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The Energy Efficiency Plan of the University of a Coruña: a Commitment to Photovoltaic Solar Energy in The Face of The Challenge of Renewable Energies

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Abstract. Since 2020, the University of a Coruña (UDC) has been developing an Energy Efficiency Plan that is already yielding its first beneficial results. An ambitious plan to renovate the building envelopes to make them thermally efficient, together with a determined policy of centralization in district heating and a commitment to photovoltaic solar energy on the roofs, constitute the essence of this Energy Efficiency Plan. The renewal of aerothermal heat pump systems, at the limit of their useful life, and the replacement of diesel boilers with aerothermal or gas boilers, which are more efficient and require less maintenance, is another major challenge. The climatic peculiarity of our area, a temperate oceanic climate with cool summers, allows the use of free cooling throughout the year with high performance. The widespread changeover of lighting to LED technology has been a determining factor in energy savings. We raise two fundamental questions to be determined for the proposed model plan: what indicators can we establish as efficient performance and what capacity does the model plan have to maintain its efficiency in another location.

Keyword:
Energy Efficiency Plan, Renewable Energies, Sustainable Building Envelopes, Photovoltaic Solar Energy

1. Introduction

The purpose of this article is to inform about the Energy Efficiency Plan of the University of a Coruña, within the framework of Spanish Universities. The CRUE, Conference of Rectors of Spanish Universities, a meeting place for all Spanish universities, public and private, develops an important promotion of networking in activities of common interest through its various sectorial. In the CRUE-Sustainability sector, there is a solid agreement on the

measures necessary for the implementation and development of sustainable and healthy campuses. Already in October 2018, a Conference on "The role of universities in the Ecological Transition within the framework of the 2030 Agenda" is organized. (1)

Three issues are de focus of the energy debate:

- Percentage of energy consumed from renewables.
- Self-consumption
- Reduction of energy demand

The relative importance of these three issues is perhaps the relevant question to answer.

The economic consequences of the war are shaking the European Union violently and energy is its main exponent. Between December 2020 and December 2021, the import price for energy* in the euro area more than doubled (115%), according to data published by the European Statistical Office (Eurostat), as shown in Figure 1. The recent development is unprecedented. (2)

