

# Energy efficiency management in public university campi – a Brazilian case

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## **Abstract**

The Brazilian pioneer experience in energy efficiency management in public university campi is the Permanent Program in Efficient Energy Use of the University of São Paulo (PURE), running since 1997. Total built area of the university totalizes above 1 million square meters throughout more than 20 cities in the state of São Paulo, which results in a very complex energy use network comprising several different end uses. Interaction between actions and appliance purchases throughout our campi under the scope of PURE, for the sake of energy management in the University, is described along this paper. Energy bills and contracting, retrofits, experiences in usage of renewables, education and diffusion of information on energy efficiency and rational energy use are some among the described instruments, and accruing savings are shown.

## **Keywords**

*Energy efficiency, Energy Management, Sustainability*

### **1. Background**

The University of São Paulo (USP) is among the top-200 universities in the world and one of the most important public universities in Brazil. It totalizes a 1,637,202m<sup>2</sup> built area and a 20,655 people staff, imparts 849 courses along several different academic areas, caters to almost 90,000 students and pays 353 energy bills along over 20 cities and 6 different campi. Its total electric power purchase expenditure for year 2008 was about 12,83 million Euros, equivalent to about 129 GWh per year and the 2009 forecast is 15 million Euros (132 GWh). This growing up electric energy consumption shows the evidence needing in energy efficiency and sustainability actions management. So that, in 1997, the Permanent Program in Energy Efficiency Management (PURE) was created to reduce costs, foster rational energy use and to issue directions to the new built areas which grows up about 5% per year. The Program has introduced in the University the concepts on energy efficiency end uses its running.

The main goals of PURE are:

- to control, monitor and assess electric power end uses, identifying potential energy and monetary savings; and
- to raise awareness on sustainable development among members of the university academic and non academic community.

### **2. Electric Energy in Brazil**

In Brazil, almost 80% of all generated electric power comes from hydroelectric power plants and almost 20% is thermoelectricity.

The Itaipu Power Plant is currently one of the largest hydroelectric power plant in the world as regards to generated power. It meets 19.3% of the Brazilian energy demand and 87.3% of the Paraguayan demand.

In 2008, the Itaipu Power Plant reached a new historic record of power generation, generating 94.7 TWh. The previous record was set in 2000, when Itaipu generated 93.4 TWh.

The largest artificial lake in Brazil is Sobradinho (at Bahia State), with a 4,240km<sup>2</sup> flooded area. The Itaipu reservoir, with a flooded area of 1,350 km<sup>2</sup>, is the seventh largest in Brazil, but holds the best water utilization to electric power generation ratio among all large Brazilian reservoirs.

Today, Brazil has more than 253 small hydroelectric power plants throughout several states. Negative social and ecological impacts accruing to Brazil from the building of such hydropower plants certainly are impressive, influences on climate change included.

### 3. Evolution of Energy Consumption Levels in the University of São Paulo (USP)

USP is a client to 5 different electric power facilities in the State of São Paulo, and keeps with them a centralizing management contract. Energy consumption for 2010 is forecast to reach about 137,000 MWh.

Annual consumption levels and electric power expenditures for the 1999-2009 period and 2010 forecasts are shown in Figure 1, which features an expenditure growth trend due to annual tariff adjustments, as regulated by ANEEL (Brazilian Electric Power Regulatory Agency). It clearly shows tariffs and consumption growing at different rates.

