Background for the implementation of an Energy Management System in the South Campus of the University of Chile

A. García [(1)], P. Zamorano [(2)], J. González [(1)]

[(1)] *Department of Wood Engineering and Biomaterials, Faculty of Forestry Sciences and Nature Conservation, University of Chile. Santa Rosa 11315, La Pintana, Santiago, Chile. Phone: 56-2-29785910, agarcia@uchile.cl*

[(2)] *Faculty of Physical and Mathematical Sciences, University of Chile.*

1. Introduction – The economic development of the countries requires the use of energy at increasing rates. This trend is also observed in Chile where the demand of energy is duplicated every ten years [1] The installed capacity of the country should increase at least 8,000 MW until 2020 in order to support the current economic growth [2], which means an expansion of 45% in comparison to the capacity available in 2013[3].

Under the Latin-American context, Chile has the most expensive energy costs; they are similar to those observed on developed countries such as Germany or Japan [4]. The generation of electric power is mainly based on the transformation of coal, which implies the release of greenhouse gases and contaminants. On the other hand the energy matrix is strongly dependent on foreign resources and the main energetics are derived from imported fossil fuels [5], so the economy is affected by international price fluctuations and as a consequence, any little change on the uses of energy and habits can have a great impact on the national economy and sustainability. These changes must be pushed by the Academy and the National Institutions in order to disseminate good practices such as those related to the concept of energy efficiency.

Under an institutional context, it is recognized that all the management practices related to the use and consumption of energy contribute to improve its efficiency. The development of requirements and structures for the management of energy has established the background for the rising of an Energy Management System (EMS). This system is based on the conjunction of processes for the management of the organization, which allows managing issues related to energy in a permanent way, improving continuously the conditions for the use and consumption of energy. The implementation of an EMS allows to an institution the management of the use and consumption of energy which provokes: savings, improvement of the competitiveness and the corporate image, and minor environmental impacts. All these benefits contribute to the energy security through a reduction of its demand. At a worldwide level and for the last 30 years, local standards have been created for the implementation of an EMS. Finally in 2011 an international standard called ISO 50,001 was published which meets the main aspects considered on different local standards.

The University of Chile, the oldest of the country signed the Clean Production Agreement called "Sustainable Campus" in 2012, together to other 24 universities, so it is expected that in the next 5 years the consumption of energy decreases 5 % as a goal derived from the implementation of energy efficiency practices as those considered on the International Standard ISO 50,001. Under this context, the project entitled "Installation of the basin for a comprehensive energy efficiency plan for the South Campus of the University of Chile", supported by the Chilean Agency of Energy Efficiency, is a first step to conduct a better performance of the use of energy at the installations belonging to the university. The present work shows the results derived from the application of an energy audit in the South Campus as a response to get the implementation of technical requirements that the international standard demands.

The main objective of this work was to evaluate the current uses of energy and their main sources in order to design a management tool able to get a better performance and finally significant savings. A second

objective was to build a basin and to identify Energy Performance Indicators (EPI) in order to take future decisions related to the improvement of the sustainability in the South Campus.

2. Experimental – The methodology applied a sequential structure that considered the requirements of Energy Planning described on ISO 50,001. This sequence is based on the application of a methodology known as Circle of Deming [6] or PDCA, which implies a continuous improvement that distinguishes 4 basic steps: Plan – Do – Check – Act.

An energy audit was performed in the built installations belonging to South Campus; these comprised 3 faculties (Faculty of Agricultural Sciences (FAS), Faculty of Forestry Sciences (FFS) and Faculty of Veterinary Sciences (FVS)) in a total surface of 273 hectares, located in the South Zone of Santiago City.

Data were collected and organized considering one year. Simultaneously, interviews were performed to different people in charge of laboratories and installations. A complete inventory of equipment and their consumption patterns of different sources of energy were also registered. A summary of the methodology is described on Figure 1.

