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The Spanish Carbon Footprint Calculation and Registration System: The Miguel Hernández of Elche University Case

A. J. Guerrero Lucendo[* a], F. García-Orenes[a], J. J. Ruiz Martínez[b] P. G. Vicente Quiles[b]

a. Environmental Office, Miguel Hernández of Elche University, Spain.

b. Vicerectorate for Infrastructure, Miguel Hernández of Elche University, Spain.

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Abstract: Universities can be considered small communities themselves, providing access to data at the community scale, as well as contributing to global sustainability through their education, research and the operation of their own estate. In this study it has been reported the greenhouse gases emissions of Miguel Hernandez of Elche University, with a breakdown by the types of scope and sources of emission. This initiative is supported by the Spanish Government that has developed a program called Carbon Footprint Registry (Royal Decree 163/2014) to promote the declaration of the carbon footprint by sectors that are not regulated through the Emissions Trading System in the European Union, such as agriculture, buildings, or waste management. The main objective of the study is to verify the tool proposed by the Government of Spain and analyze the results obtained and its evolution in a higher education institution such as Miguel Hernández of Elche University. The data obtained from the Carbon Footprint per person of an organization allows obtaining an environmental indicator directly correlated with its environmental impact, and can be used as a benchmark for making decisions aimed to reduce greenhouse gases emissions.

Key words: Carbon footprint, Climate change, Greenhouse gases, University, High education

1. Introduction

In 1992 the United Nations Framework Convention on Climate Change (UNFCCC) defined climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (UNFCCC, 1992).

Corresponding author: A. J. Guerrero Lucendo, Environmental Office, Miguel Hernández of Elche University, Spain.

Afterwards, in 2014, the Intergovernmental Panel on Climate Change (IPCC) concluded that the human influence on the climate system is evident and is growing, with impacts observed across all continents and oceans (IPCC, 2014). According to this Synthesis Report, the observed warming is extremely likely to be the cause, mainly by the anthropogenic greenhouse gases (GHG) effects, along with those other anthropogenic drivers.

The leaders of the European Union adopted in October 2014 the Climate and Energy Framework 2030, which includes binding objectives to achieve a 30% decrease by 2030 compared to the 2005 emissions in sectors that are not regulated by the Emissions Trading System (ETS), which includes the emissions produced by universities.

The carbon footprint of an organization can be defined as the measurement of total GHG emissions caused directly and indirectly due to its activity (Wright, Kemp, & Williams, 2011). An activity can have several sources of GHG, usually classified in three scopes (Fig. 1):

- Scope 1: Direct emissions.
- Scope 2: Indirect emissions for electricity consumption.
- Scope 3: Other indirect emissions.

