STRUCTURING OF AN ENERGY MANAGEMENT SYSTEM FOR REPRESENTATIVE BUILDINGS OF THE BUENOS AIRES UNIVERSITY

EXECUTIVE SUMMARY

PREPARED FOR:

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Executive Summary

This document is the final report of the project called "Structuring of an Energy Management System for Representative Buildings of the Universidad De Buenos Aires" contracted by Fundación Bariloche to WSP, within the framework of the project “Technology Transfer Networks and Mechanisms related to Climate Change in Latin America and the Caribbean”, prepared by the Inter-American Development Bank (IDB), which has financing from the Global Environment Facility (GEF).

This report summarizes the main results of the activities carried out from May to December 2019 in four representative buildings of the Universidad de Buenos Aires (UBA), which correspond to the School of Economic Sciences, the School of Law and the branches of the School of Engineering, Paseo Colón and Las Heras. In addition to the direction from Fundación Bariloche, this consultancy had the technical support of the Undersecretariat of Renewable Energies and Energy Efficiency (SSERyEE in Spanish) of the Presidency of Argentina.

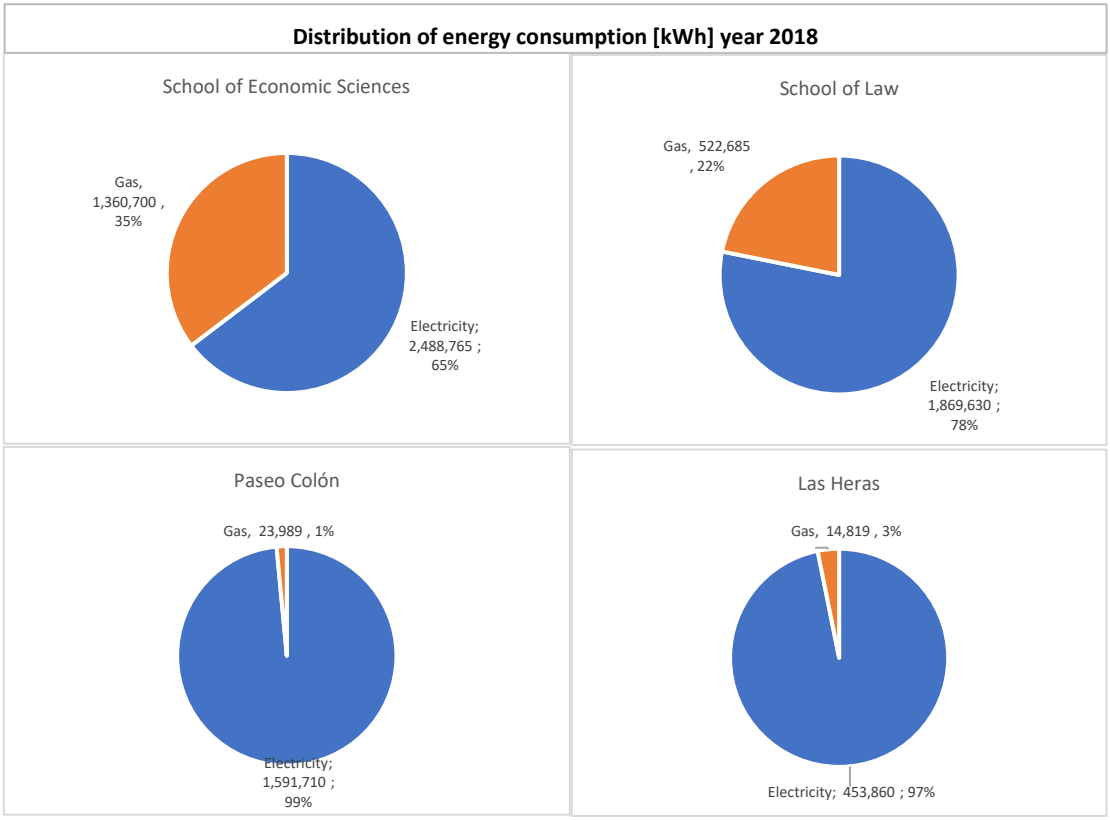
From the point of view of the energy context, it was established that the UBA, in line with Decree 140/2007 of the National Executive Power (PEN), which instructs the creation of the National Program for the Rational and Efficient Use of Energy (PRONUREE), created through its RES 141/17, the UBA's Efficient Management of Energy Resources Program (PROGEREN).

Under the consultancy, WSP developed the “Best Practices Guide for an Efficient Energy Use at the Universidad de Buenos Aires”, aimed at students, teachers, non-teaching staff, energy managers and assistants. The document was prepared based on the four representative buildings studied but can be applied to any facility of a similar nature.