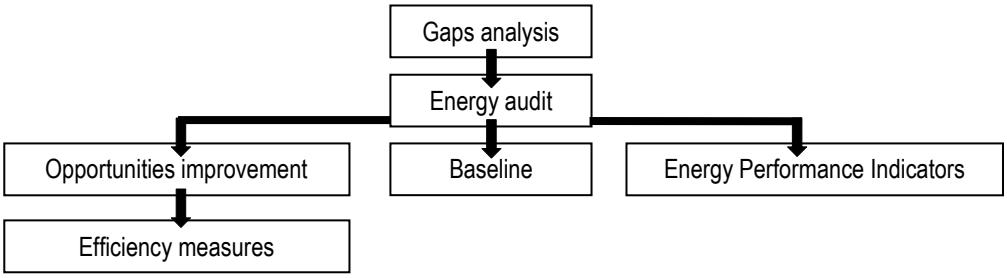

Figure 1. Summary of the methodology applied in this research

3. Results and Discussion – An initial analysis identified the gaps that were present in the South Campus according to requirements included in ISO 50,001 as a first step for the implementation of an EMS. There were not significant advances for the implementation of an EMS, however the current conditions permitted to reach the requirements for the assessment of the EMS according to the international standard. The analysis of gaps allowed determining the current situation of the Campus in order to plan the subsequent energy audit. The audit included the collection of data related to the use and consumption of energy into the Campus and its subsequent analysis. Consumptions of electricity and natural gas and their respective costs are shown in Figure 2.

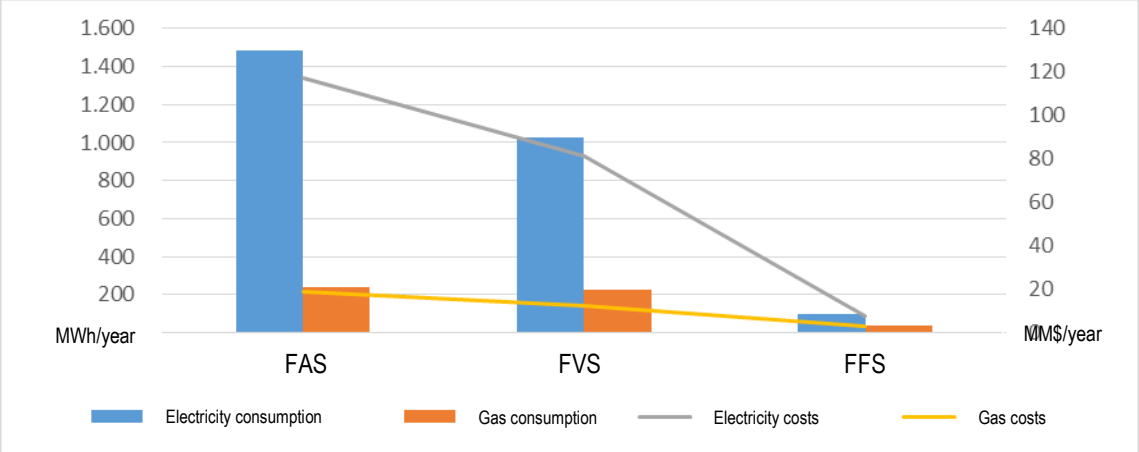

Figure 2. Consumptions and costs of electricity and gas used in the South Campus of the University of Chile.

The audit revealed that energy is mainly used for acclimatization, laboratories and heating (Figure 3). Most of the consumption is made by research activities, which is clearly related to the abundance of laboratories and their associated equipment. According to these results, opportunities were detected and they were related to contracts and energy suppliers and a more efficient use of energy for acclimatization, heating and laboratory equipment.