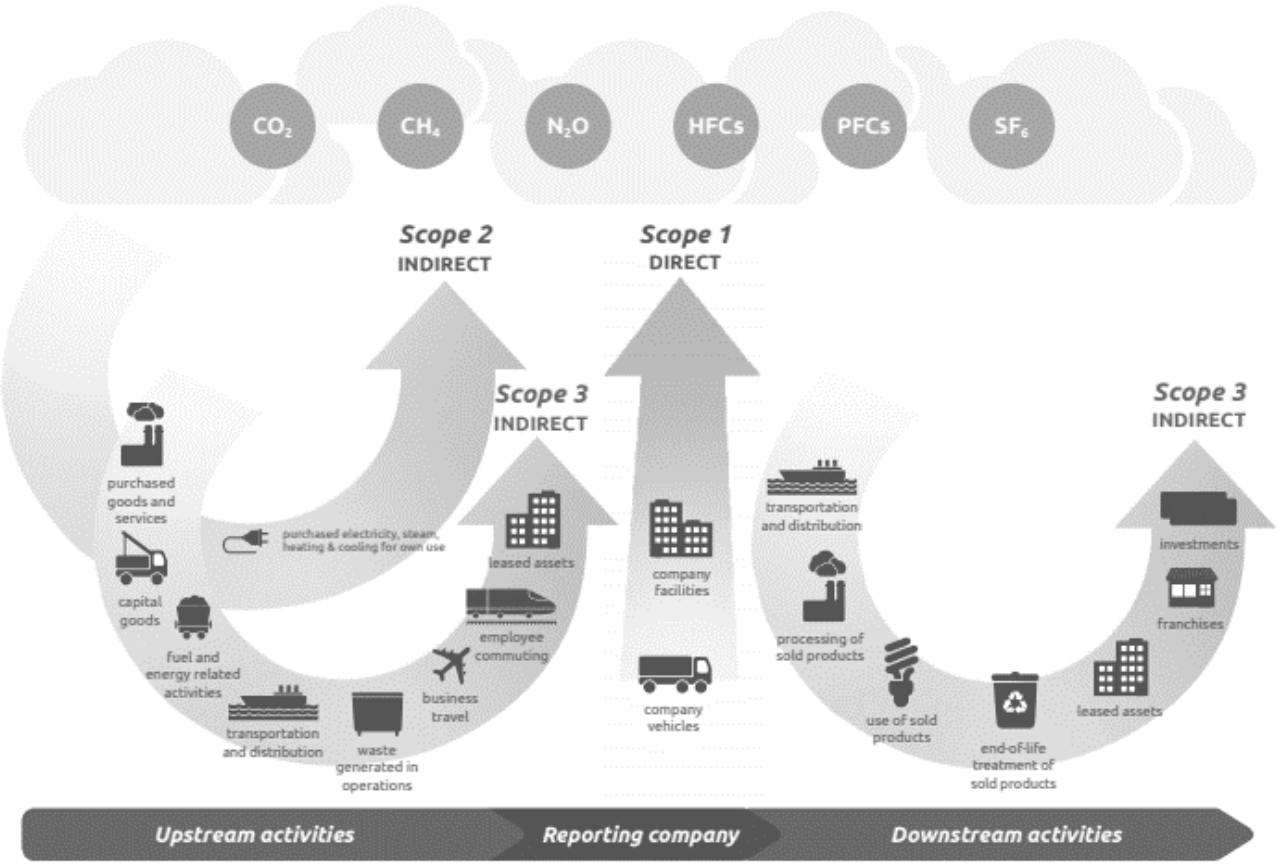

Figure 1. Overview of GHG Protocol scopes and emissions across the value chain (WRI/WBCSD, 2011)

The carbon footprint is expressed as the amount of CO_2 equivalent (CO_2e), a universal unit of measurement that indicates the global warming potential (GWP) of each one of the different GHG (CO_2, CH_4, N_2O, HFCs, etc.).

In this sense, some public Spanish organizations such as universities have been calculating their GHG emissions voluntarily and reporting their Carbon Footprint, like the 2010 carbon footprint of the University of Valencia (Puchades, de la Guardia, & Albertos, 2011), or the University of Castilla-La Mancha (period 2005-2013) (Gómez, Cadarso, & Monsalbe, 2016).

In 2014, the Government of Spain, through its Ministry of Agriculture, Food and Environment, approved the creation of the Spanish Registry of Carbon Footprint, Offsetting and CO_2 Removal (Royal Decree 163/2014). The objective of this Spanish Carbon Footprint Registry (SCFR) is to promote the calculation of the carbon

footprint, and the subsequent reduction of GHG emissions, as well as promoting projects that improve the sump capacity of Spain, and therefore becoming a tool to address the climate change problem.

This public registry, has three different sections:

a) A carbon footprint calculation and GHG reduction commitment section, where organizations that calculate their carbon footprint and establish a reduction plan can be registered.

b) A CO_2 sequestration or absorption projects section, such as agroforestry carbon sink projects.

c) A carbon footprint offsetting or compensation section, where the two previous sections can interact with each other.

