Carbon Footprint at the National University of Rosario, Argentina: Comparison of 2019 and 2022 Data

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Abstract

*Evaluating the carbon footprint of an institution or company to determine their greenhouse gases (GHG) emissions is important for contributing to the global effort to mitigate climate change. It's even more important for a university, because of its primary role in educating students at the highest educational level. In this paper, we present a comparison of the emissions recorded at the National University of Rosario, Argentina, in the years 2019 and 2022. This university is one of the largest in the country, with a built infrastructure of more than 220,682 square meters and more than 115,000 students, professors, and technical and administrative staff. The comparison is made on emissions due to fixed energy from the use of stationary electricity in buildings (motors, lighting, air conditioning, etc). Since data from the first year of the GHG assessment in 2019 are not available for mobile energy (mainly due to the different vehicles with internal combustion engines), no comparison is made, and no data were collected from other GHG sources or sinks. However, a rough estimate of the contribution of all other emission sources, such as land-use change, agriculture, industry, and waste, shows that they are significantly lower than those considered in the present work. We would like to highlight that part of these undetermined sources is offset by the absorption of carbon dioxide (CO2), the main greenhouse gas, by the large number of trees that exist mainly in the Faculties of Agricultural Sciences, located in Zavalla and Veterinary Sciences, situated in Casilda. The comparison between the data for 2019 and 2022 (the latter in parentheses) yields the following result for greenhouse gas emissions (in TnCO2/year) corresponding to category 2 of the IPCC, the Intergovernmental Panel on Climate Change (due to indirect GHG emissions caused by imported energy to generate electricity and to use natural gas, the latter mainly for air conditioning): 3 610(3 589). This corresponds to a decrease of -0.58 %. Since the number of people (chiefly students) increased from around 107,000 in 2019 to around 115,000 in 2022, annual GHG emissions per capita [in kgCO2/(year*person)] were 33.7 and 31.2, respectively, giving a GHG emission reduction of -8.01%. This corresponds to a significant mean reduction of -2.7 % per year. In the case of IPCC Category 3 (for indirect GHG emissions caused by energy used for transport mainly with cars and buses) the emitted value was 42 TnCO2 in 2022, giving rise to a percentage value of 0.99% for the year 2022, with respect to the total emission. Since it is very small, like the other contributions, even when compared to the uncertainty in the GHG calculation (estimated at 10 to 20%), the greatest effort in reducing emissions will be concentrated on imported energy.*

Keywords: *Carbon footprint, University, Climate change, Carbon dioxide; ISO 14064; GHG*

1. Introduction

The National University of Rosario (UNR), located in Rosario (Argentina) and adjacent locations, together with the National University of La Plata, the National University of Litoral, the National University of the Northwest of the Province of Buenos Aires, the Autonomous University of Madrid (UAM) and the Organic Cooperative Society of Barcelona, have joined forces to work and propose sustainable management strategies for the university system, taking the initiative to reduce their environmental impact, develop a program of sustainable management strategies in universities and carry out concrete actions against climate change. This change in the climate is directly associated with human activity, primarily emissions associated with high levels of consumption of goods and services [1].

As a first step, the group developed an indicator suitable for determining the actual state of greenhouse gas (GHG) emissions at each university, which will serve as a measure of the effectiveness of the implemented mitigation measures.

This indicator is the “institutional carbon footprint”, constructed according to the guidelines of the IPCC (Intergovernmental Panel

on Climate Change) 2006 [2], which has been adopted by the National Directorate of Climate Change of the Ministry of Environment of the Nation (DNCC) and under the ISO 14064 series standards [3].

The carbon footprint is defined as "the total amount of greenhouse gases emitted into the atmosphere, directly or indirectly, by the production or consumption of goods and services by an individual, organization, event or product [4].

The details of the accounting can range from a simple analysis that considers only direct CO2 emissions to more complex approaches that consider lifecycle analyses from the production, use, and final disposal of both the product and its packaging.

