housing projects in Brazil, in the past 40 years, were produced according to standard design solutions for individual housing units or multifamily buildings. The project concept shows the same floor type, the same size, and the same predominant technology of masonry. The use of pre-cast concrete and other technologies was exceptional and showed a much higher rate of building construction defects. Figure 4 shows a schematic plan of a multifamily building.

The purpose of using standard projects is to reduce building construction costs. For this reason, different climates and user needs were not taken into consideration. For example, all buildings have the same type of window with no possibility of adjusting the window to different climates (Figure 5 and Figure 6).

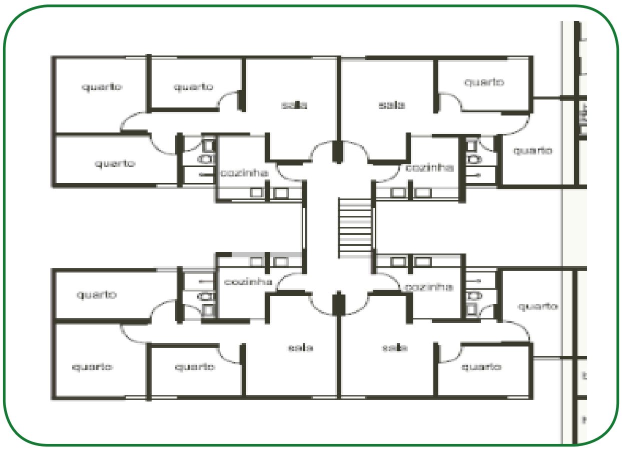


Figure 4 – Typical floor of a multifamily building. Each building has 4 floors and 16 flats.

Construction defects and housing quality

EIn general, social housing units show a relatively high rate of building construction defects as compared to high-standard buildings. These defects increase the environmental impact of building construction, the need for rehabilitation, and waste generation. Waste management must be correct so that waste does not pollute the soil and underground waters. Likewise, building construction defects reduce social benefits, considering that the unit's function and the users' quality of life may be negatively affected.

However, since the last decade of the 20th century, the civil construction quality level became a relevant issue in Brazil. CDHU's Qualihab Project (State Decree 41337 of November 25, 1996) is a pioneer effort on that matter and focuses on the supply chain, especially building construction companies and the building materials industry.

In 1998, the Federal Government created the PBQP-H - Programa Nacional de Qualidade e Produtividade na Habitação (National Housing Quality and Productivity Program), managed by the Ministry of Cities, and bringing together representatives of the whole supply chain of the civil construction industry. The PBQP-H is the nationwide version of the CDHU Qualihab project.

A national standard establishing a minimum performance rate for housing buildings was recently approved: NBR 15575 (2008) – Residences of up to five floors – Performance – Parts 1 to 6, and the SINAT -- Sistema Nacional de Avaliação Técnica (National Technical Evaluation System), based on the PBQP-H, was launched to promote the technical approval of innovative technologies.

Figure 5 – Typical window in CDHU buildings.

Figure 6 – Lack of shutters in windows of CDHU buildings

4 Local agenda

4.1 Energy matrix

Compared to the rest of the world, Brazil has a relatively clean energy matrix: 47% (including the use of fossil fuels for transportation) are considered renewable sources (Figure 7) whereas only 20% of the world's resources are considered renewable (LAMBERTS, 2008)[3] .

Hydroelectric power plants currently produce more than 84% of the electricity consumed in Brazil. However, with the increase in the Brazilian energy consumption, the energy matrix is becoming "dirtier" (i.e. increasing greenhouse gas emissions related to energy production and consumption): the governmental plan (PNE, 2030) anticipates a fivefold growth in the use of fossil fuels to generate electricity between 2010 and 2030. The Greenhouse Gas Protocol (GHG) estimated the CO2 emission in Brazil at 80 g/kWh, for the year of 2006[4] . On the other hand, official data for that year is 32.3 g/kWh (MCT, 2010).

In Brazil, about 45% of the consumed electricity is related to buildings in general and 22% to residential buildings. In terms of energy consumption by source, for the residential sector, electricity accounts for the largest share, 35.6%, followed by firewood for 34.6%, LPG for 26.5%, and the last 3.4% (Figure 8) correspond to other sources, including natural gas, kerosene and coal. To obtain more energy efficient projects in this sector it is necessary to find solutions to reduce electricity and gas consumption, as well as promote greater use of renewable energy sources.

In the Brazilian housing sector, the main consumption sources are: refrigerators (22% corresponding to refrigerators and freezers), water heating (24%, mainly for the use of electric showers), air conditioning (about 20%) and lighting (14%)[5] .

Consumption patterns differ according to the region and this should be considered in the analysis of a local project agenda. Table 2 shows that water heating and air conditioning needs vary between regions. The use of air conditioning in Brazil went from 3%, in 2001, to almost 20%, in 2007, indicating that energy efficiency and thermal comfort are two key areas to improve sustainability.

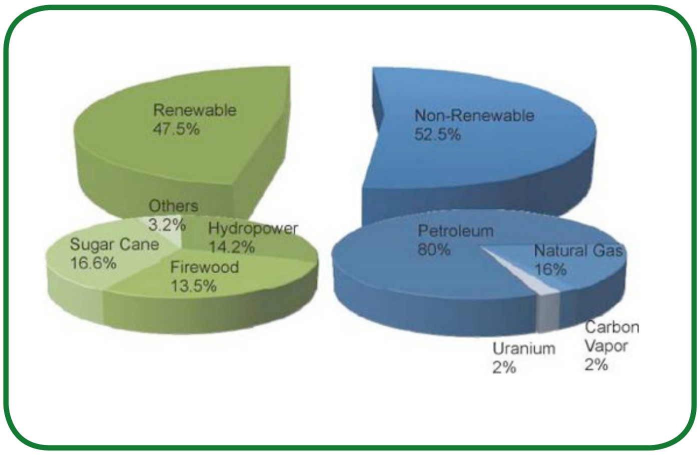


Figure 7 – Brazil's Energy Matrix. Source: MME (2006)

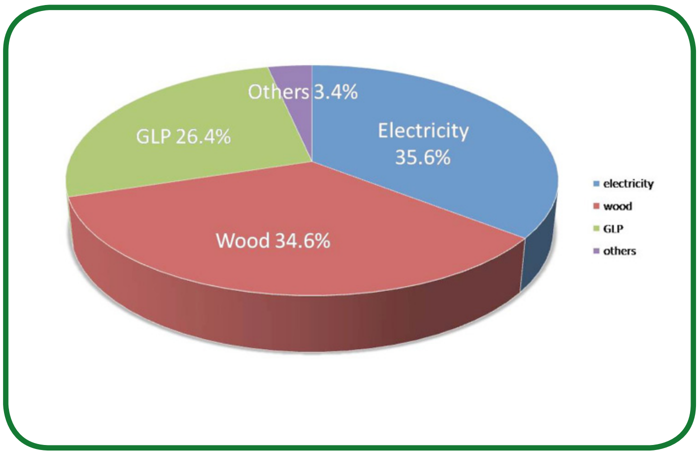


Figure 8 – Energy consumption by source in the housing sector

3 LAMBERTS, R. Desafios dos Edifícios "Zero Net Energy". Presentation to SBCS 08 - I Brazilian Symposium of Sustainable Building Construction (Presentation). 2008.

4 http://www.ghgprotocol.org/

5 ELETROBRÁS. Report on Survey of Equipment Ownership and Habits – Year Base 2007 – Residential Sector. Available at: www.procelinfo.com.br

Table 2 – Different end uses in energy consumption by residences, per region (%) (ALMEIDA et al., 2001)

Region	Refrigeration	Water Heating	Lighting	Air	Outros	Total
Southeast	33.1	23.4	11.2	3.3	29.0	100
South	32.6	22.4	10.9	1.5	32.7	100
North	35.4	4.5	19.6	9.4	31.1	100
Northeast	41.0	7.2	18.2	3.1	30.5	100
Midwest	33.6	23.2	12.1	2.3	28.9	100
Brazil	34.1	20.7	12.3	3.0	29.9	100

4.2. Regional and local climate

To evaluate the water and energy agendas of CDHU projects, it is important to analyze the local micro-climatic trends. Therefore, this item provides detailed information on local climate data availability and interpretation.