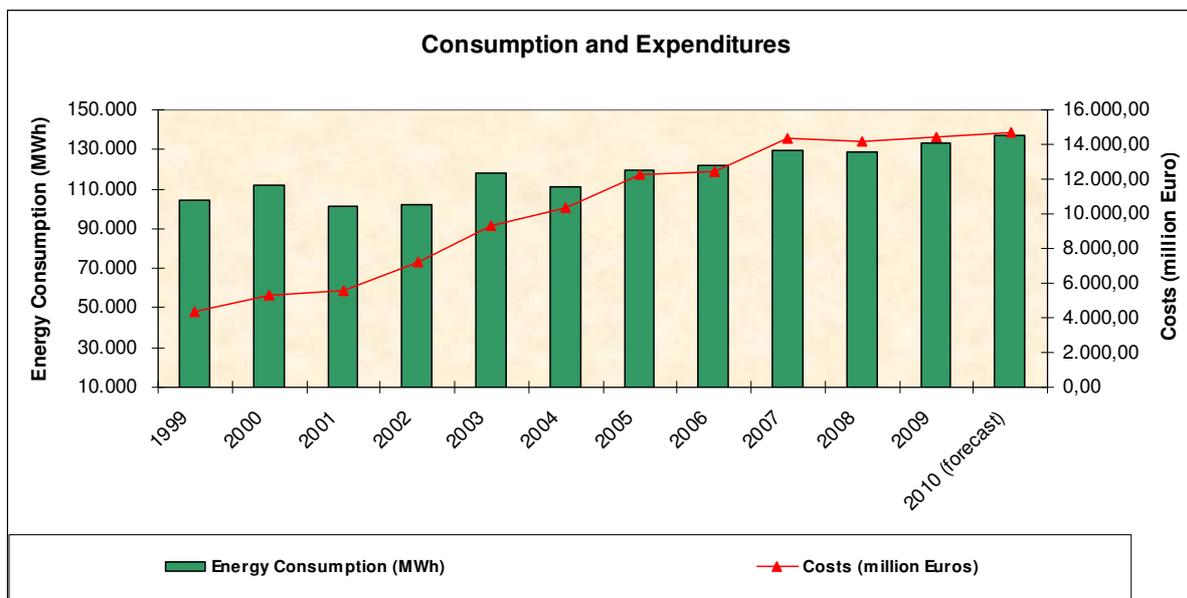


Figure 1: USP's Energy consumption levels and expenditures on electric power (MWh and Million Euro)

Pictures 2 and 3 show the real evolution of costs and consumption levels, against their trends for unchecked levels in the absence of action by PURE.

All three pictures display only 55% of all data on USP.

From the comparison of abovementioned trend against actual electric power consumption levels at USP, savings are estimated as amounting to 130 GWh. Those savings currently

amount to 13,4 million Euros. However, data extrapolation over the whole University implies total savings around 260 GWh (which is equivalent to saving 26,4 million Euros).

Those data are enough to establish PURE as an important program for energy efficiency management in the University.

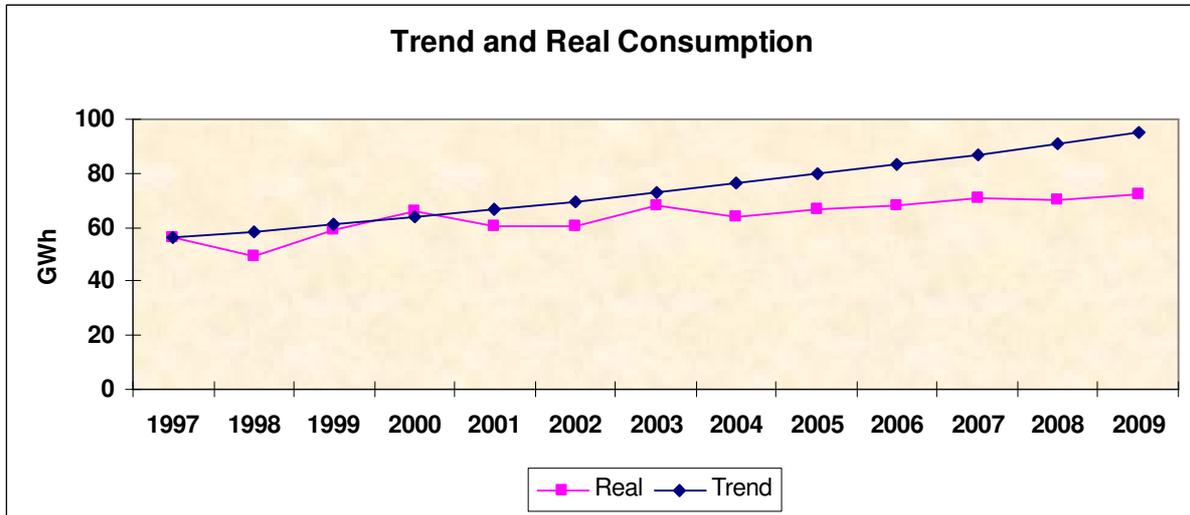


Figure 2: USP trend for unchecked electric power consumption real X consumption levels (GWh)

