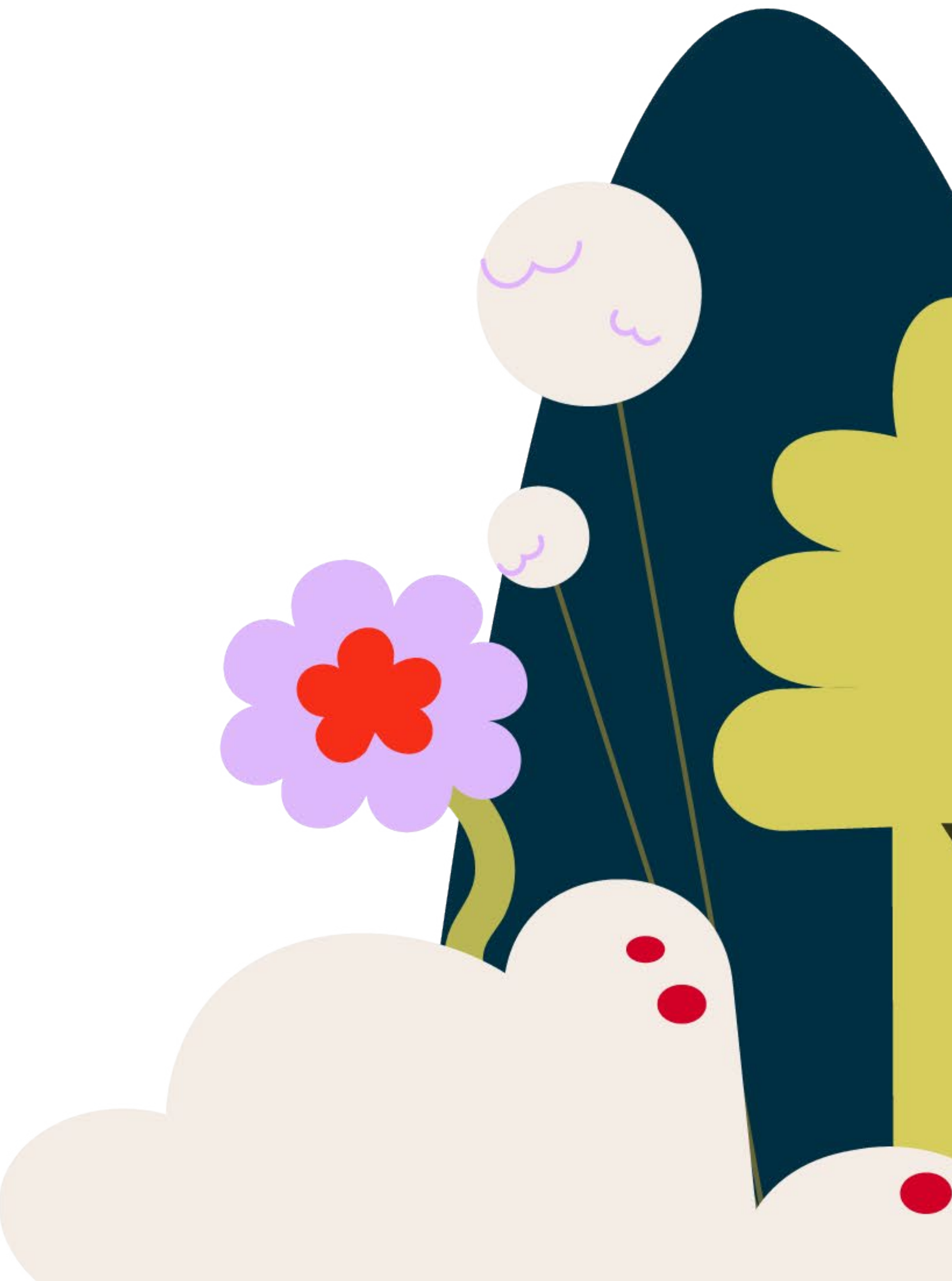
# Carbon footprint of the three university campuses of the UPB, 2019 and 2022

Race to Zero Annual Report



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UPB

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# Executive summary

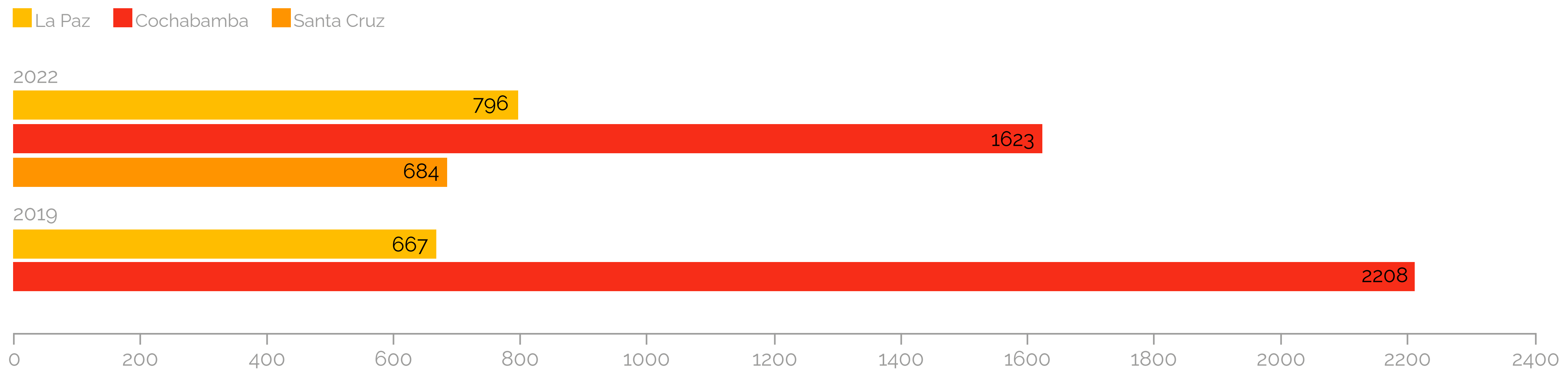
**Race to Zero** is a global campaign to rally leadership and action in the education sector in order to reduce global greenhouse gas emissions. The campaign is promoted by the United Nations Environment Programme, EAUC – The Alliance for Sustainability Leadership in Education, and Second Nature. Around
500 universities have already committed to achieving Net Zero Emissions by 2050 (see https://www. educationracetozero.org/home).

In November 2021, the UPB was the first university in Bolivia to join the campaign with the goal of achieving net zero emissions by 2030, and publishing an annual report on the direct and indirect emissions of the university and the actions that are being taken to reduce the emissions.

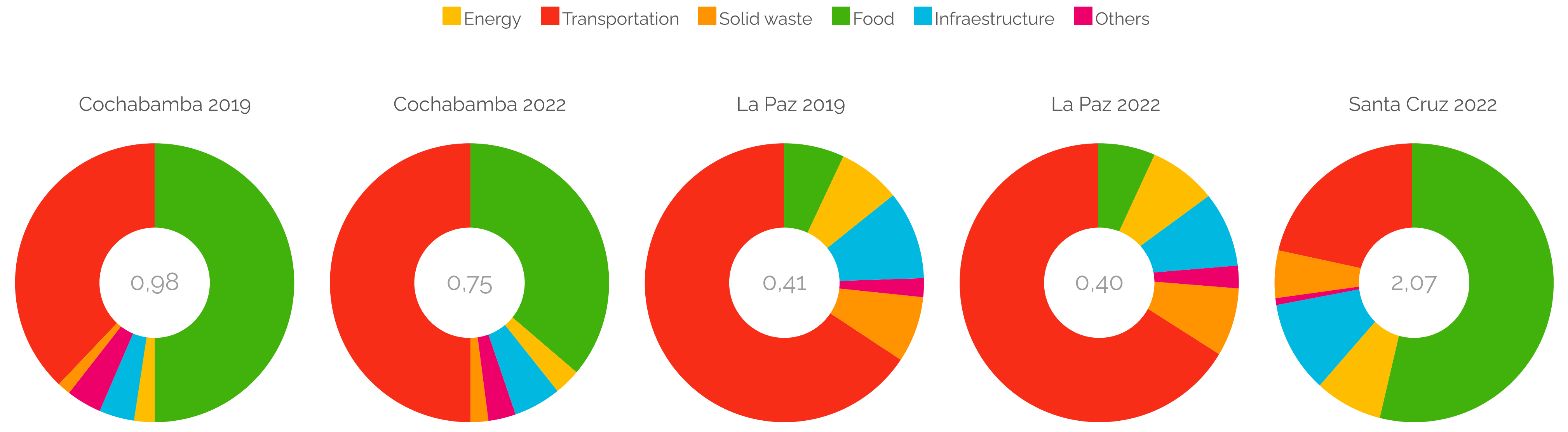
This document is the first annual report of UPB, which establishes the 2019 emissions baseline for the three UPB campuses, located in the cities of Cochabamba, La Paz and Santa Cruz de la Sierra, and the changes in emissions in 2022. The Cochabamba campus (Julio León Prado) is the oldest campus of UPB, established in 1992, and is currently the largest campus, with 2,003 enrolled students and 164 full-time employees in 2022. The La Paz campus (Fernando Illanes de la Riva) was inaugurated in 2007 and had 1,866 enrolled students and 99 full-time employees in 2022. Finally, the Santa Cruz campus was inaugurated in February 2020, a few days before the entire country went into quarantine due to the pandemic. Only in 2021 did it start operating with in-person classes, and in 2022 it had 305 students enrolled and 25 employees.