Although there are reliable climatic data for the City of São Paulo, reliable data for Cubatão are scarce, because there is neither a weather station nor long-term climate monitoring; therefore, the lack of data should be seen as the main problem for bioclimatic analysis. As Brazil has significant climate diversity, the NBR 15220 – Norma Brasileira de Desempenho Térmico (Brazilian Standard for Thermal Performance) for low-income families (ABNT, 2005) created the Brazilian climatic zoning (Figure 9), dividing the country into eight climatic regions, considering the strategies for each region, so that buildings are adequately designed.

Therefore, one source recommended to access recommendations for bioclimatic building construction is this Brazilian climatic zoning. Another source is the FINEP report on more sustainable housing technologies, prepared by five Brazilian public universities (POLI-USP/ UNICAMP/UFG / UFSC / UFU, 2008).

Cubatão is located between two bioclimatic zones, the City of São Paulo (Zone 3) and the City of Santos (Zone 5). The city's climate is humid sub-tropical (Cwa), influenced by monsoon. General recommendations, for both climatic zones, are cross ventilation in summer and solar heating and thermal mass in winter. However, winter is stronger in Zone 3 (Figure 10) than in Zone 5 (Figure 11).

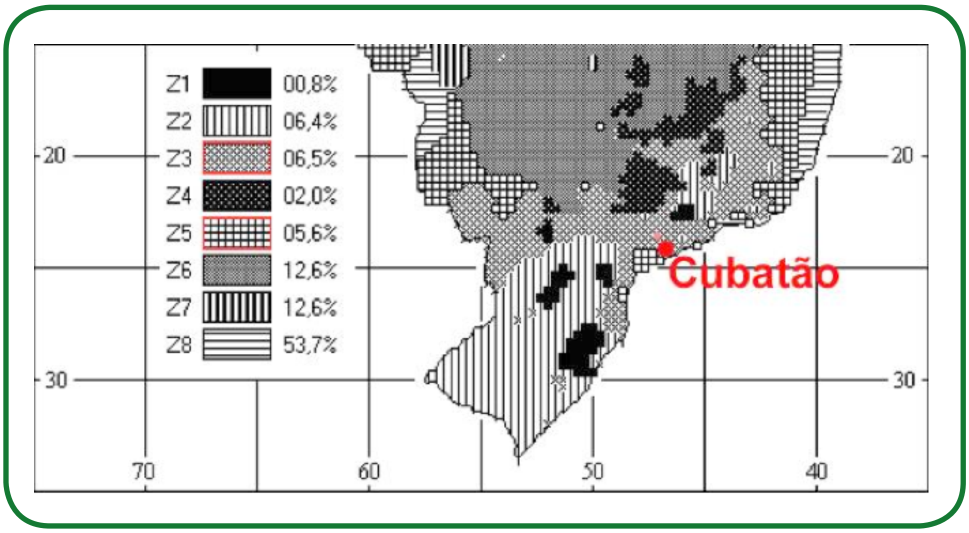


Figure 9 – Southern Section of the Brazilian Bioclimatic Zoning. Source: ABNT (2005)

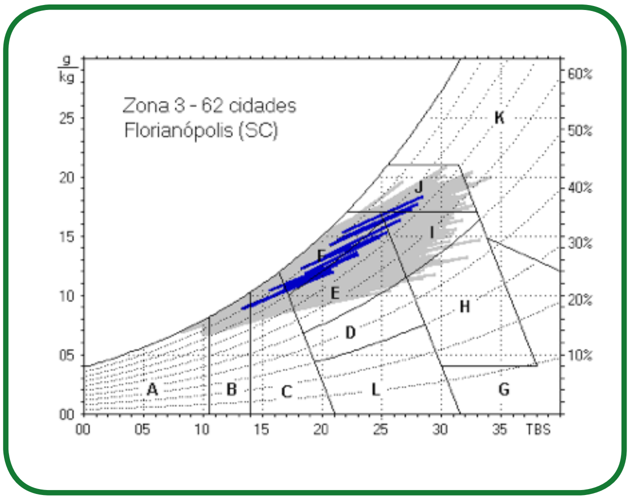


Figure 10 – Chart showing climate norms of cities in Zone 3 (grey color), highlighting the City of Florianópolis (blue color)

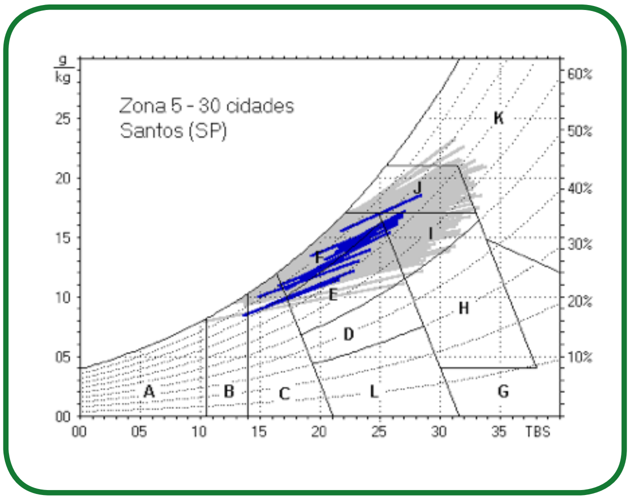


Figure 11 – Chart showing climate norms of cities in Zone 5 (grey color), highlighting the City of Santos (blue color)

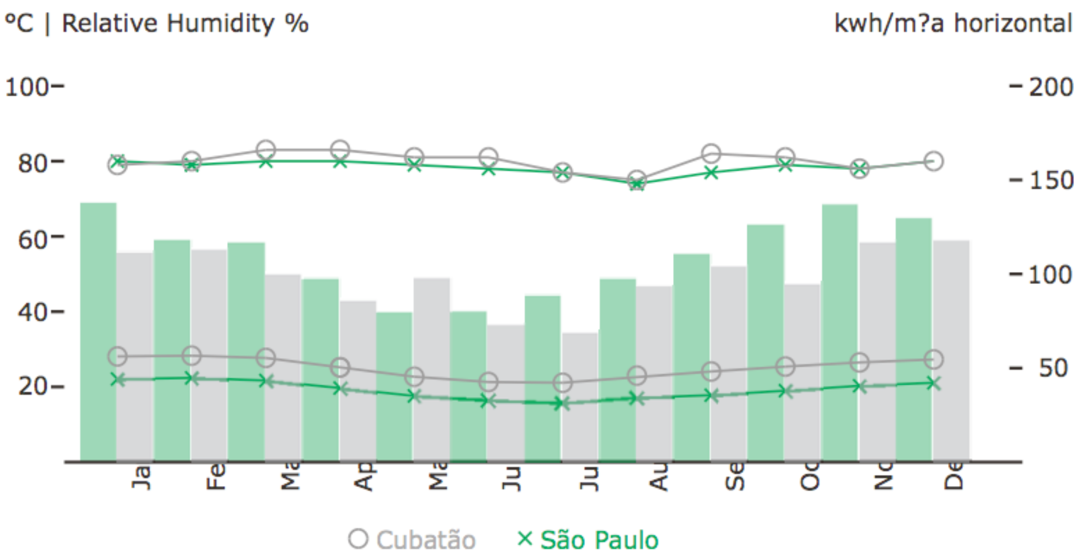


Figure 12 – Comparison between the climate in São Paulo and Cubatão

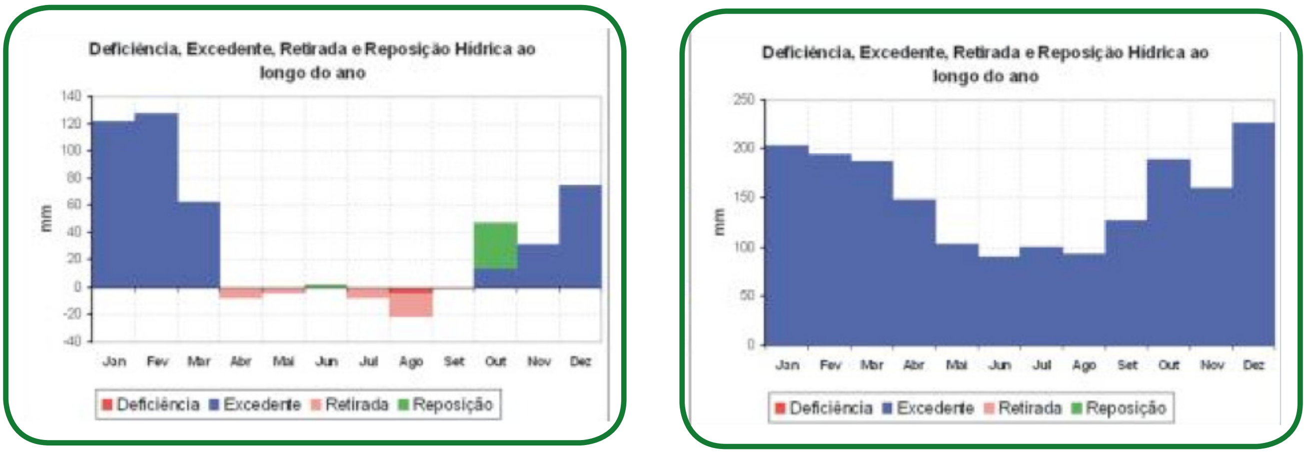


Figure 13 – Annual water balance of São Paulo (left) and Cubatão (right)

The differences in climatic data of the Cities of São Paulo and Cubatão (Figure 10 and Figure 11) lead to the following conclusions:

Precipitation: Because of the location of Cubatão at the bottom of Serra do Mar, the formation of clouds and more intense rains is common and continuous during the winter season (September-March). The average precipitation rate is twice as high in Cubatão as in São Paulo. Floods accompanied by erosion are frequent in Cubatão.

