

ENERGY EFFICIENCY AND ALTERNATIVE ENERGY SOURCES AT THE UNIVERSIDADE OF SÃO PAULO

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Abstract*. This paper describes the evolution of the energy conservation programs of the Universidade de São Paulo in the last years, with special attention to the Program of Rational Use of Energy and Alternative Sources - PUREFA, the study and evaluation of alternative energy sources at USP. The program is already under way and in pilot studies phase. Details of the proposal and its methodology are described, as well as the current state of development.*

Keywords. *energy efficiency, alternative sources.*

1. Introduction

Notwithstanding the increasing importance of the participation of alternative energy sources in the world energy matrix, Brazil has an incipient utilization of such sources, especially concerning the eolic and solar photovoltaic ones.

The Universidade de São Paulo - USP, as a reference center for teaching and research, and fulfilling its role of extending its services to the community, is consolidating the use of alternative energy sources such as biomass, natural gas, photovoltaic generation and solar heating, in a context of rational and efficient use of energy in its campi.

The implementation of this project aims mainly to: establish strategies, policies, actions and routines for the administrators, engineers, technicians of the facilities of the University; implement an energy management system (already partially existent) for measurements and billing analysis in all campi; create an energy efficiency standard for buildings, related to reducing energy consumption; and disseminate the acquired knowledge to society.

Technical aspects of implementation and operation will be appraised, as well as economical viability, through analyses of costs and energy savings.

2. Diagnosis of the current situation

The Universidade de São Paulo - USP is an advanced center of education, research and extension of services for the community, distributed in the campi of São Paulo (3), Bauru, Piracicaba, Pirassununga, São Carlos and Ribeirão Preto, and some premises in other cities of the State, in 74.533.892 m² of territorial area and 1.371.876 m² of built area. In São Paulo, the largest campus is the CUASO – Cidade Universitária Armando Salles de Oliveira. Table 1 presents the total values of electric energy consumed in February, 2003.

In the 1980s, aiming at reducing the consumption of electric energy, the University started the implementation of alternative sources of energy. Worried about the consumption of electric energy for water heating final use, it installed a system for water preheating using solar heating panels at Hospital Universitário – HU, in CUASO. One is a hybrid system, where the water of two reservoirs, of 15,000 liters each, is preheated in the solar collector and returns to it after circulating through the vapor generating system. The reservoir temperature reaches 60^{o}C with a gain of 8^{o}C due to the preheating solar system.

In 1996, an evaluation was prepared for the use of energy, with financial support from FAPESP, encompassing all the CUASO premises; the conclusion was that there was a great potential for rationalization and bigger efficiency in the use of the electric energy and, in some buildings, a potential economy above 20% was possible. During that year, the expenses with electric energy in the CUASO were over 5 million reais. Historically, the energy consumption in the University presented a growth due to new courses and the construction of new buildings, reaching about 110 GWh per year, with a demand above 25 MW in its premises and an invoice of approximately R$ 19 million in 1996.

Based on these results, the Reitoria of the University, assisted by the Escola Politécnica, established the Permanent Program for the Efficient Use of Energy at USP - PURe that aims, among other things, to permanently promote the rational and efficient use of energy in all its premisses. In the State of São Paulo, the USP is a customer of the five mais electric energy distributors and cooperates with them in central energy suplply management.

Table 1: Electric energy consumed in February/2003, in the USP campi

Campus	Consumption in kWh	% of Total
São Paulo – CUASO	5,288,312	57.38
Ribeirão Preto	1,062,859	11.53
São Carlos	849,532	9.22
São Paulo (but CUASO)	670,184	7.27
Piracicaba	887,602	9.63
Bauru	246,541	2.68
Pirassununga	169,309	1.84
Other premises	41,288	0.45
TOTAL	9,215,628	100.00

The distribution of electric energy within CUASO is the responsibility of the University, which means that CUASO has all its electric energy delivered at one point. Since the measurement of the energy is done in the Substation in a central panel, a system for monitoring and management, designed for 72 monitored loads, is in initial phase of implementation. This system will record the load characteristics at each site. Data from the previous diagnosis are shown in Tables 2 and 3 to indicate the rated power and energy consumption of the installed loads, classified by class of final use.

To evaluate the characteristic of the electric energy use in the Schools, the CUASO campus was used to relate the information gotten in the data-collection stage of the physical and operational information for each School. By comparing these parameters for the different Schools or through evaluation of the long-time trends for one given School, it is possible to evaluate the efficiency of electric energy use and estimate potential energy conservation. Some of the main parameters analyzed and their values for present equipment are shown in Table 4.