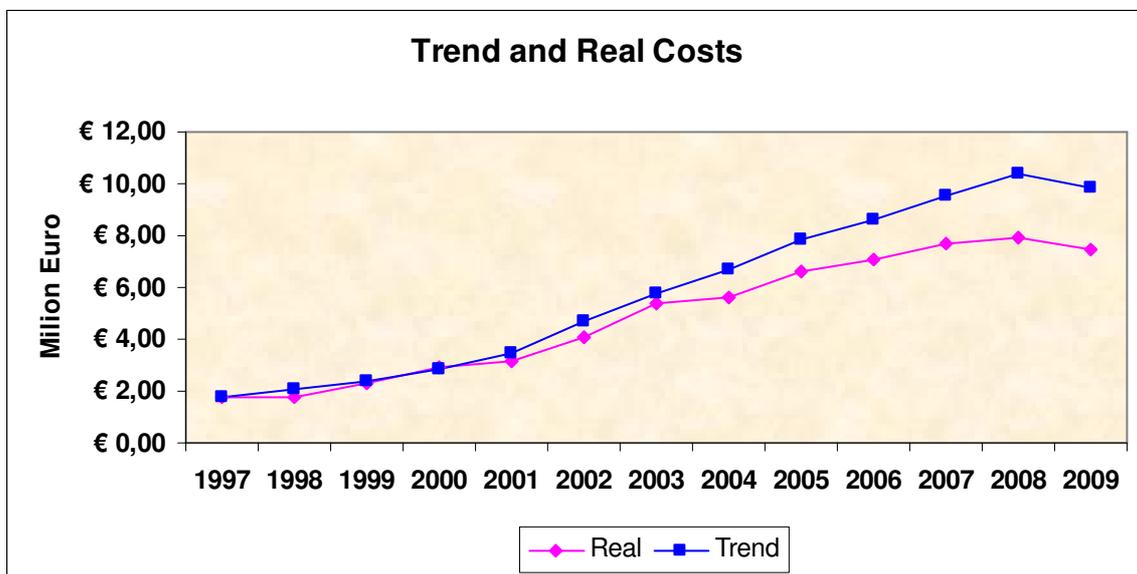


Figure 3: USP trend for unchecked expenditures and real expenditure levels on electric power (million Euro)

#### 4. Developed Actions

PURE is a multipronged program, tackling key issues in several different areas. Its main concern always has been energy end use management for the sake of fostering rational energy use and energy efficiency throughout the University and the society at large.

Actions along USP cover a wide range of complex multidisciplinary knowledge. Total savings along the 1997-2009 period add up to above 34,86 million Euros.

Developed actions are listed below.

##### *Zero Fine Project*

Aims to zeroing down either power bill fines or excess costs in electric power bills.

Figure 4 shows declining fine values from the inception of management action by PURE.

Fines are relative to excess demand, reactive power levels and delayed payment. Installing capacitor banks, raising staff awareness and managing bills along the last 10 years are the most important actions taken in order to reduce fines.

This Project saved 7,2 million Euro till 2010.

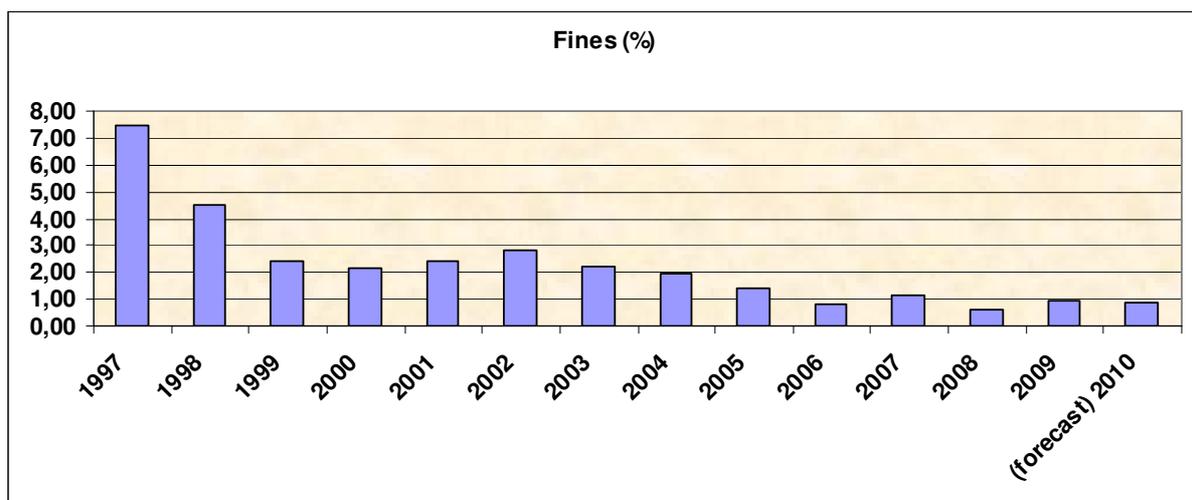


Figure 4: Declining USP fines bills since PURE had taken action

##### *Power Contracting*

PURE currently manages 102 power contracts for Medium Voltage energy supplies throughout USP, continually striving to enhance their respective cost benefit relations and to promote better use of public facilities.

Since 2004, savings by USP accruing from this kind of action have added up to about 621 thousand Euros, which means 3% of overall costs throughout the University.

