UNIVERSITÀ DI PARMA

# Inventory of $CO_2$ emissions at the University of Parma

2023

2025

# INDEX

**Document approved by the Academic Senate at its meeting on 28/10/2025 (Resolution SA/28-10-2025/122) and by the Board of Directors at its meeting on 30/10/2025.**

# 1. INTRODUCTION

This document presents the data used to estimate the $CO_2$ emissions of the University of Parma in 2023, as well as the methods used to calculate them and the main results for each sector and emission activity.

In general, the methodology used to estimate $CO_2$ emissions from different types of activities involves multiplying an activity indicator (e.g. fuel consumption or kilometers travelled by vehicle) by the corresponding emission factors.

The activity indicators were defined on the basis of data available from the University's facilities. For emission factors, reference was made to the values reported in the guidelines developed by the Climate Change Working Group of the RUS - Network of Universities for Sustainable Development (RUS-GdLCC, 2023).

After defining the types of activities and the boundaries of the system under consideration, the data sources and methodologies used for their processing are described below.

# 2. DEFINITION OF THE "BOUNDARIES" OF THE ACTIVITY

## 2.1. Reference year

The inventory was compiled for the year 2023. This is the first year for which a true emissions inventory has been compiled, covering various types of sources; prior to 2023, estimates of the University's $CO_2$ emissions were made based solely on gas and electricity consumption. It was decided to draw up the inventory for the year 2023, the most recent year for which the necessary data were available at the start of the activities. It should be noted that national and regional greenhouse gas inventories are also compiled with a delay of at least two years compared to the reference year, as the availability of complete and verified data and subsequent processing take time.

## 2.2. Organisational boundaries

The classification of University spaces considered for the emissions inventory consists of three levels: macro-areas, sites and buildings, in line with the SIPE classification.

The names of the first two categories are listed in **Table 2.1** below.

| Macro Area ID | Macro Area | ID Site | Site name |
|---|---|---|---|
| 1 | University Headquarters | 1 | University Headquarters |
| 2 | Other Historic Center Buildings | 0 | Musicology section |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex |
| 2 | Other Historic Center Buildings | 8 | Via Cavour |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex |
| 2 | Other Historic Center Buildings | 18 | Botanic garden |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex |
| 2 | Other Historic Center Buildings | 23 | Grossardi |
| 3 | Veterinary Campus | 14 | Veterinary Campus |
| 4 | University Hospital complex | 10 | University Hospital complex |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex |
| 5 | Science and Technology Campus | 13 | Science and Technology Campus |
| 6 | Valserena Abbey | 24 | Valserena Abbey |

*Table 2.1 Classification of University spaces into macro-areas and sites*

All buildings used for teaching, research, technical-administrative and service activities were considered; these data were provided by the Building Development and Infrastructure Unit of the University Building Management Department.
Buildings used as university student residences, whose current number cannot be accurately estimated, and apartments owned by the University and leased for residential use were excluded.

The sources of data on the number of students and PD-PTA staff were provided by the Planning and Management Control Unit.

The following "careers" have been grouped together in the macro-category "Teaching and technical-administrative staff":

- permanent professors;
- researchers;
- contract professors;
- technical and administrative staff;
- research fellows (not PhD students);
- PhD students

The following categories have been grouped together in the macro-category "Students":

- Active students: bachelor and master degrees, single cycle degree;
- Postgraduate students: professional master programme, advanced courses, specialization school

It should be noted that the number of students considered for the inventory of a given year always refers to the academic year ending in the reference year (e.g. for 2023, students enrolled in the 2022-2023 academic year, LT, LM, CU). Furthermore, although doctoral students can be considered students, it has been decided to include them in the category "Teaching and technical-administrative staff" as their attendance at the campus is more similar to that of members of this category than to that of students.
The distribution of floor space ($m^2$) and the number of students and PTA and PD staff by macro-area is shown in **Table 2.2**.

| ID | Macro Area | Number of Professors + Staff | | Number of Students | | Area ($m^2$) | | Number of buildings | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | University Headquarters | 307 | 11% | 2.492 | 8% | 18.549 | 9% | 4 | 5% |
| 2 | Other Historic Center Buildings | 543 | 19% | 11.420 | 35% | 44.992 | 21% | 21 | 27% |
| 3 | Veterinary Campus | 135 | 5% | 924 | 3% | 13.890 | 6% | 11 | 14% |
| 4 | University Hospital complex | 469 | 16% | 6.196 | 19% | 38.399 | 18% | 9 | 11% |
| 5 | Science and Technology Camp | 1.387 | 49% | 11.732 | 36% | 90.992 | 42% | 32 | 41% |
| 6 | Valserena Abbey | 13 | 0% | - | 0% | 8.564 | 4% | 2 | 3% |
| **Total** | | **2.854** | **100%** | **32.764** | **100%** | **215.386** | **100%** | **79** | **100%** |

*Table 2.2 - University staff, students and floor space by macro-area, year 2023*

Please note that for the year 2023, data relating to the degree courses 'Quality and procurement of raw materials for the agri-food sector' (based in Salsomaggiore Terme PR), 'Physiotherapy' (based in Fiorenzuola d'Arda AUSL Piacenza), 'Medicine and Surgery' (based in Piacenza) and 'Nursing' (based in several locations in PR - PC) have not been reported, as they were not available or because the locations themselves were not yet fully operational.

It should be noted that, for the same year, the Science and Technology Campus at the University of Parma accounted for 42% of the floor space of all university buildings, 36% in terms of enrolled students and 49% of technical and administrative staff (PTA) and teaching staff (PD).

The distribution of the number of PTA and PD staff by role and macro-area is shown in **Table 2.3**, while **Table 2.4** shows the distribution of the number of students by department and macro-area.

| | Macro Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Role** | **University Headquarters** | **Other Historic Center Buildings** | **Veterinary Campus** | **Hospital Complex** | **Science and Technology Campus** | **Valserena Abbey** | **Total** | **%** |
| Post-doctoral Researchers | 11 | 32 | 7 | 31 | 155 | | **236** | **8%** |
| Collaborators | | 21 | | 1 | 10 | | **32** | **1%** |
| Managers | 6 | | | | 2 | | **8** | **0%** |
| PhD Students | 1 | | | | | | **1** | **0%** |
| PhD Graduates | 26 | 84 | 28 | 88 | 412 | | **638** | **22%** |
| Staff | 207 | 214 | 43 | 123 | 320 | 13 | **920** | **32%** |
| Associate Professors | 18 | 85 | 26 | 99 | 211 | | **439** | **15%** |
| Full Professors | 20 | 46 | 16 | 50 | 118 | | **250** | **9%** |
| Researchers | 18 | 61 | 15 | 77 | 159 | | **330** | **12%** |
| **Total** | **307** | **543** | **135** | **469** | **1387** | **13** | **2854** | **100%** |
| **%** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0%** |

*Table 2.3 - University staff by role and macro-area, year 2023*

| **Depart. ID** | **Department** | **University Headquarters** | **Other Historic Center Buildings** | **Veterinary Campus** | **University Hospital complex** | **Science and Technology Campus** | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|
| 1 | Department of Humanities, Social Sciences and Cultural Industries | | 6.401 | | | | **6.401** | **20%** |
| 2 | Department of Law, Politics and International Studies | 2.492 | | | | | **2.492** | **8%** |
| 3 | Department of Engineering for Industrial Systems and Technologies | | | | | 2.470 | **2.470** | **8%** |
| 4 | Department of Engineering and Architecture | | | | | 2.161 | **2.161** | **7%** |
| 5 | Department of Medicine and Surgery | | | | 6.196 | | **6.196** | **19%** |
| 6 | Department of Chemistry, Life Sciences and Environmental Sustainability | | | | | 2.717 | **2.717** | **8%** |
| 7 | Department of Food and Drug | | | | | 3.318 | **3.318** | **10%** |
| 8 | Department of Economics and Management | | 5.019 | | | | **5.019** | **15%** |
| 9 | Department of Mathematical, Physical and Computer Sciences | | | | | 1.066 | **1.066** | **3%** |
| 10 | Department of Veterinary Science | | | 924 | | | **924** | **3%** |
| **Total** | | **2.492** | **11.420** | **924** | **6.196** | **11.732** | **32.764** | **100%** |
| **%** | | **0** | **0** | **0** | **0** | **0** | **1** | **0%** |

*Table 2.4 - Number of students at the University by department and macro-area, year 2023*

The distribution of the number of students by type of course is shown in **Table 2.5**.
It can be seen that most students are enrolled in Bachelor's and Master's degree courses.

| Depart. ID | Department | Degree course | Master's degree | Master | Specialization school | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | Department of Humanities, Social Sciences and Cultural Industries | 4.552 | 1.568 | 43 | 238 | **6.401** | **20%** |
| 2 | Department of Law, Politics and International Studies | 1.395 | 1.069 | 18 | 10 | **2.492** | **8%** |
| 3 | Department of Engineering for Industrial Systems and Technologies | 1.870 | 600 | | | **2.470** | **8%** |
| 4 | Department of Engineering and Architecture | 1.687 | 462 | 12 | | **2.161** | **7%** |
| 5 | Department of Medicine and Surgery | 1.828 | 2.891 | 488 | 989 | **6.196** | **19%** |
| 6 | Department of Chemistry, Life Sciences and Environmental Sustainability | 1.781 | 909 | 27 | | **2.717** | **8%** |
| 7 | Department of Food and Drug | 1.241 | 2.053 | | 24 | **3.318** | **10%** |
| 8 | Department of Economics and Management | 3.652 | 1.257 | 110 | | **5.019** | **15%** |
| 9 | Department of Mathematical, Physical and Computer Sciences | 949 | 117 | | | **1.066** | **3%** |
| 10 | Department of Veterinary Science | 478 | 389 | 32 | 25 | **924** | **3%** |
| **Total** | | **19.433** | **11.315** | **730** | **1.286** | **32.764** | **100%** |
| **%** | | **1** | **0** | **0** | **0** | **1** | **0%** |

*Table 2.5 – Number of students at the University by department and course of study, year 2023*

**Table 2.6** below shows the breakdown of the number of students by macro-area and type of course. As can be seen, the Science and Technology Campus alone accounts for almost the equivalent of the "Other historic centre complexes" (see Table 2.1) and together they are the areas where more than 70% of students are located.

| ID | Macro Area | Degree course | Master's degree | Master | Specialization school | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | University Headquarters | 1.395 | 1.069 | 18 | 10 | **2.492** | **8%** |
| 2 | Other Historic Center Buildings | 8.204 | 2.825 | 153 | 238 | **11.420** | **35%** |
| 3 | Veterinary Campus | 478 | 389 | 32 | 25 | **924** | **3%** |
| 4 | University Hospital complex | 1.828 | 2.891 | 488 | 989 | **6.196** | **19%** |
| 5 | Science and Technology Campus | 7.528 | 4.141 | 39 | 24 | **11.732** | **36%** |
| **Total** | | **19.433** | **11.315** | **730** | **1.286** | **32.764** | **100%** |
| **%** | | **59%** | **35%** | **2%** | **4%** | **100%** | |

*Table 2.6 – Breakdown of the number of students at the University by macro-area and course of study, year 2023*

## 2.3. Operational boundaries

*Pollutants*
Only carbon dioxide ($CO_2$) emissions were considered, as they are far more prevalent than emissions of other pollutants usually considered ($CH_4$, $N_2O$, F-gases). Furthermore, $CO_2$ emissions include structural emissions linked to the University's energy consumption, which can be more directly affected by the University's mitigation actions.