This study is focused on the first section, which aims to fight against climate change by promoting the calculation and reduction of the carbon footprint by the Spanish organizations from sectors not covered by the Emissions Trading System (ETS) European Union, such as agriculture, buildings, or waste management (Directive 2003/87/EC). The entities that voluntarily participate have to calculate their carbon footprint and report it. Afterwards the Government, through the Spanish Office of Climate Change, issues a seal certifying their inclusion in the registry and the level of commitment reached (calculation, reduction or offsetting).

These Higher Education institutions, which can be considered small communities that contribute to sustainability through their education, research, and the operation of their own state (Gu, y otros, 2019) are key components of education systems across the globe, transcending international borders, socio-political regimes and economic systems, however they are beginning to address climate issues through carbon reduction policies (Robinson, Tewkesbury, Kemp, & Williams, 2017) and the reporting of their carbon footprint can be considered a first step towards sustainable educational practices (D.Kulkarni, 2019).

2. Materials and Methods

Miguel Hernández of Elche University, a public university located in the southeast of Spain, was chosen for the study. It was founded in 1996 and operates in four different campuses. Its campuses extend over almost 95 hectares, with 75 university buildings and approximately 25,247 students enrolled.

To be included in the SCFR, no specific calculation methodology is required: Any internationally recognized calculation methodology can be used, like UNE-ISO 14064, GHG Protocol, PAS 2050, etc. (Dias & Arroja, 2012; Garcia & Freire, 2014). The GHG Protocol, developed between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), has become the standard for corporate reporting of GHG, adopted by other governments for regulations and corporations for compliance (Green, 2010; Patchell, 2018), hence for this study the GHG Protocol was chosen.

However, the emission factors of fossil fuels (like gasoline, natural gas, propane gas, butane gas, etc.), the global warming potentials of the different gases of the air conditioning systems, and the emission factor associated with each electric power companies (based on the energy sources used) must be provided by the Spanish Government. This data is based on official sources like the National Inventory of Greenhouse Gas Emissions, the Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC) or the National Commission for Markets and Competition (CNMC). In this regard, the Government of Spain published Order ITC / 1522/2007, of May 24, which establishes the regulation of the guarantee of the origin of electricity from renewable energy sources and high efficiency cogeneration (Government of Spain, 2007), which are considered with emission factor equal to zero.

The system required to provide the data from GHG Protocol scopes 1 and 2 as minimun, being scope 3 voluntary. GHG Protocol's scope 1 and 2 have largely succeeded in reporting GHG emissions, nonetheless achieving the scope 3 is a much more complicated and considerably less successful (Patchell, 2018). Therefore, it was decided to measure the carbon footprint associated with scope 1 and scope 2, discarding the scope 3.
To compare the evolution of Miguel Hernández of Elche University emissions, it was established as reference the year 2011, and the 7 years that followed until 2018. During this period consumption data was compiled for each GHG emission source, like natural gas, propane gas, gasoline and gases of the air conditioning system. Also the electricity consumption data was compiled for scope 2.

Using the freeware calculation tool provided by the Government and their emissions factors, the carbon footprint of Miguel Hernández of Elche University was calculated for each year, and the results reported to the Spanish Office of Climate Change.

In addition, the system requires to set a plan for reducing the GHG emissions that includes actions (the measures that are planned to be applied) by the institutions, as well as objectives (a quantitative estimate of the reductions that these will imply). However, compliance with the plan is not mandatory, failure to achieve the objectives has no consequences as regards registration in the Registry. If the organization wishes that the registration seal emitted by the Government reflects a reduction effort, it will be necessary to demonstrate a downward trend in its emissions.

The data obtained were subjected to a correlation analysis using Pearson’s correlation coefficients. For statistical analyses, SPSS program (Statistical Program for the Social Sciences 23·0;IBM, Armonk, NY, USA) was used.