All these parameters are quite high enough, when compared to their values for efficient equipment, to justify the expectation of a great potential for energy conservation in the Schools of USP (Saidel, 1997). It is expected that a project, able to consolidate the different actions directed to energy efficiency, in association with the use of non-conventional energy sources, will allow USP to establish a permanent policy for energy management, increasing efficiency in the use of natural resources and contributing to research, education and the extension of services in this area.

Table 2. Total installed power by final use

Final Use	Installed Power (kW)
Light bulbs	
Fluorescent of 40W and 110W	1,803.00
Incandescent	35.50
Self-ballasted Mercury Vapor	70.20
Metallic Vapor	193.00
Sodium Vapor	13.70
Compact Fluorescent	1.30
Air Conditioning	
Central air devices	632.40
Window devices	2,038.60
Microcomputers	1,500.00
Electric Showers	765.60
TOTAL	7,053.30

Table 3. Load Percentages by Final Uses

Lighting	43%
Air-Conditioning	28%
Microcomputers and other equipment	29%

Table 4. Energy Efficiency Parameters For Present Practice

Parameter	Maximum value
Monthly consumption per used area (kWh/m^2)	36
Power installed in lighting per lighted area (W/ m^2)	26
Power installed in air conditioning per cooled area (W/ m^2)	45.125
Illuminated area per number of switches (m^2 /switches)	58
Percentile of defective light bulbs in relation to the total (%)	19

2.2. Description of PUREFA, Programa de Uso Racional de Energia e Fontes Alternativas (Program for the Rational Use of Energy and Alternative Sources)

In the 1970s, global heating was debated within few scientific groups and only environmentalists paid any attention to the subject. In 1988, the UN created the Intergovernmental Panel on Climate Change (IPCC).

Energy consumption and toxic substances emission into the environment started to be the concern of all or, at least, of all the civilized nations. To do its share, USP is launching the Program for Rational Use of Energy and Alternative Sources (PUREFA). Still in its embryonic phase, the project intends to start policies and action for energy efficiency, to reduce electric energy consumption and to increase the participation of alternative sources. With the amount of R$ 2.2 million obtained from the Sectorial Fund for Electric Energy of FINEP (fostering agency of the Ministry of Science and Technology), the PUREFA is a part of the Permanent Program for Efficient Use of Energy (PURe), started at USP since 1997, which has led to a gradual reduction of energy consumption in all campi.

2.2.1. Goals

This project main goal, the study, implementation and evaluation of the use of alternative sources of energy is part of a management and energy efficiency program at the Universidade de São Paulo. This initiative, besides the reduction of the electric energy consumption at USP, also aims to disseminate the culture of the rational and efficient use of energy, initially within the University ambient (Alvarez, 1998) and, later, for society as a whole, given the communitarian and the opinion-maker role played by the University.

2.2.2. Methodology

The methodology for this project basically comprehends the following steps:

1^st^ stage: Collection of d*ata on the characteristics of energy use and of the potential for application of alternative power in the Universidade de São Paulo.*

At this stage, the alternative sources that best fit the goals of this project will be selected.

2nd stage: *Identification and Classification of the premises best suited for applying alternative sources of energy and retrofit of equipment*

At this stage, the sites best suited for installing alternative sources will be chosen, according to the final use characteristics and the required amounts of energy.

3rd stage*: Design elaboration and technical specification of the alternative sources that will be used.*

At this stage, a detailed design will be elaborated for the alternatives chosen for application in the selected sites.

4th stage: *Implementation of a pilot project in the selected buildings*

Encompasses specification, purchase and implementation of equipment for the pilot units.

5th stage: *Monitoring and evaluation of the results*

This stage is expected to last 2 years, starting from the installation of the first units. It foresees the monitoring of electric parameters during typical conditions of use, resulting in a detailed real time analysis of the different alternative solutions in order to serve the same final use. Finally, data will be consolidated in a final report for comparative study of the alternatives

2.2.3 Current situation of the project

Currently, the project is in its pilot project implementation phase. The current state of development of the project is as follows:

1st stage**:** According to preliminary studies, the uses to be studied were both water heating and alternative generation of electric energy. It was decided to study and evaluate the following sources: Electric, Solar Heating, Natural Gas, Biomass and Solar Phototovoltaic.