Based on assessments carried out by the Climate Change Working Group of the RUS - Network of Universities for Sustainable Development (RUS-GdLCC, 2023) and other assessments conducted on the presence of refrigeration equipment, it is estimated that $CO_2$ emissions account for more than 99% of total emissions. Neglecting other pollutants therefore does not reduce the accuracy of the overall estimate of the University's climate-changing emissions, which is much more closely linked to the accuracy of $CO_2$ emissions in a critical sector such as transport (as discussed below).

*Emission sources*

All the main direct and indirect emission sources linked to the University's main functions were considered, divided into 4 sectors and 16 activities, as shown in **Table 2.7**.

| Sector | Activity | Considered in 2023 Inventory | ISO 14064-1:2019 Category |
|---|---|---|---|
| Electricity Consumption | Lighting | yes | 2 |
| | Winter Heating/Cooling | yes | 2 |
| | Summer Cooling/Heating | yes | 2 |
| | Heavy Labs and Data Centers | yes | 2 |
| | Other Electrical Uses | yes | 2 |
| Gas Consumption | Winter Heating/Cooling | yes | 1 |
| | Summer Cooling/Heating | not existing | 1 |
| | Heavy Labs and Data Centers | not existing | 1 |
| | Electricity Generation for External Uses | not existing | 1 |
| | Other Gas Uses | not existing | 1 |
| | Electricity Generation for Internal Uses | not existing | 1 |
| District Heating | Winter Heating/Cooling | yes | 2 |
| | Summer Cooling/Heating | not existing | 2 |
| Transportation | Internal Staff Missions/Travel | yes | 3 |
| | Access to Campuses | no | 3 |
| | Mobility Students (e.g., Erasmus) | no | 3 |
| | University-Owned Vehicles | yes | 1 |
| Trees and Green Area Management | $CO_2$ absorptions by Trees | yes | 1 |
| | Green Area Management | yes | 6 |

*Table 2.7 - Sectors and activities considered for the purposes of estimating emissions, year 2023*

The following activities were not considered:

- canteens and food consumed: no reliable data is available on food consumption in canteens and other premises within the University; it should also be noted that estimates of the carbon footprint of such food are subject to considerable uncertainty and variability, depending on the source of the food itself and the methods of transport and storage;
- consumed or used goods: there is no reliable database on goods consumed or used at the University. Estimates of the carbon footprint of these goods are subject to considerable uncertainty and variability;
- services provided by third parties: the availability of reliable data on consumption related to services provided by third parties at the University has not been assessed. The exception is vehicles and machinery for green space management, which are considered in chapter 8.2;
- Fluorinated gas (HFC) emissions from refrigeration equipment: emissions related to fluorinated gas leaks from refrigeration equipment are not considered, as this information is not systematically available for all equipment present in the University. It should also be noted that the Kigali Agreement of October 2023 approved a fundamental amendment to the Montreal Protocol to accelerate the phase-out of HFCs (hydrofluorocarbons) used as refrigerants. This agreement will therefore lead to a reduction in HFC emissions from refrigeration equipment within a few years, thus reducing the impact of any additional policies introduced by the University.

In the table above, emissions have been attributed to the different categories provided for by ISO 14064:2019, as indicated by the RUS guidelines (RUS-GdLCC, 2023). ISO 14064 groups emissions into six categories:
Categoria 1 – direct emissions;
Categoria 2 - indirect emissions from imported energy;
Categoria 3 - indirect emissions from transport;
Categoria 4 - indirect emissions from products used by the organization;
Categoria 5 - indirect emissions associated with the use of products;
Categoria 6 - indirect emissions from other sources.

Category 1 includes emissions generated by sources owned or controlled by the University, and generally includes:

- emissions from stationary combustion sources based on fossil fuels for heat generation (building heating) or, where applicable, electricity generation;
- emissions from mobile combustion sources based on fossil fuels, linked to means of transport owned or controlled by the university;
- emissions linked to the unintentional release of greenhouse gases, such as fugitive emissions of refrigerants (e.g. hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) from cooling systems, or methane emissions from livestock farms owned by the university;
- emissions from any agricultural activities carried out on university-owned land, such as those related to the application of fertilisers, pesticides, manure and enteric fermentation;
- direct emissions and removals from land use, land use change and forestry (ULUCF).

Category 2 includes indirect emissions generated in the production of electricity consumed by the university, which generally includes:

- electricity purchased from the national grid;
- heat/steam/cooling purchased from third parties, such as the local district heating network or local cooling plants, where available.

Category 3 includes all emissions related to transport for various purposes, such as:

- for access to university premises by staff, students or visitors;
- for staff business trips (missions);
- for students on mobility programmes;
- for the transport of purchased materials.

Emissions from vehicles owned or controlled by the university that have already been considered in the previous categories are obviously excluded.

Category 4 includes all indirect emissions from products used by the University, for example:

- for the production of fuels used;
- for the production of sanitising products;
- for the production of refrigerant gases;
- for the production of stationery;
- for goods purchased by the university.

Category 5 includes all indirect emissions associated with the use of products originating from the University, for example for:

- solid waste disposal;
- wastewater treatment;
- assets owned by the organisation and leased to other entities;
- investments.

Category 6 includes all indirect emissions from other sources not considered.

# 3. ELECTRICITY CONSUMPTION SECTOR

## 3.1. Data source

Electricity consumption figures have been provided by the Energy Efficiency Coordination Office. These figures represent the annual consumption (in kWh) of all points of delivery (PODs) at 13 University sites; the data has been provided by electricity suppliers and verified and validated by the Office itself. PODs are not currently available for each building, so the Energy Efficiency Coordination Office provides overall data at site level.

## 3.2. Processing of electricity consumption data

The data for 2023, breakdown by site, are shown in **Table 3.1**.

| Macro Area ID | Macro Area | ID Site | Site name | Electricity consumption (kWh/year) | |
|---|---|---|---|---|---|
| 1 | University Headquarters | 1 | University Headquarters | 693.531 | 3,9% |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex | 1.165.899 | 6,5% |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex | 172.926 | 1,0% |
| 2 | Other Historic Center Buildings | 8 | Via Cavour | 1.371 | 0,0% |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex | 290.572 | 1,6% |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex | 27.374 | 0,2% |
| 2 | Other Historic Center Buildings | 18 | Botanic garden | 68.934 | 0,4% |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex | 85.259 | 0,5% |
| 3 | Veterinary Campus | 14 | Veterinary Campus | 1.426.788 | 8,0% |
| 4 | University Hospital complex | 10 | University Hospital complex | 1.409.070 | 7,9% |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex | 1.558.690 | 8,7% |
| 5 | Science and Technology Campus | 13 | Science and Technology Campus | 10.299.030 | 57,5% |
| 6 | Valserena Abbey | 24 | Valserena Abbey | 708.228 | 4,0% |
| | **Total** | | | **17.907.672** | **100%** |

*Table 3.1 - Total electricity consumption (kWh) by macro-area and site, year 2023*

Please note that consumption at the following sites has not been taken into account because:
- Casa della Musica: data on electricity consumption is not available; in future, this consumption, which is in any case very limited, could be estimated in proportion to that of the headquarters, based on the respective surface areas, which could be obtained from the Building Development and Infrastructure Unit, and considering the extent of use of the premises;
- Residences S. Ilario and Borgo Tanzi: in 2023, these complexes were assigned to indigent families and were not available to the University;
- Via Racagni (sports facilities): in 2023, they had already been reassigned to the Municipality of Parma;
- Farm S. Paolo Ravadese: there appear to have been no activities in 2023;
- Cinema District: there are still activities that are insignificant in terms of energy consumption, which have therefore not been taken into account;
- Campus sports facilities: these have always been managed by CUS.

Please also consider the following information:
- Palacampus consumption has been included in that of the Science and Technology Campus;
- the University Headquarters figure includes consumption of 34,803 kWh for the Parma UniverCity Info Point building;

- Via Cavour: in 2023, there were no staff working on the premises, as it was a building site undergoing renovation;
- The Via Kennedy/D'Azeglio campus does not include the consumption of the Vicolo Grossardi[1] complex;
- The Polyclinic-Hospital data does not include consumption relating to the premises used by the University located within some of the hospital's pavilions;
- The Botanical Garden data includes consumption of 3,070 kWh for a couple of flats housing the University Centre for International Cooperation and the Reception and Inclusion Centre;
- The electricity consumption data for the Science and Technology Campus includes 7,490 kWh for the Campus Nursery (opened in November 2023).

Most of the electricity consumption (approximately 60%) is recorded in the Science and Technology Campus Macro-area.

The electricity consumption sector is divided into five activities listed below, which, based on assessments carried out with the Energy Efficiency Coordination Office, have been assigned a percentage value of annual consumption for the following activities:

1. Lighting
2. Winter air conditioning
3. Summer air conditioning
4. Heavy laboratories and data centres
5. Other electrical uses

In the absence of specific data, which could be available following calculations relating to the breakdown of monthly electricity consumption into consumption classes F1, F2 and F3 (time bands of electricity consumption obtained from the energy service provider/supplier), or from more complex assessments related to daily and monthly consumption variability, the average values proposed by the Energy Efficiency Coordination Office, shown in Table 3.2, used for the year 2023, were considered, assuming they are the same for each site.

| ID | Activity | Electricity Consumption Breakdown (%) |
|---|---|---|
| 1 | Lighting | 15% |
| 2 | Winter Heating/Cooling | 5% |
| 3 | Summer Cooling/Heating | 7% |
| 4 | Heavy Labs and Data Centers | 35% |
| 5 | Other Electrical Uses | 38% |
| | **Total** | **100%** |

*Table 3.2 - Percentage breakdown of electricity consumption in different activities*

[1] The building is owned by the University of Parma and two floors have been leased/conceded to ER.GO., which is the registered owner of the meters for the entire building. For this reason, UniPR reimburses ER.GO. for the consumption relating to the floors used exclusively by the University. To date, the data has not been provided by the Building Development and Infrastructure Unit.

