TU Graz
2020 Greenhouse Gas Balance
and comparison with the corrected and supplemented 2017 Greenhouse Gas Balance

Final Version

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STS Science, Technology and Society Unit

ISDS Institute of Interactive Systems and Data Science

This final report on TU Graz's 2020 greenhouse gas balance was commissioned by TU Graz (Buildings and Technical Support). It provides an overview of the results in the emission categories of energy, mobility, material use, and canteen. The GHG balance was prepared using the 2020 version of the *ClimCalc* tool: ClimCalc_v3.1.3_EF2020 (Alliance for Sustainable Universities in Austria 2021b).

Client: Organisational Unit 9504.0 - Buildings and Technical Support (GuT) Technical Facility Management

Contractor: STS – Science, Technology and Society Unit / ISDS

Subject of the contract: Preparation of the TU Graz 2020 greenhouse gas balance, taking into account the categories *Energy, Mobility, Material Use,* and *Canteen*, using data collected at the TU Graz main and secondary locations.

Project management (PL)/Project processing (PB): Ass.Prof. Dipl.-Ing. Dr.phil. Günter Getzinger (PL), Franziska Häller, MA (PB), and Florian Ensbacher (PB)

Contract period: March to July 2021, preparation of the preliminary 2020 GHG balance, and October 2023 to May 2024, preparation of the final version of the 2020 GHG balance (reflecting the integration of the 2020 emission factors)

Version: Final version, 01.05.2024

Data provided by:

- TU Graz Organisational Units
    - Assistance to the Rector: Statistics and Data Protection
    - Purchasing Service
    - Finance and Accounting
    - Buildings and Technical Support
    - Institutes with official vehicles
    - International Office – Welcome Center
    - Communications and Marketing
    - Human Resources
    - Institute of Thermal Turbomachinery and Machine Dynamics
    - TU Graz Verlag [Publishing House]
- External organisations

- Harnisch Gebäudeservice Graz
- Österreichische Mensen Betriebsgesellschaft mbH
- Printkultur [HTU Copyshops]

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1. Foreword

This TU Graz 2020 greenhouse gas balance (GHG balance) is the second complete and accurate TU Graz GHG balance produced after the first 2017 GHG balance. The 2017 GHG balance serves as the reference balance for the "Climate-neutral TU Graz 2030" project (TU Graz 2020), which was accepted by the TU Graz Rectorate in 2020. The year 2020, marked by the coronavirus pandemic, was a unique year in many respects, and this is also reflected in the GHG balance results. Especially in the area of university mobility, major changes occurred in this year as compared to the 2017 balance. The extent to which 2020 can also be considered a unique year with regard to the future, namely as a year that brought about structural changes, will be reflected in the next GHG balance (2023). When interpreting the data from the GHG balance presented here, however, it is important to bear in mind that the university operations were subject to many restrictions due to the pandemic from March up to and including December 2020.

Corrections to the 2017 GHG reference balance

In addition to presenting the 2020 data, this GHG balance report also presents a comparison with the 2017 GHG balance. While preparing this report, certain data points from the 2017 GHG reference balance were corrected; these are now displayed correctly in this report. A list of the adjustments to the 2017 GHG balance is provided below:

Subcategory	Initial 2017 value	Final 2017 (corrected) value	Comment
Natural gas	34 tonnes of CO_2e	343 tonnes of CO_2e	In the original 2017 GHG balance, the value for m^3 was inadvertently entered as kWh in the *ClimCalc* tool (see p. 8)
District heating	4,429 tonnes of CO_2e (incl. canteen)	6,220 tonnes of CO_2e (incl. canteen)	The emission factor for district heating was increased by the Environment Agency Austria from 0.2483 kg CO_2e/kWh to 0.3487 kg CO_2e/kWh
Refrigerant	10 tonnes of CO_2e	30 tonnes of CO_2e	Calculated total was not correct, more consumption
Copy paper	434 tonnes of CO_2e	191 tonnes of CO_2e	The quantity (kg) of copy paper was corrected downwards by a factor of 10 after conducting a trial.
Total emissions	22,200 tonnes of CO_2e (incl. canteen, excl. new	**24,077 tonnes of CO_2e** (incl. canteen, excl. new	As a result of these corrections, emissions increased by around 2,000 tonnes of CO_2e in 2017

	buildings/"grey emissions")	buildings/"grey emissions")	

The issue of climate change is still very much present in the public sphere, and solutions are being sought to prevent and deal with the expected catastrophic consequences of global warming. The Intergovernmental Panel on Climate Change (IPCC) advises that global climate neutrality is achieved as soon as possible in order to meet the 1.5-degree target (IPCC 2018, p. 6).
The following graphs provide an overview of how the global temperature has changed since 1880 and illustrate the development of per capita CO_2 emissions since 1800 in some countries, including Austria:

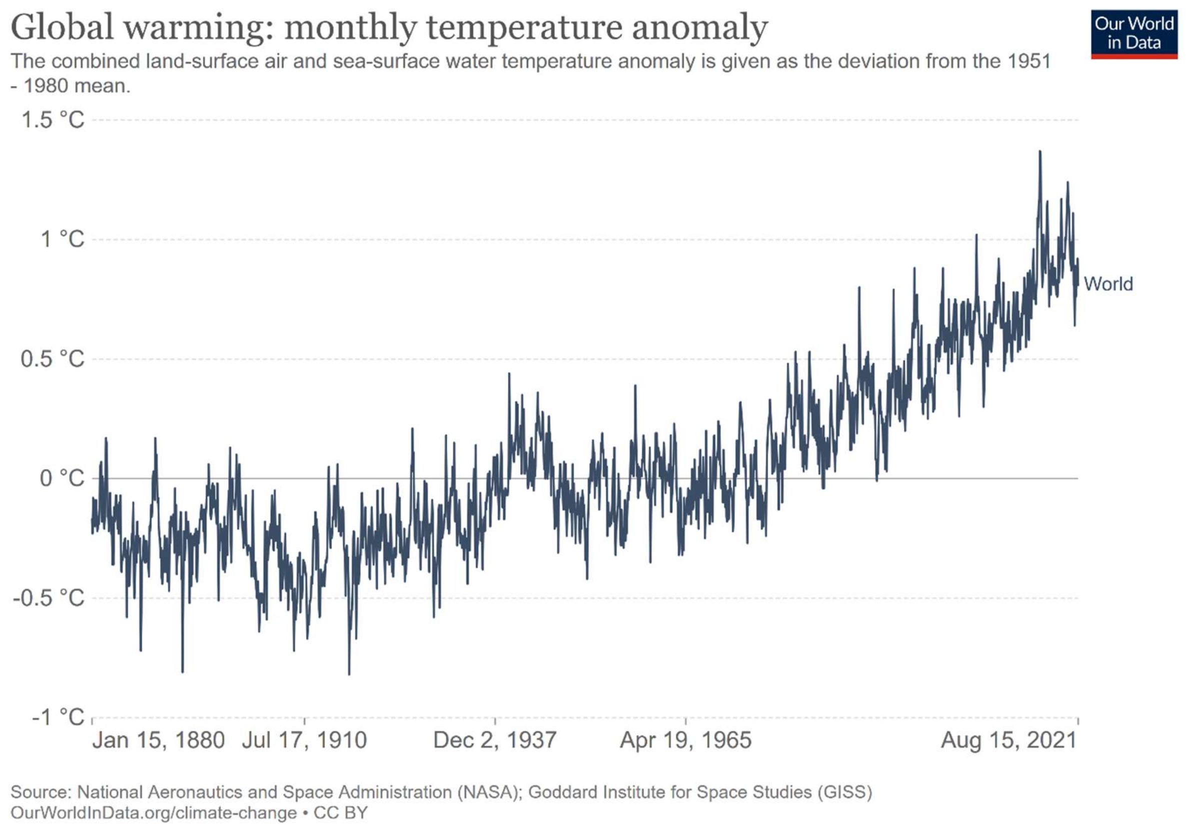


Figure 1: Global warming since 1880 (Our World In Data a))