2nd stage**:** Initially, the buildings facing the North were selected. A document survey was carried out to check layout and electric energy consumption for the final uses lighting and air conditioning. After this analysis, it was established that:

- The premises that will receive retrofit for lighting will be: Instituto de Matemática e Estatística (IME), Engenharia Elétrica, Instituto de Química de São Carlos (IQSC), CENA de Piracicaba
- The premises that will receive air conditioning retrofit will be: Instituto de Matemática e Estatística (IME)
- The biodigestor installed in the Centro Tecnológico de Hidráulica (CTH) will be used
- Gas and solar panel heating systems will be installed in the building used for students’ housing
- A solar photovoltaic system will be installed for lighting the façade of the IE building
- The Campi to be monitored by the (already existent) management system will be: Piracicaba, Ribeirão Preto, Pirassununga. Complementation is being prepared for the campi of São Paulo, Bauru and Sao Carlos.

3rd stage**:** The general characteristics of design and system specifications are described below:

2.2.3.1 Air Conditioning Systems Project

A survey on several buildings in the campi of the Universidade de São Paulo showed that the typical equipment used for thermal comfort are unit air-conditioning and split systems (nearly 90%). This kind of equipment is used mainly in professors’ offices, laboratories and classrooms. Central air conditioning systems (10%) are applied on large environments such as auditoriums, libraries and museums.

This study also allowed checking that the unit air-conditioners maintenance is quite deficient, which implies poor efficiency during operation and increased energy consumption. It should be pointed out that air-conditioning represents 30 to 40% of the total energy consumption of the buildings analyzed.

Also verified was the lack of purchasing control guidelines which mostly implies the acquisition of oversized equipment and improper use of air-conditioning systems.

Based on this scenario, two main goals were set for the air conditioning systems project in order to reduce energy consumption, i.e.:

1. establishment of a maintenance policy for the present air conditioning systems;
2. directives for purchasing new air conditioning systems/equipment.

2.2.3.1.1. Establishment of a Maintenance Policy

This goal is being pursued in two ways:

- development of internal maintenance procedures for unitary air conditioning systems;
- training courses for technical staff on maintenance practices.

These activities will provide guidance in good practices related to the maintenance of unitary air-conditioning systems, avoiding several problems in the operation/maintenance of such systems. The training courses will be taken by a group of the technical staff with minimal or even no prior background on maintenance of air-conditioning systems. This course will fill a lack of qualified labor, especially in the hinterland campi.

2.2.3.1.2. Directives for Purchasing

This goal aims to analyze how air-conditioning systems and equipment are purchased at USP nowadays and to propose recommendations that should guide USP staff to purchase the proper equipment for a given application, taking into account characteristics such as type of system (unitary or central system), conditioned area (classroom, library, etc.) and system capacity.

Included in this goal is a study for the analysis of selected areas with air-conditioning problems where an intervention will be made in order to optimize energy consumption without disturbing thermal comfort. This study is important in order to quantify the impact of using proper air-conditioning system type and capacity and, as a consequence, providing significant reduction in energy consumption. The areas selected include classrooms, laboratories and computer rooms.

Energy consumption measurements will be made on the actual systems for at least six months. After that, some modifications will be implemented, and a new set of measurements will be established in order to evaluate how effective such modifications were in reducing energy consumption. For those measurements, energy transducers are being placed in the analyzed air-conditioning systems energy supply.

Measurements of comfort parameters (dry bulb temperature, relative humidity, etc.) will be conducted in order to evaluate the thermal comfort conditions in the areas analyzed. Such measurements will also be conducted before and after the modifications. Based on the latter measurements, it will be possible to verify whether the implemented modifications did or did not degrade the thermal comfort conditions.

2.2.3.1.3. Concluding Remarks

The main goal of this project is to make the USP staff become more aware of the need for adequate purchase and use of air-conditioning. As a side effect of these actions, an increase in equipment life is expected, lessening the maintenance costs, as well as energy consumption.

Another project that is closely related to air-conditioning is the architectural standards project, which aims to propose architectural standards for the construction and/or retrofit of the University buildings. The air-conditioning and architectural solutions proposed for each project should complement each other. This effort will bring better building solutions regarding construction, operation and maintenance.

2.2.3.2. Standards of energy efficiency in architecture

Brazil does not count on any legal instruments for the regulation of energy and thermal performance of edifications be it in national, state or municipal scope.