3. Results and Discussion

During 8 years the GHG emissions have been evaluated and the carbon footprint of each year has been obtained, with a breakdown by the types of scope and sources of emission (Fig. 2). The average absolute carbon footprint of the 8 years has been 7656 tons of CO_2 equivalent per year. The year with the lowest emissions value was 2018, with 5800 tons, and on the other hand, 2015 was the year with the most absolute emissions value, with 9150 tons.

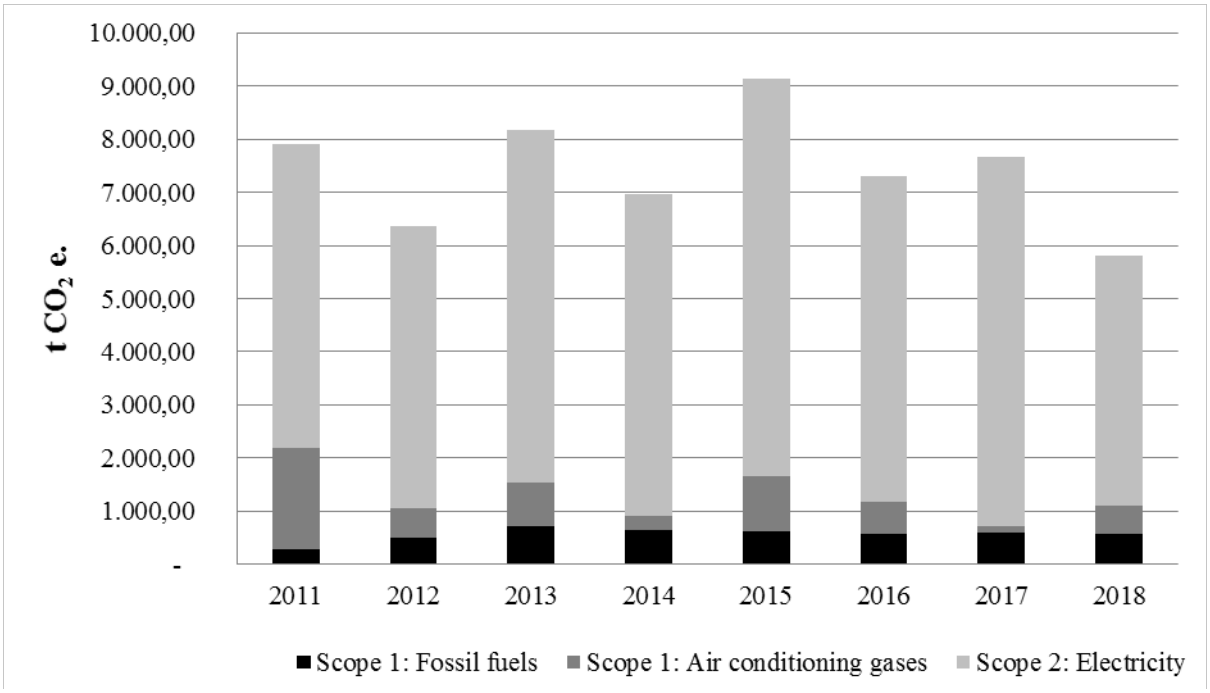

Figure 2. Evolution of the carbon footprint of Miguel Hernández of Elche University by sources of GHG emissions.

In the percentage breakdown of the carbon footprint by type of scope and emission sources (fig. 3), it was obtained that electricity consumption is the main source of GHG, with an average of 82,6% for the period 2011-2018 The data for fossil fuels and gases of air conditioning systems, for the same period, were 7,6% and 9,8% respectively.