The estimate of electricity consumption per activity is based on the definition of the percentages of total consumption for each type of activity, according to the following formula:

$$Consumo\_ee\_att = [Consumo\_ee] \cdot [Perc\_Consumo] / 100$$

where:
*Consumo_ee_att*: electricity consumption by type of activity
*Consumo_ee*: total electricity consumption of the University
*Perc_Consumo*: percentage of total consumption for each activity

**Table 3.3** shows the University's total electricity consumption for the year 2023, breakdown by individual activity based on the allocation percentages described above, for each macro-area.

| | Lighting | Winter Heating/Cooling | Summer Cooling/Heating | Heavy Labs and Data Centers | Other Electrical Uses | Total |
|---|---|---|---|---|---|---|
| **Breakdown %** | 15% | 5% | 7% | 35% | 38% | 100% |
| University Headquarters | 104.030 | 34.677 | 48.547 | 242.736 | 263.542 | 693.531 |
| Other Historic Center Buildings | 271.850 | 90.617 | 126.863 | 634.317 | 688.687 | 1.812.335 |
| Veterinary Campus | 214.018 | 71.339 | 99.875 | 499.376 | 542.179 | 1.426.788 |
| University Hospital complex | 445.164 | 148.388 | 207.743 | 1.038.716 | 1.127.749 | 2.967.760 |
| Science and Technology Campus | 1.544.855 | 514.952 | 720.932 | 3.604.661 | 3.913.631 | 10.299.030 |
| Valserena Abbey | 106.234 | 35.411 | 49.576 | 247.880 | 269.127 | 708.228 |
| **Total** | **2.686.151** | **895.384** | **1.253.537** | **6.267.685** | **6.804.915** | **17.907.672** |

*Table 3.3 - Estimated electricity consumption (kWh) breakdown by macro-area and activity, year 2023*

It should be noted that in 2017, a wood chip gasifier (built as part of the SYNBIOSE research project) was launched at the Science and Technology Campus, which powers a 125kW electric cogenerator. These emissions have not been taken into account, in line with what is generally done in emissions inventories, as the $CO_2$ is of photosynthetic origin and therefore does not increase atmospheric levels. In addition, a trigenerator came into operation at the Science and Technology Campus in December 2024, while a biomass gasifier was commissioned in 2025 (for research purposes). Neither of these are considered for the purposes of emissions for the year 2023 as they are not yet active.

## 3.3. estimated emissions of $CO_2$

To estimate indirect $CO_2$ emissions associated with electricity consumption, emission factor data estimated from data published by ISPRA (Higher Institute for Environmental Protection and Research) in the document *'Emission factors for electricity production and consumption in Italy in 2023 - publication date 22 May 2024'* (ISPRA, 2025) according to the methodology described in the document *'Operational guidelines for the preparation of greenhouse gas emission inventories in Italian universities'*, defined by the RUS Climate Change Working Group - Network of Universities for Sustainable Development (RUS-GdLCC, 2023), which provides for the consideration of network losses but not imported electricity.
In estimating the emission factor, an average network loss value of 0.1% was considered for high to medium voltage losses and 0.9% for losses related to medium to low voltage transformation (ARERA, 2025).
The emission factor to take into account the lower network losses can be calculated using the formula:

$$FE_{MT} = FE\_consumi\_ISPRA \cdot (100 - P_{BT})/100$$

where:
$FE_{MT}$: electricity consumption emission factor considering network losses up to medium voltage ($gCO_2$/kWh)
$FE\_{}_{consumi\_ISPRA}$: electricity consumption emission factor provided by ISPRA (last column in **Table 4** in ISPRA, 2024), considering network losses up to low voltage ($gCO_2$/kWh)
$P_{BT}$: network losses in the national grid up to low voltage (%)

The emission factor value is 239.9 $gCO_2$/kWh (electricity consumption column for 2023, sheet 14, ISPRA, 2024) and relates to low voltage consumption. It should be noted that, according to ISPRA data, the Italian grid records a loss of 0.1% for the transformation from high to medium voltage, while the loss for the transformation from low to medium voltage is 0.9%.
For medium voltage PODs, an FE equal to:

$$F.E._{MT} = F.E._{BT} \cdot (100 - 0,9) / 100 = 239,9 \cdot (100 - 0,9) / 100 = 237,7\ gCO_2/kWh.$$

The average value of the emission factor takes into account the share of electricity consumed in 2023 in MT (5%) and BT (95%):

$$FE = F.E._{MT} \cdot 0.05 + F.E._{BT} \cdot 0.95 = 237,8\ gCO_2/kWh.$$

The formula for estimating $CO_2$ emissions is as follows:

$$EMIS\_ee = [Consumo\_ee] \cdot [FE] / 1.000.000$$

where:
*EMIS_ee*: $CO_2$ emissions in tonnes per year from total electricity consumption
*Consumo_ee:* total electricity consumption in kWh/year
*FE*: $CO_2$ emission factor in $gCO_2$/kWh.

*Emissions from the electricity consumption sector are shown in* ***Table 3.4.***

| Macro Area ID | Macro Area | Electricity consumption (kWh/year) | FE ($gCO_2$/kWh) | $CO_2$ emissions (t/year) |
|---|---|---|---|---|
| 1 | University Headquarters | 693.531 | 237,8 | 165 |
| 2 | Other Historic Center Buildings | 1.812.335 | | 431 |
| 3 | Veterinary Campus | 1.426.788 | | 339 |
| 4 | Hospital Complex | 2.967.760 | | 706 |
| 5 | Science and Technology Campus | 10.299.030 | | 2.449 |
| 6 | Valserena Abbey | 708.228 | | 168 |
| | **Total** | **17.907.672** | | **4.258** |

*Table 3.4 - Emissions from electricity consumption ($tCO_2$/year) by macro-area, year 2023*

# 4. GAS CONSUMPTION SECTOR

## 4.1. Data source

Natural gas consumption figures were provided by the Energy Efficiency Coordination Office. These are the annual consumption figures for all gas delivery points (PDR) in kWh/year (converted to $m^3$/year using a conversion factor of 9.626) for nine University sites. the data was provided by methane gas retailers, verified and validated by the office itself. Please note that consumption data is available for individual PDRs, not for each building; the Energy Efficiency Coordination Office has provided overall data at site level.
Natural gas consumption for the year 2023 is mainly (99.9%) derived from annual consumption data (in m3/year) collected from all active gas delivery points (PDRs) at the University, as reported by the aforementioned office. This data was made available by third parties through billing invoices.

## 4.2. Processing of gas consumption data

Total gas consumption in 2023, breakdown by site, is shown in **Table 4.1**.

| Macro Area ID | Macro Area | ID Site | Site name | Gas consumption ($m^3$/year) | |
|---|---|---|---|---|---|
| 1 | University Headquarters | 1 | University Headquarters | 73.960 | 5,0% |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex | 11.480 | 0,8% |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 8 | Via Cavour | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex | 12.333 | 0,8% |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 18 | Botanic garden | 15.195 | 1,0% |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex | 0 | 0,0% |
| 3 | Veterinary Campus | 14 | Veterinary Campus | 101.562 | 6,8% |
| 4 | University Hospital complex | 10 | University Hospital complex | 215.570 | 14,5% |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex | 90.810 | 6,1% |
| 5 | Science and Technology Campu | 13 | Science and Technology Campus | 901.308 | 60,6% |
| 6 | Valserena Abbey | 24 | Valserena Abbey | 65.555 | 4,4% |
| | **Total** | | | **1.487.773** | **100%** |

*Table 4.1 - Total natural gas consumption (m3) by macro-area and site, year 2023 (sites not served by gas are shown in grey)*

It should be noted that gas consumption at Casa della Musica, Residences S. Ilario and Borgo Tanzi, Racagni (sports facilities), Farm Paolo Ravadese, Cinema District and the Campus sports facilities has not been taken into account for the same reasons outlined in point 3.2 with regard to electricity consumption.

Please also consider the following information:

- Palacampus consumption has been included in that of the Science and Technology Campus;
- Parma UniverCity Info Point: heating consists solely of electricity;
- Via Cavour: in 2023, there were no staff working on the premises as it was a building site undergoing renovation;

- The data for the Botanical Garden also includes the consumption of the apartment housing the University Centre for International Cooperation (B.go Felino);
- S. Francesco: this site has a fan coil system (water + electricity) for heating;
- S. Michele: this site has a fan coil system (water + electricity) for heating;
- Pilotta: this site has a fan coil system (water + electricity) for heating;
- The Via Kennedy/D'Azeglio campus does not include consumption for the Vicolo Grossardi[2] complex;
- The data relating to the Polyclinic-Hospital does not include consumption by the University premises located within some of the Hospital's pavilions, both because the consumption is limited and because it is difficult to separate it from that of the Hospital itself.

As can be seen, most natural gas consumption is recorded in the Science and Technology Campus Macro-area (approximately 61% of consumption, for a total of 901,308 $m^3$).

In 2023, gas was used at the university only for winter heating and not for other purposes (such as summer cooling, heavy laboratories and data centres, internal electricity production or external electricity production) indicated in the classification proposed by the RUS guidelines (RUS-GdLCC, 2023).

### 4.3. Estimated $CO_2$ emissions

To estimate indirect $CO_2$ emissions associated with natural gas consumption, data representing the average values for the three years prior to the inventory reference year (2020-2022) were used:

- Lower heating value of natural gas = 0.035457 GJ/$Stdm^3$;
- Emission factor = 56.518 $kgCO_2$/GJ and 2.004 $kgCO_2/m^3$.

These represent the average values valid for calculating emissions from 1 January 2023 to 31 December 2023.

Consumption data, available in standard m3/year, has been converted to GJ/year using the Lower Calorific Value value taken from the 'Table of National Standard Parameters', published and updated annually by the Ministry of the Environment, Land and Sea Protection (MATTM), as suggested in the aforementioned RUS guidelines (RUS-GdLCC, 2023).

The calorific value and gas emission factor data may be more accurate in the future based on specific data on the type of gas that may be communicated by suppliers.