Illustration 1: Cover and content of the Best Practices Guide for an Efficient Energy Use at the Universidad de Buenos Aires.

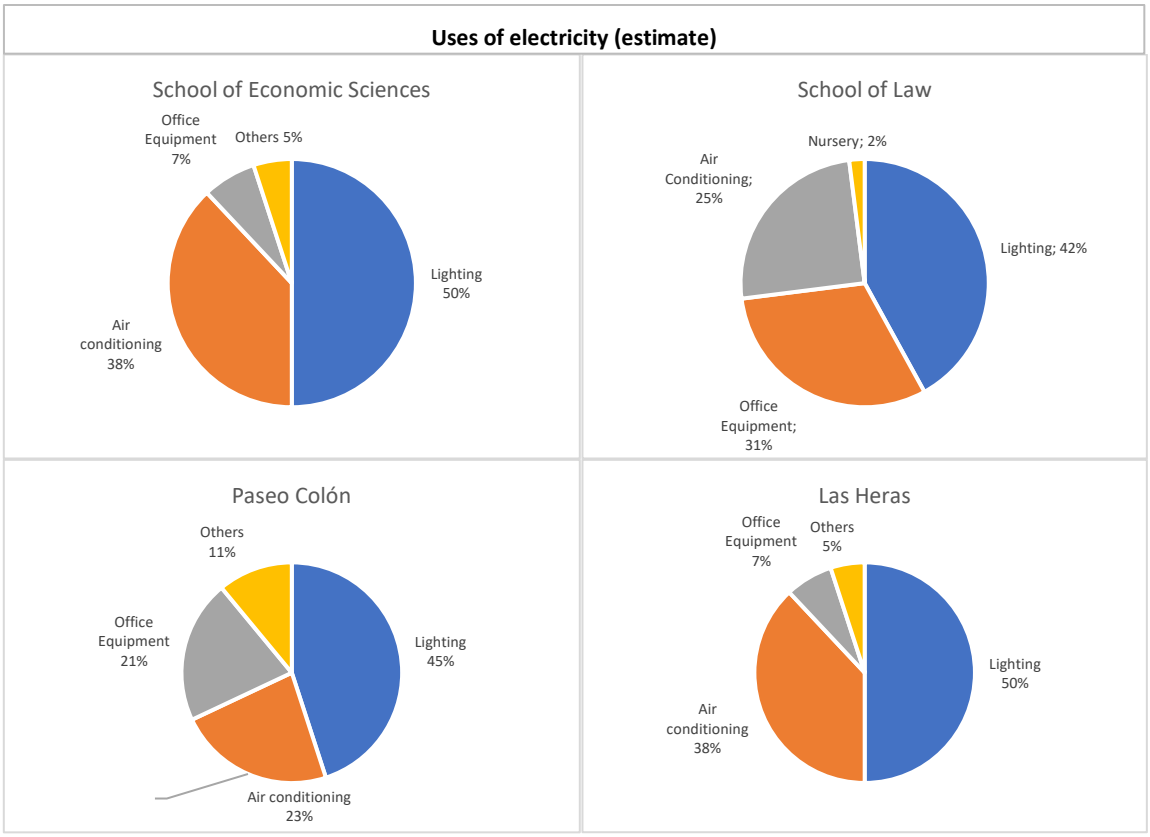
The Universidad de Buenos Aires supported the energy review in each of the four buildings through the coordination of energy managers and assistants, as well as electricity and natural gas invoicing information, which was provided from the Rectory.

Based on the information received, it was established that for the four buildings studied, the main consumption corresponds to electricity. In the case of natural gas, it has a relevant participation in the School of Economic Sciences and in the School of Law (35% and 22% respectively), while at Paseo Colón and Las Heras branches it was not significant (1% and 3% respectively).



Graph 1: Balance of energy, according to consumption of electricity and natural gas, year 2018. Source: Own elaboration based on UBA invoices

By gathering information in buildings and measuring electricity consumption, it was determined that the significant energy uses (SEUs) in electricity are lighting, air conditioning (hot/cold) and different types of office equipment. Additionally, the significant uses of energy related to the consumption of natural gas were established, which correspond to the heating of the water for a heated pool and showers in the School of Law and to the central hot water heating system of the School of Economic Sciences.



Graph 1: Distribution of uses of electricity. Source: Own elaboration based on electrical measurements on general electrical panels of representative UBA buildings

In all the circuits analyzed, there is a significant base load, during the night and early morning hours where there is no activity in the buildings. This phenomenon also repeats itself on Sunday and holidays. These consumptions correspond mainly to lighting that remains on and other devices such as refrigerators, hot/cold water dispensers, computers and printers that do not switch off due to their low individual energy consumption.