The graph below summarizes the total and per capita emissions in 2019 and 2022, for the three campuses:

**Greenhouse gas emissions of the UPB campuses in 2019 and 2022, (tCO2eq/year)**




**Greenhouse gas emissions per capita of the UPB campuses in 2019 and 2022, (tCO2eq/year/person)**




Source: authors' calculation based on information in Tables 16 and 17.

The locations of the three campuses are relatively far from the residential areas of each city, which is why transportation is among the main sources of emissions in every city. Another important source of emissions is food, mainly due to the high consumption of beef in the Cochabamba and Santa Cruz campuses. Emissions caused by water consumption are the lowest, as well as paper consumption and the use of fuels on campus. Although the Santa Cruz campus has lower total emissions than the other two campuses, it has greater per capita emissions, mainly from transportation and food.

# Resumen ejecutivo

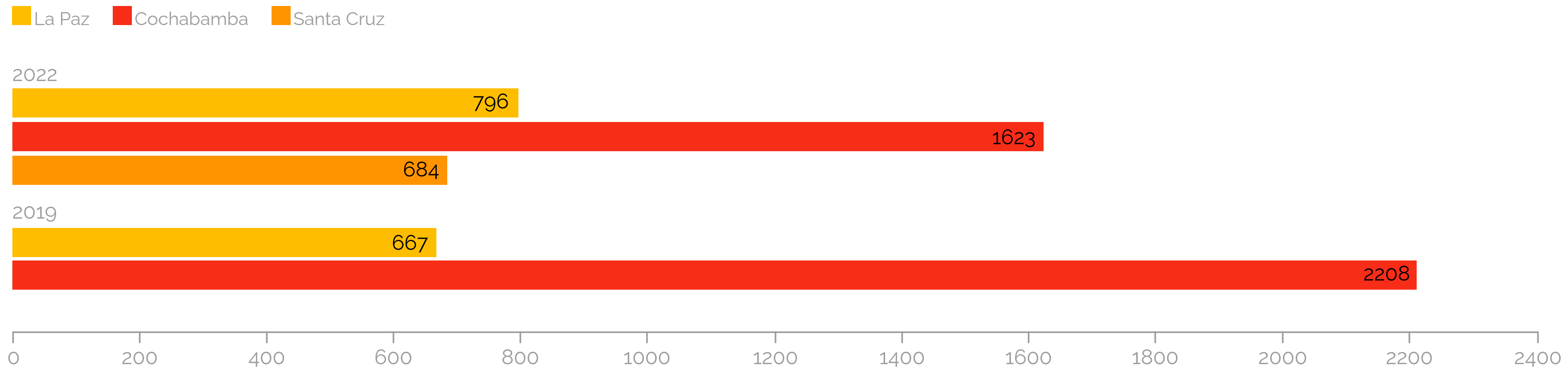
**Race to Zero** es una campaña global orientada a reunir liderazgo y acción en el sector de la educación para reducir las emisiones globales de gases de efecto invernadero. La campaña es impulsada por el Programa de las Naciones Unidas para el Medio Ambiente, EAUC y *Second Nature.* Aproximadamente 500 universidades ya se han comprometido en lograr *Net Zero* antes de 2050 (ver https://www.educationracetozero.org/home).

En noviembre de 2021, la Universidad Privada Boliviana (UPB) fue la primera universidad en Bolivia en adherirse a la campaña con el compromiso de lograr cero emisiones netas hasta 2030 y publicar anualmente un informe sobre las emisiones directas e indirectas de la universidad, que además incluya una descripción de las acciones que se están aplicando para reducirlas.

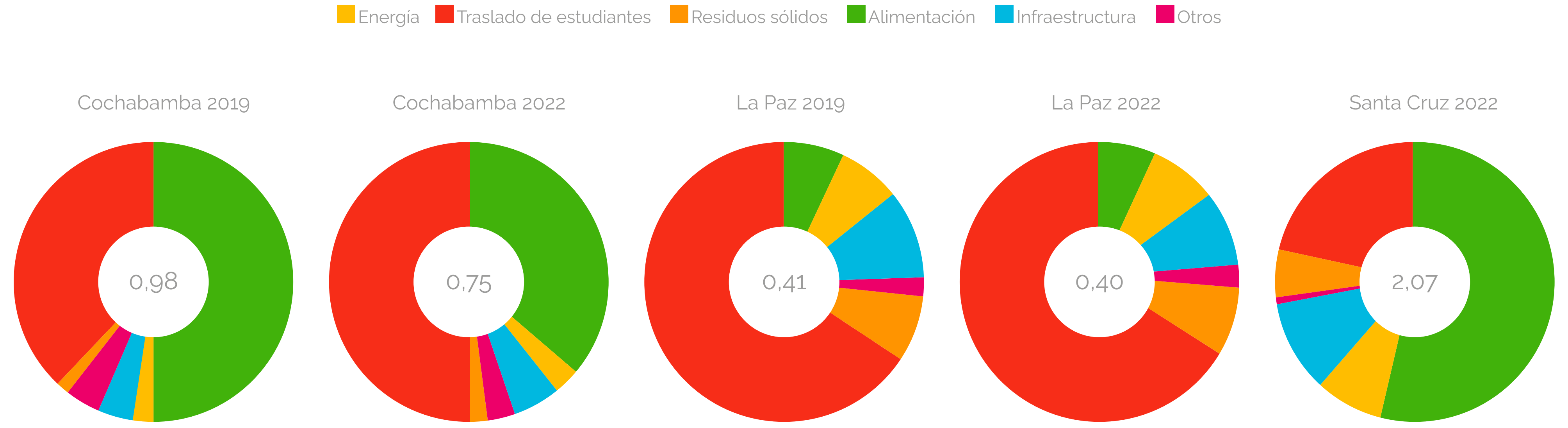
El presente documento es el primer informe anual de la UPB, el cual establece la línea base de emisiones en 2019 para los tres campus de la UPB ubicados en las ciudades de: Cochabamba, La Paz, y Santa Cruz de la Sierra, y los cambios generados hasta 2022. El campus de Cochabamba (Julio León Prado) es el campus más antiguo de la UPB, establecido en 1992, actualmente, es el campus más grande con 2.003 estudiantes inscritos y 164 empleados de planta en 2022. El campus de La Paz (Fernando Illanes de la Riva) fue inaugurado en 2007 y cuenta con 1.866 estudiantes inscritos y 99 empleados de planta en 2022. Finalmente, el campus de Santa Cruz fue inaugurado en febrero de 2022, pocos días antes de que el país entre en cuarentena como medida preventiva para contrarrestar los efectos de la pandemia provocada por el COVID-19. Recién en 2021 empezó a funcionar con clases presenciales, y en 2022 contaba con 305 estudiantes inscritos y 25 empleados de planta.

El gráfico que se encuentra a continuación, resume las emisiones totales y per cápita en 2019 y 2022, para los tres campus:

**Emisiones totales de gases de efecto invernadero de los campus universitarios UPB en 2019 y 2022, ($tCO_2eq$/año)**




**Emisiones per cápita de gases de efecto invernadero de los campus universitarios UPB en 2019 y 2022, ($tCO_2eq$/año/persona)**




Fuente: Elaboración propia en base a información de las tablas 16 y 17.

La ubicación de los tres campus se encuentra relativamente lejos de las áreas residenciales de cada ciudad, lo cual responde a que el transporte esté entre las principales fuentes de emisiones en los tres campus. Otra fuente emisora importante es la alimentación, principalmente por el alto consumo de carne de res en los campus de Cochabamba y Santa Cruz. Queda claro que las emisiones causadas por el consumo de agua son las más bajas, al igual que el consumo de papel de escritorio y el uso de combustibles en el campus. Finalmente, a pesar de que el campus de Santa Cruz tiene menores emisiones totales que los otros dos campus, las emisiones por persona son mayores, sobre todo, por las actividades de transporte y alimentación.

# 1. Introduction

The COVID-19 pandemic has caused diverse economic, social, and environmental impacts, which show the different inequalities facing Bolivia's people and its territories. Economic recovery post COVID-19 required sustainable solutions and "a test of the climate" which allow a socio-economic transformation, generating favorable conditions for investment, employment, growth, and inclusion.

Another large threat at play is the climate crisis which is accelerated by Greenhouse gas (GHG) emissions, contributing to global warming. Due to this crisis, the governments agreed in The Paris Agreement to maintain a temperature increase of less than 2°C. One of the principal goals of the Agreement is to reduce global emissions by 2030 and achieve net zero emissions by 2050.