The methodology for estimating emissions is as follows:

$$EMIS\_gas = [Consumo\_gas] \cdot [FE] / 1000$$

where:
*EMIS_gas*: $CO_2$ emissions in tonnes per year from gas consumption for domestic use
*Consumo_gas*: total gas consumption in GJ/year for domestic use
*FE*: CO2 emission factor in kgCO2/GJ.

[2] The building is owned by the University of Parma and two floors have been leased/conceded to ER.GO., which is the registered owner of the meters for the entire building. For this reason, UniPR reimburses ER.GO. for the consumption relating to the floors used exclusively by the University. To date, the data has not been provided by the Building Development and Infrastructure Unit.

The F.E. of natural gas was taken from the document 'Coefficients used for the $CO_2$ emissions inventory in the UNFCCC national inventory (average of values for the years 2020-2022)'; this value, equal to 2.004 $kgCO_2/m^3$, is specified as being usable for calculating emissions from 1 January 2023 to 31 December 2023.

**Table 4.2** below shows $CO_2$ emissions resulting from total gas consumption.

| Macro Area ID | Macro Area | Gas consumption ($m^3$/year) | FE ($kgCO_2/m^3$) | $CO_2$ emissions (t/year) |
|---|---|---|---|---|
| 1 | University Headquarters | 73.960 | 2,004 | 148 |
| 2 | Other Historic Center Buildings | 39.008 | | 78 |
| 3 | Veterinary Campus | 101.562 | | 204 |
| 4 | Hospital Complex | 306.380 | | 614 |
| 5 | Science and Technology Campu | 901.308 | | 1.806 |
| 6 | Valserena Abbey | 65.555 | | 131 |
| | **Total** | **1.487.773** | | **2.981** |

*Table 4.2 - Emissions from total gas consumption ($tCO_2$/year) by macro-area, year 2023*

# 5. DISTRICT HEATING SECTOR

## 5.1. Data source

Heat consumption (in thermal kWh) in 2023 on campuses with buildings connected to district heating networks outside the university is based on annual consumption data provided by the Energy Efficiency Coordination Office.

| Macro Area ID | Macro Area | ID Site | Site name | District Heating Consumption ($kWh_t$/year) | |
|---|---|---|---|---|---|
| 1 | University Headquarters | 1 | University Headquarters | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex | 880.307 | 48,5% |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex | 184.500 | 10,2% |
| 2 | Other Historic Center Buildings | 8 | Via Cavour | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex | 357.581 | 19,7% |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex | 88.514 | 4,9% |
| 2 | Other Historic Center Buildings | 18 | Botanic garden | 0 | 0,0% |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex | 304.111 | 16,8% |
| 3 | Veterinary Campus | 14 | Veterinary Campus | 0 | 0,0% |
| 4 | University Hospital complex | 10 | University Hospital complex | 0 | 0,0% |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex | 0 | 0,0% |
| 5 | Science and Technology Campus | 13 | Science and Technology Campus | 0 | 0,0% |
| 6 | Valserena Abbey | 24 | Valserena Abbey | 0 | 0,0% |
| | **Total** | | | **1.815.013** | **100%** |

*Table 5.1 - Total energy consumption from district heating (kWht) by macro-area and site, year 2023*

Please note that consumption figures for the following macro-areas have not been disclosed because:
- Residences in S. Ilario-B. go Tanzi: these complexes had already been assigned to low-income families in the reference year;

- Via Racagni (sports facilities): these had already been reassigned to the municipality in 2023;
- Farm S. Paolo Ravadese: there were no activities in the reference year 2023, nor are there any at present;
- Cinema District: there are still insignificant activities that are not taken into account at this stage;
- Campus sports facilities: these have always been managed by CUS.

Please also consider the following information:
- The Via Kennedy/D'Azeglio campus may also include consumption from the Vicolo Grossardi[3] complex (this is a UniPR building, with a canteen floor under concession and two floors rented to ER.GO., to which UniPR pays reimbursements, with the meter registered in their name);
- The Policlinico-Ospedale data does not include consumption relating to premises used by the University located within some of the hospital buildings (mixed use).

Most district heating consumption is recorded in the Kennedy/D'Azeglio Campus macro-area (approximately 50% for a total of 880,307 kWh).

## 5.2. Estimated $CO_2$ emissions

To estimate the indirect $CO_2$ emissions associated with district heating consumption, the emission factor data provided by Dichiarazione RINA Services/IREN zona Parma (F.E. equal to 77 $gCO_2eq/KWh$) were used.
The methodology used to estimate emissions is as follows:

$$EMIS\_TLR = [Consumo\_TLR] \cdot [FE] / 1.000.000$$

To calculate $CO_2$ emissions from district heating consumption, we use the standard emission factor for natural gas in Italy in the Parma area for the year 2022, also used for the year 2023, equal to 77 $gCO_2eq/KWh$. Multiplying this by the thermal consumption from district heating gives us the emissions directly attributable to our consumption:

$$(1.815.013 \cdot 77\ gCO_2eq/kWh)/1.000.000 = 139,8\ tCO_2/year$$

**Table 5.2** below shows $CO_2$ emissions resulting from district heating consumption.

| Macro Area ID | Macro Area | District Heating Consumption (kWht/year) | FE ($gCO_2eq$/ kWh) | $CO_2$ emissions (t/year) |
|---|---|---|---|---|
| 1 | University Headquarters | | | |
| 2 | Other Historic Center Buildings | 1.815.013 | | 140 |
| 3 | Veterinary Campus | | 77 | |
| 4 | Hospital Complex | | | |
| 5 | Science and Technology Campu | | | |
| 6 | Valserena Abbey | | | |
| | **Total** | **1.815.013** | | **140** |

*Table 5.2 - Emissions ($tCO_2$/year) from district heating consumption by macro-area in 2023*

[3] This concerns the UniPR building, the canteen floor and an additional floor rented/leased to ER.GO., to which UniPR pays reimbursements, with the meter registered in their name – to date, the data has not yet been provided by the Building Development and Infrastructure Unit.

## 6. SUMMARY OF $CO_2$ EMISSIONS FROM ENERGY CONSUMPTION

This section summarises the estimated $CO_2$ emissions from energy consumption in the electricity, gas and district heating sectors, expressed in GJ/year.
**Table 6.1** shows the total emissions from electricity consumption, natural gas consumption for internal use (excluding consumption for electricity production sold outside the University) and district heating consumption; **Table 6.2** shows the same data but converted into tonnes of $CO_2$/year.

| Macro Area ID | Macro Area | ID Site | Site name | Electricity consumption (GJ/year) | | Gas consumption (GJ/year) | | District Heating consumption (GJ/year) | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | University Headquarters | 1 | University Headquarters | 2.497 | 3,9% | 2.563 | 5% | | 0% |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex | 4.197 | 6,5% | 398 | 1% | 3.169 | 49% |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex | 623 | 1,0% | | 0% | 664 | 10% |
| 2 | Other Historic Center Buildings | 8 | Via Cavour | 5 | 0,0% | | 0% | | 0% |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex | 1.046 | 1,6% | 427 | 1% | 1.287 | 20% |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex | 99 | 0,2% | | 0% | 319 | 5% |
| 2 | Other Historic Center Buildings | 18 | Botanic garden | 248 | 0,4% | 527 | 1% | | 0% |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex | 307 | 0,5% | | 0% | 1.095 | 17% |
| 3 | Veterinary Campus | 14 | Veterinary Campus | 5.136 | 8,0% | 3.519 | 7% | | 0% |
| 4 | University Hospital complex | 10 | University Hospital complex | 5.073 | 7,9% | 7.470 | 14% | | 0% |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex | 5.611 | 8,7% | 3.147 | 6% | | 0% |
| 5 | Science and Technology Campus | 13 | Science and Technology Campus | 37.076 | 57,5% | 31.233 | 61% | | 0% |
| 6 | Valserena Abbey | 24 | Valserena Abbey | 2.550 | 4,0% | 2.272 | 4% | | 0% |
| | **Total** | | | **64.467** | **100%** | **51.556** | **100%** | **6.534** | **100%** |

*Table 6.1 - Total energy consumption by macro-area and site, year 2023*

| | | | | $CO_2$ emissions (t/year) | | | | |
|---|---|---|---|---|---|---|---|---|
| Macro Area ID | Macro Area | ID Site | Site name | Electricity | Gas | District Heating | Total | % |
| 1 | University Headquarters | 1 | University Headquarters | 165 | 148 | | 313 | 4,2% |
| 2 | Other Historic Center Buildings | 6 | D'Azeglio-Kennedy complex | 277 | 23 | 68 | 368 | 5,0% |
| 2 | Other Historic Center Buildings | 7 | Viale San Michele complex | 41 | | 14 | 55 | 0,7% |
| 2 | Other Historic Center Buildings | 8 | Via Cavour | | | | | 0,0% |
| 2 | Other Historic Center Buildings | 9 | B.go Carissimi complex | 69 | 25 | 28 | 121 | 1,6% |
| 2 | Other Historic Center Buildings | 16 | Pilotta complex | 7 | | 7 | 13 | 0,2% |
| 2 | Other Historic Center Buildings | 18 | Botanic garden | 16 | 30 | | 47 | 0,6% |
| 2 | Other Historic Center Buildings | 19 | San Francesco complex | 20 | | 23 | 44 | 0,6% |
| 3 | Veterinary Campus | 14 | Veterinary Campus | 339 | 204 | | 543 | 7,4% |
| 4 | University Hospital complex | 10 | University Hospital complex | 335 | 432 | | 767 | 10,4% |
| 4 | University Hospital complex | 21 | Integrated Bio-tech complex | 371 | 182 | | 553 | 7,5% |
| 5 | Science and Technology Campus | 13 | Science and Technology Campus | 2.449 | 1.806 | | 4.255 | 57,7% |
| 6 | Valserena Abbey | 24 | Valserena Abbey | 168 | 131 | | 300 | 4,1% |
| | **Total** | | | **4.258** | **2.981** | **140** | **7.379** | 100% |
| | **%** | | | **58%** | **40%** | **1,9%** | **100%** | 0% |

*Table 6.2 - Total $CO_2$ emissions (t/year) from energy consumption by macro-area and site, year 2023*

## 7. TRANSPORT SECTOR

$CO_2$ emissions from the transport sector took into account the following main sources:

- travel by staff using vehicles owned by the University;
- travel by University staff on business trips.

For 2023, emissions from journeys made by teaching staff, students and technical and administrative staff to access the campus were not taken into account due to the lack of reliable data on the number of kilometers travelled.