A more detailed analysis includes the absorption (uptake) of these gases, as occurs with plants (trees, etc.) due to the process of photosynthesis. It is usually measured in kilograms or tons of greenhouse gas emissions [5]. This study allows the identification of all sources of GHG emissions and based on this knowledge, establish effective reduction measures.

2. Results

The GHG emissions calculated for the National University of Rosario for 2022, show a reduction compared to those presented in the report prepared for the 2019 base year. Thus, for the year 2022, 3,589 TnCO2 [6] were recorded, while for the year 2019, 3,610 TnCO2 [7] were determined, representing a nominal difference of 21 TnCO2, as described in Figure 1.

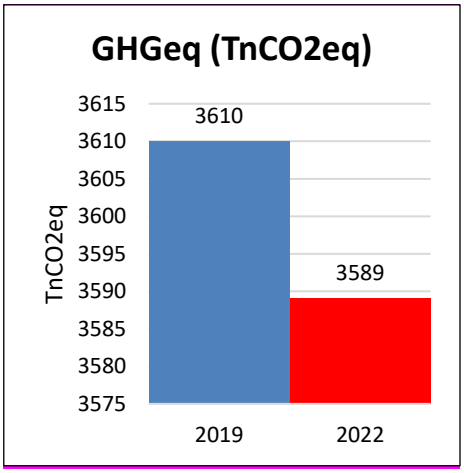

Fig. 1. Comparison of Greenhouse Gases emission calculated for the base years 2019 and 2022 for the National University of Rosario, Rosario, Argentina

This difference represents a small decrease in total emissions of 0.58% in percentage terms, with respect to the 2022 year.

Tab. 1: GHG emissions of the National University of Rosario, Argentina by source (TnCO2eq).

Emission source	Emission 2019 ($TnCO_2eq$)	Emission 2022 ($TnCO_2eq$)	Difference ($TnCO_2eq$)
Electricity	2,900	2,884	-16
Natural Gas	680	663	-17
Mobility (transportation employees)	30	42	+12
Waste	Not available	Not available	--
Total	3,610	3,589	-21

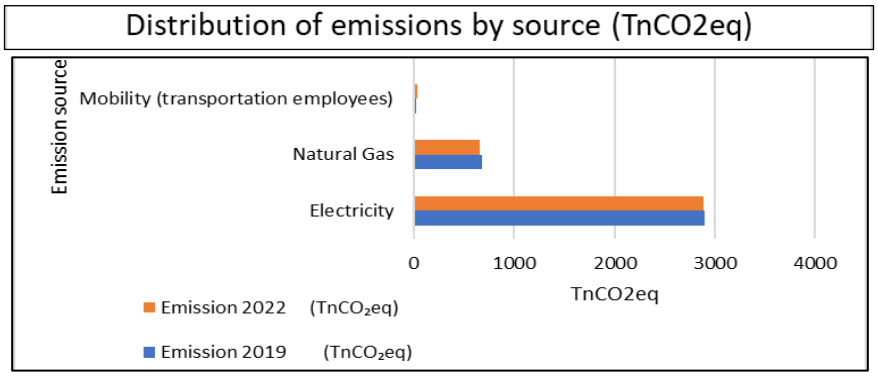

Fig. 2. Distribution of emissions by source (in TnCO2eq). The emission sources of the National University of Rosario are: Mobility; Natural Gas and Electricity for years 2019 and 2022.

From the data presented in Table 1 and displayed in Figure 2, Electricity is the main source of greenhouse gas emissions, according to calculations made in 2019 [8] and 2022 [6,7] for the National University of Rosario. This source exceeds 80% of total emissions in both reports [9]. The value of the electricity emission factor, was obtained by the Red Eléctrica Argentina del ex-Ministerio de Energía, which includes the following energy sources: thermal, hydroelectric and renewables. In both reports the value of 0.3933 TnCO2/MWh was adopted [9,10]. In the case of mobility, an increase in emissions was recorded in 2022 compared to 2019, which could be due to greater use of transportation by employees and the increase in the number of students.