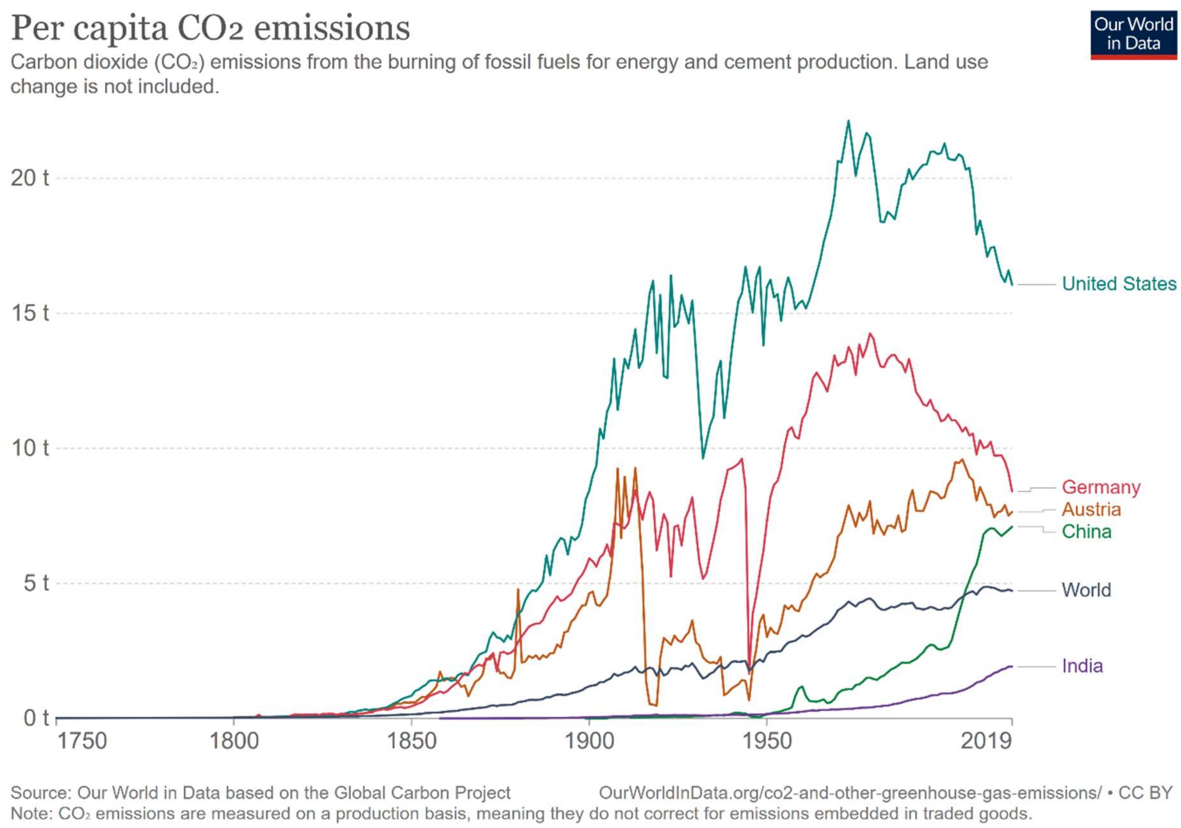


Figure 2: Comparison of per capita CO_2 emissions (Our World In Data b))

As a member of the *Alliance of Sustainable Universities in Austria* (in German: *Allianz Nachhaltige Universitäten in Österreich*) and the *Climate Change Centre Austria (CCCA)*, TU Graz takes its responsibility seriously. In spring 2020, TU Graz set the goal to achieve climate neutrality by 2030. Based on the 2017 GHG balance, a roadmap with measures that would enable it to achieve this goal was created and adopted by the Rectorate in August 2020 (TU Graz 2020). These measures have been fully implemented since December 2021 and continue to be fully implemented (as of May 2024).

The 2020 GHG balance should provide information about the status of progress in 2020, but also should show where additional actions can and must be taken. It also indicates what can be predicted for the future based on data from the forcibly "decelerated" year of 2020, as well as where readjustments need to be made to certain areas of the "Climate-neutral TU Graz 2030" project adopted in August 2020. The findings reported in this 2020 GHG balance also contribute to the biennial evaluations of this project, which began in 2022.

2. Descriptions of tools and methods

2.1 ClimCalc

The 2020 GHG balance was prepared using the *ClimCalc* tool from the *Alliance of Sustainable Universities in Austria*, which has provided customised GHG accounting services for universities since 2015 (Alliance of Sustainable Universities in Austria 2021). *ClimCalc* was developed based on the *Greenhouse Gas Protocol* (WRI and WBCSD 2004), which sets a globally recognised standard in GHG accounting for companies and organisations. This tool can be used to record all three scope categories of GHG emissions: scope 1 emissions, i.e. emissions caused directly by an organisation, scope 2 emissions, i.e. emissions caused indirectly by the generation of purchased electricity, steam, and district heating and cooling services, and scope 3 emissions, i.e. emissions also caused indirectly (upstream and downstream), including those from the *Mobility* and *Material use* categories (Getzinger et al. 2019, Alliance of Sustainable Universities in Austria 2021a). Scope 3 emissions are also attributed to an organisation, because their level can be influenced at least in part by the organisation. The following figure shows the scope categories defined in *ClimCalc*:

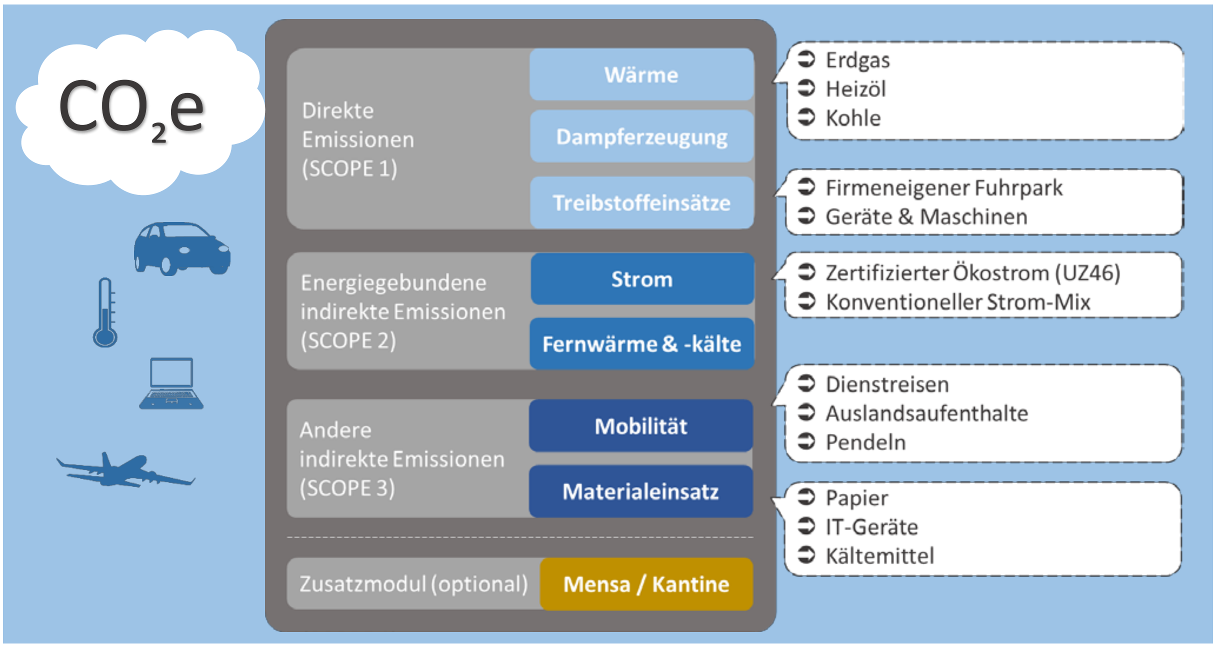


Figure 3: Scope categories defined in ClimCalc (Alliance for Sustainable Universities in Austria 2021a)

The emissions shown in the GHG balance are expressed in CO_2e, i.e. CO_2 equivalents. The emission factors used are provided by the Environment Agency Austria. The final emission factors for 2020 have now (as of May 2024) been applied for this purpose.

2.2 Method descriptions and system limits

The 2020 GHG balance is the second complete and accurate TU Graz GHG balance created after the 2017 GHG balance. In order to compare data optimally, the data were collected and are presented in the same categories. The categories defined are based on *ClimCalc* and include *Energy*, *Mobility*, *Material use*, and the additional module *Canteen*. Data were recorded and assigned to the following main and subcategories:

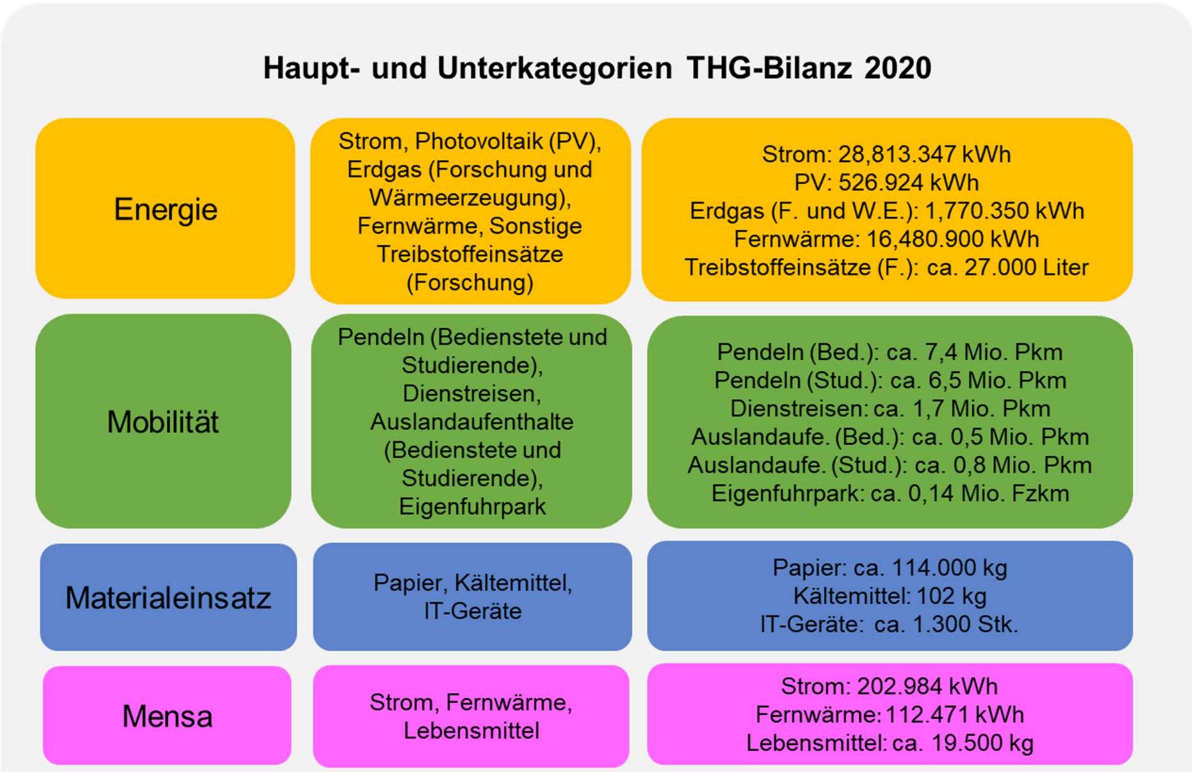


Figure 4: Overview of main and subcategories included in the TU Graz 2020 GHG balance (F = Forschung (DE) / Research (EN); W.E. = Wärmeerzeugung (DE) / heat generation (EN))

In this GHG balance, data were recorded for all TU Graz primary and secondary locations (see Annex 1).

The total area of TU Graz in 2020 (GuT 2020; cut-off date: 1.10.2020) is:

	with canteen	without canteen
Total net floor area	253,362 m^2	251,586 m^2
Heated net floor area	230,037 m^2	228,261 m^2

Table 1: TU Graz net floor area in 2020

The number of staff and students at TU Graz was obtained from the 2020 Intellectual Capital Report (Wissensbilanz 2020, p. 14). In addition, the number of staff was updated to include the number of staff in shareholdings, data provided by the Organisational Unit *Assistance to the Rector: Statistics and Data Protection.* Shareholding data have been included in the GHG balance if these are closely connected to TU Graz in terms of both location and personnel (see Annex 2).

	According to the 2020 Intellectual Capital Report	Shareholdings 2020	Total
Staff			
Individuals (as of 31.12.2020)	3,852.0	935.0	**4,787.0**
Full-time equivalents (FTE) (annual average)	2,475.1	716.0	**3,191.1**
Students *(cut-off date: 21.12.2020)*	16,091.0		**16,091.0**

Table 2: Number of staff and students at TU Graz in 2020

Compared to the number in 2017, the number of staff had increased, while the number of students had decreased.

	According to the 2017 Intellectual Capital Report	Shareholdings 2017	Total
Staff			
Individuals (as of 31.12.2017)	3,324.0	385.0	**3,709.0**
Full-time equivalents (FTE) (annual average)	2,219.7	298.5	**2,518.2**
Students *(cut-off date: 21/12/2017)*	16,816.0		**16,816.0**

Table 3: Number of staff and students at TU Graz in 2017

The data used to prepare this GHG balance were provided by TU Graz organisational units and external partners (see p. 2).
The number of kilometres travelled by commuters (both staff and students) was obtained from the 2019 traffic survey carried out by the TU Graz Institute of Highway Engineering and Transport Planning as part of a master's thesis (Forstner 2021). The numbers were broken down into the number of staff (4,787 individuals incl. those at shareholdings) and students (16,091 individuals) in 2020. In addition, the numbers of kilometres travelled by commuters were adjusted with regard to the pandemic-related home office regulations based on certain assumptions. This adjustment is described in more detail in the chapter on *Mobility*.

Comparison with the 2017 GHG balance
When comparing the 2017 and 2020 balances, it is important to emphasise that the emission factors used are updated annually, as this explains certain differences between the two balances. The changes in consumption or in kilometres travelled by passengers and vehicles, the emission factors, and the resulting emissions in t CO_2e are presented below in tables for each category.
Please note that some corrections were made to the 2017 GHG balance (see p. 5–6) in the process of comparing the 2017 and 2020 GHG balances. The correct values for the 2017 GHG balance are now shown in this report.
Please note that the methodologies used to calculate the 2020 GHG emissions for some subcategories differ from those used for the 2017 GHG balance. The adjustments are shown below:

(Sub)Category	2017 procedure	2020 procedure
Fuels	Survey of company vehicle fuel consumption for 5 institutes and organisational units (OU).	Survey of the fuel consumption for a total of 10 institutes and OUs.
Paper	Consumption recorded by Purchasing Service and Printkultur (HTU Copyshops).	Additional consumption data collected by the TU Graz Verlag and OU Communication and Marketing.
Food (canteen)	Data for dairy products, rice, fruit, and vegetables also collected.	Data for dairy products, rice, fruit, and vegetables not included, as these categories are not included in *ClimCalc*.