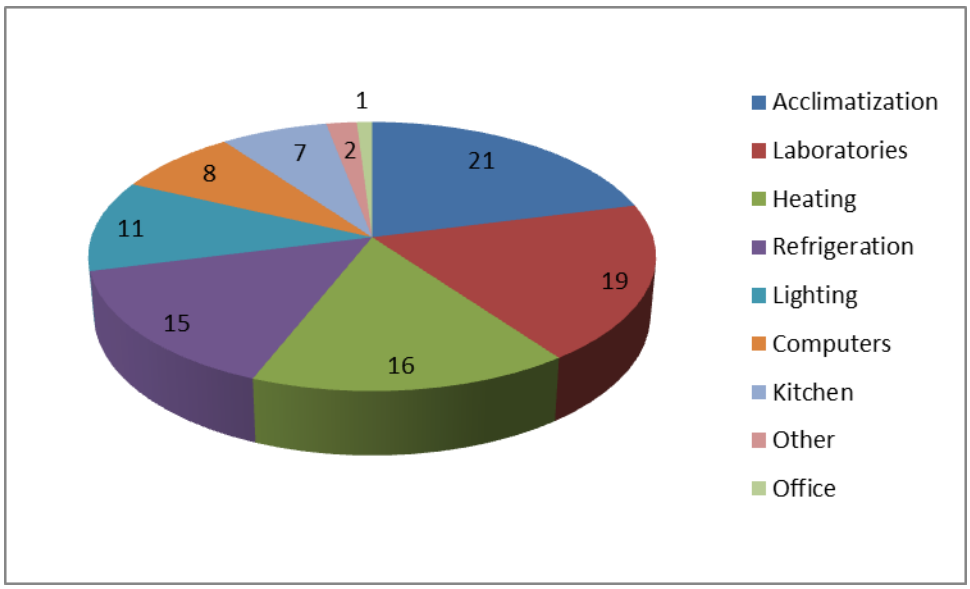

Figure 3. Uses of energy in the South Campus of the University of Chile.

The consumption of energy in each faculty belonging to the South Campus was used to obtain a baseline in order to compare their performances related to the use of energy. This is especially important when improvement measures need to be evaluated. EPI values were obtained according to criteria that permitted to establish a comparison with other universities. Selected EPI were: consumption of energy per square meter per year and consumption of energy per person per year. EPI values are shown in Table I.

Table I. EPI values calculated for gas and electricity consumptions in the different faculties belonging to the South Campus of the University of Chile.

Faculty	Electricity Consumption		Gas consumption	
	kWh/year/m^2	kWh/year/person	kWh/year/m^2	kWh/year/person
FAS	57.55	1,140.04	9.21	182
FVS	76.72	994.54	16.72	217
FFS	26.52	241.23	9.14	83
South Campus	60.88	953	11.55	181

Some opportunities to improve the energetic performance related to the use and consumption of energy were detected in order to propose measures to optimize them. An important part of these measures have no costs and simply involve changes in the management of the resource or the replacement of the supplier. Table II shows some proposed measures intended to improve the performance of South Campus.

Table II. Proposed measures to improve the energetic performance of the different faculties belonging to the South Campus of the University of Chile and expected savings derived from its implementation.

Faculty	Recommended measure	Expected saving (%)
FAS	Change of electricity fee	0
	Gas Price monitoring	0
	Construction of an efficient heating system in old buildings	>5
	Technical evaluation of refrigeration system in old buildings	>1
	Technical evaluation of enveloping in old buildings	>1
FVS	Manual control of demand during peak hours	0
	Protocol for the efficient performance of laboratories	<5
	Technical evaluation of enveloping in the pharmacology building	2
	Replacement of incandescent lamps	1
FFS	Gas Price monitoring	-
	Construction of an efficient heating system in A building	6
	Replacement of computers	-

4. Conclusions – Calculated values for EPI were relatively low compared to those exhibited by other institutions. It could be due to the generalized low comfort conditions that are present in most of the buildings belonging to the South Campus. So the impact of the envelopes on the total consumption of energy deserves to be investigated in a next effort. Most of the measures proposed to reach a better energy performance do not require investment and they can mean significant potential savings, so we recommend prioritizing this kind of measures and utilizing the derived savings to implement new proposals that demand investment.

5. References

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