



The permanent program for efficient use of energy at university of São Paulo – PURE-USP

PURE-USP

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Abstract

Purpose – The purpose of this paper is to analyze the use of energy management and sustainability in the government sector using a study case conducted by the Permanent Program for Efficient Use of Energy at University of São Paulo (PURE-USP), a pioneer initiative of its kind active since 1997.

Design/methodology/approach – The paper describes the actions and results of PURE-USP.

Findings – The energy savings promoted by PURE's actions are estimated in about 25 percent after 15 years since the program was implemented. This means a saving of approximately 37 MWh or R\$9 million (€2.91 million) for an investment of R\$1.73 million (€560,000).

Practical implications – The results show that the program is viable and could be replicated in other Brazilian institutions or even in other countries.

Originality/value – PURE-USP provides in addition to electricity savings (which implies in avoiding environmental impacts) resource savings which in the case of a public institution like the University of São Paulo implies in a more efficient management of public funds.

Keywords Sustainability, Behaviour, Efficiency, Contracts, Energy management, Energy policy

Paper type Case study

1. University of São Paulo (USP) – energy consumption data

The USP is a public University from the state of São Paulo and was founded in 1934. Nowadays it is the top ranked university of Brazil and Latin America and has a total area of 1,776,670 m² spread throughout 23 cities: São Paulo (the State capital), Bauru, São Carlos, Ribeirão Preto, Piracicaba, Pirassununga, Lorena, Anhembi, Araraquara, Brasília, Cananeia, Cássia dos Coqueiros, Cubatão, Diadema, Itatinga, Itirapina, Itu, Pariquera-Açu, Piraju, Santos, São Sebastião, Ubatuba e Vinhedo. The University staff is composed of 5,940 academics, 16,512 support employees, 57,902 undergraduate students and 33,117 graduate students.

The University's average energy consumption is around 12 GWh per month. Seven different power companies provided energy to USP and it was charged through 400 bills each month. Just the campus of São Paulo itself (Cidade Universitária Armando de Salles Oliveira (CUASO) the biggest campus of the University) was responsible for almost half of the whole consumption (Table I).

2. The history of Permanent Program for Efficient Use of Energy at University of São Paulo (PURE-USP)

There was a contradiction involving USP up to 1996. The University was a large energy consumer and at the same time courses related to energy matters were being taught there but no energy management action was being taken. The exact consumption and expenses of the University with energy were unknown.

According to PhD Professor Marco Antonio Saidel “this reality is not different from those in other major public institutions because the task of monitoring consumption



Table I.
Distribution of electric
energy consumption
per campus in 2012

Campus	Share of total electricity consumption (%)
CUASO	48.03
São Paulo – outside CUASO	9.95
USP Leste	1.19
Ribeirão Preto	15.39
São Carlos	9.56
Piracicaba	7.66
Bauru	3.36
Pirassununga	2.76
Lorena	1.36
Others units	0.74

Source: Self-made

characteristics of each building – which could be considered just the beginning of the energy management once it assumes anticipating problems and devising a plan – usually lies with the maintenance sector. What happens is that the maintenance sector operates in a way that it attends the operational functions of the facilities ensuring it is operational. Naturally the activities related to energy management end up occupying low priority. This scenario gets more intense when the facilities were separated with time or by the expansion.”

The research on energy management in public services started from a debate between professors, researchers and engineers from the University. They saw the opportunity to use the Universities’ facilities as a laboratory. So these ideas turned into a research project: the CONSERVUSP.

The project was funded by FAPESP (Foundation for Research Support of the State of São Paulo) and took place in 1996. Initially the main goals of the research were:

- Knowing the general characteristics of the use of energy at the USP.
- Evaluate the effective potential for energy conservation in some University buildings.

The lack of knowledge in the activities developed in other USP campuses restricted the research to CUASO that was (and still is) the biggest electrical plant of the University and represented the diversity of all activities that took place in it.

The CONSERVUSP project concluded that there was significant potential for energy saving. The research identified that the largest energy use was for lighting and the most used lamps were fluorescents of 40 W and 110 W, which were already considered inefficient at that time. The energy saving potential of two USP’s building was also checked: the Zoology Building had a 28.6 percent potential and the Electric Engineering Building had a 44 percent.