Air temperature in summer: Because the area is located only 20 to 500 meters above sea level, the air temperature in Cubatão is considerably hotter than in the City of São Paulo (additional 3-5°C on average). This leads to high thermal stress and the tendency to use air conditioning systems in summer.

Air temperature in winter: The low altitude and the proximity to the sea also lead to a better thermal comfort during winter, since temperatures are milder.

Taking a local approach, the predominant trends for local microclimate should be analyzed so that correct building construction strategies may be adopted. Torres et. al. (2002) shows the microclimates prevailing in Cubatão, of which the mountain climate (1) and the climate of wetlands (4) are of particular interest to the project:

1. **Mountain climate** – The climatic barrier of Serra do Mar leads to the condensation of moisture and the formation of clouds and mist. The increase of humidity enabled the development of a rich vegetation cover. Because of the altitude and humidity, the air temperature is generally 2-3°C lower than in coastal plain.

2. **Climate of the valley** – Characterized by the formation of intense fog and change in temperature through ascending and descendant breezes.

3. **Climate of industrialized area (bottom of Serra do Mar)** – Air pollution causes condensation of the atmospheric moisture and, depending on the hydrometric state of the air temperature, the formation of wet or dry mists. The temperatures in that area are always higher than in the coastline, because of the absence of sea breeze (FREITAS et. al., 2007).

4. **Climate of wetlands** – This region is not affected by breezes, therefore climate is relatively hot. And because of the organic decomposition and seawater evaporation, the air is sometimes permeated with the smell of ammonia.

5. **Climate of the sierra** – Since it is more directly exposed to predominant winds, high temperatures may be attenuated, but that phenomenon may also accentuate low temperatures, as it happens in the valleys.

6. **Coastal climate** – This region has a higher atmospheric concentration of sodium chloride, which increases the oxidation of building construction materials. The climate is one of the most pleasant in the municipality, thanks to the sea breeze, that mitigates heat. The climate is strongly influenced by the predominant winds such as those from the Northeast quadrant (hot) and Southeast quadrant (violent, accompanied by thunderstorms).

4.3 Water scarcity

Water availability in a region is measured according to two basic parameters: surface waters and underground waters. The demand varies according to weather conditions, activities, and social, cultural and economic needs of users. One may evaluate the scarcity level of a region through the balance between availability and demand and, in view of the result, decide the most attractive actions for water conservation (actions on demand and actions on supply) to be implemented in buildings (FINEP, 2006).

A low-availability scenario, associated to a highly concentrated population, may be verified by the Tietê river, that traverses the City of São Paulo and supplies several municipalities of the State of São Paulo, and in the rivers that flow into the region of the Guanabara Bay, in the City of Rio de Janeiro, attaining values lower than 500 m3/ inhabitant/ year, representing a situation of water scarcity (FINEP, 2006). Figure 14 presents the water demand compared to the available flow (Q7,10) in the different hydrographic unities for management of water resources in the State of São Paulo.

Large Brazilian cities such as São Paulo have shown problems of adequate water supply to the population. Shortages are frequent, caused by a set of factors including population concentration, leakages in the distribution network and excess consumption because of users' lack of technological knowledge and awareness (JOHN et al, 2000).

This requires the development of measures to manage the use of water, so as to avoid scarcity and reduce the quantities in the public water treatment system. Such measures are divided into two modalities: 1) rational use of water; and 2) use of alternative water sources (FINEP, 2006).

The **rational use** of water consists of demand-oriented actions, that is, measures to reduce the water used to perform a certain activity, to raise awareness on the actual need of water to develop a task, and measures to prevent water waste. In addition to awareness-raising campaigns, the rational use of water may also be directly related to measures adopted in the design or construction phases. This is done through: a) using high-quality equipment to avoid leakages; and b) installing water efficient appliances, that allow to reduce the total water use (FINEP, 2006).

The **use of alternative water sources** consists of actions directed to expand supply, that is, measures taken to capture water that originally would not be intended for use, and make it available to be exploited at least in some secondary uses. At present, the use of alternative water sources is directly related to: a) rainwater use; and b) collection of water for reuse.

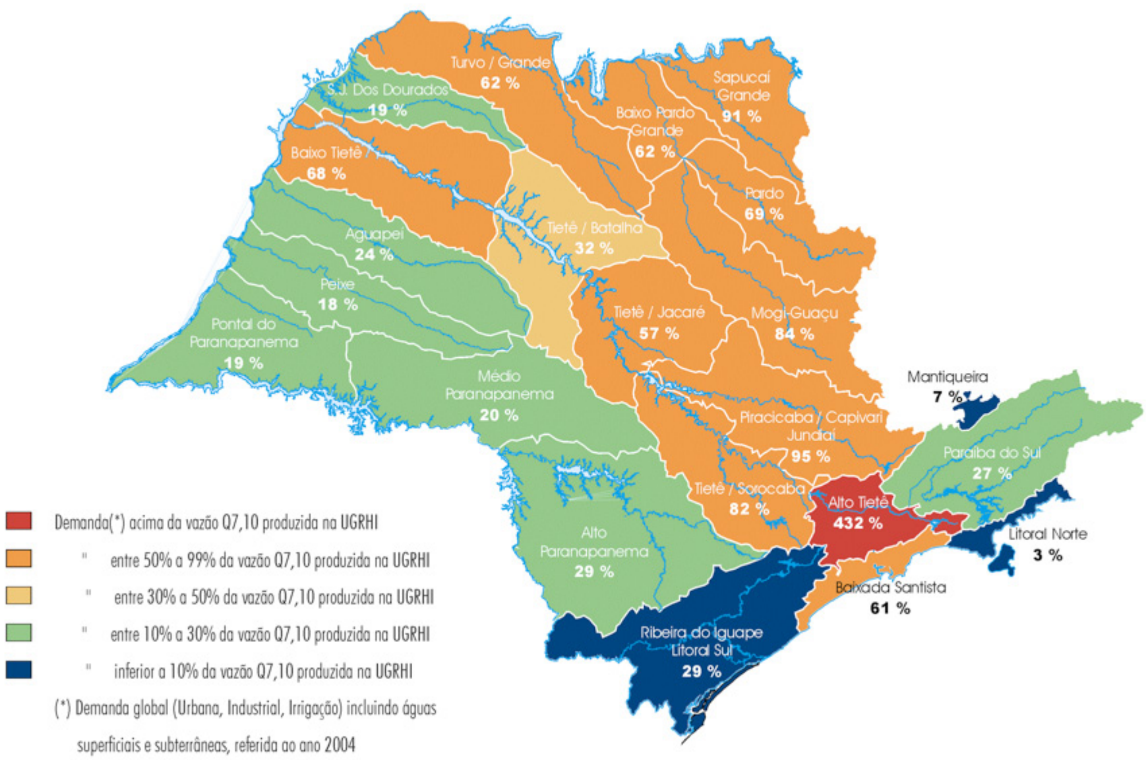


Figure 14 - Water demand compared to availability. Source: Prof. Ricardo Toledo-Secretariat of Sanitation and Energy of the State of São Paulo (2010)

Water reuse involves collection and treatment of wastewater that would be destined to the sewage network, specifically the so-called greywater. Greywater may be used for certain non-potable purposes, but should be appropriately treated, stored and distributed through independent building systems (FINEP, 2006).