A major alliance was created to mobilize the different non-state parties, companies, and financial, education, and health institutions to achieve net zero emissions by 2050, backed by the United Nations Organization (ONU), which is famous for its International Campaign, *Race to Zero* (UNFCCC, 2022). According to the official page of *Race to Zero Universities and Colleges (https:// www.educationracetozero.org/),* there are an increasing number of academic institutions in the world that adhere to the campaign, or approximately 500 more universities in 50 countries, representing 10,843,991 students. Universities are spaces of creation and the sharing of knowledge, so they play an important role in climate change and sustainability education. They are also institutions that support research, knowledge, and community action (SDSN, 2022).

In November 2021, the UPB joined the Campaign *Race to Zero* to achieve systemic change through the practice, education, and the implementation of initiatives that reduce carbon emissions and promote research and climate knowledge. This document shows the calculations of the carbon footprint of UPB's three university campuses under a pre and post pandemic focus for the years 2019 and 2022, in order to determine which university activities emit more GHG Emissions, directly or indirectly, in order to create decarbonization strategies in each campus.

# 2. Methodology

The carbon footprint is an environmental measure that measures the greenhouse gas emissions generated by each person or institution, measured in masses of carbon dioxide equivalent ($CO_2$eq), since carbon dioxide is the most abundant gas amongst the GHG (Greenpeace, 2020). These GHG contribute to global warming. However, knowledge of the carbon footprint can raise public awareness, which can reduce emissions in certain activities.

According to the Greenhouse Gases Protocol, the most used international measurement tool, emissions are classified in three Scopes to identify their origin:

**Table 1. Classification of direct and indirect GHG emissions**

| Direct emissions | Indirect emissions | |
|---|---|---|
| Emissions from sources that are owned or controlled by the university.<br><br>Emissions released in the activity's location. | Emissions for university activities, by from sources that are owned or are controlled by a different institution. | |
| **Scope 1** | **Scope 2** | **Scope 3** |
| Emissions from fuel use or vehicles owned by the university or by fugitive emissions from air conditioning or refrigerators. | Emissions associated with electricity acquired or consumed by the university. | Consequences of activities from sources that are neither owned nor controlled by the university. |

Source: Table compiled by universities based on information from the Corporate Standard of Accounting and revised Report- Edition (https://ghgprotocol.org/corporate-standard).

There are different international methods of quantifying carbon dioxide emissions released in the atmosphere. Each one has different development purposes and processes. The methods used to measure the emissions were: Greenhouse Gas Protocol Corporate Standard (GHG Protocol), and ISO 14064-1 e IPCC 2006 GHG Workbook, taking into account relevance, integrity, consistency, precision and transparency.

Due to the calculation of the carbon footprint measures how much an activity contributes to global warming, it requires the following two variables: (i) **the activity data,** or the activity which generates GHG emissions, and (ii) **the emission factor,** or the amount of GHG emitted by each unit of activity.

**Carbon footprint (tons of $CO_2$eq) = activity data x emission factor**

The formula is simple in that it only requires the multiplication of both variables to know how much $CO_2$ each analyzed activity emits. The emission factors will change for each activity and can be available or not in the GHG Emission Inventories of each country. If a country does not use official emission factors, they should choose emission factors from valid international sources or from other countries that have a similar context.

# 3. Carbon footprint calculation

## 3.1. Presentation of the organization

The UPB was founded in 1992 as a business-oriented institution with a national vocation, committed to training professionals and entrepreneurs to lead the construction of a more productive and competitive country. To date, it has three university campuses in the cities of Cochabamba (Julio León Prado), La Paz (Fernando Illanes de la Riva) and Santa Cruz de la Sierra, inaugurated in 1992, 2007 and 2020 respectively.

Since its foundation, it has carried out different activities related to recycling, forestation, preservation of wildlife, reduction of the use of plastics and others. In 2016, UPB Green was launched, an initiative based on the principles of UN Global Compact and the 2030 Agenda to contribute to the solution of environmental problems, involving personal administration, teachers and students.

The solutions that stand out in UPB *Green* are: the installation of solar panels in the three university campuses which diversify the energy sources, and the change from flood irrigation to spray irrigation which optimizes water use. Due to the commitment UPB has to a sustainable environment, in November 2021 they signed an agreement to implement policies similar to the international campaign Race to Zero, which should generate reports and calculate the GHG emissions generated each year in the three campuses.

## 3.2. Carbon footprint calculation limitations

### Organizational limits

The study provides context for the educative and administrative activities carried out by the university infrastructure of the three campuses, which are found in three of the nine departments of the country: La Paz, Cochabamba and Santa Cruz. They estimated the carbon footprints for 2019 and 2022 for the La Paz and Cochabamba campuses. For the Santa Cruz campus, since it has only been in existence since 2020, the study only used the 2022 data. They chose both years because the university activities were interrupted in 2020 and 2021 due to the COVID-19 pandemic. For the emissions calculations for previous years, the base year for comparison has to be 2022 because that was when activities returned to normal and because the Santa Cruz campus was just founded in 2020.

### Operational límits

Obtaining the data of the three university campuses and of the cafeterias allowed the full report of *Scopes 1, 2, and 3* emissions to be completed.

Frame 1 specifies the limits in the measurement of GHG emissions for each Scope:

### Frame 1: Operational limits in the carbon footprint calculation of UPB

**Location:** La Paz, Cochabamba y Santa Cruz
**Years of calculation:**
- 2019 y 2022: La Paz y Cochabamba
- 2022: Santa Cruz

**Data collection**

**Scope 1**
Fuel used for heating or cooking
**Scope 2**
Purchased electric energy
**Scope 3**
Student and personal transfers
Solid waste
Water
Writing paper
Food
Infrastructure

They excluded activities with no solid and precise information, including international and departmental trips taken by UPB teachers, students, or authorities. However, they recommend that they are included in Scope 3 in the following measurements.

There were no limits in the calculation of Scopes 1 and 2 so that they used reported data in the gas and electricity bills. For Scope 3 they made several assumptions in order to proceed with the calculations. As for the sources of information, the data for activities related to student transport and food were collected from an online poll, added in September 2022 to the students' academic system. The rate of response was almost 100%, given that the poll was mandatory and there was a campaign to raise awareness about the purpose of the poll previously.

The rest of the information was obtained from the campuses and the cafeterias. Next, they specified the limits of the information collected and the assumptions made for each activity in Scope 3:

**- Personal and student travel:** They obtained information about the transport used and the time it takes to go and return from the university. To do this, they averaged the time it takes students to go and return from university, by type of transport and campus. In order to calculate the emissions they made the following assumptions:

- Assumption 1: The different methods of transport used by the students have an average velocity of 45 km/ hour[1].
- Assumption 2: Every transport method uses gasoline as a fuel source.
- Assumption 3: Every transport method used by the students spends 1 liter of gasoline every 12 kilometers[2].
- Assumption 4: The calculation of liters used corresponds to 38 weeks of attendance, considering that not everybody attends summer or winter classes and they used to take classes until the middle of December.
- Assumption 5: The capacity utilization rate varies between transport method: 70% for a bus, 58% for a minibus and 40% for shared automobiles.

Since the poll only collected data on UPB students, not UPB personnel, they calculated the annual $tCO_2$ quantity per capita based on the student data, and later they calculated the annual emissions of 2019 and 2022 for the total population, assuming that the behavior of personnel is similar to the behavior of the students.

**- Solid waste:** information on annual waste generation could not be obtained, only an approximation of weekly or monthly waste. In the case of the La Paz and Santa Cruz campuses, they got information about the kilograms (kg) of trash generated each week, while for the Cochabamba

[1] According to the International Monetary Background in Bolivia study, it has a velocity between 30 and 60 km/h, in this case the average is assumed. https://www.lostiempos.com/actualidad/pais/20220712/estudio-senala-que-carreteras-bolivia-colombia-ecuador-estan-mas-lentas-del
[2] Based on data calculated by the Digital Driving School for Management: ONROAD. For more information visit: https://www.onroad.to/practico/aprender-conducir/calcular-gasto-gasolina-kilometros

campus, they got information about the number of full dumpsters per week in liters, which was later converted to kilograms. Since the information is for 2022, for 2019 they made the following assumption:

- Assumption 1: The quantity of waste generated by each person in 2022 is equal to that of 2019.

**- Water:** the quantity of water in cubic meters according to the monthly invoices could be obtained for the La Paz and Santa Cruz campuses. However, for the Cochabamba campus, due to its use of well water, they could not collect the information. For Cochabamba, they made an approximation of campus water consumption based on average water consumption data in the area where the campus is located, Zona Periferia Norte (0.2049 $m^3$/ person/day)[3]. In 2019 and 2022 they counted every person on campus in the data, from registered and personal, in the calculation of daily water consumption.

However, the estimation of the quantity of water consumed per person includes activities in all locations, so they estimated the proportion of consumption from activities within the university. Since the number of people in the Cochabamba and La Paz campuses are very similar, the proportion came from the percentage of water consumed daily per person on the La Paz campus, with respect to the water consumed daily per person in the city (0.1074 $m^3$/person/day). For this, the following assumptions were made for this purpose:

- Assumption 1: Cochabamba campus' registered students and staff consume the same quantity of water daily and attend from Monday to Friday.