Meanwhile the USP administration was studying ways to expand the management of sectors like telecommunications, water, sanitation and electricity. So, with all the results obtained and concepts formulated by CONSERVUSP it was possible at that time to justify an institutional pioneer program that aims to make the University’s facilities more efficient.

The PURE-USP was created on May 15, 1997. The first concerns of the program were to disseminate it in the USP community, analyze and systematize the energy bills (the only element available at that time to provide data about the University energy consumption) and encourage the purchase of efficient equipment.

Even with few resources and postponing some actions at the first moment in order to disclose some concepts, the program prepared its first report with information about the characteristics of energy use at the University that until then was unknown by many.

Additionally the analysis of energy bills were initiated and immediately pointed out some issues like:

- a significant incidence of penalties for late payments;
- the identification of the bills did not follow a pattern and there was no guarantee if some of them belonged to USP;
- the route that each energy bill followed did not follow a standard procedure; and
- the expiration dates were spread alongside the month witch made it difficult to manage.

In order to solve these problems, the following actions were taken:

- updating of the registration data of all electric units;
- adoption of a single criteria for identifying electric units;
- fixing expiration dates for the end of the month according to the interests of the University in terms of its cash flow; and
- establishing a standard procedure for receiving energy bills: all of them now are sent in blocks from each campus to the Program office for verification and then forwarded to payment.

These actions were successful: the fines and penalties represented 7.5 percent of the electric energy costs in 1997; in 2011 the same index was 1.06 percent. Furthermore, thanks to the procedure of bills identification there was no difficulty for the goals compensation to prove that those units belonged to USP during the rationing period.

3. The rationing period

Between 2001 and 2002 the country suffered an electric energy crisis. The long years with a lack of investments in the electrical sector, combined with an increasing demand of energy in the economic sectors and also the low rainfall rate, which reduced the level of the hydropower plants reservoirs, caused the crisis. The solution founded was to delegate responsibility to consumers to reduce their energy consumption by 20 percent.

The University's answer was the creation of the Energy Saving Program by the Regulation No. 3283 of May 15, 2001 (the energy rationing was announced by the Chamber of Electric Energy Crisis Management on May 18, three days later).

The experience of the CONSERVUSP and the PURE-USP showed that it was possible for the University to achieve the goal of 20 percent energy saving. The success, however, depended on the involvement of all USP community. The Energy Saving Program created the figure of the energy manager, a person responsible for the energy management in each University unit. Moreover, a wide campaign was created to sensitize the community with panels, seals, etc. The Figure 1 shows one of the campaign advertisements at the time.

The University Regulation No. 3287 of May 28, 2001 complemented the previous regulation in order to achieve the 20 percent energy saving goal with a set of actions such as:

- To put the coordination of the Energy Economy Program under responsibility of PURE-USP.

- To determine the role of the energy manager and to indicate the managers for each unit.
- To specify a desirable profile for the managers: they should be close to the upper management, be able to formulate projects, budget resources required, ensure the implementation and monitoring the achievement of results, have the ability to manage time and exercise leadership and have interpersonal skills.
- To define guidelines: selection of goals and projects for energy saving; decentralization of projects planning and implementation; identification of managers and the determination of their authority and responsibility; involvement of the community on planning, implementation and evaluation of energy saving projects; allocation of financial and human resources, including investments in training to make viable the approved projects.
- To present a set of projects that composed the Energy Saving Program.

Those projects were:

- The Rational Use of Illumination and Air Conditioning Project: it was the main project and consisted in ensure an effective reduction of energy consumption by reducing the number of electric lamps and stimulating the use of natural lighting and restricting the use of air conditioning equipments to the strictly necessary environments.
- Surveillance Project: set out guidelines for the University security personnel to assist the shutdown of some lightning points when these were not necessary.
- Human Resources Training Project: identifies the technical staff's training needs on each unity to reach the aims of the program.
- Energy Efficiency Project: allowed replacement of lamps and equipments in order to increase the efficiency in energy use. The cost of all proposals should be quantified to evaluate the investment.
- Special Projects: planned according to specificities of each unit or office like, for example, the physical reallocation of activities or equipments.
- Consumption Monitoring Project: monitored the consumption and disclosed the information about the actions results.