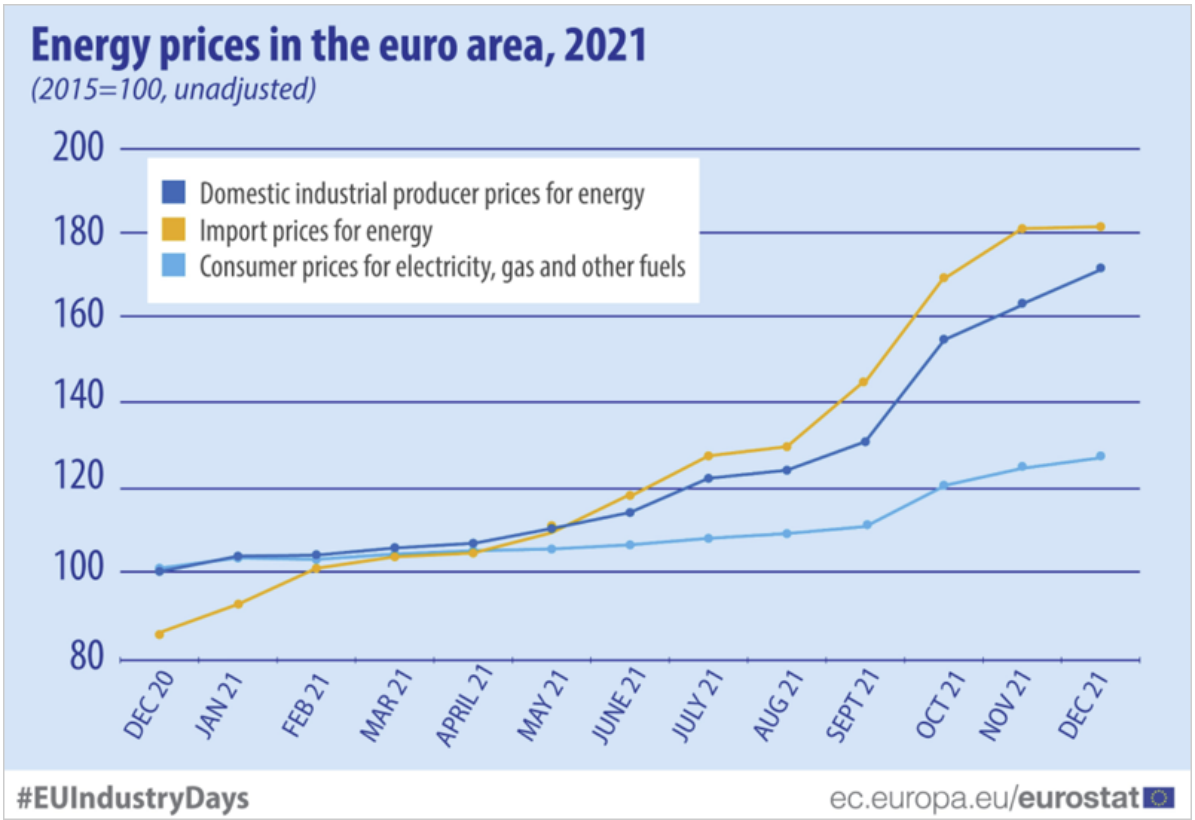

Figure 1. Increase in energy prices throughout 2021. Figure by Eurostat.
* Energy import prices exclude water supply, sewerage, waste management.

In this context, we present the Energy Efficiency Plan of the University of A Coruña as a convinced commitment to demand reduction, firstly, and secondly, to photovoltaic energy generation at the point of consumption. Environmental awareness in the face of inexorable climate change is the reason for the commitment, not the unprecedented rise in energy prices, as the article will try to demonstrate.

2. Reduction of energy demand

Improving the efficiency of the energy envelopes of buildings is the first challenge toñ

obtain the desired reduction in energy demand. This is a transcendental condition in our buildings, whose average age is 30 years. Spanish building regulations in those years allowed low thermal insulation standards, very simple exterior carpentry and, in general, a very elementary construction quality.

The reduction of energy demand of air conditioning and sanitary hot water equipment will be another aspect of our work in two ways: the renewal of aerothermal heat pump systems, at the limit of their useful life, and the replacement of diesel boilers with aerothermal or gas boilers, which are more efficient and require less maintenance.

The widespread switch to LED lighting in all buildings is undoubtedly a major savings.

2.1. Improving the thermal envelope of buildings

During 2019, the University of A Coruña presents to the Energy Institute of Galicia (INEGA) of the Xunta de Galicia, eight comprehensive energy improvement projects for eight of its centers. This is an initiative proposed by our University to the Autonomous Government to improve, little by little, the envelopes and equipment of its buildings. The initiative was successful and INEGA launched a call for grants for the three public universities of Galicia. (3)

As a result, of competitive bidding among the three universities, we obtained financing for six of the eight proposed buildings. The European Regional Development Funds (ERDF) financed 80% of the total investment, 2.75 million euros. It was a great economic and technical effort for us, but the result is very satisfactory. Of course, in terms of energy savings, the results are very beneficial, but we must also highlight the improvement in the quality of life of the university community and the exemplary factor of these measures taken by the public sector for its own buildings.

The table in Figure 2 shows the importance of the measures related to the design of passive strategies applied in the different buildings that received aid: reduction of the form factor, high thermal insulation, thermal bridge free design, high performance windows.

STANDARD PASSIVHAUS	ETSAC	Pavillón	Normal	Reitoría	EPS	Humanidades
Bioclimatic Design - Form Factor						
High Thermal Insulation						
Thermal Bridge Free Design						
High Performance Windows						
Mechanical Ventilation with Heat Recovery						
Air Tightness						
External Sun Protection						
Efficient Hot Water Systems						
Efficient Electrical Equipment and Lighting						
Efficient Heating/Cooling System						
Renewable Energy Generation						
Sustainable Drainage System						
District Heating						

Figure 2. Energy strategies applied in the works funded for thermal renewable energy projects and integral energy saving and efficiency projects for the Public Universities of Galicia. INEGA - ERDF. Figure by the authors.

The measures taken in all six buildings together provide the following data: 3.6 Gigawatts hour of annual energy savings and a reduction of 706 tons of CO2 emitted per year.

2.2. Renovation and replacement of thermal and lighting systems

The table in Figure 2 also shows the relevance of the improvement and replacement of hot water production equipment and air conditioning systems, heating and cooling, in the works as a whole. Perhaps the most novel contribution in the air conditioning systems is the incorporation of free cooling generalized because of the climatic peculiarity of our area, a temperate oceanic climate with cool summers. The use of free cooling throughout the year results high performance.