## 7.1. Vehicles owned by the University

### 7.1.1. Data source

The data is derived from information provided by the University's General Accounting and Procurement Office, which reported consumption data for 24 vehicles for the year 2023 out of a total of 34 vehicles, which are classified into the following categories:

- 16 cars
- 14 lorries
- 2 special-purpose vehicles (one for transporting disabled persons and one for transporting horses)
- 1 lawnmower
- 1 tractor

For the 10 vehicles, for which consumption data was not provided by the accounting department, it was necessary to request consumption data from:

- Department of Veterinary Sciences for two lorries, one petrol and one diesel, for a special-purpose diesel vehicle (horse transport) and a diesel tractor;
- Department of Mathematical, Physical and Computer Sciences (Administration and Technical Scope) for a petrol-powered car;
- Department of Food and Drug for a petrol car;
- Department of Engineering and Architecture (Technical Division) for a diesel lorry;
- Department of Chemistry, Life Sciences and Environmental Sustainability for a petrol lorry;
- VISLAB (Society correlated to DIA) for a diesel car;
- University Headquarters for a diesel car.

Electric vehicles (five in total, including four cars and one lorry) were excluded as their energy consumption is already included in the University's electricity consumption.
The data comes from all University departments (areas and departments) that use service cars or vans and from the supplier of the fuel cards purchased by the University, through Consip, for refuelling, which may vary from year to year. With regard to the fuel purchased for 2023 by the four vehicles in use by the Department of Veterinary Sciences, only the total figure for the four vehicles was provided, so the figure was divided equally between the four vehicles (payment of £2,694). Veterinary Medical Sciences, only the total figure for the four vehicles was provided, so the figure was divided equally between the four vehicles (total payment of €2,694.70 for adherence to the Consip Framework Agreement called “FUEL CARD 2” - REF: ODA MEPA 6646609).

### 7.1.2. Data processing

Since consumption data was provided in €/year for all vehicles (and only for some vehicles also in litres/year), it was decided to adopt €/year as a uniform indicator. Subsequently, the values expressed in €/year were converted into litres/year, using the average fuel sales prices shown in the following table.

| Type of Fuel | Service Type | Average Price (€/l) * |
|---|---|---|
| Gasoline | Self-Service | 1,75 |
| | Attended | 1,95 |
| Diesel | Self-Service | 1,65 |
| | Attended | 1,85 |
| CNG | Attended | 1,3 |

* €/kg for CNG

*Table 7.1 - Average fuel price considered, year 2023*

| | Macro Area ID | Macro Area | Gasoline (l/year) | Diesel (l/year) | CNG (kg/year) |
|---|---|---|---|---|---|
| **Consumption** | 1 | University Headquarters | 2.359 | 1.024 | 1.403 |
| | 2 | Other Historic Center Buildings | 74 | 1.051 | |
| | 3 | Veterinary Campus | | 2.055 | |
| | 4 | Hospital Complex | | | |
| | 5 | Science and Technology Campus | 1.229 | 2.741 | |
| | 6 | Valserena Abbey | | | |
| | | **Total** | **3.662** | **6.871** | **1.403** |

*Table 7.2 - Fuel consumption of vehicles owned by the University by macro-area, year 2023*

***Table 7.3** shows the consumption of different types of fuel breakdown by vehicle type for the year 2023.*

| Vehicle Type | Type of Fuel | Vehicle n° | Fuel Consumption Year 2023 (l/year)* |
|---|---|---|---|
| Truck | Gasoline | 1 | 173 |
| | Diesel | 17 | 3554 |
| Special Purpose Vehicle | Diesel | 2 | 949 |
| Car | Gasoline | 18 | 3489 |
| | Diesel | 7 | 1647 |
| | CNG | 2 | 1403 |
| Lawnmower | Diesel | 1 | 357 |
| Tractor | Diesel | 1 | 364 |

* kg/year for CNG

*Table 7.3 - Fuel consumption of vehicles owned by the University by type of vehicle and fuel, year 2023*

### 7.1.3. $CO_2$ emissions stimate

The emissions estimation algorithm is as follows:

$$EMIS\_veic = [Consumo\_carb] \cdot [FE\_medio]/1000$$

where:
*EMIS_veic*: $CO_2$ emissions in tonnes per year from vehicles owned by the University
*Consumo_carb*: total consumption by type of vehicle
*FE_medio*: $CO_2$ emission factor in $kgCO_2/l$ by type of vehicle.

The emission factors used for petrol and diesel vehicles were 2.33 $kgCO_2/l$ and 2.63 $kgCO_2/l$ respectively, derived from the average values proposed by the RUS guidelines (RUS-GdLCC, 2023) based on ISPRA data. This figure has a low degree of uncertainty as it is linked to fuel composition.
For methane-powered vehicles, the data in kg of fuel were multiplied by an emission factor of 2.75 $kgCO_2/kg$ derived from the same source.

**Table 7.4** shows $CO_2$ emissions (t/year) relating to the consumption of different types of fuel, breakdown by macro-area.

| | Macro Area ID | Macro Area | Gasoline $CO_2$ (t/year) | Diesel $CO_2$ (t/year) | CNG $CO_2$ (t/year) | Total $CO_2$ (t/year) |
|---|---|---|---|---|---|---|
| **$CO_2$ emissions (t/year)** | 1 | University Headquarters | 5,5 | 2,7 | 3,9 | 12,0 |
| | 2 | Other Historic Center Buildings | 0,2 | 2,8 | - | 2,9 |
| | 3 | Veterinary Campus | - | 5,4 | - | 5,4 |
| | 4 | Hospital Complex | - | - | - | - |
| | 5 | Science and Technology Campu | 2,9 | 7,2 | - | 10,1 |
| | 6 | Valserena Abbey | - | - | - | - |
| | | **Total** | **8,5** | **18,1** | **3,9** | **30,5** |

*Table 7.4 - CO2 emissions (t/year) related to fuel consumption by macro-area, year 2023*

## 7.2. UniPR staff missions

### 7.2.1. Data source

The data comes from information provided by the University's Salaries, Remuneration and Social Security Unit, which reported data on business trips for the year 2023. The data comes from all University departments (areas and departments) that used trains, cars, taxis, aeroplanes, buses, underground trains and ships. However, for the purposes of the analysis, only travel by car, train and aeroplane was considered, as an initial assessment showed that emissions associated with other means of transport are more complex to quantify and have a negligible impact on the overall total.

### 7.2.2. Data processing

*Car*

The data relating to car travel was provided by the Salaries, Remuneration and Social Security Unit, which indicated the city or town of destination and the amount of reimbursement, but not the actual number of kilometers travelled during the missions. It was found that reimbursements varied significantly even for the same destinations: this suggests that, in some cases, the car journey was made directly from the University headquarters (Parma) or from home to the final destination, while in other cases the location was reached by other means and the car was used only for local journeys, for example to reach the railway station or airport. Consequently, it was not possible to use the distance between Parma and the destination for the calculations, but it was necessary to estimate the kilometers travelled based on the amounts reimbursed, assuming an average cost of approximately €0.37/km, considered as the average cost per kilometer for the purposes of mission reimbursement.

*Train*

The data relating to train travel was provided by the Salaries, Remuneration and Social Security Unit, which indicated the city or town of destination and the amount of reimbursements, but not the actual kilometers travelled during the missions. It was found that reimbursements varied significantly even for the same destinations: beyond the differences in the cost of different trains (e.g. high-speed, intercity, regional), it was found that, in some cases, the location was reached via different routes, also using other types of transport to reach the indicated destination. Consequently, it was not possible to use the distance between Parma and the destination for the calculations, but it was necessary to estimate the kilometers travelled based on the amounts reimbursed, assuming an average cost of train travel of approximately £0.2/km. This value is an average of the cost of regional trains (€0.10-0.15/km), intercity trains (€0.12-0.22/km), high-speed trains (€0.20-0.45/km) and trains in other countries, which have higher costs.

*Airplane*

Data relating to train travel was provided by the Salaries, Remuneration and Social Security Unit, while data relating to air travel was provided by indicating the destination city. To obtain the distances in kilometers, the Carbon Emissions Calculator of the International Civil Aviation Organisation (ICAO, 2024) was used, which provides the distance for each route, as well as the average $CO_2$ emissions for air travel.

The total estimated kilometers for emissions from different means of transport are shown in **Table 7.5**.

| Macro Area ID | Macro Area | Car (km/year) | Train (km/year) | Plane (km/year) | Total (km/year) | % |
|---|---|---|---|---|---|---|
| 1 | University Headquarters | 16.170 | 75.952 | 48.288 | 140.409 | 4% |
| 2 | Other Historic Center Buildings | 34.648 | 160.693 | 570.876 | 766.217 | 24% |
| 3 | Veterinary Campus | 34.726 | 17.038 | 28.238 | 80.002 | 3% |
| 4 | Hospital Complex | 81.173 | 67.312 | 194.138 | 342.623 | 11% |
| 5 | Science and Technology Campus | 331.344 | 292.901 | 1.215.576 | 1.839.821 | 58% |
| 6 | Valserena Abbey | - | - | - | - | 0% |
| **Total** | | **498.060** | **613.896** | **2.057.116** | **3.169.073** | 100% |
| **%** | | 16% | 19% | 65% | 100% | 0 |

*Table 7.5 - Distances (km/year) travelled for missions by macro-area and type of vehicle, year 2023*

### 7.2.3. $CO_2$ emissions estimate

*Car*

Once the distance in kilometers was obtained, the average emission factor (FE_average) of 163 $kgCO_2/km$ reported in the RUS guidelines (RUS-GdLCC, 2023) was applied.
Emissions were then estimated using the following formula:

$$EMIS\_miss\_auto = [km\_tot] \cdot [FE\_medio]/1000000$$

where:
*EMIS_miss_auto*: $CO_2$ emissions in tonnes per year from cars used for university business
*km_tot*: total kilometers travelled for the mission
*FE_medio*: $CO_2$ emission factor in $kgCO_2/km$.

*Train*
Once the distance in kilometers was obtained, the emission factor (EF) of 27 $gCO_2$/passenger/km reported in the RUS guidelines (RUS-GdLCC, 2023) was applied.
Emissions were then estimated using the following formula:

$$EMIS\_miss\_treno = [km\_tot] \cdot [FE] / 1000000$$

where:
*EMIS_miss_treno*: $CO_2$ emissions in tonnes per year from train journeys
*km_tot*: total consumption by type of vehicle
*FE*: $CO_2$ emission factor in $gCO_2$/passenger/km

*Airplane*
To obtain the emission values, the Carbon Emissions Calculator of the International Civil Aviation Organisation (ICAO, 2024) was used, which provides the average emission value of air travel for each route, expressed in $kgCO_2$.
To simplify the calculations, the distances between the nearest airport from which the route was planned to the destination were calculated; for arrival locations that were not directly accessible – if more than 100 km away – domestic flights were evaluated in order to reach the destination, and these data were also added in terms of distances in km and additional emissions in $kgCO_2$.