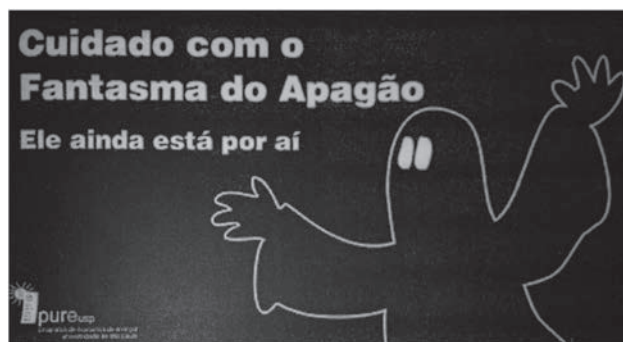


Figure 1.
Advertisement launched
at the rationing period.
“Beware with the
Darkness Phantom.
It’s still around”

Source: Saidel (2005)

Several means of disclosure were employed in order to present the actions, the goals and the results of the program, especially the internet once it was necessary to spread data in a faster way.

The results of the energy management actions were the following:

- The goals were achieved in most parts of the campuses and in its unities. Some of them, however, had some difficulties in reaching those goals which led to a renegotiation of the terms with the power energy distributor since several USP unities achieved its goals with clearance. That showed that the decision taken years ago on registering all the energy bills under the same ID number was well succeeded since it allowed to prove that those bills were responsibility of the University.
- 7,292 MWh were saved in the rationing period representing savings of R\$940,000.00 (€300,000) in values of that time.
- The 2001 energy consumption were 9.5 percent bigger than the 2000. On the other hand the 2002 energy consumption were only 0.8 percent bigger than the year before.

Part of those savings was reverted to actions of efficiency improvement. In total, 15,700 32 W fluorescent lamps and 9,000 ballasts were acquired and distributed to 23 unities in order to improve the efficiency of the lightning systems, which led to a permanent energy economy.

In the behavioral aspect teachers, students and employees in several USP unities were deeply involved in creative actions to establish improvement opportunities.

The ending of the rationing period did not represent the closure of the Program's activities; according to Professor Marco Antonio Saidel in the year of 2005 "the Saving Energy Program can be understood as a movement inside PURE-USP. It was necessary to give a conscious response to a specific demand to guide the activities during the period of rationing and besides that it created conditions to extend the energy efficiency actions in the post-rationing period under responsibility of PURE-USP."

4. Administrative management

The PURE-USP administrative management consists in bill and contracts management. Since there are hundreds of bills and dozens of contracts to manage it was necessary to develop a management software called Contaluz System.

Contaluz management system tool

The ANEEL 414/2010 regulation sets bill as a "commercial document which shows the total amount that should be paid by the consumer to the distributor, due to the electricity supply, to the connection and usage of the electrical system and to the services provided. It should specify clearly which services were provided, the respective amount, the fares or the billing period." It also determines the minimum amount of information that a bill should contain.

It happens that each bill contains the energy consumption technical features referring to just one month but the appropriate analysis involves the history of consumption and other data that are not present in a single bill. The analysis of hundreds of bills each month is impossible due to the short time between its receiving and its expiration date (ten working days for government clients).

In order to solve this matter PURE-USP developed a software management tool named Contaluz System. The purpose of this software is to register the data of all

energy bills received and paid by USP and to make this information available for energy managers (the professionals involved with energy matters in USP) and researchers.

In Contaluz the data entry takes place through an interface similar to the energy bill itself, which makes it easier to insert the data into the system since this work is to basically copy the contents of the energy bill to the computer. Despite the regulation of ANEEL 414/2010 that defines the minimum amount of information that should appear in an energy bill it does not set how this information should appear what leads to confusion on reading the data since each distributor has its own model of billing.