Figure 3 shows images and investments of the six buildings that have benefited from INEGA's aid program. This is the most important investment made at the University of A Coruña in the last decade.

ETSAC	453.975,06 €	Pavillón universitario	696.828,46 €	Edificio A Normal	368.025,59 €
Axudas	363.180,05 €		557.462,77 €		294.420,47 €

Fondo Europeo de Desarrollo Regional. Programa Feder-Galicia 2014-2020

Reitoría	517.870,60 €	EPS	428.466,48 €	Humanidades	285.423,38 €
Axudas	414.296,49 €		342.773,19 €		228.338,70 €

Figure 3. Buildings and amounts invested. INEGA - ERDF funds. Figure by the authors.

3. Self-Consumption

These works already include the generation of photovoltaic energy on two roofs, the Elviña Sports Pavilion and the "Normal: Space for Cultural Intervention" building. During 2020, we also install, with our own resources, a photovoltaic system in the Technological Workshops of Ferrol.

The commitment to the self-consumption of electricity generated by photovoltaic solar panels is maturing, its implementation is mandatory for all the works of integral rehabilitation of our buildings and, of course, for new construction. We recently completed the refurbishment of the Battalion Building in Ferrol, on loan from the Ministry of Defence, with the fourth photovoltaic installation.

On November 9, 2021, INEGA publishes the call for aid corresponding to programs linked to Self-Consumption and Storage for Public Administrations within the framework of the Recovery, Transformation and Resilience Plan-funded by the European Union -

NextGenerationEU. (4)

We submitted and obtained a grant in this call for twelve photovoltaic solar energy production facilities for self-consumption without storage on twelve roofs of our buildings. These works are currently in the bidding process. The investment amounts to one million euros, 80% of which again covered by the European Funds.

Figure 4 shows some of the work performed: improvement of building envelopes, generalized changeover to LED lighting, improvement of indoor air quality systems and renewable energy installations.

At the same time, projects for the centralization of heat production, specifically district heating, are in progress, as are those for the rationalization of our medium-voltage transformation centers into low-voltage transformers, in order to optimize photovoltaic energy production.

By the end of this year, we will have 16 photovoltaic installations, with an annual production capacity of 2.75-megawatt hours, equivalent to the consumption of 350 homes, and we will reduce the emission of half a ton of CO2.

4. Concluding Remarks

Another indispensable tool for energy control is the remote management of all data on a single platform. Energy consumption meters, generation of photovoltaic installations, temperature, relative air humidity, air quality: CO2 and suspended particles, radon concentration... unifying all these data has been a great difficulty to dump them in the same digital environment.

This introduces the question of indicators. We believe that it is clear that the indicator for the percentage of renewable energy consumption as a percentage of total energy must reach 100%. It will be necessary to specify, instead, what part of it comes from self-consumption.

The second question raised is the universal validity of the efficiency plan model proposed here. We cannot ignore a determining factor such as the existence of sources of financing external to the university itself. In our case, we have the support of the Galician Energy Institute with which we work closely, but we finally obtain the grants in competitive calls.

We believe that the prevalence of the measure to improve the thermal envelopes of buildings is indisputable. In terms of investment per kWh of energy saved, the results are conclusive, although the high amounts of these investments do not make them assumable with our own resources, at least for us.

Regarding the relevance of the improvement and replacement of air conditioning and domestic hot water systems, there are other types of limitations for their application of a technical nature, climatic conditions, existence of water, even topography, which may or may not validate the proposals.

In this context, we are proposing the use of water-to-water heat pumps with high thermal stability, in addition to photovoltaic solar energy, because of the abundance of surface and subsurface water we have. This reality, together with the possibility of widespread year-round use of free cooling, are local, probably not universal, opportunities.

The Ministry of Defense ceded the premises occupied by the former A Coruña Weapons Factory to the UDC to promote the ICT City, an urban strategy for the creation of an ICT hub for digital innovation of national and international reference. The implementation of the plan from its beginning on this future campus will provide us with new perspectives.

As a final note, on May 25, 2022, the Plan of Energy Saving and Efficiency Measures for the General State Administration and the Entities of the State Institutional Public Sector was approved. (5) From that moment on, all universities began to draw up their plans; UDC published on November 3, 2022 the Energy Saving and Environmental Impact Reduction Plan. (6)

This document covers the Energy Efficiency Plan described in this text, born as a technical and systematic response to coordinate action against the effects of climate change, with the main objective of avoiding or reducing present and future damage and building a fairer economy and society.

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