The GHG emissions by Area obtained from the UNR Carbon Footprint reports for the years 2019 and 2022, as well as their differences, are detailed in Table 2 and Figure 3.

Tab. 2. Comparison of GHG emissions by each Area of UNR.

Area	Emission 2019 ($TnCO_2eq$)	Emission 2022 ($TnCO_2eq$)	Difference ($TnCO_2eq$)
Area Centro	1,250	1,238	-12
CUAS	1,020	1,000	-20
CUR	670	655	-15
CUAP Zavalla	480	475	-5
CUAP Casilda	190	221	+31
Total	3,610	3,589	-21

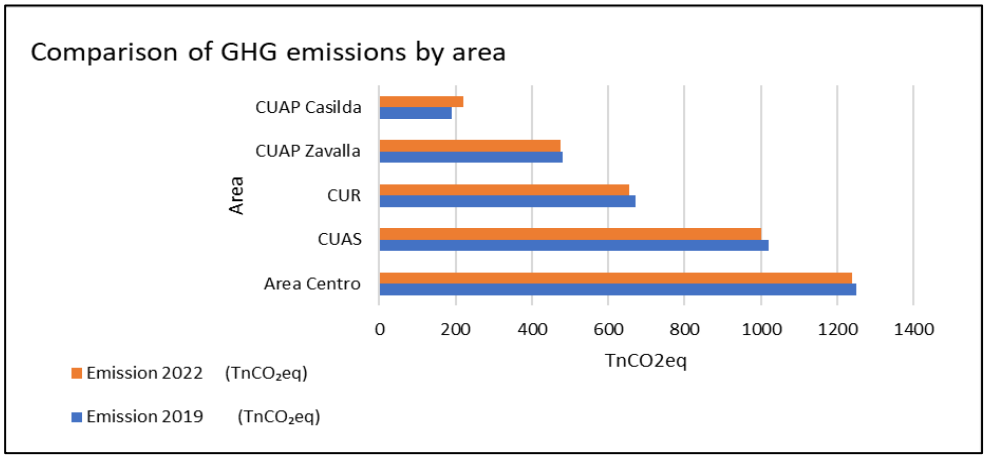

Fig. 3. Comparison of GHG emissions by Area of UNR. The Areas are Area Centro, CUAS, CUR, CUAP Zavalla and CUAP.

Table 2 shows that the areas with reductions were Centro Area, CUAS, CUR, and CUAP Zavalla, all of which managed to reduce their emissions, albeit to relatively low levels. The Casilda CUAP Area showed an increase of 31 TnCO2eq, which corresponds to a 14% increase. This increase may be attributed to new institutional activity (giving rise to more electricity and fossil fuel consumptions).

Table 3 and Figure 4 presents a comparison of the GHG emissions of teaching staff, administrative staff and students from the different areas of the UNR (in KgCO2eq/person).

Tab. 3. Comparison of GHG emissions from teaching and administrative staff and students by UNR area (kg CO2e/person)

Area	Emission 2019 (kg CO_2eq/person)	Emission 2022 (kg CO_2eq/person)	Difference
Area Centro	**19**	**19**	**No changes**
CUAS	**35**	**34**	**-1**
CUR	**30**	**29**	**-1**
CUAP Zavalla	**210**	**206**	**-4**
CUAP Casilda	**75**	**80**	**5**
Average	**74**	**73**	
Total	**369**	**368**	**-1**

Table 3 and Figure 4 show a slight decrease in average emissions per person, from 74 kgCO_2eq/person in 2019 to 73 kg CO_2eq/person in 2022. The areas with the reduction were CUAS, CUR, and CUAP Zavalla, but they were not significant. This last area has the largest emission per person, corresponding to the Faculty of Agricultural Sciences. In the CUAP Casilda area, an increase of 5 kgCO_2eq/person was observed.