The Brazilian civil construction market uses this lack of legal instruments that would qualify energy and thermal performance of architecture projects. The construction of buildings of low quality and disregarding the local climate characteristics, forces users to be permanently in air-conditioned environments, either for cooling or for heating.

This trend has been observed in this country since the 1950s when, on behalf of aesthetic and lightness, the rational use of materials and the concerns with thermal comfort and energy consumption were put aside, a fact further aggravated by the dissemination of the so-called international style.

The experience of countries that have adopted legislation that disciplines the thermal performance of buildings based on norms and technical criteria demonstrate that the legislation was responsible for reduced consumption and upgraded energy performance in the last two decades.

The problems with the Universidade de São Paulo buildings are not different from the energy and thermal problems found in the buildings all over the country. However, the buildings of the University have peculiar architectural solutions that are, in greater or lesser degree, adapted to the climate.

USP architecture, all over the campi, can be divided into three distinct phases:

1st phase - Buildings constructed up to 1960: the architectural style is concerned with the local climate. The architecture has the following characteristics:

- high thermal inertia;
- cement slab or ceiling re-covered by adobe roofing tiles;
- the high height from floor to floor;
- window wall rate around 50%;
- natural lighting;
- individual control of comfort conditions.

2nd phase - Buildings constructed between 1960 and 1975: rupture regarding climate due to aesthetic values. The architecture has:

- reduced thermal inertia;
- cement slab without protection in the covering;
- high window wall rate (close to 100%);
- high amount of openings to the outside, some of them without closing possibilities;
- large voids;
- difficulty in controlling comfort conditions.

3rd phase - Buildings constructed from 1975 until now: total disruption with reference to the values of the previous phases. The architecture has the following characteristics:

- buildings with an average thermal inertia;
- cement slab covered by asbestos-cement roofing tiles;
- low height from floor to floor;
- window wall rate higher or equal to 60%;
- presence of "thermal bridges";
- lack of control of comfort conditions or control made by air-conditioning systems.

The present trends that emphasize energy consumption and comfort control led to the following proposals for a next phase.

The architecture of these new buildings is expected to be based on projects with the appropriate thermal and energy conditioning with the following characteristics:

- respect for the local climate;
- environments less dependent on conditioning systems;
- adjusted thermal inertia;
- greater presence of natural illumination;
- window wall rate around 50%;
- adequate treatment for possible thermal bridges;
- long-term savings due to smaller electric energy consumption.

2.2.3.2.1 Goals of this proposition

The goals to be reached by the creation of an energy efficiency regulation in architecture are related to a reduced energy consumption.

This reduction, in the existing buildings, could be achieved through the identification of possible interventions by the use of passive systems that could reduce the thermal loads inside the buildings at the same time as they improve comfort conditions. In the buildings that are in the preliminary design phases , the regulation has as main purposes to develop the use of natural lighting, to reduce both conditioning equipment use and thermal loads.

2.2. 3.2.2 Results To Be Attained

The introduction of an energy and thermal regulation for the Universidade de São Paulo will cause impacts in the short and in the long runs, amongst which the most relevant are:

- reduction in electric energy consumption;
- improvement in the quality of buildings, with more comfort for staff and students;
- creation of parameters for the evaluation of new designs;
- opening possibilities for new debates and research on technologies that aim to improve building comfort.

2.2.3.4. Gas and Solar Water Heating Systems for Student Dormitory Buildings

Student dormitories at the São Paulo Campus of the Universidade de São Paulo are 7 six-floor buildings, each totaling 66 apartments, occupied by up to 3 students. Each apartment is equipped with a 5.4 kW electrically heated shower with an average energy consumption of 81 kWh/month per apartment (considering 1 shower a day/person lasting 10 min each). Our estimates indicate that around 35% of the total electric bill of the dormitories are due to showers. Within the main goal of reducing the electrical energy consumption, two other water-heating systems were considered, using different energy sources. The first system consists on gas (natural gas or LPG) usage, and the other relies on solar panels. Both systems are described in the following subsections.

Once the two new water-heating systems are operational, a continuous monitoring of the performance parameters will take place, such as electric power and water flow rate. In addition to this, a third building with conventional electrical heating showers will also be monitored, so that the three systems operation will be compared for one year .

Water and other fittings reach each apartment through service tunnels. Each building has 6 service tunnels, and each tunnel serves 2 apartments per floor, except for one tunnel that serves an apartment and a communitarian kitchen. These service tunnels will also be used to house hot water pipelines.