The Contaluz System generates reports and graphics by the data inserted which allow full analysis. Figures 2 and 3 show some screenshots from the system.

5. Bill management

The PURE-USP bill management goals are:

- to search for mistaken charges such as those for inaccuracy on billing or inappropriate tax fees like ICMS (a tax which USP is free of charge);



Figure 2.
The main screen
of Contaluz

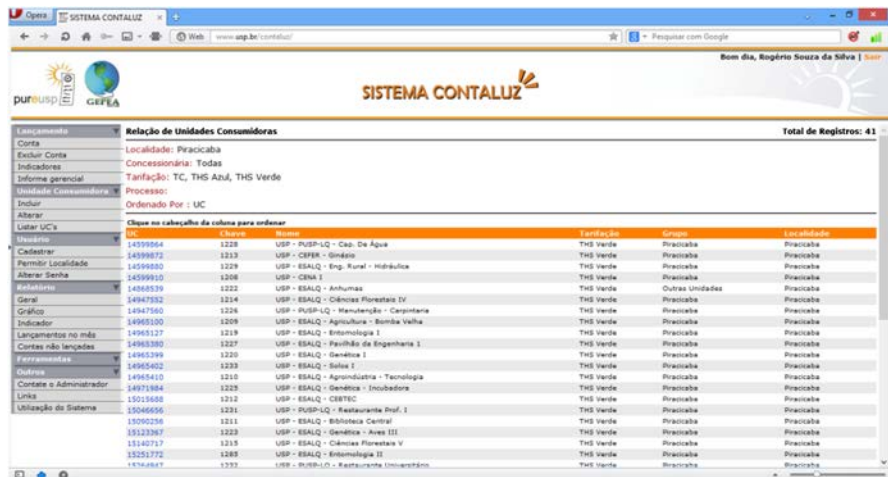


Figure 3.
The report screen
of Contaluz

- to manage the information listed in the bills which are important for checking the activities and actions taken course in USP and in PURE itself; and
- to avoid payments after the deadline since it leads to fines.

A methodology was defined and adopted concerning the management of all energy bills of the University related with the identification and register of its unities.

All bills present the same pattern of identification: USP – unity – place. They are classified as “State Public Sector Bill” and carry the main University ID number (since the central administration does the payments). The deadlines are scheduled according to the University’s Financial Department, which centralizes the payments. Each unity, however, receives its own bills. This order of things allows each campus to be aware of their energy consumption and ensures control of the University on their expenses.

The billing data are inserted in Contaluz System by a specialized team designated on each campus. Before dispatching them to the Financial Department the bills are sent to the PURE-USP team for analysis and checking of the data inserted into the system.

With time this procedure has been improved and has now evolved to a point where all bill are in direct debit for payment. This helps to avoid late payments but there is a risk on losing control over the bills caused by the lack of need of managing them.

Furthermore during the years of 2001-2008 it was common to happen inaccuracies with the billing. At this time the procedure adopted by PURE-USP was once the error had been spotted to communicate it to the distributor and cancel the payment. USP being a major governmental client imposed itself on the energy companies who then sent a new corrected bill with an extended deadline for payment. The Figure 4 shows one of these error cases:

Among the possibilities for improving billing management there is the option of receiving the bill by internet directly from the electric companies that reduces considerably the amount of paper in use nowadays. The companies already offer this alternative, however, its adoption requires a reorganization of PURE systems. Another action in study is the automatic data insertion into Contaluz System that would reduce its operation time once it is made by manually typing. This requires data availability with a digital spreadsheet form or similar which is not provided by the electrical companies yet.

6. Contract management

The National Regulatory Agency of Energy (ANEEL) has a Regulation No. 414/2010 which sets the obligation of a signed contract between the local electric company and the consumer. USP has 124 electric units that fit into this category. These contracts are renewable every 12 months.