It must be pointed out that the annual GHG emissions per capita were 33.7 kgCO2/(year*person) in 2019 and 31.2 kgCO2/(year*person) in 2022. The reduction in the main GHG source of emission (electricity) and the increase in the number of students in the same period of 3 years, determined a GHG emission reduction of -8.01% , corresponding to a significant mean reduction of -2.7 % per year.

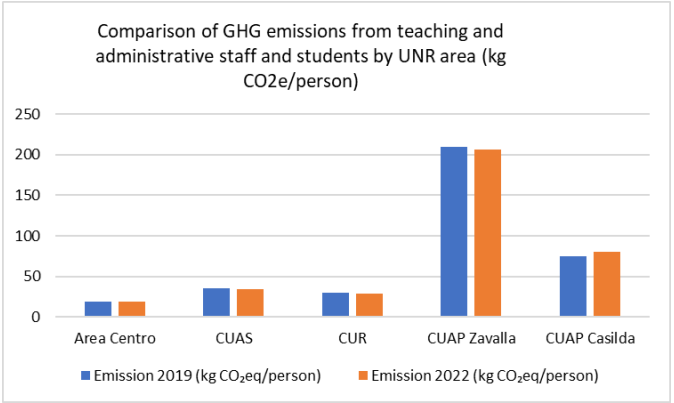

Fig. 4. Comparison of annual GHG emissions in the years 2019 y 2022 from teaching and administrative staff and students by UNR area.

3. Conclusions

The main conclusions that can be derived from the present work are the followings:

-The most important contribution to the GHG emissions in the UNR was electricity. The reduction of these emissions in the year 2022 with respect to the base year 2019 was quite small (0.55 %), mainly since the UNR's electricity consumption has remained rather stable, even if the number of persons (mainly students) increased in about 7 %. An important goal for the near future is to improve significantly the efficiency in the electricity use by the implementation of measures through the replacement of more energy-efficient appliances and devices, the use of building automation, and the use of renewable energy sources.

It must be pointed out that a rough estimate of the contribution of all other emission sources, such as land-use change, agriculture, industry, and waste, shows that they are significantly lower than those considered in the present work. Even part of these undetermined sources is offset by the absorption of carbon dioxide (CO2), the main greenhouse gas, by the large number of trees that exist on the University grounds, principally in the Faculty of Agricultural Sciences, located in Zavalla (at about 30 km from Rosario) and the Faculty of Veterinary Sciences, situated in Casilda (at about 50 km from Rosario).

The continuity of the UNR Carbon Footprint calculations contributes (and will contribute) to providing accurate and transparent data to UNR management, improving environmental development policies and the management of energy resources [11, 12], as well as the incorporation of measures that tend to significantly expand Sustainability, within the UNR and as a reference for its students and the community. It also reinforces the commitment to an environmental culture within the UNR and serves as an example for other institutions, whether educational or not.

The use of ISO 14064 and other standards in the series [13,14] strengthens the work of calculating emissions, as it follows the procedure of an internationally recognized methodology. This methodology generates detailed information that facilitates an accurate diagnosis of the UNR's energy situation, providing tools for continuous improvement in the quest to reduce UNR's carbon footprint.

The UNR proposes establishing a program to obtain the most reliable data, which will not only serve to determine GHG emissions and how to reduce them, but also to achieve greater efficiency in the use of energy and natural resources. To achieve this program, various related sectors will be trained in these topics and in energy management.

It is proposed to set an energy and emissions reduction target, based on an action plan for this purpose. These initiatives must be addressed through an energy assessment to gain insight into UNR's energy consumption, understand the energy variables, and identify opportunities for improvement and efficient energy use. The implementation of energy saving, and efficiency measures will be developed, based in the following actions:

a) Reduce energy demand and costs of this energy and of equipment maintenance,

b) Reduce GHG emissions,

c) Improve the education process, incorporating subjects that will permit to contribute to the University and World efforts to reduce GHG emissions (main responsible of Climate Change), and to improve the quality of life [15].

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