At present, there are two programs in progress in Brazil that are worth highlighting: the PURA – Programa para Uso Racional da Água (Program for Rational Use of Water), implemented in the State of São Paulo; and the PNCDA – Programa Nacional de Combate ao Desperdício de Água (National Program Against Water Waste). These two programs develop educational campaigns; activities for measurement and water use management in buildings; and research & development of low-consumption methodologies, technologies and equipment, many of which are already available on the market for immediate use. Despite the remarkable progress in recent years and the functional and economic efficiency of new appliances, the use levels are still low. In addition, some appliances and equipment are widely used abroad but not in Brazil (JOHN et al, 2001).

4.4 Urban floods

In addition to the problem of water scarcity, the major Brazilian urban centers have experienced more frequent events of floods. The main causes of this problem are the increase in soil sealing, which reduces the natural soil capacity to absorb rain water, and the volume of intense rains, which may be the result of the emission of pollutants and phenomena such as heat islands and climate change.

Where available, *piscinões* (retention reservoirs) that collect and stock rainwater, even if for a short period of time, help drain water from areas subject to floods, considering that the flow of rainwater that would contribute to the formation of floods is partially delayed.

5 Definition of pilot functions

The focus areas, or pilot functions, chosen for buildings are reduced water and energy consumption within their life cycle. It is important to note that these resources (energy and water) are subsidized for low income populations, resulting in an initial lack of incentive for responsible consumption behavior.

The following pilot functions were chosen for the projects in Cubatão:

- Natural thermal comfort – avoiding future energy consumption from air conditioners (except for low energy consumption equipment such as fans).
- Energy efficiency – not only in relation to the generation of thermal comfort, but also to the use of energy.
- Responsible use of water – concerns the small and large scale water cycles throughout the building's life cycle.

There are several technologies that can improve the efficiency of water and energy consumption.

The SUSHI team chose to concentrate on the water and energy challenges because they have the potential for preventing environmental problems for society as a whole (macroeconomic efficiency at urban, regional and national levels).

5.1 Energy

Since the main use of electricity in the residential sector is for refrigerators, water heating, air conditioning and lighting, social housing projects would strongly benefit from energy efficiency through strategies such as:

- Solar water heating (specially in the southeast and south regions);
- Increased natural thermal comfort through passive techniques, decreasing the need for air conditioners; and
- Decreased consumption of energy in lighting and refrigeration, through increased equipment efficiency.

A significant share of the electricity demand in households in the South comes from heating water in electric showers ranging from 3.5 to 10 kW, without hot water storage tanks. Electric shower consumption rises particularly in the evening, peaking at around 7pm. A promising solution for water heating in the residential sector is the use of solar energy, a renewable energy source that is easily accessed and has a relatively low cost.

The second issue to consider, due to the low thermal comfort found in housing and the effect of urban heat islands, is that the use of air conditioners is also increasing in low income families.

In this regard, the Brazilian Electricity Regulatory Agency (ANEEL) is implementing a project that, through the use of an energy fund, can promote energy efficiency strategies for low income families. There are also some initiatives to replace inefficient appliances, such as refrigerators and incandescent light bulbs, by newer and more efficient ones, as well as for adoption of solar heaters.

Electricity is subsidized in Brazil for the lower income populations, so consumer behavior and awareness become important issues for achieving reduction of energy consumption. It is particularly important to avoid future installation of air conditioners. Therefore it is essential to focus specifically on improving ventilation and passive thermal comfort systems. However, one additional challenge in this case is dealing with urban noise and air pollution.

Since natural ventilation is not a reliable resource in this case, as it is generally low in urban areas, forced ventilation is the recommended strategy. Initially, the combination of natural ventilation strategies, shading and simple equipment (such as ceiling fans) looks promising. Besides strategies for energy efficiency, the water agenda should also be given a high priority.

5.2 Water

Like energy, water is subsidized for low income families. It is still a cheap and relatively abundant resource. However, the Metropolitan Region of São Paulo (made up of some 45 towns) is dealing with an increasing demand for water and has had to acquire water in remote or distant places, resulting in several technical and political difficulties.

At present the demand for water in the metropolitan region is around 66 m^3/s with a projected increase of up to 75 m^3/s by 2025. To reduce this demand, some important strategies related to water efficiency are required, such as individual metering, which is already in place in some CDHU projects, as well as equipment that allow saving water without decreasing the families' comfort level.

The team recognizes that the final pilot functions are closely related to the locations chosen, the design phase and the willingness of interested parties in addressing the challenge.

6 Identification of existing building policies

There are several companies, organizations and government agencies interested in implementing more sustainable models for housing construction in the country. To develop efficient models for conceptualization, design, construction, use and maintenance of buildings, all stakeholders should be involved in the process (contractors, planners, financial institutions, government, users and building administrators).

One of the most cited obstacles for the implementation of more sustainable housing systems is the additional cost, estimated to be of 5 to 12%. This affects negatively the perceptions of contractors and clients, even though this cost can be compensated in the medium term by the savings generated through efficient water and energy solutions.

It is extremely common, in the social housing sector, to give priority to achieving minimum costs, without consideration of the quality of the building. However, perceptions are starting to change, as stakeholders realize the potential benefits of sustainable buildings, including that these housing units provide greater comfort and housing quality and buidlings are less expensive to run and maintain.

Similarly, governments are beginning to address the issue, based on the positive results of the first housing projects that incorporate improvements such as solar water heating, floor and wall finishing materials that allow easier cleaning, higher ceilings for thermal comfort, universal accessibility (for the elderly and physically impaired), individual water meters, etc. This leads to a demand for improvement by residents of other social housing projects.

In Brazil, the technological development of products and methodologies for sustainable design and management of buildings has gradually advanced, but is still limited in comparison to countries that use formal methodologies for evaluating buildings and that have public incentive programs for developing sustainable buildings (FINEP, 2005a).

However, some public policies have already been introduced in Brazil, with favorable results. The aim of these policies is to control the quality of civil construction products and services. Some of the main public policies developed in Brazil are described below.

6.1 PBQP-H

The Brazilian Program for Quality and Productivity in the Habitat (PBQP-H) aims at promoting productivity in the housing materials' supply chain, using the State's purchasing power to stimulate observance of technical standards, development of performance standards and of new construction technologies. The manufacturers that repeatedly do not meet the standards or disrespect the legislation will no longer be able to sell their products to the government, and the lack of quality of products is made public through a list of non-compliant companies (FINEP, 2005a). This program has resulted in a quality improvement in products used in civil construction, such as the adoption of 6.8-liter flush tanks, and reduced consumption of natural resources.

6.2 PROCEL

In the past decades, the implementation of an energy efficiency agenda in Brazil has lead to changes in public policies to promote energy saving measures in the construction industry.

The National Electricity Conservation Program (Procel) was created in 1985 as a joint venture between the Ministry of Mines and Energy and Eletrobrás, an energy company controlled by the Brazilian Government. Its main objective is to promote the rationalization of electricity production and consumption, eliminating waste and reducing costs and sector investments. In 1991, it was made into a governmental program and has expanded its scope and responsibility.

Law no. 10.295 (dated October 17, 2001) was an important step towards the establishment of a National Policy for the Conservation and Sound Use of Energy. It promotes nationwide energy efficiency with special emphasis on equipment, buildings and renewable energies. Since the law was enacted, PROCEL has developed together with INMETRO (National Institute of Metrology, Standardization and Industrial Quality) into programs to improve the efficiency of household appliances (Brazilian Labeling Program – PBE) and of buildings (Technical Regulations for Quality in public and commercial buildings -RTQ).

The Brazilian Labeling Program (PBE) aims at making the consumer aware of the energy efficiency of appliances, rating them from A (most efficient) to E (least efficient) (Figure 15 and Figure 16). Refrigerators, freezers, air conditioners, electric showers, light bulbs and solar heaters are, among others, part of the program. There are two separate programs according to the kind of energy used: electricity or gas. Products showing the best energy performances in their category are acknowledged with an energy efficiency seal (PROCEL for electrical appliances or CONPET for gas appliances).

The technical regulations for buildings aim at improving the energy efficiency of buildings by verifying reference parameters. They were developed according to the specific demands of the two sectors: commercial and residential. The commercial label was approved in 2008 and is voluntary for new buildings. Labeling for residential buildings is under development and should be approved by the end of 2010. For commercial buildings, the regulations focus on the use of air conditioners. The new residential regulations will instead promote natural ventilation solutions.

Figure 15 – PBE Seal level A and Procel Seal for appliances that consume electricity

Figure 16 – National Energy Conservation Seal – ENCE – for commercial buildings

6.3 PROACQUA

ProAcqua is a program developed to ensure the quality and the productivity of individual water metering systems. This program is the result of a partnership between the Center for Development and Documentation of Urban Infrastructure and Housing (Cediplac), a private non-profit institution for promoting social responsibility and quality in housing, and the Basic Sanitation Company of the State of São Paulo (Sabesp).