As a result of the energy review, the following opportunities to improve energy performance were identified:

- Replacement of fluorescent tubes with LED tubes.
- Replacement of existing equipment with high efficiency units.
- Decrease consumption during hours of inactivity (night, Sunday and holidays).
- Reduce base load of electricity consumption at night, Sundays and holidays.
- Install thermostatic valves on radiators (only in the School of Economic Sciences).
- Replacement of hot water tank (only in the School of Law).

In addition, it is proposed to install a system for measuring and recording electricity consumption that allows monitoring the energy performance of each building.

The potential for reducing energy consumption was estimated at 2.54 GWh per year, which corresponds to 31% of aggregate energy consumption of the four buildings. If this reduction in energy consumption materializes, greenhouse gases equivalent to 1,218 tons of carbon dioxide would no longer be emitted.

The estimated investment amount is 651,883 US dollars. With this, energy cost savings of 341,447 US dollars per year could be obtained, achieving the first investment returns of 4 to 5 months with the change to LED lighting, and in a period of 4 to 6 years compared to air conditioners. Table 1 shows the summary of the required investment.

Table 1: Summary of investment required for improvement measures (USD)

Building	Lighting	Air conditioning	Base load	Thermostatic Valves	Boiler	Measurement system	Total
Law	3,496	154,880	-	-	6,200	10,000	174,576
Economic Sciences	9,471	277,760	-	4,000	-	10,000	301,231
Paseo Colón	4,430	120,600	-	-	-	10,000	135,030
Las Heras	2,046	29,000	-	-	-	10,000	41,046
Total	19,443	582,240	-	4,000	6,200	40,000	651,883

In order to compare the energy performance of the four buildings, the methodology of the STARS Program of the Association for the Advancement of Sustainability in Higher Education (AASHE)[1] was used.

As a result of the benchmarking, it was obtained that the Energy Performance Indicator (ENPI) of the School of Economic Sciences is above 389 [Btu/m^2/°C], which is the maximum recommended by the STARS methodology, while the remaining three buildings have significantly lower values. The result of the energy performance indicator for benchmarking is shown in Table 2.

Table 2: ENPI calculation for benchmarking

Building	Total energy [MMBtu]	CDD [°C]	HDD [°C]	Area [m^2]	ENPI [Btu/m^2/°C]
School of Law	16,137	971	820	66,490	135.5
School of Engineering, Paseo Colón campus	12,227	971	820	45,678	149.5
School of Economic Sciences	23,756	971	820	32,890	403.3
School of Engineering, Las Heras campus	3,537	971	820	15,071	131.0

As appreciated by the WSP team, these differences lie mainly in the thermal comfort levels of the users of the buildings, given that the School of Economic Sciences has proportionally more air-conditioned spaces (air conditioning and heating), compared to the other buildings[2]. This point should be of special attention, since comfort improvements may be associated with the installation of new air conditioning equipment (hot/cold), which will necessarily mean an increase in the energy consumption of buildings.

[1] https://stars.aashe.org/

[2] During the period studied, only the School of Economic Sciences has a centralized heating system in operation, with the use of natural gas boilers.

In order to quantify the energy performance improvements in each of the buildings, it is proposed to implement ENPIs such as "Measured Energy Value" and "Ratio of Measured Values"[3], that consider the energy consumption, the built area (in square meters) and the outdoor daily ambient temperature, expressed as Heating Degree Day (HDD) and Cooling Degree Day (CDD)[4].

The creation of indicators incorporating the equivalence at the primary energy level is also proposed, multiplying electricity consumption by the factor 2.25[5], before adding it with the gas energy. The total sum is called "equivalent energy".

In this way, the following ENPIs indicated in Table 3 are proposed.

Table 3: Energy performance indicators

No.	Description	Indicator type	Calculation
ENPI 1	Total energy divided by area	Measured energy value	$\frac{Electricity\ [kWh] + Gas\ [kWh]}{Area\ [m^2]}$
ENPI 2	Equivalent energy divided by area	Measured energy value	$\frac{Electricity\ [kWh] * 2{,}25 + Gas\ [kWh]}{Area\ [m^2]}$
ENPI 3	Total energy divided by area and degree days	Ratio of measured values	$\frac{Electricity\ [kWh] + Gas\ [kWh]}{Area\ [m^2] * (CDD + HDD)[°C]}$
ENPI 4	Equivalent energy divided by area and degree days	Ratio of measured values	$\frac{Electricity\ [kWh] * 2{,}25 + Gas\ [kWh]}{Area\ [m^2] * (CDD + HDD)[°C]}$

When reviewing the energy performance of the four buildings during 2018 compared to 2017 (baseline), it was seen that most of the ENPIs present downward values.