The total $CO_2$ emissions resulting from staff missions are shown in **Table 7.6**.

| Macro Area ID | Macro Area | Car $CO_2$ (t/year) | Train $CO_2$ (t/year) | Plane $CO_2$ (t/year) | Total $CO_2$ (t/year) | % |
|---|---|---|---|---|---|---|
| 1 | University Headquarters | 2,6 | 2,1 | 9,5 | **14,1** | **4%** |
| 2 | Other Historic Center Buildings | 5,6 | 4,3 | 72,1 | **82,1** | **23%** |
| 3 | Veterinary Campus | 5,7 | 0,5 | 2,3 | **8,5** | **2%** |
| 4 | Hospital Complex | 13,2 | 1,8 | 25,9 | **41,0** | **12%** |
| 5 | Science and Technology Campus | 54,0 | 7,9 | 143,1 | **205,0** | **58%** |
| 6 | Valserena Abbey | - | - | - | **-** | **-** |
| **Total** | | **81** | **17** | **253** | **351** | **100%** |
| **%** | | **23%** | **5%** | **72%** | **100%** | **0%** |

*Table 7.6 - $CO_2$ emissions (t/year) by mission, macro-area and type of vehicle, year 2023*

The two tables above clearly show that trains are by far the most advantageous means of transport in terms of emissions per kilometer.

## 8. TREES AND GREEN SPACE MANAGEMENT

This chapter provides estimates of $CO_2$ absorption flows from trees located in various areas of the University and emissions resulting from green space management activities, which include both trees (pruning, felling, etc.) and green spaces (grass cutting, hedge management, etc.). $CO_2$ absorption from mowing lawns and trimming hedges is not considered, as this contribution is considered negligible.

## 8.1. absorption by trees

### 8.1.1. Data source

The data collected on the number of trees in the various University locations was provided by the Surveillance and Logistics Unit. For each tree, the identification number, location, height, trunk diameter, genus and species were provided.

### 8.1.2. Data processing

The data for 2023 on the total number of trees, broken down by site, are shown in **Table 8.1**.

| | | Macro Area | | | | | | Tree n° | |
|---|---|---|---|---|---|---|---|---|---|
| **Macrotype ID** | **Tree Macrotype** | University Headquarters | Other Historic Center Buildings | Veterinary Campus | University Hospital complex | Science and Technology Campus | Valserena Abbey | **Total** | **%** |
| 1 | Norway Spruce | - | 2 | 1 | 4 | - | - | **7** | **0,2%** |
| 4 | Mountain Pines | - | 2 | 1 | 1 | 4 | - | **8** | **0,2%** |
| 6 | Other Conifers | 2 | 32 | 3 | 1 | 10 | - | **48** | **1,4%** |
| 7 | Beech | - | 3 | - | - | - | - | **3** | **0,1%** |
| 8 | Turkey Oak | - | 1 | - | - | 4 | - | **5** | **0,1%** |
| 9 | Holm Oak | - | 3 | - | - | - | - | **3** | **0,1%** |
| 10 | Other Oaks | - | 5 | - | - | 317 | 2 | **324** | **9,6%** |
| 12 | Hornbeams | - | 20 | - | - | 3 | 3 | **26** | **0,8%** |
| 14 | Poplar | - | 3 | 20 | 1 | 389 | 25 | **438** | **13,0%** |
| 15 | Other Broadleaf Tre | - | 142 | 123 | 177 | 2.030 | 34 | **2.506** | **74,4%** |
| **Total** | | **2** | **213** | **148** | **184** | **2.757** | **64** | **3.368** | **100%** |
| **%** | | **0,1%** | **6,3%** | **4,4%** | **5,5%** | **81,9%** | **1,9%** | **100%** | **0,0%** |

*Table 8.1 – Total number of trees by macro-area, year 2023*

**Table 8.2** below shows data relating to trees in 2023, broken down by site as in the previous table, but with a more detailed classification of the genera and macrotypes to which they belong.

| | | Macro Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tree Macrotype** | **Genus** | University Headquarters | Other Historic Center Buildings | Veterinary Campus | University Hospital complex | Science and Technology Campus | Valserena Abbey | Total | **%** |
| Other Conifers | Calocedrus | | 1 | | | | | 1 | 0,0% |
| Other Conifers | Cryptomeria | | 1 | | | | | 1 | 0,0% |
| Other Conifers | Cunninghamia | | 1 | | | | | 1 | 0,0% |
| Other Conifers | Sequoia | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Broussonetia | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Carya | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Clydicina | | | | | 1 | | 1 | 0,0% |
| Other Broadleaf Trees | Eucommia | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Hovenia | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Koelreuteria | | | | | 1 | | 1 | 0,0% |
| Other Broadleaf Trees | Olea | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Pistacia | | 1 | | | | | 1 | 0,0% |
| Other Broadleaf Trees | Punica | | | | 1 | | | 1 | 0,0% |
| Other Broadleaf Trees | Trachycarpus | | 1 | | | | | 1 | 0,0% |
| Holm Oak, Cork Oak | Quercus | | 1 | | | | | 1 | 0,0% |
| Other Conifers | Metasequoia | | 2 | | | | | 2 | 0,1% |
| Other Conifers | Taxodium | | 2 | | | | | 2 | 0,1% |
| Other Broadleaf Trees | Diospyros | | 2 | | | | | 2 | 0,1% |
| Other Broadleaf Trees | Gymnocladus | | 2 | | | | | 2 | 0,1% |
| Other Broadleaf Trees | Parrotia | | 2 | | | | | 2 | 0,1% |
| Other Broadleaf Trees | Salix | | | | | | 2 | 2 | 0,1% |
| Other Broadleaf Trees | Sambucus | | | | 1 | 1 | | 2 | 0,1% |
| Holm Oak, Cork Oak | Phellodendron | | 2 | | | | | 2 | 0,1% |
| Other Conifers | Picea | | 3 | | | | | 3 | 0,1% |
| Other Broadleaf Trees | Ailanthus | | 1 | | 1 | 1 | | 3 | 0,1% |
| Other Broadleaf Trees | Crataegus | | 1 | | | | 2 | 3 | 0,1% |
| Other Broadleaf Trees | Ficus | | | | 1 | 2 | | 3 | 0,1% |
| Other Broadleaf Trees | Ginkgo | | 3 | | | | | 3 | 0,1% |
| Other Broadleaf Trees | Lagerstroemia | | | | | 3 | | 3 | 0,1% |
| Other Broadleaf Trees | Laurus | | 2 | | 1 | | | 3 | 0,1% |
| Other Broadleaf Trees | Magnolia | | 2 | | 1 | | | 3 | 0,1% |
| Beech | Fagus | | 3 | | | | | 3 | 0,1% |
| Other Conifers | Cupressus | | 3 | 1 | | | | 4 | 0,1% |
| Other Broadleaf Trees | Hibiscus | | | | | 4 | | 4 | 0,1% |
| Other Broadleaf Trees | Malus | | 4 | | | | | 4 | 0,1% |
| Other Conifers | Thuja | | | | 1 | 4 | | 5 | 0,1% |
| Other Broadleaf Trees | Liriodendron | | 3 | | | 2 | | 5 | 0,1% |
| Turkey Oak | Quercus | | 1 | | | 4 | | 5 | 0,1% |
| Other Broadleaf Trees | Paulownia | | 2 | | | 4 | | 6 | 0,2% |
| Norway Spruce | Picea | | 2 | 1 | 4 | | | 7 | 0,2% |
| Other Broadleaf Trees | Gleditsia | | 1 | | | 6 | | 7 | 0,2% |
| Mountain Pines | Pinus | | 2 | 1 | 1 | 4 | | 8 | 0,2% |
| Other Conifers | Taxus | | 9 | | | | | 9 | 0,3% |
| Other Broadleaf Trees | Sorbus | | | | | 12 | | 12 | 0,4% |
| Other Broadleaf Trees | Liquidambar | | 4 | 2 | | 7 | | 13 | 0,4% |
| Other Conifers | Cedrus | 2 | 9 | 2 | | 6 | | 19 | 0,6% |
| Other Broadleaf Trees | Cercis | | 7 | | 2 | 4 | 9 | 22 | 0,7% |
| Other Broadleaf Trees | Catalpa | | 6 | | | 18 | | 24 | 0,7% |
| Other Broadleaf Trees | Morus | | | 1 | 1 | 21 | 1 | 24 | 0,7% |
| Hornbeams | Carpinus | | 20 | | | 3 | 3 | 26 | 0,8% |
| Other Broadleaf Trees | Celtis | | 1 | | | 26 | | 27 | 0,8% |
| Other Broadleaf Trees | Sophora | | 8 | | 1 | 23 | | 32 | 1,0% |
| Other Broadleaf Trees | Albizia | | | | 17 | 39 | | 56 | 1,7% |
| Other Broadleaf Trees | Aesculus | | 7 | | 11 | 73 | | 91 | 2,7% |
| Other Broadleaf Trees | Robinia | | 5 | | 50 | 70 | | 125 | 3,7% |
| Other Broadleaf Trees | Pyrus | | 3 | | | 152 | | 155 | 4,6% |
| Other Broadleaf Trees | Platanus | | 8 | 105 | 46 | 2 | | 161 | 4,8% |
| Other Broadleaf Trees | Juglans | | 5 | | 2 | 166 | | 173 | 5,1% |
| Other Broadleaf Trees | Prunus | | 11 | | | 169 | 1 | 181 | 5,4% |
| Other Broadleaf Trees | Ulmus | | 6 | | | 187 | 14 | 207 | 6,1% |
| Other Broadleaf Trees | Acer | | 30 | 13 | 23 | 146 | 5 | 217 | 6,4% |
| Other Broadleaf Trees | Fraxinus | | 5 | | | 318 | | 323 | 9,6% |
| Other Oaks | Quercus | | 5 | | | 317 | 2 | 324 | 9,6% |
| Poplar | Populus | | 3 | 20 | 1 | 389 | 25 | 438 | 13,0% |
| Other Broadleaf Trees | Tilia | | 4 | 2 | 18 | 572 | | 596 | 17,7% |
| **Total** | | **2** | **213** | **148** | **184** | **2.757** | **64** | 3.368 | 100% |
| **%** | | **0,1%** | **6,3%** | **4,4%** | **5,5%** | **81,9%** | **1,9%** | **100%** | **0** |

*Table 8.2 – Total trees divided by genus and macrotype, by macroarea, year 2023*

It should be noted that most of the trees are located on the Science and Technology Campus (approximately 82% for a total of 2,757 trees) and that most of the trees on the University grounds are lime trees (Tilia), accounting for 18%, followed by poplars (Populus), accounting for 13%.