- Assumption 2: The percentage of water consumed daily by students or university staff is 14.25% of the daily water consumption of a person who lives in Zona Periferia Norte (see section 3.4.3.3).

**- Food:** the consumption of beef in the campus cafeterias was the information considered, due to its high impact on GHG emissions.[4] Therefore, they requested the weekly weight of each type of beef purchase, which was calculated by the cafeteria managers, the following assumptions were made for this purpose:

- Assumption 1: The cafeterias buy the same amount of beef each month.

**- Writing paper:** Each campus reported the number of packets of paper bought annually, where each packet contains 500 sheets and weighs 75 grams.

**- Construction:** They obtained information about the square meters of surface constructed on each university campus. Following the single mission factor they make the following assumption:

- Assumption 1: The average lifespan of a construction is 50 years.

## 3.3. Identification of GHG sources and emission factors

The emission factors can be based on the last activity or on the life cycle of the activities, and therefore, are counted in different inventories of greenhouse gases. In the carbon footprint calculation made in this document, emission factors that reference to the last activity were considered. Since the recent Greenhouse Gases Inventory of Bolivia does not specify nationally applicable emission factors, the factors most suited for each activity were chosen, taking into account the type of emission source and the data conversion.

[3] According to the data of daily water consumption in the Socioeconomic Survey for SEMAPA, for more information visit: http://www.semapa.gob.bo/resources/plugins/tiny_mce/plugins/filemanager/source/Institucion/ESTUDIO%20SOCIOECONOMICO%20SEMAPA.pdf
[4] For more detail on the impact of GHG emissions,visit: https://sdsnbolivia.org/emisiones-de-gases-de-efecto-invernadero-por-consumo-de-carne-vacuna-en-bolivia/

**Table 2. Emission factors for the carbon footprint calculation**

| Emission source | Description of information | Data conversion | Emission factor | Source of emission factor |
|---|---|---|---|---|
| Stationary fuel | Natural gas used on campus for heating and/or cooking, measured in thousands of cubic feet (Mcf) and kilograms (kg) | Mcf to kilowatt-hour (kWh)<br>Kg to kWh | 0.203 kg CO2/ kWh | Extracted from the "Guide for the carbon footprint calculation and for the calculation of an improvement plan for an organization" of the Ministry of the Ecological Transition of the Spanish Government<br>Pg. 33 |
| Electric energy | Electrical energy consumption bought in KWh | kWh a Terajulio (TJ) | 56,100kg $CO_2$/TJ | Extracted from the document "Third national communication of the Republic of Argentina at the Goal Convention of the United Nations regarding Climate Change" because Argentina, like Bolivia, generates electricity primarily through natural gas.<br>Pg. 255 |
| Student and personal transport | Number of recorded kilometers (km) to arrive and return from university, reflected in the amount of gasoline the chosen transport method consumes | 1. Average transport time in average recorded kilometers<br>2. Km. recorded as liters of gasoline<br>3. Liters of gasoline in TJ | Gasoline: 69,300kg $CO_2$/TJ | Chapter 3: IPCC Mobile Fuel 2006 Workbook<br>Commercial/institutional Scope-Level 1 IPCC 2006<br>Pg.16 |
| Solid waste | Weekly amount of waste in kg or liters | Kg. of weekly waste in a year | 1.92 kg $CO_2$/kg | Extracted from the emission factors of La Salle University, Sede Norte Colombia, which calculate the emission factor according to university wastes and based on the IPCC 2006 methodology, using percentages assigned to the generation of waste in South America.<br>Pg. 105 |
| Water | Cubic meters (m³) of water consumed | none | Well: 0.31 kg $CO_2$eq/ m³<br>Municipal: 0.36 kg $CO_2$eq/ m³ | Extracted from the BID document "GHG Indexes for water use in Mexico" which categorizes emissions depending on whether it comes from a well, a barrel or a network. |
| Writing paper | Amount of packets of writing paper bought annually | Packets by Kg | Fiber paper 1.84 kg $CO_2$/kg paper | Extracted from the document "The carbon footprint of the University of Córdoba. 2013" because the other available sources mention assumptions that are not applicable to Bolivia.<br>Pg. 13 |
| Food | Kg of each type of beef bought for the cafeteria menus | none | 384 kg $CO_2$ eq/kg of beef consumed | Extracted from the blog of the Sustainable Development Solutions Network Bolivia. "GHG Emissions from beef consumption in Bolivia." |
| Infrastructure | Amount of surface constructed for each campus in square meters (m²) | none | 10.4 kg $CO_2$/ m²/ year | Extracted from the document "The carbon footprint of the University of Córdoba. 2013" because it calculates the annual emissions of constructions that are less than 50 years old and that are primarily made of concrete. |

Source: author's calculation.

## 3.4. Calculation of Emissions of $CO_2$

The emissions calculation was made using Excel sheets with the GHG inventories format, making linear projections for the months in 2022 with no information. It also analyzed the results of the survey through the STATA 16 software. Then it shows the calculations for direct and indirect emissions, indicating the quantity of $tCO_2$ emitted during each of the activities.

### 3.4.1. Scope 1: Direct emissions

The data from Scope 1 was obtained in units of volume (m³) and weight (kg), through the data reported by the university campuses. In the case of the Santa Cruz campus, they did not count the installation of gas, because it was not included in the calculation of emissions of this Scope. The conversation units for the emission factor (0.203 kg $CO_2$/ kWh) were the following:

*Thousands of cubic feet = 1,000 cubic feet (cf)*
*1 cubic foot (cf) = 0.02831 cubic meters ($m^3$)*[5]
*1 kilogram (kg) = 0.4889 cubic meters ($m^3$)*[6]
*1 cubic meter ($m^3$) = 11.7 kilowatts per hour (kWh)*[7]

Once we converted all the data into kWh, we had the annual consumption of gas. The La Paz campus consumed 25,134 kWh (2019) and increased to 53,750 kWh (2022); while the Cochabamba campus reduced its consumption from 51,895 kWh (2019) to 39,749 kWh (2022).

**Table 3. $CO_2$ Emissions contribution to the carbon footprint for heating and/or cooking ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Natural gas used in the campus for heating and/or cooking | 5 | 0,76 | 11 | 1,37 |
| Cochabamba | | 11 | 0,48 | 8 | 0,50 |

Source: authors' calculation based on data given by the campus.

### 3.4.2. Scope 2: Indirect emissions

The data for this Scope was obtained in units of energy (kWh), through the electricity bills of each university campus, which is why this activity was not necessary for converting the data. The annual consumption of electricity on the La Paz campus reached 244,540 kWh (2019) and increased to 316,301 kWh (2022). The electricity consumption of the Cochabamba campus also increased from 223,160 kWh (2019) to 248,990 kWh (2022); and the Santa Cruz campus totaled 262,481 kWh (2022).

**Table 4. $CO_2$ Emissions and contribution to the carbon footprint of purchased electric energy ($tCO_2eq$/year)**

| Campus | Actividad emisora | 2019 | Contribución 2019 (%) | 2022 | Contribución 2022 (%) |
|---|---|---|---|---|---|
| La Paz | Energía eléctrica comprada | 49 | 7,40 | 64 | 8,03 |
| Cochabamba | | 45 | 2,04 | 50 | 3,10 |
| Santa Cruz | | No existía el campus | - | 53 | 7,75 |

Source: authors' calculation based on data given by the campus.

### 3.4.3. Scope 3: Indirect Emissions

The data in this Scope correspond to the six different activities detailed below.

#### 3.4.3.1. Student and personal transport

The calculation of transport emissions was based on the survey managed by the UPB students in September 2022. This survey obtained 1,083 responses from the Cochabamba campus students, 1,038 from the La Paz campus students, and 243 from the Santa Cruz campus students, for a total of 2,364 responses. Based on all the responses, it was identified that the majority of students travel in their own car or use the university bus. A minority of students use a shared vehicle as means of travel.

[5] Extracted from the file with conversion factors for natural gas. For more information visit: https://www.gob.mx/cms/uploads/attachment/file/116104/Factores_de_Conversi_n-Gas_Natural.pdf
[6] Extracted from the file with conversion factors for the gas industry. For more information visit: https://ingbioquimicacvhblog.files.wordpress.com/2018/08/tablas_unidades.pdf
[7] Extracted from the gas company "PrecioGas". For more information visit: https://preciogas.com/faq/factor-conversion-gas-natural-kwh

### Table 5. Transport method use by UPB students, 2022

| | % of students |
|---|---|
| Auto propio | 38,87 |
| Bus de la universidad | 31,98 |
| Transporte público | 20,98 |
| Auto compartido | 8,16 |

Source: authors' calculation based on data from the survey.

The emissions calculation required that estimates the quantity of average kilometers recorded by the students in each one of the time ranges included in the survey[8], including the travel and return time to and from the university. It is assumed that the average velocity of a car in Bolivia is 45 km/h, so they approximated the recorded kilometers according to each time range, choosing the longest times for each.

### Table 6. Recorded kilometers per person in a day, according to transport time, 2022

| | Less than 29 min. | 30-59 min. | 60-120 min. | More than 120 min. |
|---|---|---|---|---|
| Transport method | 21,75 | 44,25 | 90,00 | 111,75 |

Source: authors' calculation based on data from the survey.