Based on previous studies, a central gas water heater will be used to feed apartments served by a common service tunnel (12 apartments). That decision was made based on an efficient hot water distribution system and to avoid excessive weight concentration on the ceiling. Furthermore, this configuration minimizes cold water waste, since there is a shorter distance between the boiler (hot water tank) and the shower, when compared with a single central heater serving the whole building (Procel/CEMIG, 1993). Usually, water that remains in the pipe cools off during the night; therefore, most of it is lost during the first showers. Another possibility analyzed was the use of a passage gas heater for each individual apartment. Estimates of additional installation costs indicated that this configuration was prohibitive.

This second system is based on using passive solar panels to heat the water. The whole system configuration and water distribution are quite similar to the gas heated water described above. Calculations show that 800 m^2 total area of panels is necessary, considering an average solar radiation of 300 W/m^2, which is above the available roof area (around 300 m^2) (Agência Nacional, 1999). Therefore, a complementary heating system will use gas.

2.2.3.5. Photovoltaic Systems

In Brazil, photovoltaic systems are currently diffused in decentralized rural electrification programs. The experience with distributed power generation through photovoltaic systems connected to the grid is limited to a few pilot projects (Zilles, 2001). However, the distributed generation of electric power with these systems is one of the solar power applications which has been most significantly used in developed countries. Several countries such as Germany, Spain, Japan and USA are currently promoting these systems as a means to increment the participation of renewable sources in power generation (Maycock,2000; Maycock, 2001). As a result of such government incentives, the increment of distributed generation of power connected to the conventional power supply distribution grid is observed. Of the 287MWp in photovoltaic modules produced in 2000, 44% were installed in systems connected to the conventional electrical grid, 122MWp were connected to buildings of both residential and commercial consumers and only 5MWp were applied to centralized systems.

The generation of power through photovoltaic modules incorporated to a house or to a residential or commercial building, makes them power generators. An important aspect to point out about such systems is the fact that they are intended to work in parallel with the conventional electric supply distribution grid. That means that the client is consuming power from both sources simultaneously. If the power consumption is less than its photovoltaic system generated power, the generated surplus can be injected into the distribution grid, and the conventional consumer operates as an electrical power supplier.

2.2.3.5.1Current situation

The IEE-USP started its activities with grid-connected photovoltaic systems in April/1998, supported by FAPESP, the São Paulo State foundation for supporting scientific research. The first unit, with 695Wp, started after meetings with the distribution company, ELETROPAULO, in order to agree on the quality of the photovoltaic-generated power and to measure the exceeding power made available to the distribution grid. Since then, the system has been monitored and this follow-up has allowed an assessment of the behavior of a distributed power system when connected to the low voltage grid. The results achieved during the first three years of operation fostered the expansion of the experiment with the implementation of 6.3kWp in the administration building of the IEE-USP.

Now, with the PUREFA project, 10kW_p divided into two systems will be installed; 4kWp outside CUASO campus and 6kWp as an expansion to the already existing 6.3kWp.

2.2.3.5.2. Conclusions

The data obtained indicated that the system can reach a yearly output close to or above 1300kWh/kWp. These preliminary results demonstrate the potential use of photovoltaic solar power at the USP campus as a complementary and distributed system for power generation. In fact, if we consider the buildings already existing at the USP campus , there is a possibility to incorporate approximately 1MWp. However, the diffusion of these systems, either at the USP campus or at urban centers in the country requires, in addition to economical incentives, the urgent establishment of regulation contemplating the consumer as a power producer. Moreover, quality, safety and photo-generated power measurement technical standards must be established.

2.2.3.6. Generation of energy from biogas

This project allowed opportunities to increase efficient energy use as well as a stronger participation of renewable energy, including biomass, in the São Paulo University (USP).

In this context, the Brazilian Biomass Reference Center (CENBIO), located in this university and supported by the Secretaria de Energia do Estado de São Paulo, Instituto de Eletrotecnica e Energia – (IEE –USP), Biomass Users Network (BUN), Ministério de Ciência e Tecnologia, have a commitment with two phases of PUREFA, related to biogas use, as a contribution to this project.

The first corresponds to phase eleven, whose main goal is the implementation of generation, besides a storage system for the biogas produced by a biodigestor located in Centro Tecnológico de Hidráulica (CTH - USP), at São Paulo Campus. Once this step is concluded, phase twelve, related to biogas use for electric energy generation, will be started.