The distribution of trees by diameter class is shown in **Table 8.3**.

| | | Diameter | | | | | | | | | | Diameter Classes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Macrotype ID** | **Tree Macrotype** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **≥ 100** | Total | **%** |
| 1 | Norway Spruce | | | 1 | 2 | 1 | 2 | 1 | | | | 7 | 0% |
| 4 | Mountain Pines | | | 4 | 2 | | 1 | | 1 | | | 8 | 0% |
| 6 | Other Conifers | 1 | 7 | 9 | 6 | 9 | 5 | 2 | 1 | 1 | 7 | 48 | 1% |
| 7 | Beech | | 2 | | 1 | | | | | | | 3 | 0% |
| 8 | Turkey Oak | 1 | 3 | | | | 1 | | | | | 5 | 0% |
| 9 | Holm Oak | | 1 | | 1 | | 1 | | | | | 3 | 0% |
| 10 | Other Oaks | 11 | 286 | 8 | 12 | 2 | | 3 | | 1 | 1 | 324 | 10% |
| 12 | Hornbeams | 3 | 10 | 10 | 3 | | | | | | | 26 | 1% |
| 14 | Poplar | 3 | 17 | 60 | 196 | 82 | 48 | 21 | 6 | 2 | 3 | 438 | 13% |
| 15 | Other Broadleaf Tr | 359 | 751 | 519 | 622 | 115 | 62 | 40 | 15 | 11 | 12 | 2.506 | 74% |
| **Total** | | **378** | **1.077** | **611** | **845** | **209** | **120** | **67** | **23** | **15** | **23** | **3.368** | 100% |
| **%** | | **11%** | **32%** | **18%** | **25%** | **6%** | **4%** | **2%** | **1%** | **0%** | **1%** | **100%** | 0 |

*Table 8.3 – Total trees divided by diameter classes, by macro-area, year 2023*

### 8.1.3. Estimation of $CO_2$ absorption

The estimate of $CO_2$ absorption by trees is based on the annual increase in mass of the above-ground part of the plant. The methodology described in the guidelines developed by the RUS Climate Change Working Group has been adopted - Network of Universities for Sustainable Development (RUS-GdLCC, 2023) was adopted, calibrated with annual growth data measured in over 6,000 forest sampling areas throughout Italy by the 2015 National Forest and Carbon Reservoir Inventory. Specifically, the data in Table 13 of the above document were used, which shows the annual absorption rate for 15 tree types for different plant diameter sizes. The data actually used are shown in bold in **Table 8.4**.

From the product of the number of trees and the relative absorption factor, for each macro-type and average diameter, the total annual $CO_2$ absorption by the trees present in the University was obtained, as shown in **Table 8.5**.

| | Diameter at Breast Height (cm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tree Macrotype** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **≥ 100** |
| White Fir | 3 | 9 | 17 | 28 | 41 | 55 | 72 | 90 | 110 | 131 |
| **Norway Spruce** | 3 | 8 | **17** | **27** | **40** | **54** | **70** | 87 | 107 | 127 |
| **Other Conifers** | **3** | **10** | **19** | **31** | **45** | **62** | **80** | **100** | **122** | **146** |
| **Other Broadleaf Trees** | **3** | **11** | **22** | **36** | **52** | **71** | **92** | **115** | **141** | **168** |
| **Other Oaks** | **3** | **11** | **22** | **36** | **52** | 71 | **92** | 115 | **140** | **168** |
| **Hornbeams** | **3** | **11** | **21** | **35** | 51 | 69 | 89 | 112 | 137 | 163 |
| Chestnut | 3 | 10 | 20 | 32 | 47 | 64 | 83 | 104 | 126 | 151 |
| **Turkey Oak** | **4** | **12** | 24 | 39 | 57 | **78** | 101 | 127 | 154 | 185 |
| Eucalyptus | 4 | 12 | 23 | 38 | 55 | 75 | 97 | 121 | 148 | 177 |
| **Beech** | 3 | **11** | 21 | **34** | 50 | 68 | 88 | 110 | 134 | 160 |
| Larch | 3 | 10 | 20 | 32 | 46 | 63 | 82 | 102 | 125 | 149 |
| **Holm Oak, Cork Oak** | 6 | **20** | 40 | **64** | 94 | **127** | 165 | 207 | 252 | 302 |
| Mediterranean Pines | 4 | 12 | 25 | 40 | 58 | 79 | 103 | 129 | 157 | 188 |
| **Mountain Pines** | 3 | 10 | **21** | **33** | 49 | **66** | 86 | 108 | 131 | 157 |
| **Poplar** | **2** | **6** | **13** | **20** | **30** | **40** | **52** | **66** | **80** | **96** |

*Table 8.4 – $CO_2$ absorption factors (kg/year) for different tree types and average trunk diameter (Source: RUS-GdLCC, 2023)*

| | | Macro Area | | | | | | $CO_2$ absorption (t/year) | |
|---|---|---|---|---|---|---|---|---|---|
| **Macrotype ID** | **Tree Macrotype** | University Headquarters | Other Historic Center Buildings | Veterinary Campus | University Hospital complex | Science and Technology Campus | Valserena Abbey | Total | **%** |
| 1 | Norway Spruce | | 0 | 0 | 0 | | | 0 | 0,3% |
| 4 | Mountain Pines | | 0 | 0 | 0 | 0 | | 0 | 0,4% |
| 6 | Other Conifers | 0 | 2 | 0 | 0 | 0 | | 3 | 3,1% |
| 7 | Beech | | 0 | | | | | 0 | 0,1% |
| 8 | Turkey Oak | | 0 | | | 0 | | 0 | 0,1% |
| 9 | Holm Oak | | 0 | | | | | 0 | 0,3% |
| 10 | Other Oaks | | 1 | | | 4 | 0 | 5 | 5,5% |
| 12 | Hornbeams | | 0 | | | 0 | 0 | 0 | 0,5% |
| 14 | Poplar | | 0 | 1 | 0 | 10 | 0 | 11 | 13,6% |
| 15 | Other Broadleaf Tre | | 7 | 6 | 7 | 42 | 1 | 63 | 76,1% |
| **Total** | | **0,3** | **10,6** | **6,7** | **6,9** | **56,1** | **1,7** | **82,3** | 100% |
| **%** | | **0,4%** | **12,9%** | **8,2%** | **8,4%** | **68,1%** | **2,1%** | **100%** | 0 |

*Table 8.5 - Absorption by trees ($tCO_2$/year), by macro-area, year 2023*

It should be noted that 76% of $CO_2$ absorption comes from various types of trees which, for the sake of brevity, have been included in the category “other broadleaf trees”.

## 8.2. Vehicles and machinery for green space management

In order to assess the $CO_2$ balance benefit of the trees on the university campus, it is useful to consider that tree management involves the use of pruning and felling machinery, which is discussed below.

### 8.2.1. Data source

The company that manages the university's green spaces and trees provided data on the annual consumption of diesel and petrol used by both work vehicles (5 tractors, 1 aerial platform) and manual equipment (1 brush cutter, 2 hedge trimmers, 1 blower, 6 chainsaws).

### 8.2.2. Data processing

Total consumption amounted to 5,215 litres of diesel fuel for work vehicles and 3,140 litres of petrol for manual equipment. These figures have been divided among the various campuses in relation to the total number of trees present at the different sites, initially assuming a distribution of managed green areas similar to that of trees, using the percentages shown in the last row of Table 8.1 above.
The distribution of fuel consumption is shown in **Table 8.6** below.

| | **Macro Area** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Carburante veicoli e macchinari** | University Headquarters | Other Historic Center | Veterinary Campus | University Hospital complex | Science and Technology Campus | Valserena Abbey | **Totale consumption l/year** |
| **% Tree cover** | 0,1% | 8,9% | 6,2% | 7,7% | 74,3% | 2,7% | 100% |
| **Diesel** | 4 | 466 | 324 | 403 | 3.877 | 140 | 5.215 |
| **Gasoline** | 3 | 281 | 195 | 243 | 2.335 | 84 | 3.140 |

*Table 8.6 – Breakdown of fuel consumption (litres/year) for green space management, year 2023*

### 8.2.3. $CO_2$ emissions estimate

The estimate of $CO_2$ emissions resulting from the use of vehicles and machinery for green space management at the University of Parma was calculated using the same methodology used for vehicles owned by the university, i.e. using the formula:

$$EMIS\_veic = [Consumo\_carb] \cdot [FE\_medio]/1000$$

where:
*EMIS_veic*: $CO_2$ emissions in tonnes per year from vehicles owned by the University
*Consumo_carb*: total consumption by type of vehicle
*FE_medio*: $CO_2$ emission factor in $kgCO_2/l$ by type of vehicle

The emission factors used for petrol and diesel vehicles were 2.33 $kgCO_2/l$ and 2.63 $kgCO_2/l$ respectively, as proposed by the RUS-GdLCC (2023) document, which were also used for vehicles owned by the university.
**Table 8.7** shows $CO_2$ emissions (t/year) relating to the consumption of different types of fuel, distributed by macro-area.

| | **Macro Area ID** | **Macro Area** | **Gasoline $CO_2$ (t/year)** | **Diesel $CO_2$ (t/year)** | **Total $CO_2$ (t/year)** |
|---|---|---|---|---|---|
| **$CO_2$ emissions (t/year)** | 1 | University Headquarters | 0,0 | 0,0 | 0,0 |
| | 2 | Other Historic Center Buildings | 1,1 | 0,7 | 1,8 |
| | 3 | Veterinary Campus | 0,8 | 0,5 | 1,3 |
| | 4 | Hospital Complex | 0,9 | 0,6 | 1,6 |
| | 5 | Science and Technology Campus | 9,0 | 6,1 | 15,2 |
| | 6 | Valserena Abbey | 0,3 | 0,2 | 0,5 |
| | **Total** | | **12,2** | **8,3** | **20,4** |

*Table 8.7 - $CO_2$ emissions (t/year) related to fuel consumption by vehicles and machinery for green space management, by macro-area, year 2023*