6.4 Blue House Seal

The Blue House Seal, awarded by the largest housing financing agency of Brazil, the Caixa Econômica Federal – CAIXA (which finances around 70% of Brazil's residential property), classifies projects according to socio-environmental criteria that prioritize sustainable practices and reduction of natural resource consumption. The Seal is the main instrument of CAIXA's Sustainable Construction Program.

To award the seal, CAIXA will analyze criteria grouped in six categories: urban insertion, design and comfort, energy efficiency, conservation of material resources, sound use of water and social practices. The objective is to encourage construction of housing units that respect the environment during construction, while at the same time providing good comfort and health conditions for their users.

The "Blue House Seal" will be divided into gold, silver and bronze categories, defined by the number of criteria met. To receive a gold ranking, the building must meet at least 24 of the 46 conditions. Those that meet 19 criteria will receive silver, and those that meet at least the 14 mandatory criteria will receive bronze.

6.5 Conama 307/348 – waste management

With regard to Brazilian legislation, the CONAMA Resolution 307, dated July 5, 2002, establishes the classification of civil construction waste and recommends its disposal according to this classification.

CONAMA Resolution 348, dated August 16, 2004, merely alters CONAMA Resolution 307 by including asbestos in the class of hazardous wastes.

7 Sustainable solutions for buildings found on the market

Some solutions for sustainable housing have already been adopted by the Brazilian civil construction market. Below is an overview of the main solutions that can be applied to social housing.

7.1 Water appliances: 6.8-liter flush tanks

The Brazilian market has a variety of water saving devices but not all are suitable for residences and in particular for single family social housing.

Since 2002, all the flush tanks manufactured in Brazil, which previously had a volume of 12 liters, can only have a maximum flush volume of around 6.8 liters (nominal 6 liter capacity) (FINEP, 2005a). This simple change in flush volume delivers a significant reduction in a building's water consumption.

7.2 Waste management in civil construction

Another popular solution is waste management at the building construction site. Its importance is due not only to the volume this waste represents - around 50% of all the solid waste produced in urban areas – but also to the impacts it causes, particularly when taken to inappropriate sites (FINEP, 2005a).

Waste management includes classification, sorting, packaging and transport to appropriate sites, according to CONAMA Resolution 307/2002. Construction waste may not be disposed of in landfills for household waste, dumps, hillside slopes, bodies of water, empty lots and areas protected by law. The disposal of waste in appropriate sites contributes to the preservation of the environmental quality of the physical, biotic, and anthropic environments, not only in the disposal area but also in its surroundings.

7.3 Low emission cements

In Brazil, great variability is seen in energy consumption among the various production plants due to technological differences. In the cement industry, energy consumption can vary from 6000 MJ/ton in the wet process manufacture, to 3000 MJ/ton in the modern dry process manufacturing plant, equipped with pre-heaters and pre-calciners (FINEP, 2005b). A study developed in 14 recently built cement plants in Brazil (Sathaye et al., 2001) using similar technologies, showed that the CO_2 emissions of the most efficient plants were 45% less than average emissions, mainly due to differences in the type of fuel used.

In addition to the differences among the plants, differences also exist among the types of cements. According to Carvalho (2002), the Portland cement (PC) type that generates less CO_2 is type III, whose emission is approximately 78% smaller than PC I, the largest CO_2 emitter (Figure 17). The adoption of lower emission cements can lead to buildings with reduced environmental impacts.

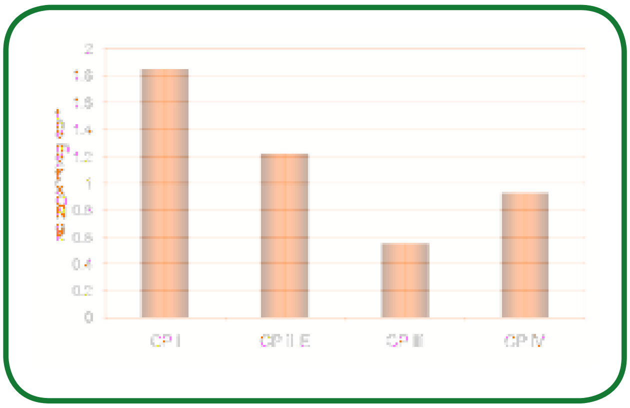


Figure 17 – CO_2 emissions by cement type. Source: Carvalho (2002).

7.4 Solar heaters

It is estimated that at least 80% of the area of solar collectors installed in Brazil are used for heating water in single family households, and 8% are used in multi-family buildings. A small but growing number is used for heating swimming pools and in the service industry, mainly hotels, motels, hospitals, day care centers and schools. The share of the industrial sector is still very small, of less than 1% of the area of installed collectors (FINEP, 2005b).

Normally, a solar water heating system is composed of solar panels (which can be flat collectors or evacuated tubes, the latter being used in some countries, but still not in Brazil), water storage tank (boiler) and a system backup, which may be an electric or electronic shower, or use of gas or electrical resistance. Each project should be analyzed to determine the best alternative from economic and system efficiency perspectives. The design of the system depends on the daily hot water demand of the housing unit. The efficiency classification level of the collector is given by INMETRO.

Solar heating systems are ideal for single family units. For multi-family housing they can be installed independently for each family or for the common use of the whole building. However, installed in this manner they may generate problems such as cost division and, depending on the height of the building, unsatisfactory water heating on the first floor.

The system can operate passively, when using the thermo siphon effect, which depends on the location and height of the components, and having the collector lower than the other components. Or it can operate with the help of a pump to circulate the water, when the ideal conditions for localization and height of components are not available.

The collector can be installed on the roof, directed towards north and at an angle dependent on the local latitude. It can also be installed on a separate structure, but some projects of this kind, in social housing, have shown that these structures should not be too light or users can sell them. The boiler can be coupled to the collector on the outside of the roof or can be placed in a separate area. The system backup provides support for when there is insufficient sunlight and it allows the use of an electric shower as a back-up, thus allowing the user to have greater control over the water temperature.

The efficiency of the system depends on the quality of products and installation, as well as on the maintenance carried out by the user.

7.5 Certification methodologies

Product and technology standards have a limited scope, and aim at ensuring a minimum performance, but provide no incentive to try and meet higher standards. Voluntary systems, on the other hand, aim at creating a market drive for the development of environmental standards. Companies may lead this transformation because of an environmental commitment, or for competitiveness and market differentiation reasons (FINEP, 2005b).

Building environmental certification schemes are one of the available voluntary instruments. However, they show specific limitations for Brazil. First of all, some certification systems such as LEED (USA) and HQE (France) have been imported, and although there has been an attempt to adapt them to Brazil, these systems were developed for entirely different economic and social realities and this leads to distortions in the certification criteria.

Furthermore, these systems are not locally regulated and the cost of their implementation is high. If certification is not economically viable, companies end up not carrying it out. A more viable option for certifying social housing is the CAIXA's "Blue House Seal". This seal is optional and has the advantage of being based on Brazilian conditions.

8 Practical experiences in social housing

Based on interviews with CDHU and CAIXA technical staff, it was possible to obtain an overview of the practical experiences conducted in social housing in Brazil. Below are the experiences of CAIXA, the largest federal financing agency for social housing and also of CDHU, the largest state agency for social housing in Brazil.

8.1 CAIXA

CAIXA promotes actions for sustainability in the building of social housing in two ways: through financing mechanisms and trough the Blue House Seal.

Financing mechanisms

CAIXA has special financing mechanisms for sustainable initiatives under the program "My house, my life". Items that can be financed under this program include:

a) Solar water heaters – CAIXA offers financing of R$ 1,800 per house and R$ 2,500 per apartment to install these systems. The areas prioritized in this program are the south, southeast, and mid-west, due to their climatic conditions;

b) Individual water and gas meters; and

c) Planting of trees.

Blue House Seal

The objectives of the use of this label are:

- To encourage the sound use of natural resources in the construction of housing units;
- To encourage the inclusion of sustainability items in projects;
- To publicize the most sustainable projects;
- To reduce the maintenance cost of buildings and monthly expenses of users; and
- To raise awareness of contractors and users as to the advantages of sustainable construction.

8.2 CDHU

Throughout its existence, CDHU has developed pilot projects to incorporate sustainable alternatives in the area of both water and energy. A share of the financial resources for implementing energy efficiency programs comes from the energy distribution companies, which must, by law, invest a minimum of 0.5% of their net billing in these programs.