With the estimation of recorded kilometers per person in a day, according to time range, which came from the calculation of every person on the university campuses, they obtained the following results:

### Table 7. Kilometers recorded for all students per day, according to transport time in Cochabamba, 2022

| | Less than 29 min. | 30-59 min. | 60-120 min. | More than 120 min. |
|---|---|---|---|---|
| Bus | 147 | 99 | 46 | 21 |
| Shared car | 446 | 152 | 337 | 11 |
| Car | 5.590 | 1.218 | 3.785 | 87 |
| Public transport | 295 | 180 | 124 | 31 |

Source: authors' calculation based on data from the survey.

### Table 8. Recorded kilometers for all students per day, according to transport time in La Paz, 2022

| | Less than 29 min. | 30-59 min. | 60-120 min. | More than 120 min. |
|---|---|---|---|---|
| Bus | 201 | 163 | 28 | 31 |
| Shared car | 489 | 272 | 141 | 11 |
| Car | 3.132 | 1.349 | 1.697 | 261 |
| Public transport | 261 | 270 | 93 | 152 |

Source: authors' calculation based on data from the survey.

[8] The established times for the route durations were: less than 29 minutes, 30-59 minutes, 60-120 minutes and more than 120 minutes.

**Table 9. Kilometers recorded for all students per day, according to transport time in Santa Cruz, 2022**

| | Less than 29 min. | 30-59 min. | 60-120 min. | More than 120 min. |
|---|---|---|---|---|
| Bus | 28 | 15 | 4 | 1 |
| Shared car | 109 | 11 | 120 | 0 |
| Car | 1.153 | 370 | 1.283 | 65 |
| Public transport | 28 | 59 | 31 | 16 |

Source: authors' calculation based on data from the survey

Considering that the data were calculated daily, its conversion into annual data assumed a 38-week attendance of the students, approximately four days per week in each of the campuses, based on the survey carried out by the students. From these values, they calculated the use of fuel in liters of gasoline according to the range of transport times, assuming that 1 liter of gasoline lasts every transport method 12 km. According to these methods, the annual gasoline consumption per campus in 2022 was 122,933 liters (La Paz), 178,709 liters (Cochabamba) and 4,633 liters (Santa Cruz).

Afterwards, the quantities from liters were converted to Terajoules (TJ) in order to estimate the $CO_2$ emissions. Finally, they calculated the $tCO_2eq$ per capita emitted in 2022. This corresponds to the students who responded to the survey, so they had to estimate comparable numbers for all the alumni, teachers and administrative personnel for 2019 and 2022.

**Table 10. CO2 Emissions and contribution to the carbon footprint of student and personal transport per campus, ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Student and personal transport | 438 | 65,62 | 527 | 66,29 |
| Cochabamba | | 842 | 38,13 | 810 | 49,94 |
| Santa Cruz | | Did not exist | Did not exist | 147 | 21,42 |

Source: authors' calculation based on data from the survey.

### 3.4.3.2. Solid waste

The data for this activity was obtained in kilograms and liters according to the waste generated by week or month. The conversion unit of liters to kilograms (1.92 Kg $CO_2eq$/Kg) used the following density of trash[9]:

*80 kilograms per cubic meter*

The annual generation of solid waste is highest in the La Paz campus; reaching 26,893 kg (2019) and 32,400 kg (2022), in comparison to the Cochabamba campus that generated 17,132 kg (2019) and 16,493 kg (2022), and 19,200 kg (2022) in the Santa Cruz campus

[9] The density was obtained from the document "Recommendations for the characterization and quantification of universities' solid waste. Case study: Salesian Polytechnic University, South Campus, Quito. Available at: https://www.redalyc.org/journal/4760/476051461009/html/

**Table 11. $CO_2$eq Emissions and contribution to the carbon footprint of solid waste, ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Solid waste generated per campus | 52 | 7,74 | 62 | 7,82 |
| Cochabamba | | 33 | 1,49 | 32 | 1,95 |
| Santa Cruz | | Did not exist | Did not exist | 37 | 5,39 |

Source: authors' calculation based on data given by the campus.

### 3.4.3.3. Water consumption

The data for this activity was in units of volume ($m^3$) and was only obtained from the La Paz and Santa Cruz campuses. In 2019, the La Paz campus consumed 9,267 $m^3$ of water and 13,548 $m^3$ in 2022, and the Santa Cruz campus consumed 2,593 $m^3$ in 2022.

For the Cochabamba campus, their water came from wells, so they estimated an approximation of water consumption for 2019 and 2022. First, they recognized that water consumption per person on a university campus is not the same as the daily consumption of a resident in the area where the university is located. Therefore, they used the La Paz[10] data to calculate the percentage of annual consumption of water in a university campus, with regards to the annual consumption of a citizen. For this, they used the data in the following table:

**La Paz campus water consumption, 2019**
- 9,267,000 liters

**Daily water consumption per person in La Paz**
- 107.37 liters/person/day

**Number of people on campus, 2019**
- 1,659

The daily water consumption per person in La Paz was multiplied by the number of students, teachers, and administrative personnel in 2019 (1,659), in order to convert it into the annual consumption (65,016,293 liters). Later, the percentage that represents the 9,267,000 liters consumed in the La Paz campus were calculated with regards to the approximate total annual consumption, which represents the 14.25%.

From there, the calculations for Cochabamba[11] were made using the following data:

**Data of daily consumption in the Periferia Norte Cochabamba zone**
- 204.9 liters/person/day

**Number of people that were in the Cochabamba campus, 2019**
- 2,251

**Number of people that were in the Cochabamba campus, 2022**
- 2,167

Once they converted the data to cubic meters, the daily water consumption of 2,251 people in 2019 rose to 461 m3. Because approximately 14.25% is allocated to water consumption in the university, that would replace 66 $m^3$. So the annual well water consumption was 23,661 $m^3$ and 22,778 m3 in 2022. Table 12 presents the emissions generated in both years for the three university campuses:

**Table 12. $CO_2$ Emissions and contributions to the carbon footprint for water consumption, ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2019 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Water consumption | 3 | 0,50 | 5 | 0,61 |
| Cochabamba | | 7 | 0,33 | 7 | 0,44 |
| Santa Cruz | | Did not exist | Did not exist | 1 | 0,14 |

Source: authors' calculation based on data given by the campuses.

[10] The data of water consumption are based on the Informative Bulletin of the INESAD N° 17 Foundation, "Water in La Paz and El Alto" (https://www.inesad.edu.bo/images/BoletinSintesis/Boletin17.pdf )
[11] The data of daily consumption are based on the Socioeconomic Survey for SEMAPA that estimates liters consumed per person following different zones in Cochabamba. For more information visit: http://www.semapa.gob.bo/resources/plugins/tiny_mce/plugins/filemana-ger/source/Institucion/ESTUDIO% 20SOCIOECONOMICO%20SEMAPA.pdf

### 3.4.3.4 Writing paper

The data for this activity was obtained in units of 500-page packets of paper, where each page weighs 75 grams. The annual purchases of packets on the La Paz campus were 80 packets per year, the same as Santa Cruz, while the Cochabamba campus bought 1,000 (2019) and 500 packets (2022). The weight from grams had to be converted to kilograms for the total number of packets. With this, the following carbon dioxide emissions were calculated:

**Table 13. $CO_2$ Emissions and contribution to the carbon footprint of writing paper consumption ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Consumption of writing paper | 6 | 0,83 | 6 | 0,69 |
| Cochabamba | | 69 | 3,13 | 35 | 2,13 |
| Santa Cruz | | Did not exist | Did not exist | 6 | 0,81 |

Source: authors' calculations based on data given by the campuses.

### 3.4.3.5. Food

The data for this activity were obtained from the operators of the cafeterias of each campus, who indicate the quantity of beef purchased in kilograms. These weekly data were converted into annual data. With this, the beef consumption per capita were calculated for both years.

The annual consumption of beef in the La Paz campus cafeteria increased from 118 kg (2019) and 134 kg (2022), both of which is lower than the Cochabamba campus (2,891 kg in 2019 and 1,536 kg in 2022) and the Santa Cruz campus (960 kg and 2022). During the interview with the person in charge of the La Paz campus cafeteria, they mentioned that each time there are more students who choose options without meat, which has lowered the amount of beef bought per week.

**Table 14. $CO_2$ Emissions and contribution to the carbon footprint of beef consumption ($tCO_2eq$/year)**

| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Beef consumption in the cafeterias | 45 | 6,78 | 52 | 6,49 |
| Cochabamba | | 1.110 | 50,29 | 590 | 36,35 |
| Santa Cruz | | Did not exist | Did not exist | 369 | 53,87 |

Source: authors' calculation based on the weekly purchases of the cafeterias.

### 3.4.3.6. Infrastructure

The data for this activity were recorded as square meters ($m^2$) of surface in the university campuses. The surface constructed on the La Paz campus covers 6,654 $m^2$, 8,745 $m^2$ on the Cochabamba campus, and 7,000 $m^2$ on the Santa Cruz campus. The emission factor used allows the calculation of annual emissions that would generate a construction less than 50 years old, which is appropriate because the oldest infrastructure is only 30 years old. Table 15 shows that the emissions are equal in both years because there was no increase in surface constructed.