This paper presents some technical aspects of the biodigestor and reports the current situation only for phase 11 and some topics of phase 12, because this will be started only in 2004. However, the paper still does not provide any technical results, since the project has recently been started.

2.2.3.6.1. Biodigestor

The equipment is a UASB Biodigestor (Up-flow Anaerobic Sludge Biodigestor), which operates 24 hours a day. The biogas produced is estimated at 4 cubic meters per day, using human dejects from the residential buildings at the São Paulo Campus.

Due to the dimensions of the equipment, which is 6 meters high and 25 cubic meters, it will not be possible to treat the entire amount of the rejects, consuming just 3 cubic meters per hour. Currently, it is being used for water treatment research. The biogas obtained on the top of the biodigestor is emitted into the atmosphere.

2.2.3.6.2. Current situation

The most important aspect of biogas utilization is the identification of its mass flow, chemical composition and its heat value. These parameters are necessary for an adequate determination of electricity for energy generation potential and to indicate if it will also be necessary to remove H_2S from the biogas produced.

Thus, the research for this phase requires contact with industries and laboratories to determine the parameters described above.

The research for this phase indicates some conversion technologies used for biogas. Gas is planned to be used in an “otto” cycle engine.

2.2.3.6.3. Concluding Remarks

The low amount of biogas produced makes it impossible to use this renewable energy in a Demonstration Project, whose results could be used on larger biogas units.

This project also has an important environmental aspect, because it converts CH_4, one of the biogas chemical components, into CO_2 , decreasing the greenhouse effects.

2.2.3.7. Energy Management

The Energy System Management (SISGEN) is composed, in its implementation, by physical equipment of collection, transmission and reception of energy data, besides monitoring software, which performs the treatment and follows up the data.

The system for collecting energy information may be composed of transducers for energy measurement or pulse recorders , where an available electronic measurer from the utility counts on digital output.

The monitoring of the collected data is performed by means of monitoring software that handles the information collected and graphically presents them numerically in form of energy parameters that characterize the use of the electric energy. Such parameters are presented according to seasonal hour segments (peak and out of peak hours) graphically distinguished by colors (green, blue and orange) for better visualization.

The parameters monitored are:

- Instantaneous active demand
- Active and reactive demands
- Energy consumption
- Power factor
- Frequency
- Phase and line currents

All the information can be remotely accessed by means of graphical screens easily understood, such as Internet or Intranet.

The SISGEN also allows:

- To know and to follow the evolution of the energy consumption characteristics of a building
- To manage electric energy expenses
- To follow the results of energy efficiency actions
- To provide a support tool for the management and maintenance sectors

2.2.3.7.1. Current situation

Currently 25 points of consumption are being monitored and 72 points of measurement are expected to be reached with this project.

The Campi to be monitored by SISGEN are: Piracicaba, Ribeirão Preto, Pirassununga. Complementation will also be made at the São Paulo, Bauru and São Carlos campi.

The places where the alternative sources are installed, as well as the areas undergoing lighting and air-conditioning retrofits, will also be monitored.

3. Conclusions

From the studies and analyses of the buildings and equipment, the development of a standard for using energy and acquiring equipment are expected so as to direct the purchase of materials and equipment powered by electric energy. Such acquisitions, usually done by the University teaching or non-teaching staff, would have the rational use of electric energy as an important parameter.

The implementation of the energy management system will result in an on-line follow-up of the load curves and consumption profiles for some of the USP units , allowing the management of different energy sources, checks on the consumption trends, seasonalities, problems with excess reactive energy, detection of possible fines for excessive demand and reactive energy limits, specificities of the different units. Also as part of the improvement of this Energy Management System , there is the intention to implement an interface that allows availability of such data through Internet for different users who will be able to analyze the data collected from different USP campi .

With the implementation of a maintenance policy and/or substitution of air-conditioning systems the aim is greater awareness by users regarding air-conditioning equipment use and acquisition, as well as the reduction of energy consumption. This will result in an increased service life for the equipment, reduction in maintenance costs and energy consumption for other buildings of the University.

With the implementation of alternative sources of generation based on natural gas, solar photovoltaic, biomass together with the alternatives for energy efficiency increase on the demand side, it is expected to reduce electric energy consumption to levels lower than the current ones. Moreover, the knowledge acquired with the implementation and operation of these generation sources will be disseminated in the academic area and to the community in general, in what regards technical, economic, environmental and energy efficiency aspects.

The PUREFA will become USP virtual laboratory for research on energy sources, while optimizing the management of energy resources.

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