Table 4 presents the results of ENPI 4.

Table 4: ENPI 4 result. Energy consumption per square meter and total degree days

Building	ENPI 4 (Wheq/m²/Degree Days)		% variation
	2017	2018	
Law	1,638	1,342	-18.0%
Economic Sciences	2,155	1,920	-10.9%
Paseo Colón	712	605	-15.0%

[3] According to ISO 50006:2014 *Energy management systems -- Measuring energy performance using energy baselines (ENPI) and energy performance indicators (ENPI) -- General principles and guidance*

[4] Due to the low correlation with independent variables, it was not possible to establish statistical indicators.

[5] The value of 2.25 according to AASHE methodology is to bring electricity consumption to primary energy. This value responds to average parameters applied by the methodology for Universities in Latin America. This factor was validated with the Undersecretariat of Renewable Energies and Energy Efficiency (SSERyEE).

Las Heras	605	537	-11.3%
Total	5,110	4,404	-13.8%

As part of the consultancy, an UBA Energy Policy was proposed, whose objectives and goals are aligned with ISO50001: 2018, which were worked with the representatives of the faculties.

UBA
Universidad de Buenos Aires

UBA Energy Policy

Throughout its history, the Universidad de Buenos Aires has been established and consolidated as an academic center for the training of professionals and a scientific space for the circulation and production of knowledge, cultural development and extension in the community. It is a leading institution, not only in the university field but in that of the entire community, whose purpose is to develop a correct policy for the growth, treatment and transfer of information to achieve access to knowledge with quality and equity to all the university community.

As a public entity for the training of professionals, it has created the Efficient Management of Energy Resources Program (PROGEREN), whose mission is to generate a framework for the sustainable use of energy resources - in the short, medium and long term - and to articulate general policies regarding the rational use of energy resources.

This energy policy requires the participation of the entire university community to achieve adequate energy performance and for this it has implemented an Energy Management System committing to:

- **Efficiently manage the resources and energy consumption of its schools.**
- **Comply with the legal requirements that apply from its autonomy and other requirements to which it subscribes regarding the use and consumption of energy, as well as energy efficiency.**
- **Implement the acquisition of energy efficient equipment and services and the design of solutions for better energy performance of activities and facilities. For this, it has prepared its Best Practices Guide for an Efficient Energy Use.**
- **Incorporate the use of energy from clean sources.**
- **Inform and disseminate to the university community about the actions and objectives on improving energy performance.**
- **Adhere to actions that seek to reduce climate change.**

To achieve the established commitments, the UBA ensures the availability of energy information, allocating the necessary resources to periodically achieve and verify energy goals and targets, establishing and promoting actions that promote a culture of responsible use of energy.

Rector's Signature (include first and last name)

City of Buenos Aires, XXXXXX, XX, 2019.

Illustration 2: UBA Energy Policy Proposal

In accordance with the definitions of ISO 50001: 2018, *the targets are a result to be achieved and are established by the organization in a manner consistent with the energy policy to achieve specific results*. Furthermore, *an energy goal is a measurable target of energy performance* and may be included in a goal. Table 5 presents the proposed targets and goals.

Table 5: Energy goals and targets

Energy Policy Guideline	Energy targets	Energy goals	Responsible
This energy policy requires the participation of the entire university community to achieve adequate energy performance.	Improve the energy performance of its buildings	Decrease Energy Performance Indicators by 31% by 2023, in the 4 representative buildings *.	- Rector's Office: Assign the necessary financial resources for the activities described in the action plans of each school. - Deans of Schools: Assign funds and responsibilities to the corresponding directorates for the implementation of the Plan. - Energy Managers: manage the necessary purchases or activities and control the correct implementation. - Assistants from each School: support with the implementation of the improvement activities established in the plan.
	Incorporate the university community in the efficient use of energy and apply the established energy management operational measures.		- Energy Managers: Lead awareness campaigns on the efficient use of energy. - Maintenance and Services Personnel: Comply with the operational parameters of efficient use of energy. - Teachers and Students: Collaborate with the efficient use of energy in classrooms.
Implement the acquisition of energy efficient equipment and services and the design of solutions for better energy performance of activities and facilities.	Establish and apply energy efficiency criteria in the acquisition of equipment and contracting of services related to significant uses of energy.		- Ministry of Finance and Administration: Communicate the energy efficiency criteria and verify their application in the purchasing and contracting processes.