**Table 15. $CO_2$ Emissions and contribution to the carbon footprint of infrastructure constructed ($tCO_2eq$/ year)**

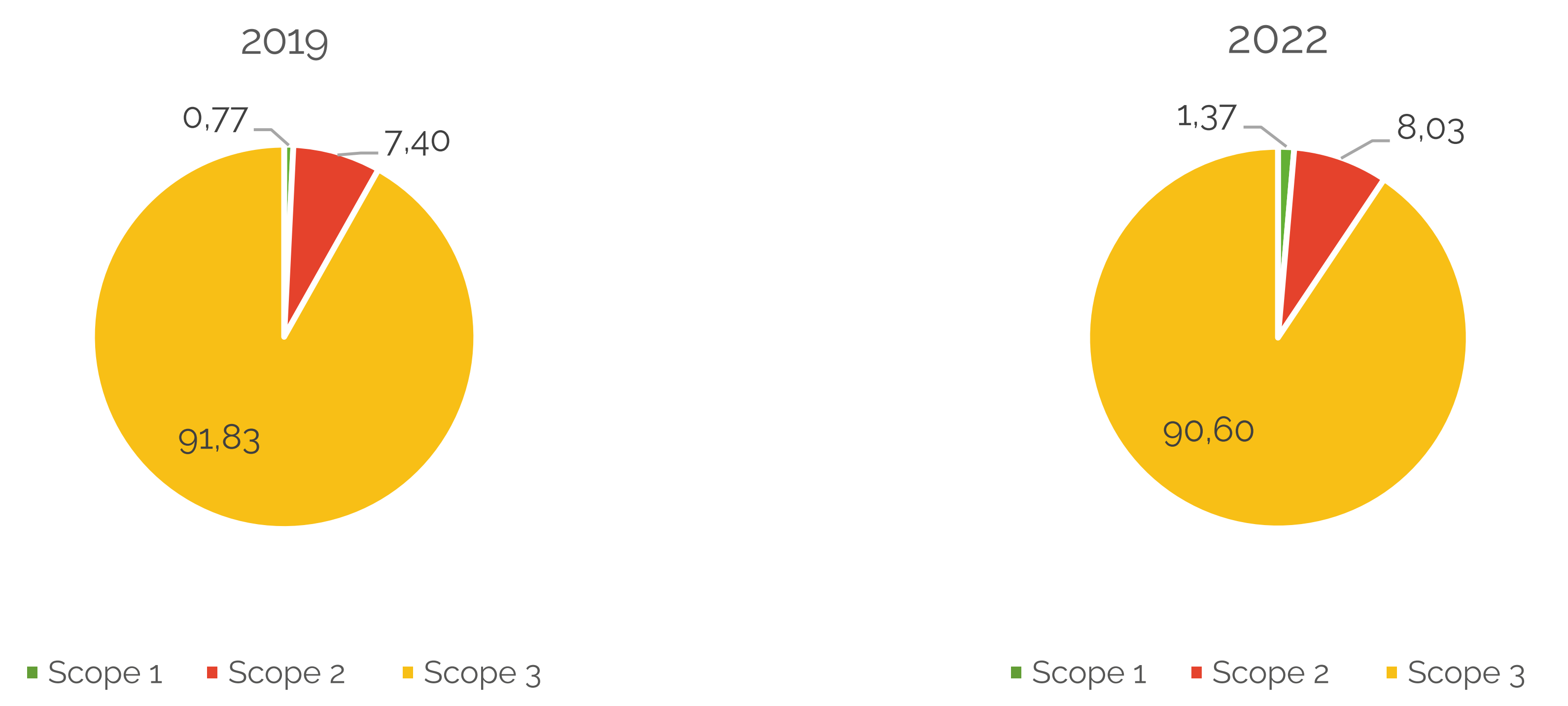
| Campus | Emission activity | 2019 | 2019 Contribution (%) | 2022 | 2022 Contribution (%) |
|---|---|---|---|---|---|
| La Paz | Infrastructure constructed | 69 | 10,37 | 69 | 8,70 |
| Cochabamba | | 91 | 4,12 | 91 | 5,61 |
| Santa Cruz | | Did not exist | Did not exist | 73 | 10,64 |

Source: authors' calculation based on data given by the campuses.

## 4. Carbon Footprint Results

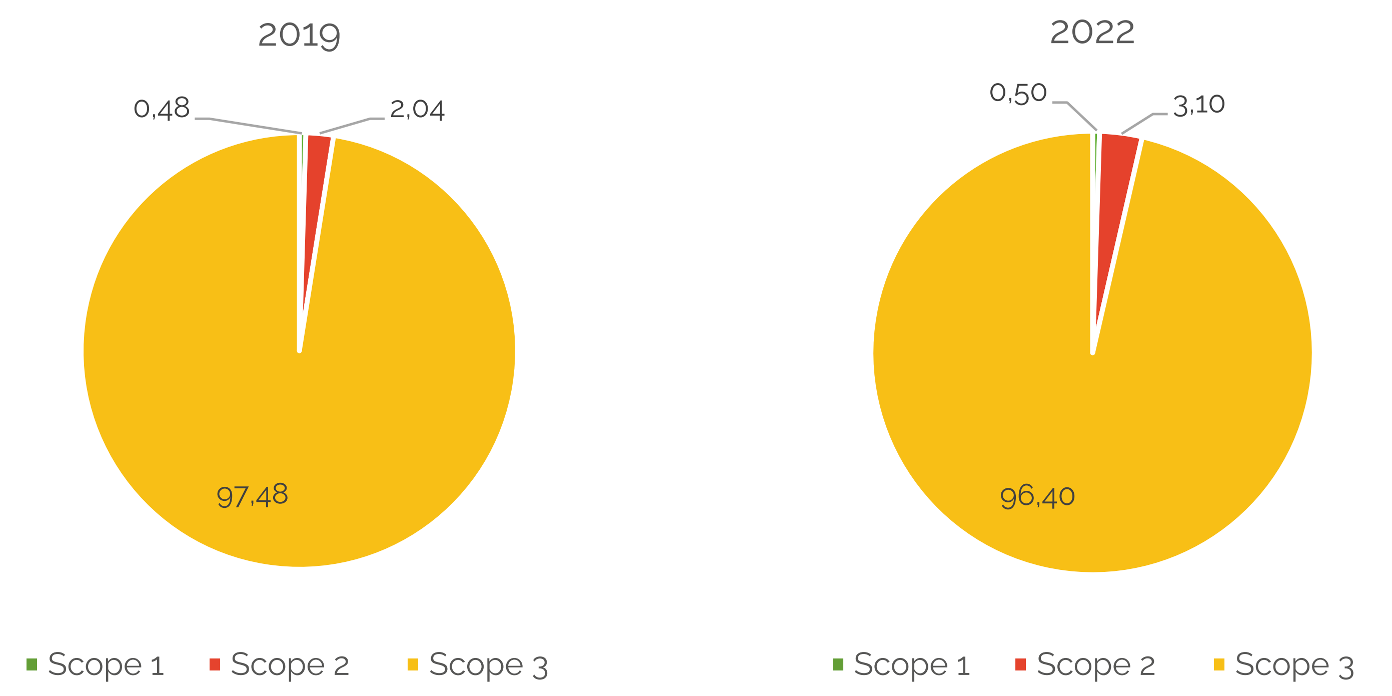
The $CO_2$ emissions vary by university campus, however, we can recognize that among the three Scopes, the most important is Scope 3 as it contributes to more than 90% of the carbon footprint. This means that the majority of emissions come from activities that UPB does not have absolute control over, but it is possible to raise awareness and support a future with less university emissions. It is important to stress that since the Santa Cruz campus does not have gas installations, we only have the emissions for Scopes 2 and 3.

**Figure 1. La Paz campus contribution to the carbon footprint by Scopes, (%)**



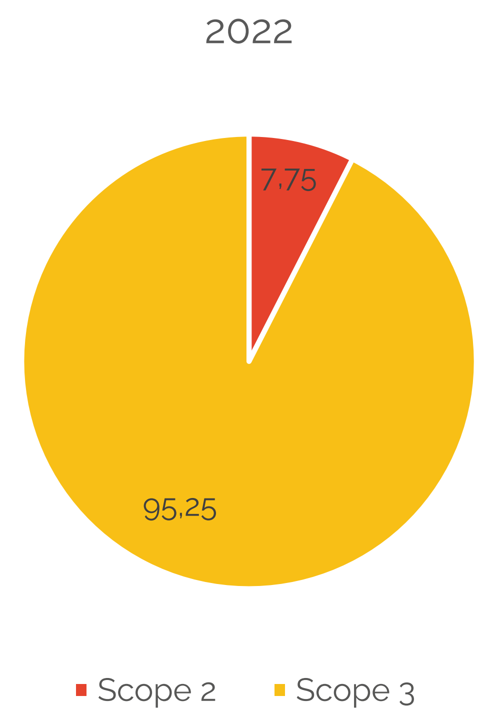

Source: authors' calculation.