In the year 2000 the electric companies started to sign the first contracts with the public sector but those companies were not prepared to deal with this kind of client in view that the contracts signed had some imposed clauses that broke certain legal

DEMANDA CONTRATADA	EX	15588,0	16,31080	2.713.331,57
DEMANDA FATURADA	RA	571.912	23,17879	1.026.944,47
CONSUMO ATIVO	RNE		0,00000	11,00
CONTRIB. SET. CONTRIBUIÇÃO IL. PUBLICA		571.912	16,00476	38.269,83
SCC - KWVAR. CAPACIDADE ENERGIA				
				=271.486,06

Source: Saidel (2005)

Figure 4.
An example of a
incorrect billing

principles. An example of this was the adoption of an unauthorized index to calculate the fine for delayed bills. Another issue that required negotiation was the penalty clause imposed by the companies for contract rescission which stipulated a fine equivalent to six months of consumption.

Those issues revealed the importance of a legal advisor for a program like PURE-USP. The University's Attorney Office is the responsible for this kind of support in finding solutions for each detail within each contract.

The legal representative who signs the contracts is the President of the University; so no one else can sign a contract with the energy companies without the knowledge of PURE and the University administrative sectors.

The Contaluz System is also an important contract management tool. The data from the bills monthly inserted in the system provide a necessary update for managing the energy contracts. The system is able to analyze the most advantageous fare for each electric unit between three options – conventional fare, blue fare and green fare – and then make a simulation with the energy demands to be contracted. Figures 5 and 6 present Contaluz screens with parameters to simulate and analyze consumption and fares.

As an example in 2011 a new electric unit arising from another government company was incorporated by the University and through Contaluz the PURE team was able to make a new contract and change the fare class from blue fare with, a 100 kW contracted power between 08:30 p.m. and 05:30 p.m. and a 414 kW contracted power between 05:30 p.m. and 08:30 p.m. to the green fare, with a all-day 170 kW contracted power which lead to a 30 percent savings for this unit (Figure 7).

A future challenge in the contract management area for PURE is the entering of USP in the free market of energy without the obligation of buying energy from local companies but the Program team understands that the investments involved with this kind of initiative are not worthy yet to the University.

7. Technology management

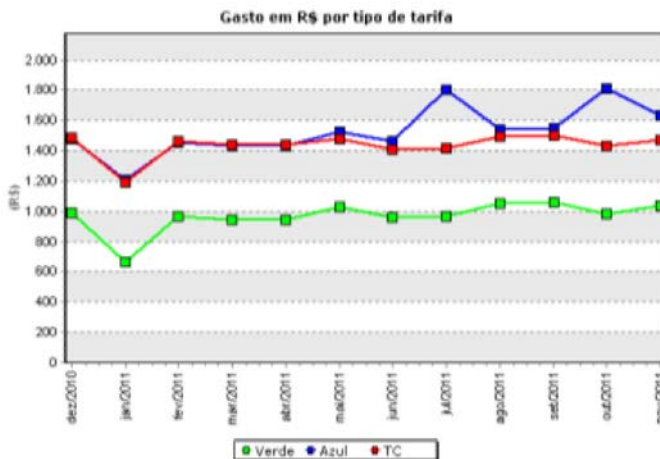
The technology management has two fronts. One looks at the updating of technical specifications of efficient equipments into Mercurio System (the University's computerized purchasing system) and the other looks at the renovation of the electrical installations.

The screenshot shows a software interface titled "Análise Tarifária". It is divided into several sections:

- Dados da Unidade Consumidora:** This section contains four fields: "Localidade:" with a dropdown menu showing "Piracicaba"; "Unidade Consumidora:" with a dropdown menu showing "THS Verde - 15046656 - USP-CCLQ-Restaurante Prof. I"; "Limite de tolerância:" with a text input field containing "5 %"; and "Selecionar as contas de" with a text input field containing "12" and the label "meses".
- Estimativa de crescimento em %:** This section contains two fields: "Consumo:" with a text input field containing "5 %"; and "Demanda:" with a text input field containing "5 %".
- Na falta de registro de Ponta e Fora Ponta usar:** This section contains four fields: "Dem. Ponta:" with a text input field containing "90 % da Demanda Máxima"; "Dem. Fora Ponta:" with a text input field containing "100 % da Demanda Máxima"; "Cons. Fora Ponta:" with a text input field containing "70 % do Consumo Total"; and "Cons. Ponta:" with a text input field containing "30 % do Consumo Total".