In order for energy targets and goals to be achieved, it is necessary for the schools to design and implement action plans to carry out in each building. Table 6 presents a proposal for action plans for the respective schools, where a four-year implementation horizon of the plan (2020-2023) is considered.

Table 6: Action Plan to implement in each building

Target	Goal	Activities	Responsible	Deadline for achieving the target
Improve the energy performance of its representative buildings.	Reduce total energy consumption by 31% by 2023.	Replacement of fluorescent lights in classrooms and hallways with LED technology equipment.	- Energy Manager: make purchase requests incorporating the applicable energy efficiency criteria. Coordinate implementation with maintenance and service personnel. Verify implementation and track energy consumption and savings - Maintenance and services staff: comply with the implementation plan and supervise third-party works if applicable.	2021
		Execute replacement plan of the air conditioning equipment with Inverter technology equipment with efficiency A or higher.		2023
		Replace the hot water tank for heating pool water and showers with a condensing boiler [School of Law only].		2023 or when necessary
		Install thermostatic valves on heating radiators [School of Economic Sciences only].		2021
		Monitoring of electricity consumption at night to determine base load reduction.	Energy Manager: manage the electricity consumption measurement service of at least one week in general panel circuits and compare with previous measurements to verify reduction.	2020
Incorporate the university community in the efficient use of energy.		Carry out awareness campaigns to all users of the school in the efficient use of energy.	- Energy Manager: Lead awareness campaigns on the efficient use of energy, coordinating support with the SSERyEE, the FIUBA Energy Department and other organizations	2020
		Conduct training workshops for janitorial, maintenance and cleaning personnel to raise awareness of operational energy management measures, established in PROGEREN and in the UBA's Best Practices Guide for an Efficient Energy Use.	- Energy Manager: Lead awareness campaigns - Maintenance and service personnel: Participate in training and comply with the operational controls defined for the efficient management of the building.	2020
Establish energy efficiency criteria in the acquisition of equipment and contracting of services related to significant uses of energy.		Application and awareness of energy efficiency criteria in the acquisition of equipment and contracting of services related to significant uses of energy.	- Energy Manager: incorporate the criteria in requests for acquisitions and services - Purchasing Department: verify compliance with the criteria in the offers or quotes.	2020

To complement the points of the PROGEREN Action Plan, additional measures were proposed to improve energy performance, among which are:

- Missing or damaged luminaires must be replaced with LED technology.
- A minimum illuminance standard of 300 lux is defined in classrooms, auditoriums and offices, 500 lux in laboratories and 150 lux in corridors.
- In air conditioner purchases, quote equipment with label A or higher, with and without Inverter technology, to technically and economically evaluate both options.
- Include the concept of energy efficiency within the evaluation of purchases of goods and services that affect energy consumption. Communicate this criterion to suppliers.
- A bid eligibility criterion may be incorporated, requesting bidders to declare the actions of efficient use of energy or use of efficient technologies or sustainable practices.
- The UnderSecretaries of Habitat, together with the Energy Managers and other areas related to new projects, should review current and future energy demands.
- Review annually the contracted power and the maximum demand of each one of the existing junction boxes or meters.
- In the case of new projects that require increasing energy use and consumption, the circuit or junction that has the capacity to supply said demand must be identified. In the event that the electrical installation needs to be modified, the current electrical regulations must be respected, ensuring the safety of people and the UBA infrastructure. Likewise, the considerations indicated in the Best Practices Guide for an Efficient Energy Use must be taken into account.

Based on the information collected and the analyzes carried out, the WSP consulting team recommends the following:

- Evaluate the improvement of the energy performance of each building systematically using the proposed ENPIs.
- Disseminate to the university community the actions to improve energy performance and how the community contributes to its achievement, especially with the good use of energy in rooms and offices.
- Install electricity measurement equipment in main circuits in order to have online measurements and perform proper energy management.
- Implement an UBA revolving fund for Energy Efficiency that is an incentive to execute improvement measures and promote energy savings. In this way, the reduction achieved in energy costs can be reassigned to the academic units that generate it to continue investing in energy efficiency measures.
- Follow up on initiatives that may arise through the IDB or the Undersecretary for Renewable Energy and Energy Efficiency.

Lastly, it should be noted that the UBA, as an academic center for the training of professionals and a scientific space for the circulation and production of knowledge, cultural development and extension to the community, has the potential to be a benchmark in energy efficiency. Therefore, it is recommended to replicate this energy study and expand the action plan to the other schools.