### *Billing Management*

Managing bills yielded USP several advantages. This activity is important to the University since it has identified retrievable credits, speeds up payment of bills, and sets up a database on energy billing by the several facilities catering to USP campi (335 different bills each month).

The CONTALUZ database was built to support those actions. Thus, currently USP is most probably the only public university in Latin America to have so complete a database on electric power usage along the 1997 through 2009 period. Contaluz has all the necessary information on electric power supplies and usage, besides data on power consumption and demand levels, informing action in energy efficiency and rational energy use.

Figure 5 shows overall PURE recoveries along 2003 to 2009 period through billing management, totaling 10,7 million Euro.

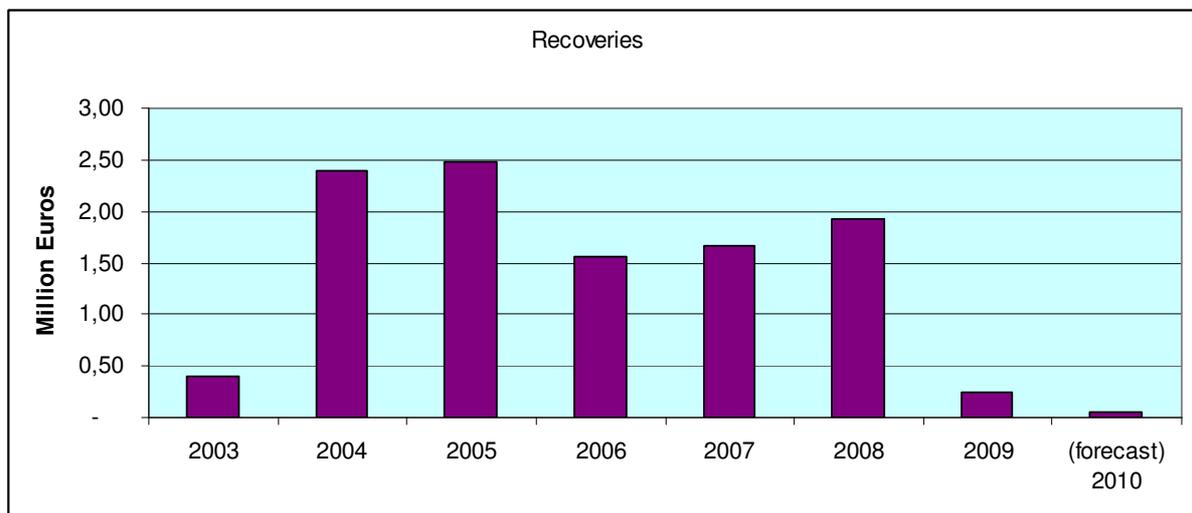


Figure 5: PURE recoveries through billing management

### *Energy Power Usage Monitoring System*

SISGEN is a remote electric power usage monitoring system designed to provide PURE data on every power system related magnitude from all supplying facilities meeting USP demands, to track electric power and consumption in isolated buildings or a group of them, and to identify problems in energy end-uses or demand.

All energy data is collected in real time, examined and monitored by software which features numeric and graphic data analysis, in accordance to Brazilian and utility standards, and is available on line.

As a product, this software was acknowledged by the Brazilian Mines and Energy Ministry as an innovative energy technology.

### *Recovering bills*

Since July 2008, PURE has been helping the Financial Department at USP to standardize and control reimbursements from people and organizations using the University to further their own financial goals, such as restaurants, banks, canteens, stationeries and so on. SISGEN has an important role for it monitors and generates invoices to be paid so that USP has better control over its financial resources. Monthly reimbursements add up to about 26.000 Euros.

### *Training and Diffusion*

Acknowledged as the most important communication channel between USP and the society at large, this area has been having several foci, including awareness raising activities on energy efficiency issues, as well as continued education for technical and maintenance staff. The main strategies were:

- lectures to staff, professors and students on energy efficiency and sustainability concepts;
- training of electricians on energy efficiency techniques and concepts, by the imparting of courses and lectures;
- training of air conditioning maintenance staff by the imparting of courses;
- Masters and Doctorate theses about several academic subjects have been published, supported by PURE actions and database;
- diffusion activities on energy conservation are run along all of the USP community;
- labels advising on energy efficient use of switches, PC monitors and air conditioners;
- bookmarks, folders, pens, pins, t-shirts and durable mugs were distributed throughout the USP community as PR (Public Relations) activities on behalf of PURE;
- out-doors and other media, such as internal newspapers, newsletters, sites, advertisements on USP-radio, magazines and general information, were used to advertise on PURE and its actions;
- talking in interviews to non USP related media;
- publishing comic books on rational energy use, energy savings and energy efficiency;
- providing internships to USP students in order to foster research activities and interest in the aforementioned areas while propitiating activities on energy efficiency;
- publishing energy data in scientific papers, congresses and magazines;
- naming managers and giving them the means to act on energy efficiency at each Administrative and Educational Unit;
- holding meetings to celebrate USP environment weeks showing action by PURE, lectures, seminars and workshops with cultural incentives, as well as promoting

- diffusion of sustainability concepts on energy efficiency and waste management;  
and
- running an internet site.