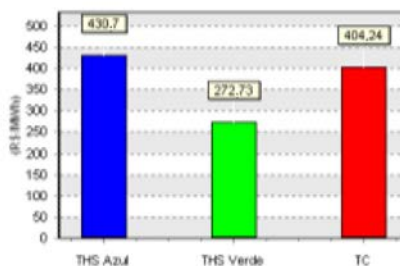
At the bottom right of the window, there is an orange button labeled "Definir".

Figure 5.
Setup screen of Contaluz



Demandas

THS Azul	
Ponta:	23
Fora Ponta:	30
Valor em R\$:	18,339,26
THS Verde	
Única:	30
Valor em R\$:	11,612,96
Convencional	
Única:	30
Valor em R\$:	17,212,41



*Calcula sem impostos(ICMS, PIS e COFINS)

Figure 6.
The screen with the result of a fare analysis

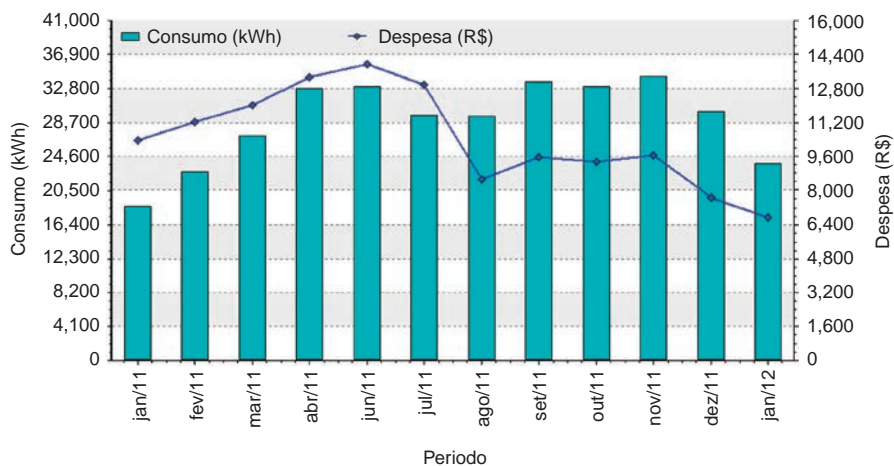


Figure 7.
The screen with power demand bars and the consumption line in Reais (BRL)

Equipment specifications

The acquisition of equipments must consider their quality, efficiency and lifetime and not only the price. Then it is necessary to establish parameters for buying efficient lamps. PURE handled this problem developing a Manual of Electric Equipment Specifications where the conceptions about efficient energy were incorporated and the electricians and people involved with purchasing equipment could take proper directions by accessing: www.usp.br/pure/estatico.php?v_content_id=423, the handbook page.

Projects on energy efficiency

The projects on energy efficiency driven by PURE include basically the renovation of electrical installations inside the University's units. These projects involve changing lamps, ballasts and luminaries for more efficient ones and also the change of air conditioning systems and equipments.

The project budget is limited and usually PURE counts with funds from the electrical companies since they have to invest 0.5 percent from their profits in energy efficiency according to an ANEEL regulation. From the beginning until nowadays PURE acquired around 15,000 ballasts, 28,000 lamps and 1,000 luminaries.

8. Behavior management

The procedures to save energy by the acquisition of efficient equipments, efficiency projects and management of energy contracts aiming on buying cheaper electricity also needs the conscious use of energy.

So in trying to change people's behavior PURE acts on providing training courses and conferences to electricians, security guards, workers and all the University's community; posters, outdoors, adhesives, comic strips, instruction booklets are some examples of what has been made by PURE to promote a more responsible conscious and sustainable behavior. The Figures 8-10 show some examples of these kinds of material.