### 8.3. Total CO2 from trees and green space management

**Table 8.8** shows the calculation of CO2 absorption by trees located in different areas of the University, taking into account the number of different types of trees and their absorption capacity.
The data on the trees present was provided by the Surveillance and Logistics Unit. For each tree, the identification number, location, height, trunk diameter, genus and species were provided.

| Macro Area ID | Macro Area | $CO_2$ absorption by trees | $CO_2$ emissions from green area management | $CO_2$ total (t/year) |
|---|---|---|---|---|
| 1 | University Headquarters | -0,3 | 0,0 | -0,3 |
| 2 | Other Historic Center Buildings | -10,6 | 1,8 | -8,8 |
| 3 | Veterinary Campus | -6,7 | 1,3 | -5,5 |
| 4 | Hospital Complex | -6,9 | 1,6 | -5,3 |
| 5 | Science and Technology Campus | -56,1 | 15,2 | -40,9 |
| 6 | Valserena Abbey | -1,7 | 0,5 | -1,1 |
| **Total** | | **-82,3** | **20,4** | **-61,9** |

*Table 8.8 – Summary table of CO2 absorption and emissions (t/year) from trees and vehicles and machinery for green space management, by macro-area, year 2023.*

## 9. RESULTS - SUMMARY TABLE

### 9.1. Final results

**Table 9.1** shows emissions and absorptions for the sectors considered, broken down by macro-areas. The graphs in **Figure 9.1** and **Figure 9.2** also show that the electricity and gas consumption sector accounts for the largest share of emissions, followed by the missions sector, with the Science and Technology Campus contributing 57% of the University's total $CO_2$ emissions. The graphs also show negative bars in the histograms, which are not very visible due to the very low values, representing the $CO_2$ absorption of trees.

| | | $CO_2$ emissions and absorptions (ton/year) | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| Macro Area ID | Macro Area | Electricity | Gas | District Heating | Vehicles | Business Trips | Trees and Green Area Management | ton$CO_2$/ year | % |
| 1 | University Headquarters | 165 | 148 | - | 12 | 14 | -0,3 | 339 | 4,4% |
| 2 | Other Historic Center Buildings | 431 | 78 | 140 | 3 | 82 | -8,8 | 725 | 9,4% |
| 3 | Veterinary Campus | 339 | 204 | - | 5 | 8 | -5,5 | 551 | 7,2% |
| 4 | Hospital Complex | 706 | 614 | - | - | 41 | -5,3 | 1.355 | 17,6% |
| 5 | Science and Technology Camp | 2.449 | 1.806 | - | 10 | 205 | -40,9 | 4.429 | 57,5% |
| 6 | Valserena Abbey | 168 | 131 | - | - | - | -1,1 | 299 | 3,9% |
| **Total** | | **4.258** | **2.981** | **140** | **30** | **351** | **-62** | **7.699** | **100%** |
| **%** | | **55,3%** | **38,7%** | **1,8%** | **0,4%** | **4,6%** | **-0,8%** | **100%** | **0%** |

*Table 9.1 $CO_2$ emissions and absorption (t/year) of the University of Parma by macro-area, and percentage incidence, in 2023*

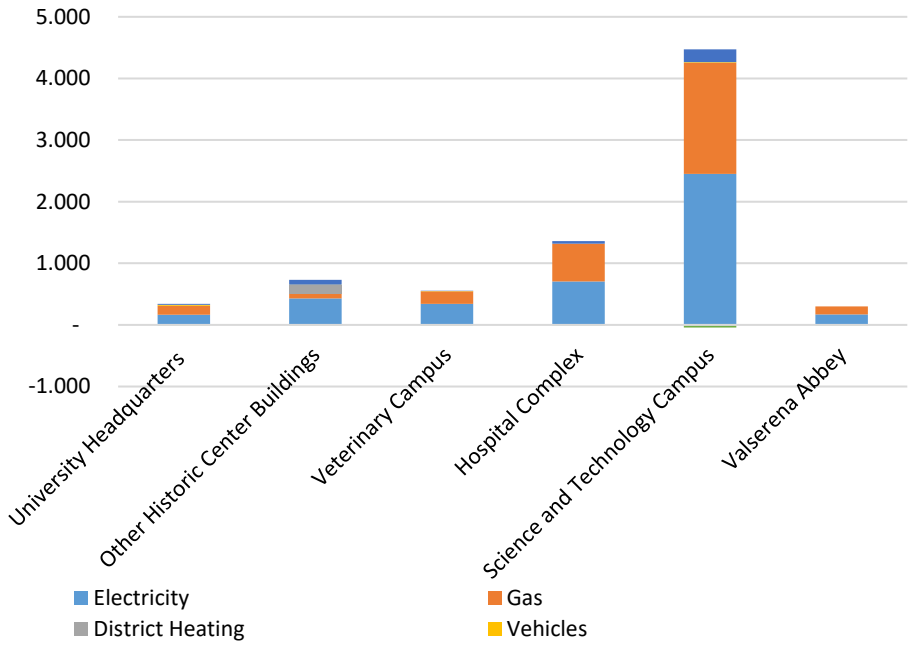


*Figure 9.1 - CO2 emissions and absorption (t/year) of the University of Parma by macro-area, year 2023*

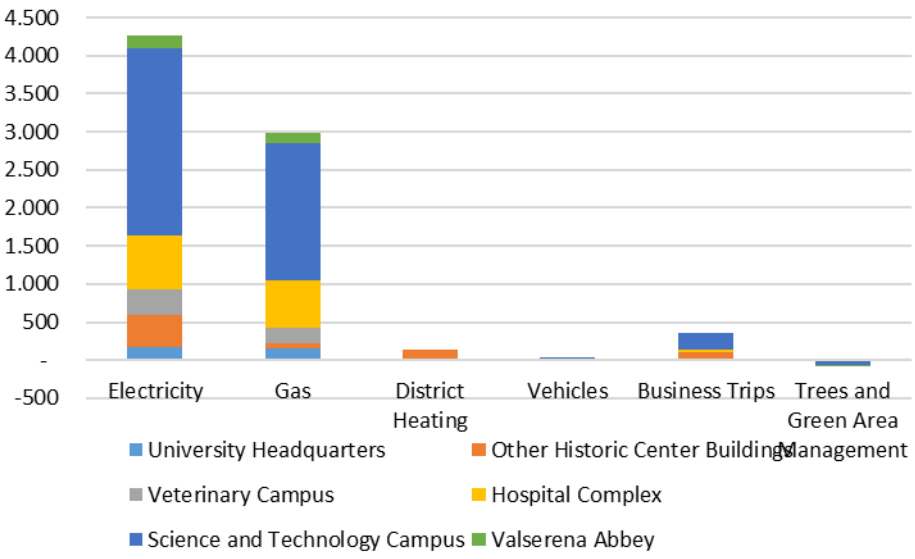


*Figure 9.2 - $CO_2$ emissions and absorption (t/year) of the University of Parma, by sector, in 2023*

**Tables 9.2** and **9.3** below show estimates of specific emission indices, per person and per square metre of floor space, relating to emissions from electricity consumption and building heating for the various macro-areas.

| | | $CO_2$ emissions (ton/year) | | | | | $CO_2$ emissions per capita | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Macro Area ID | Macro Area | Electricity | Gas + District Heating | Other | Total | Number of Students + Professors + Staff | Electricity | Gas + District Heating | Other | Total |
| 1 | University Headquarters | 165 | 148 | 26 | 339 | 2.799 | 59 | 53 | 9 | 121 |
| 2 | Other Historic Center Buildings | 431 | 218 | 76 | 725 | 11.963 | 36 | 18 | 6 | 61 |
| 3 | Veterinary Campus | 339 | 204 | 8 | 551 | 1.059 | 320 | 192 | 8 | 521 |
| 4 | Hospital Complex | 706 | 614 | 36 | 1.355 | 6.665 | 106 | 92 | 5 | 203 |
| 5 | Science and Technology Campus | 2.449 | 1.806 | 174 | 4.429 | 13.119 | 187 | 138 | 13 | 338 |
| 6 | Valserena Abbey | 168 | 131 | - 1 | 299 | 13 | 12.955 | 10.106 | - 88 | 22.973 |
| | **Total** | **4.258** | **3.121** | **319** | **7.699** | **35.618** | **120** | **88** | **9** | **216** |

*Table 9.2 Emissions (t/year) and per capita $CO_2$ emissions (kg/year/person) of the University of Parma, year 2023*

| | | $CO_2$ emissions (ton/year) | | | | | $CO_2$ emissions per unit area | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Macro Area ID | Macro Area | Electricity | Gas + District Heating | Other | Total | Area ($m^2$) | Electricity | Gas + District Heating | Other | Total |
| 1 | University Headquarters | 165 | 148 | 26 | 339 | 18.549 | 9 | 8 | 1,4 | 18 |
| 2 | Other Historic Center Buildings | 431 | 218 | 76 | 725 | 44.992 | 10 | 5 | 1,7 | 16 |
| 3 | Veterinary Campus | 339 | 204 | 8 | 551 | 13.890 | 24 | 15 | 0,6 | 40 |
| 4 | Hospital Complex | 706 | 614 | 36 | 1.355 | 38.399 | 18 | 16 | 0,9 | 35 |
| 5 | Science and Technology Campus | 2.449 | 1.806 | 174 | 4.429 | 90.992 | 27 | 20 | 1,9 | 49 |
| 6 | Valserena Abbey | 168 | 131 | - 1 | 299 | 8.564 | 20 | 15 | - 0,1 | 35 |
| | **Total** | **4.258** | **3.121** | **319** | **7.699** | **215.386** | **20** | **14** | **1,5** | **36** |

*Table 9.3 Emissions (t/year) and emissions per unit of surface area of $CO_2$ (kg/year/$m^2$) of the University of Parma, year 2023*

### 9.2. Conclusions

The University of Parma's emissions inventory shows that the largest contributions to emissions come from electricity and natural gas consumption. Mitigation activities should focus primarily on these two areas, with particular attention to the Science and Technology Campus, the Veterinary Centre and the Polyclinic-Hospital, which have the highest CO2 emissions per unit of surface area.
Ongoing activities plan to consider an additional source of CO2 emissions linked to the university's activities and travel to access the premises by students, teaching staff and technical and administrative staff, which could not be considered for 2023 due to the unavailability of data on distances travelled.
This first emissions inventory also serves as a methodological reference for future activities, which may also include the establishment of a University Emissions Mitigation Plan, with commitments defined in absolute terms and verifiable through successive and consistent versions of the inventory itself.

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