The data used in the following sections are partly based on estimates. However, it can be assumed that the resulting inaccuracy related to the total TU Graz emissions does not exceed +/- 3%.

3. GHG balance

3.1 Summary

In total, around **15,725 tonnes of CO_2e** were produced at TU Graz in **2020**. This represents around 8,500 tonnes or about **35% less** GHG emissions than those reported in **2017 with 24,100 tonnes of CO_2e**. The largest share of emissions is recorded in the *Energy* category (11,520 tonnes of CO_2e), followed by *Mobility* (3,410 tonnes of CO_2e), *Material use* (614 tonnes of CO_2e), and finally the *Canteen* (181 tonnes of CO_2e).

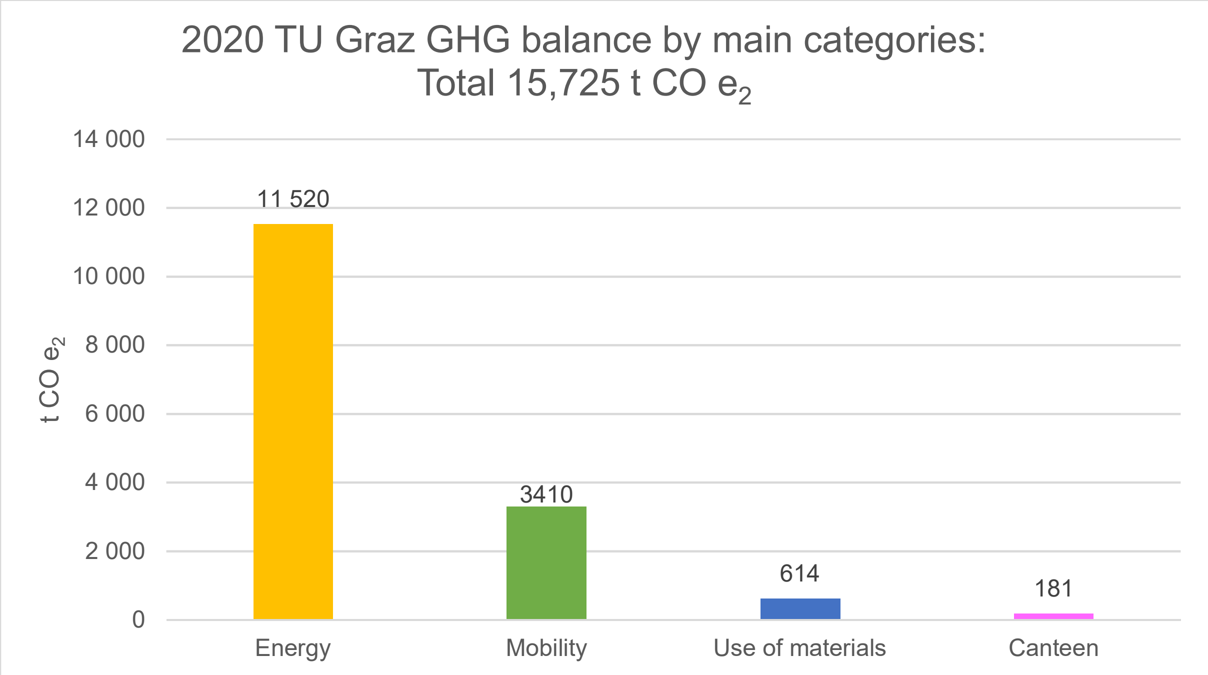


Figure 5: TU Graz 2020 GHG balance by main categories: Total 15,725 tonnes CO_2e

Compared to 2017, emissions have decreased significantly, mainly due to the coronavirus pandemic. Emissions in the *Mobility* category in particular dropped sharply due to the pandemic.