Furthermore, CDHU will begin to require, in its public tenders, educational projects for users, to teach them to use and preserve the new technologies that are being implemented in social housing. The main projects developed are described below.

Water

a) Individual metering of water in buildings with multiple floors
The first housing development to adopt the system was built in the city of Mogi Mirim, state of São Paulo. Reading of the hydrometer is carried out by Sabesp remotely. Although the cost of this system is R$ 4.00 more expensive than the old system of dividing the costs equally among the apartments, it was well accepted and became CDHU standard practice.

b) Water saving devices
Water saving devices (namely 6.8-liter flush tanks and faucet aerators) are used in social housing units.

c) Rainwater collection
Due to the problems caused by floods, mainly in the city of São Paulo, CDHU places internal reservoirs to collect rainwater. These reservoirs keep the water for a certain period of time, and after that period, they discharge it slowly into the city's rainwater drainage system.

d) Electrical and water kit
The system is assembled at the building site and later connected to the house's water pipes.

e) Sewage treatment
This project was first implemented in Area 7 of the Baixada Santista housing development, using a compact sewage treatment plant. Difficulties were encountered in plant management, namely the need for regular oversight by a technician, thus increasing the maintenance cost. However, in places where there is no public sewage network, the adoption of this system is mandatory.

f) Sewage treatment using plants (phyto treatment)
This system has still not been used in any housing development. There is, however, a pilot project ready to test this technology.

Energy

a) Hybrid solar water heating
The first housing development to use this system was in Cafelândia, state of São Paulo, with financial support from the electricity distribution companies of the state of São Paulo. This project was well received by users of the housing development.

b) Natural gas water heating
Systems for heating water with natural gas were used in some buildings of the metropolitan region of São Paulo, with funds from Comgás, the company responsible for distribution of natural gas in the state of São Paulo. Although this project was well accepted by users, no studies were carried out to check whether it caused any improvement in the energy and/or environmental performance of these houses. Thus, this technology was not used again.

c) Steel roof structure
The first steel roof structure project was implemented in the Rubens Lara development, located in the Baixada Santista. The steel was supplied by Cosipa, a large Brazilian steel company, in payment for its fiscal debt to the state of São Paulo.

At present, CDHU is making steel roofs in new housing developments mandatory because of the problems seen previously with the use of illegal timber. However, the cost of implementation of the steel structures is greater than when using timber and sealing problems have been noticed.

d) Clay roofing tiles
To improve the thermal comfort of social housing, CDHU uses clay roofing tiles. Nevertheless, new projects are seeing a return to fiber cement, which worsens the thermal comfort for the user.

e) Roof slabs and lining
In order to improve thermal comfort, CDHU uses roof slabs and linings.

f) Concrete walls molded in loco
This technology was used in a housing development in the town of Peruíbe; however, no study was carried out to evaluate the environmental performance and cost of this system.

g) Power Line Comunication (PLC)
This was first used in a housing development in Mooca, metropolitan region of São Paulo, and it intended to use the energy transmission lines to send communications signals for remote metering of electricity, gas and water consumption. Nevertheless, the system was not efficient because the communications companies were not adapted to this system and the electricity, gas and water consumption data were only available to the electricity transmission company. Thus, this system was put aside.

h) Exchange of light bulbs
This project was implemented in the housing developments of the Baixada Santista, funded by CPFL, an electric energy transmission company. The objective of this project was to exchange 40,000 incandescent bulbs by energy saving bulbs. However, in the absence of a program to educate the user, many of these energy saving light bulbs were sold by the users, not leading to the expected reduction in energy consumption in respective areas.

i) Exchange of refrigerators
With the same objective as the exchange of light bulbs, but this time better accepted by users. It was introduced with funds from AES Eletropaulo, an electric energy transmission company.

j) **Landscaping**

Landscaping projects are being used to contribute to the thermal comfort of social housing and to integrate housing developments to the urban environment.

k) **Photovoltaic**

Photovoltaic systems were first used in the Boiçucanga housing development, with funds from Bandeirantes, an electricity transmission company. However, the cost for implementing this technology was very high and CDHU set this program aside.

l) **Bathroom timer**

Bathroom timers are used to reduce energy consumption in hybrid solar water heating systems.

m) **White roofs**

White roofs have been used in a housing project in Ilha Bela. This action was included in the “One Degree Less” campaign, that aimed at reducing heat island effect, and in the protocol signed by CDHU with the Green Building Council, in 2009, for sustainability in buildings.

In addition to these projects that have already been used and tested by CDHU, some sustainability projects were not implemented due to maintenance difficulties. Rainwater use and sewage water reuse systems were not implemented because of the risks of contamination for the user in case of incorrect use of this technology. Green roofs are another solution that was not applied due to the cost and difficulty of system maintenance.

Conclusions

Barriers to the introduction of sustainable solutions in social housing

Although several sustainability projects have already been implemented in social housing in Brazil, there are still many barriers to implement them. The main barriers identified are:

- **Cost:** The cost of both implementation and maintenance of these technologies is higher than conventional technologies. Although savings can be achieved at longer term, there is no available financial model to distribute costs and financial benefits over the life cycle of the building.
- **Lack of technical capacity:** There is a shortage of qualified professionals for project development as well as for implementation and maintenance of sustainable building technologies in Brazil.
- **Lack of user awareness-raising and training**: The absence of training and awareness programs for the users leads to improper preservation of equipment and reduces the performance of alternative solutions.
- **Lack of an integrated institutional policy for sustainability:** Solutions are considered by each department, but there is no integrated response or strategy in companies and agencies.
- **Tendency to develop standard regional and national solutions.**

Consequently, solutions do not take into account the particularities of each project. There is little integration of the various stakeholders in the design, construction and use of the residences. This reduces the opportunities for cross-cooperation to improve housing quality, in terms of efficiency in energy consumption, thermal comfort, rational use of water, health issues in the built environment and reduction of maintenance costs.

More broadly speaking, it is still necessary to integrate the housing developments to the urban environment, providing support to the daily needs of the families (business/ employment, transportation, schools, health services (primary care), etc.). This is crucial to avoid transportation costs and related environmental impact, as well as to improve the quality of life of families by an urban planning agenda that takes into account the needs of residents.

In addition to developing guidelines to be applied to social housing (with a first pilot test phase in the Serra do Mar project), outputs of the SUSHI project include reports and books to disseminate the knowledge compiled and propose innovative sustainable solutions that can be tested in social housing.

Dissemination activities

To disseminate the acquired knowledge, the following products are planned:

- **Mapping Report, i.e. this report;**
- **Report of Lessons Learned,** listing the lessons learned in interviews with the CDHU staff. The practical experiences in social housing, which are mentioned briefly in this report, will be presented in detail.
- **A book on energy efficiency in social housing,** with a summary of the presentations given by experts in the Energy Efficiency Seminar organized by CBCS on 5 November 2009 in São Paulo.
- **A book on the rational use of the water in social housing,** with a summary of the presentations given by experts at the Rational Use of the Water Seminar, held in April 2010.

Proposal of sustainable solutions

During the mapping of the various technologies, many were discussed, but still have not been introduced in the strategies / list of classification, such as:

- Collective collectors and individual hot water reservoirs;
- Heat pump for water heating;
- Increasing ceiling height;
- Certified timber;
- Windows that have a 100% opening to promote cross ventilation;
- Shading of windows; and
- Thermal variation of the wall filler.

Many of these solutions, as well as others identified during the study, can be evaluated and tested in pilot projects, with the possibility of replication in other social housing projects, if these technologies are approved.

Recommendations

Generally the low income population in Brazil is not very aware of the need to reduce water and energy consumption, probably for two reasons: energy and water are still cheap resources and people fear the loss of comfort more than they are able to see individual possibilities for saving money. Therefore, a cost-benefit analysis is a crucial instrument for convincing users of the need to reduce consumption of these resources.

Furthermore, social housing is partly subsidized by the government and users begin to demand greater energy efficiency and savings in the costs associated to the use and maintenance of their residences.

It is also important to highlight that the knowledge acquired by the technical staff that works in the construction of social housing in Brazil has never been published or made available officially. During the SUSHI Project, the collection and publication of this knowledge will be important for the development of guidelines for social housing projects in Brazil. This work will help decision makers improve requirements and policies for social housing.

Lastly, it will be necessary to obtain field measurements from a CDHU project unit in the Serra do Mar in order to create sustainability indicators and gather concrete data on the performance of the units.