### *Retrofits*

PURE has annual monies to spend on retrofits in buildings and electric power systems.

Old systems were observed on USP such as 40W, 20W, 110W fluorescent lamps and bulbs, some of them featuring electromagnetic reactors.

Those projects have several foci as well:

- replacing lamps, reactors and luminaries with more energy efficient ones;
- replacement of air conditioning appliances;
- 12.3 kW photovoltaic generation in a test building;
- solar driven water heating system to be installed at the students lodgings;
- gas driven water heating system, also to be installed at the students lodgings;
- biogas storage, purification and generation system (demonstration project).

Since then these projects have retrofitted 45,000 reactors; 89,000 lamps; 28,000 luminaries and 32 air conditioning efficient systems in the 9,000 to 30,000Btu range at the Dean's Office building.

Partnerships with Energy Facilities have been improving retrofits in the field campi. Almost 1,5 million Euros has been invested by these companies to change old illumination systems. Nowadays, USP has the first public university campi in Brazil with completely efficient artificial lighting systems.

### *Technical Specifications for Energy Efficient Appliances*

PURE has been updating technical specifications for electric appliances for the online purchase system, so that patterns on acquisition of energy efficient equipment are established in the university. Currently only the best and more efficient illumination and air conditioning equipments are bought. Electricians and Unit Managers at USP are advised on how to purchase such appliances and using them in their facilities and systems.

### *New Buildings*

PURE also advises on the building of new structures at USP new buildings in the sense of using bioclimatic architecture techniques and concepts, such as efficient active thermal and lighting systems, spatial orientation of lighting patterns in accordance to the external building envelope and the proper setting and usage of glass windows.

Studies on labeling new and old buildings on energy efficiency with simulating programs may be implemented in the next few years.

### *Rationing*

Along 2001 and 2002, Brazil has detected a great and growing demand for electric power, unmet by the Brazilian hydroelectric power systems. The Brazilian government imposed rationing over all consumption. The rationing impacted consumption of electric power in a singular way, reducing overall Brazilian consumption in about 24%.

As a public authority, USP was assigned a 20% reduction in electric power consumption as its goal.

PURE had an important role in that new scenario helping the whole USP community to save electric power. The main developed actions were:

- retrofit of air conditioning and lighting systems;
- surveillance turned on electric systems;
- personnel training;
- monitoring of energy data; and
- continued education and diffusion on energy saving techniques.

Savings accruing at the time due to the rationing totalled 7.3 MWh (about 353.000 Euros).

### *Agreements and consultancy*

Contaluz and SIGGEN systems are offered outside USP to help companies managing energy usage. Those pieces of software were sold as a package with orientations and technical support as a consultancy tool. São Paulo City Hall, Federal Brazilian Bank, Water and Wastewater Company from São Paulo State and Petrobras are some of the companies which already have used this software package.

Federal University of Espírito Santo State (UFES) has also signed an academic cooperation with PURE to install and implement this project on its buildings, facilities and systems. The idea is to replicate the method and actions by PURE.

### *Support on general electric power services*

PURE has partnerships with all USP Units which allow it defining electric power usage patterns and ways of right for each campus (every single campus is a complex energy system itself). PURE offers support and orientation for electric power plants to help them to operate with high efficiency and quality at all levels, as well as to abide to Brazilian standards and save money on the contracting of retrofits and building companies.

## **5. Conclusion**

PURE has an important role in the diffusion and adoption of energy efficiency concepts along the USP community and the society at large. It has been raising the awareness of

professionals, students and other public authorities on Brazilian sustainability, social, ecological and economic issues. For all the PURE coverage, it has been to public universities a pattern and showed ways to sustainable actions and policy to energy efficiency management.

It is thus fine tuned to our most urgent priorities: a culture of sustainable consumption patterns encouraging sound practices meeting environment and Brazilian people needs.

A prosperous economy allied to a fair society and preserved environment are not the sole reserve of a small group of intellectuals and scientists. It is easily understandable to the common citizen, and can be put into practice at the common people level, as acknowledged by these PURE actions started on a public university in Brazil.

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