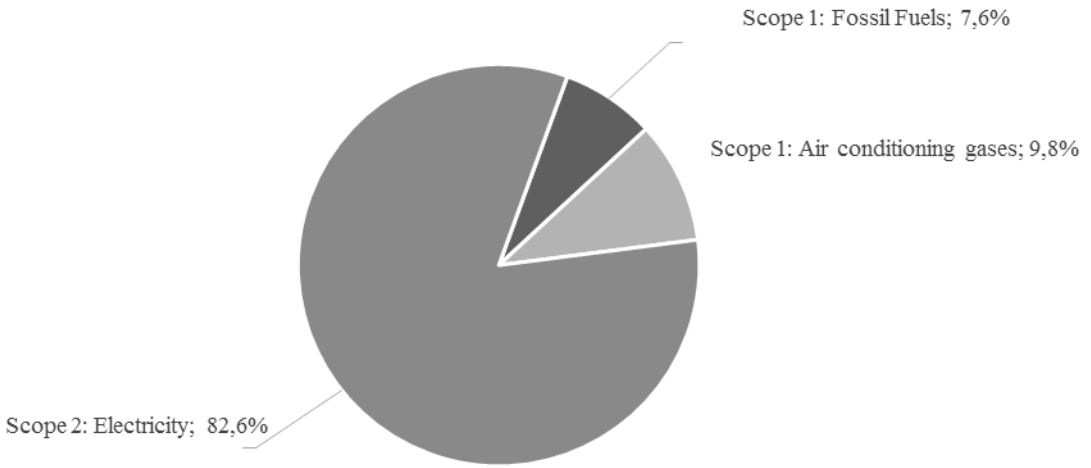

Figure 3. Percentages of the average carbon footprint of Miguel Hernández of Elche University by sources of GHG emissions for 2011-2018 period.

Due to the values obtained from carbon footprint by air conditioning gases, a strict control of the operating protocols of the air conditioning systems was implemented at the University to prevent the escape of gases into the atmosphere, going from an average of 12,1% for the first four years (2011-2014 period), to a 7,6% for the last four years (2015-2018 period).

It has been built an indicator, taking into account the university population (students, administration staff, professors and researchers), that shows the account of emissions per person. The average value obtained was 0,52 tons of CO2e per year per person. As the number of people in the university community remained fairly constant during the study, the years with the lowest and highest relative carbon footprint value are the same as with the absolute values: 2018 being the year with the lowest emissions (0,40 tCO_2e), and 2015 the year with the highest value (0,60 tCO_2e) (fig. 4).