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Annex 2. Glossary

CBCS - Acronym of the Brazilian Council for Sustainable Construction. CBCS is a non-governmental organization that provides support for sustainable construction through the development and dissemination of technical information, regulations, educational programs and research in social aspects to promote sustainability. By means of a systematic perspective, it analyzes the interrelations in the building industry with the materials sector, financing agencies, government, academia and society, promoting the development of good standards, innovation, discussion of guidelines, sector and public policies and other activities in the thematic committees.

Thermal comfort - is understood as bearable local climatic conditions. This is obviously a controversial issue as it depends on individual adaptation, health, clothing, etc.

Paradigm - is understood as a set of suppositions, concepts and attitudes of a group of scientists regarding a specific scientific problem. The term in this spirit is particularly associated to the name of Thomas Kuhn (1922-1996), professor of philosophy and history of science.

Pilot function - is a component of construction or a function in a building that is used to show how it is possible to include sustainable construction characteristics in social housing programs. “Alternative solution” is defined as a technology or material within a pilot function that has a better sustainable performance than conventional technologies and materials. For example, the alternative solutions for the pilot function “lighting” could include the use of compact fluorescent light bulbs, better use of lights and movement sensors to control lights.

Annex 3. Partner organizations and project team

Partner organizations

To create a knowledge network, possible partners and stakeholders were contacted and invited. Therefore, the CBCS (Brazilian Sustainable Construction Council), chosen as project lead by UNEP, started the project with institutions that bring people with vast experience to exchange information and to establish actions to improve energy efficiency, promote rational use of water and also improve social housing quality by future residents. The basic project structure was defined as shown in Figure 18.

The United Nations Environment Programme (UNEP) is a programme of the United Nations, whose mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. UNEP launched the SUSHI project and is coordinating the work of teams in Brazil and Thailand.

The CBCS - Conselho Brasileiro de Construção Sustentável (Brazilian Sustainable Construction Council) is a non-governmental organization that seeks to promote the Brazilian population's quality-of-life improvement and preservation of its natural resources by developing and implementing more sustainable concepts and practices that contemplate the social, economic and environmental dimensions of the civil construction industry's supply chain.

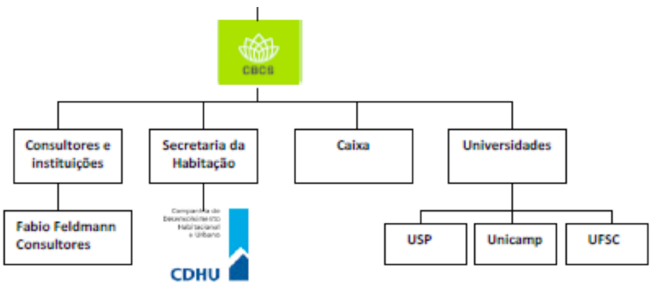

Figure 18 - Organizational Chart of the Brazilian partner network

The Caixa – Caixa Econômica Federal (Brazilian Federal Savings Bank) is the main federal government's public policy agent responsible for about 70% of the social housing funding. It assists not only its banking clients but all formal workers in Brazil, the latter through payment of FGTS (Mandatory Fund for Unemployment Benefit-provisional Fund), PIS (Employees' Profit Participation Program) and unemployment insurance; social program beneficiaries and Lottery bettors. In addition, it prioritizes funding in the housing, basic sanitation, infrastructure and services provision sectors.

The State of São Paulo's CDHU - Companhia de Desenvolvimento Habitacional Urbano (Urban Housing Development Company) is a company connected to the State of São Paulo's Housing Department and the largest popular housing promoting agent in Brazil. Its purpose is to implement housing programs in the whole State of São Paulo, focusing exclusively on meeting the needs of low-income population earning 1 to 10 minimum wages.

For the project's technical support some of Brazil's best universities were incorporated into the project, such as the USP – University of São Paulo's Poly-Technical School, UNICAMP (State University of Campinas) and UFSC (Federal University of Santa Catarina). They worked in cooperation with Fabio Feldmann Consultores, whose shareholder is one of the main environmental activists in Brazil, mainly in the Climate and Biodiversity area, has participated to a large extent in the formulation of the environmental legislation on a national, state and local level since the nineteen eighties.

Recognized specialists also cooperated in the project: The housing department and CDHU were responsible for the design and implementation of the social housing and Caixa Econômica Federal for the funding of the project.

In a further stage of the project, other partners will join to expand the network of experts and to incorporating more sustainable actions in every step of the construction industry supply chain. These partners will include: representatives of the materials industry, construction industry, building managers, academia, etc.

Team

Main Team	Reviewers	Contributors
Prof. Dr. Vanderley M. John	Prof. Dr. Roberto Lamberts	Eduardo Trani (CDHU)
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The project team makes up a network of the main specialists of each area in Brazil. Below is a brief biography for each participant.

(a) Scientific knowledge

- **Prof. Roberto Lamberts** - Civil Engineer, Master's degree in Civil Engineering, UFRGS and PhD in Civil Engineering, University of Leeds. Currently Professor of the Federal University of Santa Catarina (UFSC). Working in the area of civil engineering, with emphasis on energy efficiency, thermal performance of buildings, bioclimatology and thermal comfort. Supervisor of the UFSC Laboratory for Energy Efficiency in Buildings, coeditor of the journal Ambiente Construído, member of the editorial committee of the journal Advances in Building Energy Research and of the Journal of Building Performance Simulation. Member of the scientific associations ANTAC, Brazilian Association for Technology of Built Environments and IBPSA, International Building Performance Simulation Association, and member of the Buildings Group of the Ministry of Mines and Energy (MME) providing support for the development of energy efficiency labeling for buildings.

- **Prof. Orestes M. Gonçalves** - Civil engineer, Master's, Ph. D and lecturer in Civil Construction Engineering, Escola Politécnica of the University of São Paulo. Currently Professor of the Escola Politécnica of the University of São Paulo, where he coordinates the teaching, research and extension group in Building Systems Engineering of the Civil Construction Engineering Department. Member of the W62 Commission - Water Supply and Drainage for Buildings of CIB - International Council for Research and Innovation in Building and Construction. Working in the area of building systems for water, gas and fire safety, conservation and sound use of water, building input demand models, evaluation of performance and quality of building systems components.

- **Prof. Lucia H. Oliveira** - Civil engineer, Master's and PhD in Civil Engineering, University of São Paulo. Currently Professor of the Escola Politécnica of the University of São Paulo. Researcher in civil engineering, with emphasis in building systems, working mainly in the following subjects: water conservation, sound use of water and management of water use in buildings.

- **Prof. Marina S. O. Ilha** - Civil Engineer, Federal University of Santa Maria, Master's and Ph.D. in Civil Engineering, University of São Paulo. Currently associate professor (lecturer) of the Faculty of Civil Engineering, Architecture and Town Planning of the State University of Campinas. Experienced in civil engineering, with emphasis in building installations, acting mainly in the following areas: water, sanitary and gas fuel systems for buildings, and water conservation in buildings. Founding member of the CBCS - Brazilian Council for Sustainable Construction.

- **Architect María Andrea Triana Montes** - Bachelor and Master's degree in Architecture, Federal University of Santa Catarina (2005). Working mainly in the areas of sustainability and multi-family residential projects

(b) Social housing market specialists

- Eduardo Trani - Chief of Cabinet of the Office of the Housing Secretariat.
- Eduardo Baldacci - CDHU energy efficiency manager.

(c) Civil servants

- Gil Scatena - Advisor to the Chief of Cabinet of the Office of the Housing Secretary.
- Leonardo Figueiredo - Member of CDHU's Qualihab - Program for Quality of Housing Construction of the state of São Paulo.
- Altamir Tedeschi – Specialist working on CDHU's projects for the sound use of water.
- Stella Bilenjiam - Specialist working on CDHU's energy efficiency projects.
- João Luiz F. Neves – Specialist working on CDHU's energy efficiency projects.

(d) Consultants;

Fabio Feldmann Consultores

Arq. María Andrea Triana Montes

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Annex 4. Selection of the project in the socio-environmental recovery area of the atlantic forest, serra do mar state park.

Selection of the area

The residential market, in Brazil, is only directed to 30% of the population, excluding many cities and the middle class that has an income of 5 to 7 minimum wages. A large share of this population invades land for survival. These are often areas with fragile ecosystems that fall under environmental protection legislation, such as mangroves, dunes, margins of streams, meadows, steep slopes and areas covered by native forests.