**Figure 2. Cochabamba campus contribution to the carbon footprint by Scopes, (%)**




Source: authors' calculation.

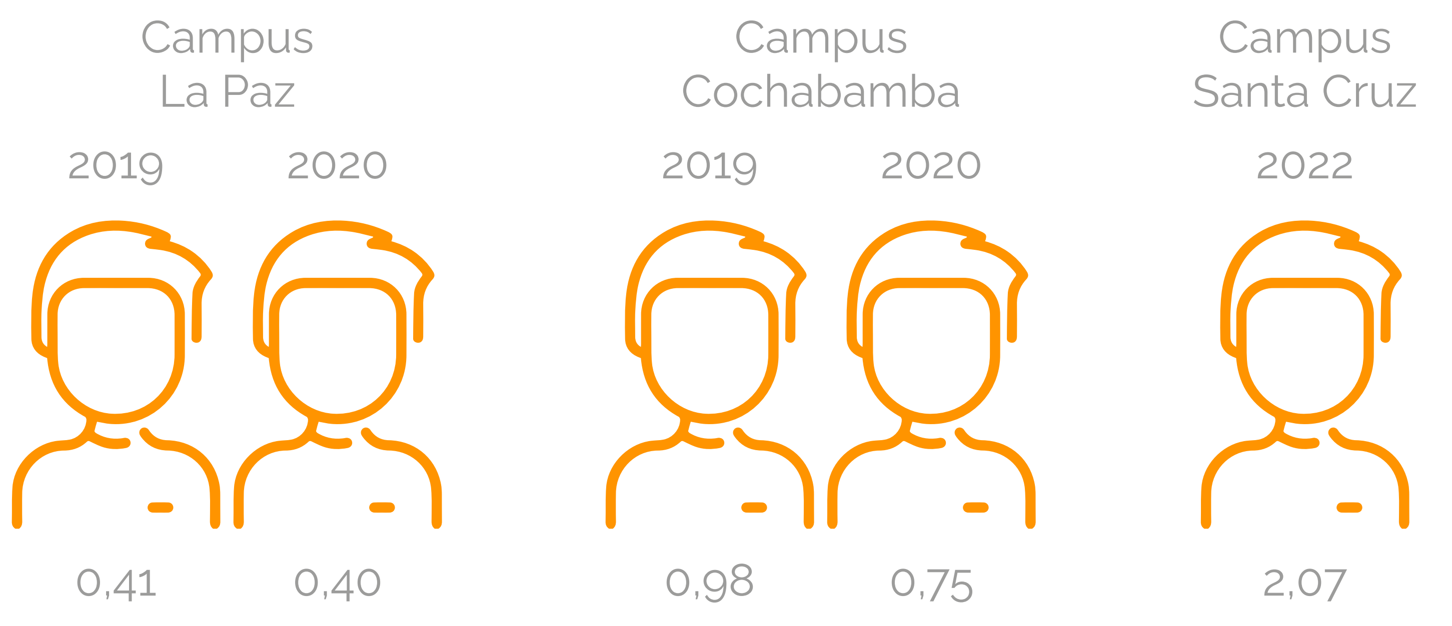
**Figure 3. Santa Cruz campus contribution to the carbon footprint by Scopes (%)**




Source: authors' calculation.

The carbon footprint of the La Paz campus is 667 $tCO_2eq$ in 2019 and 796 $tCO_2eq$ in 2022. Both of these values are lower than the emissions generated by the Cochabamba campus, which emitted 2,208 $tCO_2eq$ and 1,623 $tCO_2eq$. If the emissions are compared to the number of people on each university campus, it can be seen that the Santa Cruz campus contributes the most $CO_2$ emissions per capita, even though its actual contribution is lower than the La Paz and Cochabamba campuses (684 $tCO_2eq$).

### Illustration 1. $CO_2$ Emissions per capita in 2019 and 2022, ($tCO_2eq$/year/person)



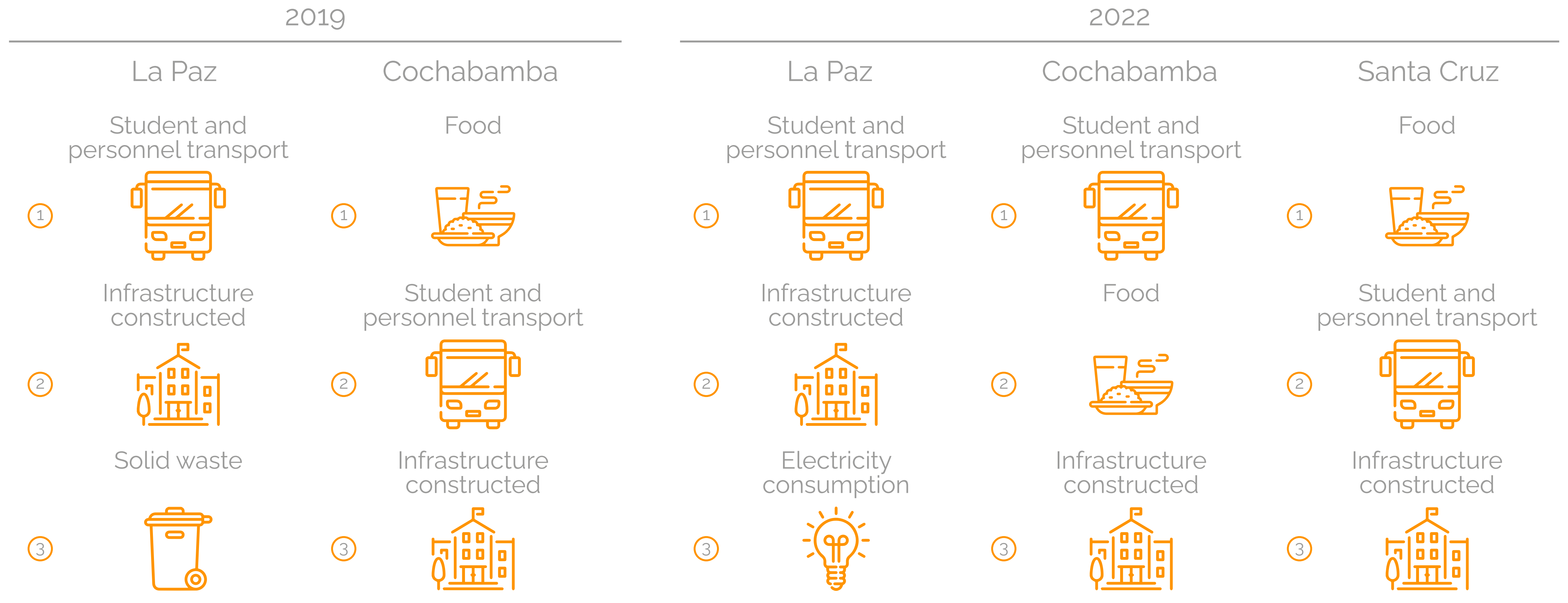

Source: authors' calculation.

If the impact of each of the activities is considered separately, the activity that emits the most amount of $tCO_2eq$ varies per campus, but it tends to be transportation and food related activities. In the La Paz campus, the transport of students and administrative personnel is the activity that emitted the highest amount of $tCO_2eq$ in 2019 and 2022, as well as in the Cochabamba campus in 2022. However, food- related activities led emissions in the Santa Cruz campus in 2022 and in the Cochabamba campus in 2019.

The activity that emits the second highest amount of $tCO_2eq$ differs by campus and year. The transport of students and personnel is the second highest source of carbon dioxide in the Cochabamba campus in 2019 and the Santa Cruz campus in 2022, while in 2022 the second highest source in the Cochabamba campus was food. For the La Paz campus in both 2019 and 2022, it was infrastructure constructed.

The third highest source of emissions for the Santa Cruz and Cochabamba campuses in both 2019 and 2022 was infrastructure constructed, while for the La Paz campus it was solid waste (2019) and electricity consumption (2022).

### Illustration 2. The three activities that emitted the most $CO_2$ in 2019 and 2022




Source: authors' calculation.

The contribution in $tCO_2eq$ of each of the activities is shown below, together with the emissions generated per person, recognizing that the activity that generates the least amount of $tCO_2eq$ is water consumption.

### Table 16. Carbon footprint contribution by campus and person in 2019, ($tCO_2eq$)

| | Total emissions, La Paz campus | Total emissions, Cochabamba campus | Emissions per capita, La Paz campus | Emissions per capita, Cochabamba campus |
|---|---|---|---|---|
| **SCOPE 1** | | | | |
| Stationary fuel | 5 | 11 | 0,003 | 0,005 |
| **SCOPE 2** | | | | |
| Electric energy bought | 49 | 45 | 0,030 | 0,020 |
| **SCOPE 3** | | | | |
| Student and personnel transport | 438 | 842 | 0,268 | 0,374 |
| Solid waste | 52 | 33 | 0,032 | 0,015 |
| Water | 3 | 7 | 0,002 | 0,003 |
| Writing paper | 6 | 69 | 0,003 | 0,031 |
| Food | 45 | 1.110 | 0,028 | 0,493 |
| Infrastructure constructed | 69 | 91 | 0,042 | 0,040 |
| TOTAL | **667** | **2.208** | **0,41** | **0,98** |

Source: authors' calculation.