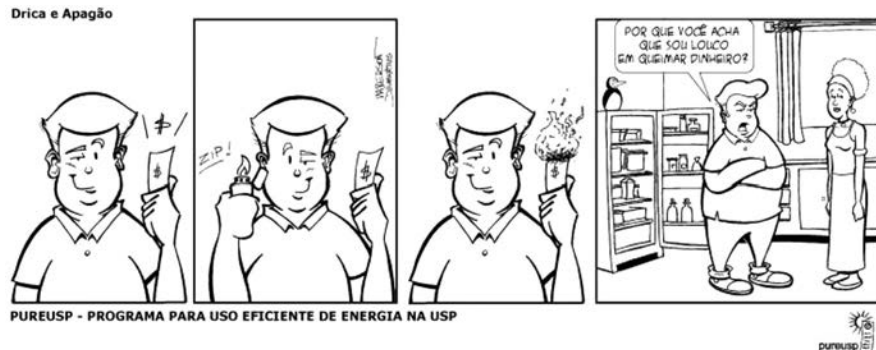


Figure 8. Comic strip with the extravagant “Apagão” and his conscious friend, “Drica”

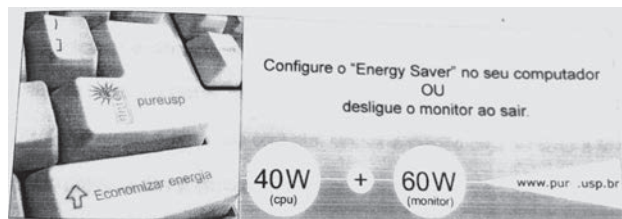


Figure 9. Computer adhesive: set the machine on “Energy Saver” mode and turn-off the screen when it’s not in use

Source: Saidel (2005)

9. PURE-USP results

To measure the energy saving in a project or a program is not a simple task. The energy consumption is influenced by so many elements that the uses of estimation techniques become an imperative.

Pre-PURE period consumption data were collected for this estimation. At that time the average energy consumption growth rate was 5.4 percent. If PURE or a similar initiative did not exist it would be very likely that this growth rate would have raised once the University's activities increased since then with four new campuses and a 30 percent academic community growth rate. Still to not overestimate the program's results we estimate a smaller energy consumption growth rate of 4.5 percent per year (Table II).

Therefore 36,281.89MWh were saved in the year of 2011. To estimate the money savings once again trying not to overestimate the program results it was considered a cost of R\$25,000/MWh, lower than the average market price.

$$36,281.89\text{MWh} \times \text{R}\$250/\text{MWh} = \text{R}\$9,074,472.50$$

(equivalent €2,935,780.00) saved in 2011

Another important index is the program cost. Table III shows the values for the year of 2011.



Source: Saidel (2005)

Figure 10.
Adhesive for interrupters asking to turn off the lights

Year	Checked	USP energy consumption		Variation (%)
		Estimated		
2001	101,578.2	113,950.5		-12.18
2002	102,365.9	119,078.2		-16.33
2003	117,954.5	124,436.8		-5.50
2004	111,620.5	130,036.4		-16.50
2005	119,557.4	135,888.1		-13.66
2006	121,933.9	142,003.0		-16.46
2007	129,247.2	148,393.1		-14.81
2008	128,631.9	155,070.8		-20.55
2009	134,013.0	162,049.0		-20.92
2010	136,815.6	169,341.2		-23.77
2011	140,679.7	176,961.6		-25.79

Table II.
Checked consumption vs estimated consumption

Table III.
PURE-USP budget (2011)

PURE-USP 2011 budget		
Energy efficiency projects	R\$1,030,000.00	Equivalent €333,000.00
Marketing and presence in events	R\$10,000.00	Equivalent €3,240.00
Training	R\$30,000.00	Equivalent €9,700.00
Human resources	R\$642,000.00	Equivalent €207,700.00
Material resources	R\$18,000.00	Equivalent €5,820.00
Total	R\$1,730,000.00	Equivalent €559,460.00

10. Conclusions

PURE-USP is an innovative initiative in the government and educational sector in Brazil.

The Program presented consistent results over the years with an annual savings estimated in 36,281.89 MWh or R\$9,074,472.50 (equivalent €2,935,780.00).

Although PURE-USP actions takes place in Brazil considering therefore the country's own specificities it is reasonable to assume that the Program can be replicated in other countries as well.

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