One of these areas is the region of the Serra do Mar, where development can be consolidated, since it does not represent a risk for permanent preservation and environmental recovery of the area.

In this regard, CDHU invited the SUSHI Project to become a part of the largest and most advanced project of the company in the area of urban settlements. This project is part of the "Socio-environmental Recovery of the Atlantic Forest of the Serra do Mar - Serra do Mar State Park".

In the city of Cubatão only 7,700 families are included in settlement programs (Table 3). According to CDHU, the pressure on the environment is more evident in mountain slopes, which were originally covered with the Atlantic Forest, the biome with the largest global diversity.

There are several settlements scattered along the Immigrants highway, which connects São Paulo and Santos. The settlements are called Bairros Cota ("Elevation Districts") (Figure 19) due to their height above sea level. They are found at 95/100, 400 and 500 meters above sea level. Of the 7,700 families tended to in Cubatão, 5,500 will be resettled in the coastal strip of the Serra do Mar in the plains close to the area of Jardim Casqueiro.

In the risk area mapping carried out by the IPT (Institute of Technological Studies) all the elevations were analyzed, applying different risk indicators. Since the inhabitants consider the area "very beautiful", it is difficult to convince them to move, thus the need for scientific and objective mapping.

The plan is to resettle the families that live in risk areas, mostly on high declivity areas, where landslides and erosion occur during torrential rains. Later, the remaining urban structure will be improved and adapted.

The border areas, from where houses will be removed,

Figure 19 – Current situation in the Bairro Cota 500

Number of families affected by the Program in the various areas and main reason for resettlement							
Irregular housing areas	Total Families	Permanence (not affected area)	Total no. moved families	Reason for Resettlement			
				Technological Risk	Geo-technical Risk	Environmental Risk	Private and Municipal Area
Cotas 400 / 500	203	0	203	-	-	203	-
Cota 200	2.108	719	1.389	741	252	395	-
Cota 95/100	1.037	401	637	157	156	325	-

Table 3 - Statistics of the low income families tended to in the city of Cubatão only.

will be reforested with plants from the original Atlantic Forest biome (Figure 20). The urbanized area will be delimited by a ring road that will be regularly patrolled by the environmental police to avoid new invasions, appropriations and occupations.

The inhabitants of the three "Bairro Cota" districts will be settled in three new housing projects situated in the lowlands of Cubatão, known as: Rubens Lara Complex, Area 7 and Area 9 (Figure 21).

These three areas conform to Cubatão's land use development plan and have been adapted to the steering plan of the municipality (Figure 22), which lacks areas to build social housing because of the mountains in the region. Thus, CDHU agreed to build these housing developments over former construction dumps of the Imigrantes highway that had been donated to CDHU in exchange for preserving the mangroves around them.

The sites were proposed by CDHU as a showcase for the change in the social paradigm for housing in Brazil (Figure 23). The Project "Socio-Environmental Recovery of the Atlantic Forest of the Serra do Mar - Serra do Mar State Park" in the city of Cubatão is following the new standards for urban housing and for social housing in the state of São Paulo, which include:

- Health facilities;
- Education facilities and a school;
- Private and public green areas (partnership with the State Environment Agency - SMA); and
- Bicycle lanes.

CBCS also agreed to this project because of the phase-wise construction of these housing developments and the possibility of implementing a pilot project in these localities.

Figure 20 – State planning, including removal, reforestation, urbanization and partial ring road and mapping of the real situation of the district on contour curve 200

Figure 21 – CDHU steering plan for settlement in the Cubatão plains between the Anchieta and Imigrantes highways (Area 7, Area 9 and Rubens Lara)

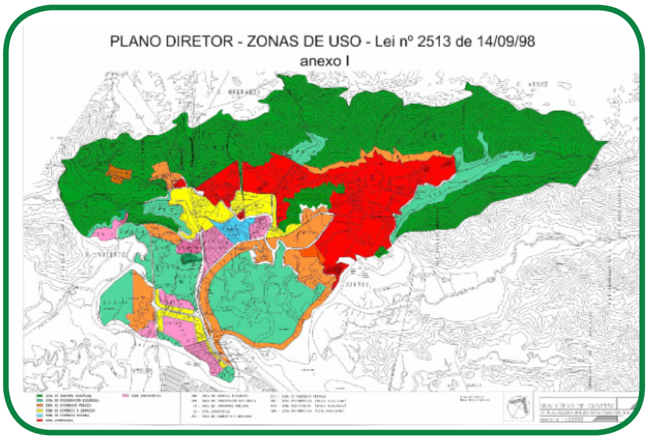

Figure 22 – Cubatão steering plan, including recommendation for removal and resettlement (residential-Z3 areas, pink)

Project

Below are the details of the housing project selected for this study.

Rubens Lara Residential Complex

The Rubens Lara Residential Complex is located between Jardim Casqueiro, a middle-class neighborhood, and another CDHU housing project built in the 1980s.

The new properties were to be delivered by the end of 2010 and on the day they were visited, the buildings were at various stages of construction (Figure 24).

Below are the design characteristics of this housing development:

Land use and origin:

The Rubens Lara Residential Complex is located on an already consolidated sanitary landfill. Construction began in 1940 with materials from the construction of the Anchieta highway tunnel and, later, with construction wastes in general, in an old mangrove in the region.

Foundations:

Foundations for constructions in the mangrove areas of Cubatão require deep concrete foundations of up to 115 m.

Sewage system:

The project will be part of the Sabesp's "Onda Limpa" program, which will connect all public sewage units to a treatment station.

Buildings and houses:

Mixture of several construction typologies in concrete structures and concrete block or brick (Figure 25). The wooden structures and aluminum roof will be covered with roofing tiles.

All the walls will have external ceramic lining using 2x2 cm tiles (in various colors from light gray to dark blue), and internal lining made from plaster and paint. Most of the units have a third room. The windows with aluminum frames will have an opening of 50%, without shading elements over the windows.

Furthermore, some apartments may have their cross-ventilation compromised because of the position with respect to the predominant winds in hot days, the distances between buildings, geometry and urban vegetation.

Energy and Water:

All the units will be equipped with individual water monitoring and solar collectors for hot water.

For this project, the height between the floors was increased from the former standard of 2.40 m to 2.60 m. This decision was taken to increase the thermal comfort and the quality, although it only contributes indirectly to savings.

Recycling of construction waste:

The building site has a yard where concrete, wood, paper, plastic wastes and others are separated for recycling or reuse (Figure 26).

Employees:

The construction company committed itself to hire preferably local workers. Due to a local deficit of workers, masons were brought in from São Paulo.

Infrastructure:

Paths will be made from recycled concrete construction wastes, streets will be covered with asphalt, energy supply lines will be underground in most of the development and urban trees will be planted.

Figure 23 – Old housing in the elevated areas and the new housing developments (plains).

Figure 24 – Building site of the Rubens Lara development in February 2010

Figure 25 – Construction of the Rubens Lara development

Figure 26 – Waste recovery in February 2010.

Figure 27 – Construction of the Rubens Lara Complex.

Area 7 - future Vila Harmonia

Area 7 (Figure 27), will also be settled next to another CDHU housing development, built in the 1980s. In addition to the residential complex, informal trade is growing because of the needs of residents. Although the distance by bus to the town center is only 4 km, the site was considered peripheral, given the lack of commercial establishments close by. Therefore, the future Vila Harmonia will have mixed uses, including apartment buildings and commercial typologies.

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Figure 27- Aerial image of Area 7 in February 2010

About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

> **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
> **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
> **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
> **Energy** (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
> **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
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UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

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This publication is the first in a series of three technical assessments developed during the implementation of the Sustainable Social Housing Initiative (SUSHI) in Brazil. This project aims at promoting the use of sustainable solutions in affordable housing projects in developing countries.

In these countries, and especially in Brazil, the buildings sector is a central part of the economy. With the current population growth and urbanization, the sector faces a rapidly increasing demand for housing, namely for low-income population. The quantitative importance of the social housing sector provides the rationale for addressing the impact of these activities on the environment.

Public housing developers have a unique role to play in transforming and shaping the construction industry in Brazil. This reports aims at providing an analysis of the current status of social housing projects in the State of São Paulo, Brazil, in order to identify opportunities for introduction of more sustainable solutions in these construction projects.

The assessment of existing policies, available solutions, and previous experiences allowed to identify barriers to the uptake of sustainable solutions in social housing. The consultation with partner institutions resulted in the request for a more elaborate analysis of past experiences, which will be presented in the second issue of this series, the "Lessons Learned" report.

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