### Table 17. Carbon footprint contribution per campus and person in 2022, ($tCO_2eq$)

| | 2022 | | | | | |
|---|---|---|---|---|---|---|
| | Total emissions, La Paz campus | Total emissions, Cochabamba campus | Total emissions, Santa Cruz campus | Emissions per capita, La Paz campus | Emissions per capita, Cochabamba campus | Emissions per capita, Santa Cruz campus |
| **SCOPE 1** | | | | | | |
| Stationary fuel | 11 | 8 | s/d | 0,006 | 0,004 | s/d |
| **SCOPE 2** | | | | | | |
| Electric energy bought | 64 | 50 | 53 | 0,033 | 0,023 | 0,161 |
| **SCOPE 3** | | | | | | |
| Student and personnel transport | 527 | 810 | 147 | 0,268 | 0,374 | 0,444 |
| Solid waste | 62 | 32 | 37 | 0,032 | 0,015 | 0,112 |
| Water | 5 | 7 | 1 | 0,002 | 0,003 | 0,003 |
| Writing paper | 6 | 35 | 6 | 0,003 | 0,016 | 0,017 |
| Food | 52 | 590 | 369 | 0,026 | 0,272 | 1,117 |
| Infrastructure constructed | 69 | 91 | 73 | 0,035 | 0,042 | 0,221 |
| TOTAL | **796** | **1.623** | **684** | **0,40** | **0,75** | **2,07** |

Source: authors' calculation.

# 5. UPB Decarbonization Methods

Higher education institutions can reduce their GHG emissions, thus reducing the effects of global warming. For this reason, UPB created two primary measures to reduce emissions: the installation of solar panels and planting trees in the three campuses. The implementation and situation of each measure are explained below, along with the lower $CO_2$ emissions with each year.

## 5.1. 5.1. Solar energy

Solar energy plays an important role in the decarbonization of university campuses. For this reason, UPB decided to install photovoltaic systems in each university campus, which are overseen by the company INNOVASOL.

The La Paz campus was the first to install solar panels, with a peak capacity of 30.6 Kilowatts and an annual capacity of 63,450 Kilowatts. In October 2018, the solar panels were installed on the roof of one of the pavilions. Later, in January 2020 other solar panels were installed in the sector of the parking lots, with a potential of 18.5 Kilowatts.

In August 2019, the Cochabamba campus installed solar panels in the parking lots, with a peak capacity of 79.2 Kilowatts and an annual production of 142 Megawatts which is equivalent to the annual demand of 20 households. While the Santa Cruz campus formally opened in February 2020 with solar panels installed on the roof of the parking area, with a peak capacity of 29.25 Kilowatts.

For the university campuses that did not install the photovoltaic system, the $tCO_2$ emission per electricity consumption became higher, as can be observed in the following table:

**Table 18. $tCO_2$ emissions in electricity with and without solar panels in 2019 and 2022**

| Campus | 2019 Without solar panels | 2019 without solar panels | 2022 without solar panels | 2022 with solar panels |
|---|---|---|---|---|
| La Paz | 49 | 40 | 64 | 48 |
| Cochabamba | 45 | 43 | 50 | 34 |
| Santa Cruz | Did not exist | Did not exist | 53 | 46 |

Source: authors' calculation.

For this reason, the incorporation of solar energy is an alternative to energy based on fossil fuels. Table 19 shows the tons of carbon dioxide that the campuses did not emit due to using solar panels as an alternative source of energy.

**Table 19. $tCO_2$ not emitted in electricity due to solar energy use in 2019 and 2022**

| Campus | 2019 | 2020 |
|---|---|---|
| La Paz | 9 | 16 |
| Cochabamba | 2 | 16 |
| Santa Cruz | Did not exist | 7 |

Source: authors' calculation.

### 5.2. 5.2. Number of trees

The reduction of carbon in the atmosphere due to trees is the other alternative method of mitigating the effect of global warming. The trees photosynthesize the carbon dioxide and transform it into nutrients for the plant. So the reduction potential depends on the density of the wood, since denser and more durable trees will absorb a higher amount of carbon (Muñoz & Vásquez, 2020).

They will also contribute to the air quality and lower local temperature. In order to estimate the carbon absorption of all the trees on each university campus, they visited each campus. To calculate the 2019 and 2022 carbon footprint, 2019 and 2022 satellite maps for each campus had to be reviewed, in order to identify if there were differences in the green areas. If there were no differences, they assumed that the number of trees counted in 2022 was equal to 2019.

#### 5.2.1. Trees in the La Paz campus

**Image 1. Ground use**

Source: authors' calculation based on satellite imaging from Google Earth.

From the image we can see that areas 4, 6, 7, 8, 9, 11, 12, 19, 20, 22 and 24 are green areas, although with the campus visit some trees in areas 13 and 21 were observed, reaching an areas of 9,114.82 $m_2$. According to (Aquae Fundación, 2016), a tree absorbs 10 kg of $CO_2$ a year[12], or 0.010 tons, meaning that the 209 trees on campus absorb approximately 2 tons of carbon per year.

#### 5.2.2. Trees in the Cochabamba campus

**Imagen 2. Ground use**

Source: authors' calculation based on satellite imaging from Google Earth.

In the Cochabamba university campus the areas with trees are 0, 3, 4, 7, 8, 9, 10, 18, 31, 33, 37, 38, 39, 40, 41 and 43, representing a total of 17,473.31 $m^2$. During a campus visit a total of 494 trees were identifies, which represent an absorption capacity of approximately 5 $tCO_2$ per year.

[12] For more information visit: https://www.fundacionaquae.org/wp-content/uploads/2016/04/infografia_oxigeno.pdf

### 5.2.3. Trees in the Santa Cruz campus

**Image 3. Ground use**

Source: authors' calculation based on satellite imaging from Google Earth.

In the Santa Cruz university campus, the areas with trees are 1, 3, 4, 5, 6, 7, 11 and 16. They occupy 7,102,59 m². In the campus visit the trees that are within the campus and on the sidewalks were counted for a total of 58 trees, with an annual carbon absorption capacity of approximately 1 $tCO_2$. The $tCO_2$ that gets absorbed by the trees on each campus are shown below, recognizing that the Cochabamba campus has the highest number of trees, while the Santa Cruz campus has a lower absorption capacity because it has the lowest number of trees.

**Image 4. $tCO_2$ absorbed per number of trees in 2019 and 2022**

| | |
|---|---|
| Campus La Paz | 2 |
| Campus Cochabamba | 5 |
| Campus La Paz | 1 |

Source: authors' calculation based on counting the trees.

These data suggest that the annual emissions of $tCO_2$ in each UPB campus will decrease due to the absorption of $CO_2$ by the available trees in each campus.

**Table 20. Carbon footprint with and without the absorption of $CO_2$ by campus trees in 2019 and 2022 ($tCO_2$)**

| Campus | 2019 Without absorption | 2019 With absorption | 2022 Without absorption | 2022 With absorption |
|---|---|---|---|---|
| **La Paz** | 667 | **665** | 796 | **794** |
| **Cochabamba** | 2.208 | **2.203** | 1.623 | **1.618** |
| **Santa Cruz** | | | 684 | **683** |

Source: authors' calculation

# 6. Conclusions

The 2019 carbon footprint of the La Paz and Cochabamba campuses, without decarbonization measures through the absorption of CO2 by trees, is 667 tCO2eq and 2,205 tCO2eq. Although the Cochabamba campus emits more tons of carbon dioxide compared to the La Paz campus, the difference between the two campuses in terms of tCO2eq emission per capita is small.

The total emissions of $tCO_2eq$ for the La Paz campus increased by 19% (796 $tCO_2eq$) between 2019 and 2022. This is because the $CO_2$ emissions increased in all of the activities of Scopes 1, 2, and 3, with the exception of the infrastructure. The activities with the highest growth between 2019 and 2022 were gas (114%), water (46%) and electric energy (29%).

The Cochabamba campus emissions were reduced by 26% (1,623 $tCO_2eq$) because all of the activities, with the exception of infrastructure and electricity, diminished their impact. The activities with a higher decrease in $CO_2$ emissions were the consumption of writing paper (-50%), the consumption of beef (-47%) and the use of gas (-23%). This highlights that although the Santa Cruz campus has lower emissions (684 $tCO_2eq$), it has higher emissions per capita (2.07 tCO2eq/person) between the three campuses.

In terms of the distribution of the carbon footprint per Scope, Scope 3 contributes more than 90% of $CO_2$ emissions, which includes activities such as student and personnel transport, the generation of solid waste, the consumption of water, infrastructure constructed, food and writing paper use. Between all these activities in 2019 and 2022, the ones that generated the most carbon dioxide emissions were transport, food, infrastructure, solid wastes, and electricity consumption.

These two measures alone are not sufficient to reach net zero emissions by the year 2030. For this reason, it is important to think of new actions and measures that can be implemented constantly, along with the support of the students and personnel of each campus.

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