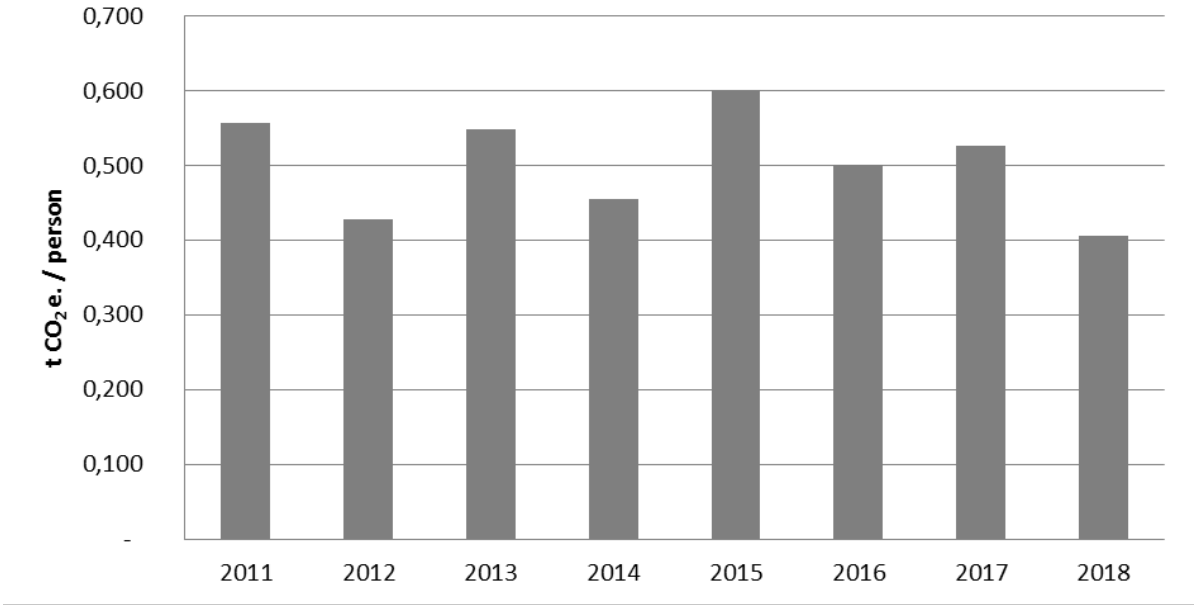

Figure 4. Relative values of carbon footprint per year and person

We can observe that the GHG emissions data from the electricity consumption are not correlated with the amounts of electricity consumed. It is correlated with the emission factor associated with the source of that electricity, which is different depending on the supplier company (table 1).

Table 1. Pearson Correlations between different parameters measured.

		Electricity consumption	Emission Factor	Carbon Footprint
Electricity consumption	Pearson correlation	1	-,062	,340
	Sig. (bilateral)		,773	,104
	N	24	24	24
Emission Factor	Pearson correlation	-,062	1	,**916****
	Sig. (bilateral)	,773		,000
	N	24	24	24
Carbon Footprint	Pearson correlation	,340	,**916****	1
	Sig. (bilateral)	,104	,000	
	N	24	24	24

**. The correlation is significant at the 0,01 level (bilateral).

For example, in 2017 the electricity consumption was reduced by 5,7%, but due to an increase in the emission factor of the energy consumed (kg CO_2 / kWh), the CO_2 equivalent emissions were increased by 13,9% (fig. 5).

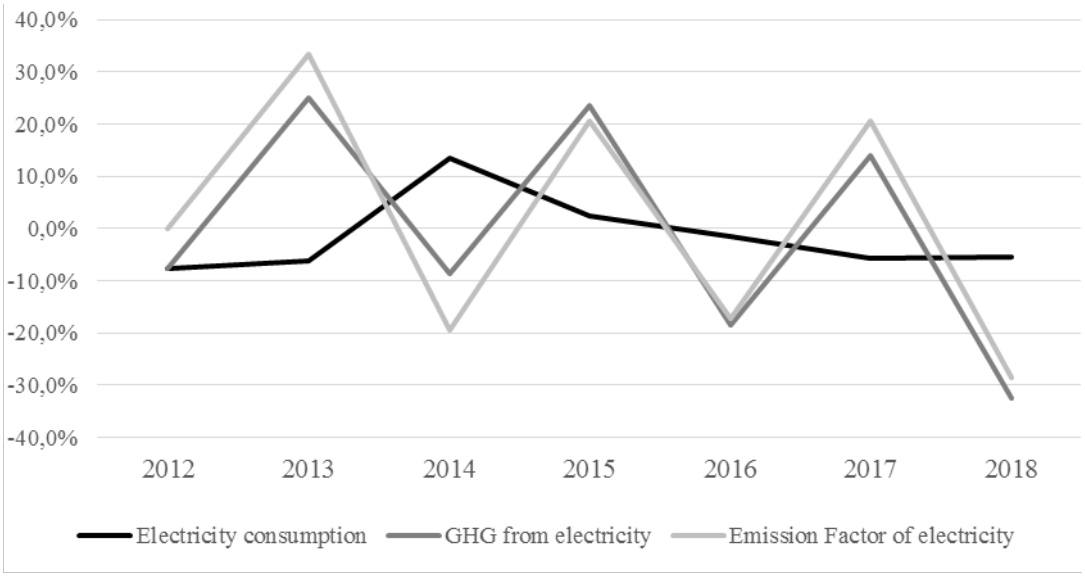

Figure 5. Variation with respect to the previous year of GHG emissions from electricity consumption, electricity consumption and the associated emission factor.

In 2015, the Miguel Hernández of Elche University was the first university to register in the SCFR its carbon footprint due to activities carried out in all its campuses during year 2013. The registry of the University carbon footprint for each year, has permitted to obtain the corresponding certificates and seals, showing the year of calculation and the level reached. For example, in figure 6 we can observe two of the seals obtained (for years 2015 and 2016), in which the number “2” indicates the number of scopes analyzed (scope 1 and 2).

Figure 6. Examples of seals granted to Miguel Hernández of Elche University by the Spanish Government in 2015 and 2016 respectively: a) One of the level 1 seals (Calculate) and b) one of the level 2 seals (Calculate and Reduce)

The seals can also represent three different levels of participation for organizations that calculate their carbon footprint:

- Level 1: Calculate
- Level 2: Calculate and Reduce, or, Calculate and Offsetting.
- Level 3: Calculate, Reduce and Offsetting.

In 2016 and in 2018, Miguel Hernández of Elche University obtained the level 2 certificate "Calculate and Reduce" (figure 5.b). But it is important to note that neither in 2012 nor in 2014, despite having reduced the carbon footprint, the level 2 certificate (calculate and reduce) was not obtained. This is due to the fact that the Government of Spain requires a comparison of the average carbon footprint (based on an activity index defined by the organization) of the last three years with respect to the average of the previous three years, so that the reduction is considered significant. For example, to validate the reduction in 2016, the average emission ratio per person for the years 2014, 2015 and 2016 was calculated, and was compared with the average ratio of the years 2013, 2014 and 2015, resulting in a reduction of almost 3% of emissions.

The registration was done without verification by an accredited third party because only scope 1 and 2 were registered, and Miguel Hernández of Elche University is a public administration and no process emissions were generated by the activity. In case of not fulfilling any of these three conditions, verification by an accredited third party would have been necessary.

At the beginning of the study there was no university registered in the SRCF. The Miguel Hernandez University was the first one in 2015. As of June 2019, there were 29 carbon footprints registered from 8 different universities (table 2).

Table 2. Universities carbon footprints included in the Spanish Carbon Footprint Registry.

	Scope	First registration date	First year registered.	Number of carbon footprints registered*.
University Miguel Hernández of Elche	Scope 1+2	13/10/2015	2013	5
Technical University of Madrid	Scope 1+2	15/02/2016	2013	4
San Jorge University	Scope 1+2	23/02/2016	2012	6
Technical University of Valencia	Scope 1+2	02/06/2016	2014	4
University of Vigo	Scope 1+2	18/09/2017	2015	1
University of Zaragoza	Scope 1+2	15/12/2017	2016	2
Technical University of Cartagena	Scope 1+2	26/09/2018	2016	4
University of Cantabria	Scope 1+2	02/10/2018	2015	3

** According to the Climate Change Office report published in June 2019*

5. Conclusions

The mayor contribution of carbon footprint in Miguel Hernández of Elche University were the emissions associated with the electrical consumption. But this depends primarily on the type of energy source used and the emission factor associated to them.

It is recommended to obtain the electrical energy from sources with a lower emission factor or even from renewable energies (with emission factor equal to zero), which would imply a decrease of 84% of the Carbon Footprint.

The data obtained from the carbon footprint per person of an organization allows obtaining an environmental indicator directly correlated with its environmental impact. Also it serves as a benchmark for making decisions aimed at reducing GHG emissions.

Including an organization in the SCFR, allows external recognition as an environmentally responsible company.

Carbon footprint can be used as a tool to raise environmental awareness, encouraging customers and staff to collaborate in reducing GHG emissions.

There is an increase in the number of Spanish universities that are calculating their carbon footprints and reporting their results to the Government of Spain for inclusion in the SCFR and creating their greenhouses gases reduction plans.

The creation of the registry will contribute to the reduction at the national level of greenhouse gas emissions, as well as to encourage projects which improve Spain's sink capacity and to facilitate the fulfillment of the international commitments assumed by Spain in the matter of climate change.

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