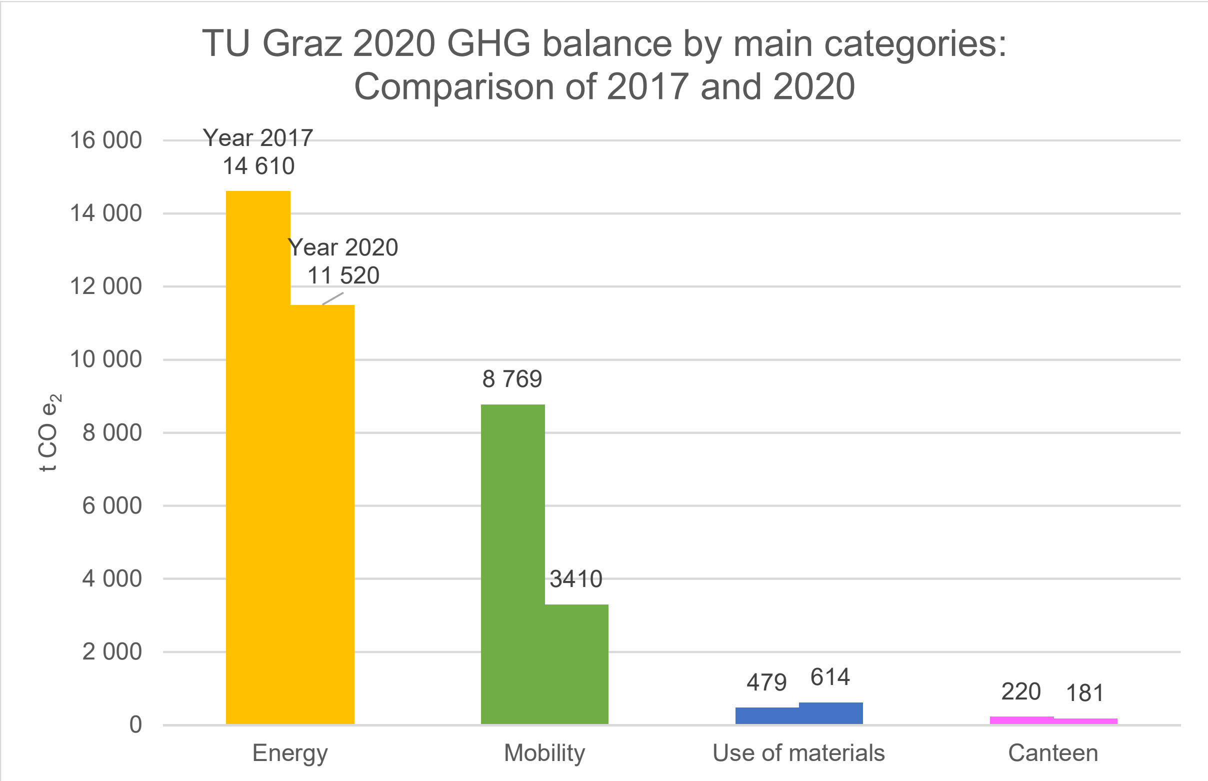


Figure 6: TU Graz 2020 GHG balance by main categories: Comparison of 2017 and 2020

The GHG emissions by subcategory are presented below, indicating emissions for 2020 alone and the comparison with those for 2017:

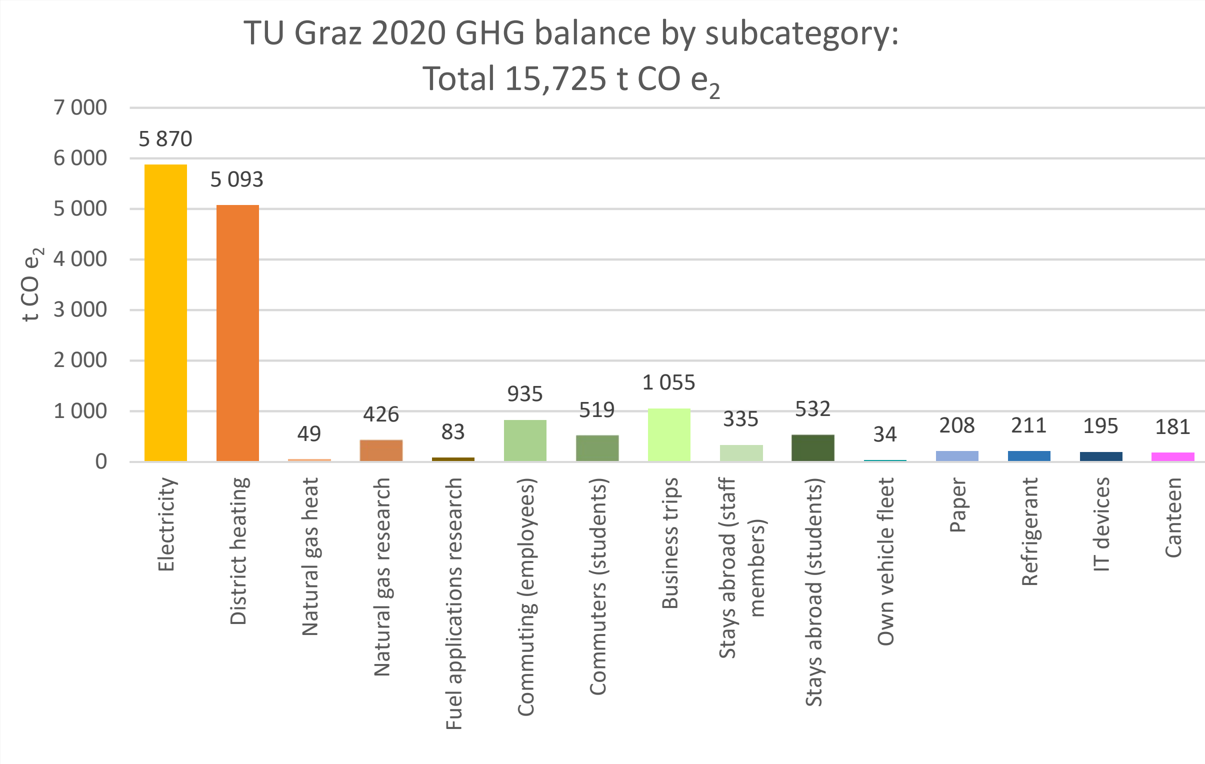


Figure 7: TU Graz 2020 GHG balance by subcategory: Total 15,725 tonnes of CO_2e

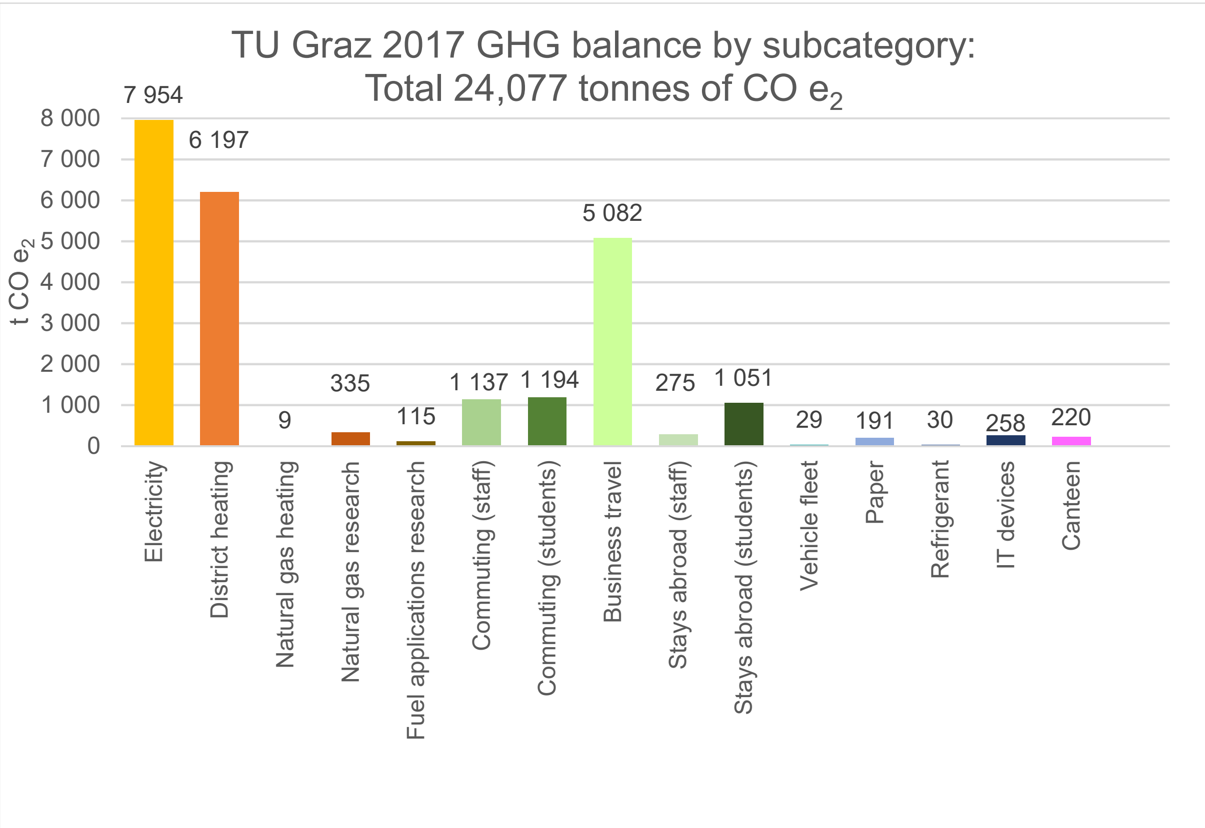


Figure 8: TU Graz 2017 GHG balance by subcategory: Total 24,077 tonnes of CO_2e

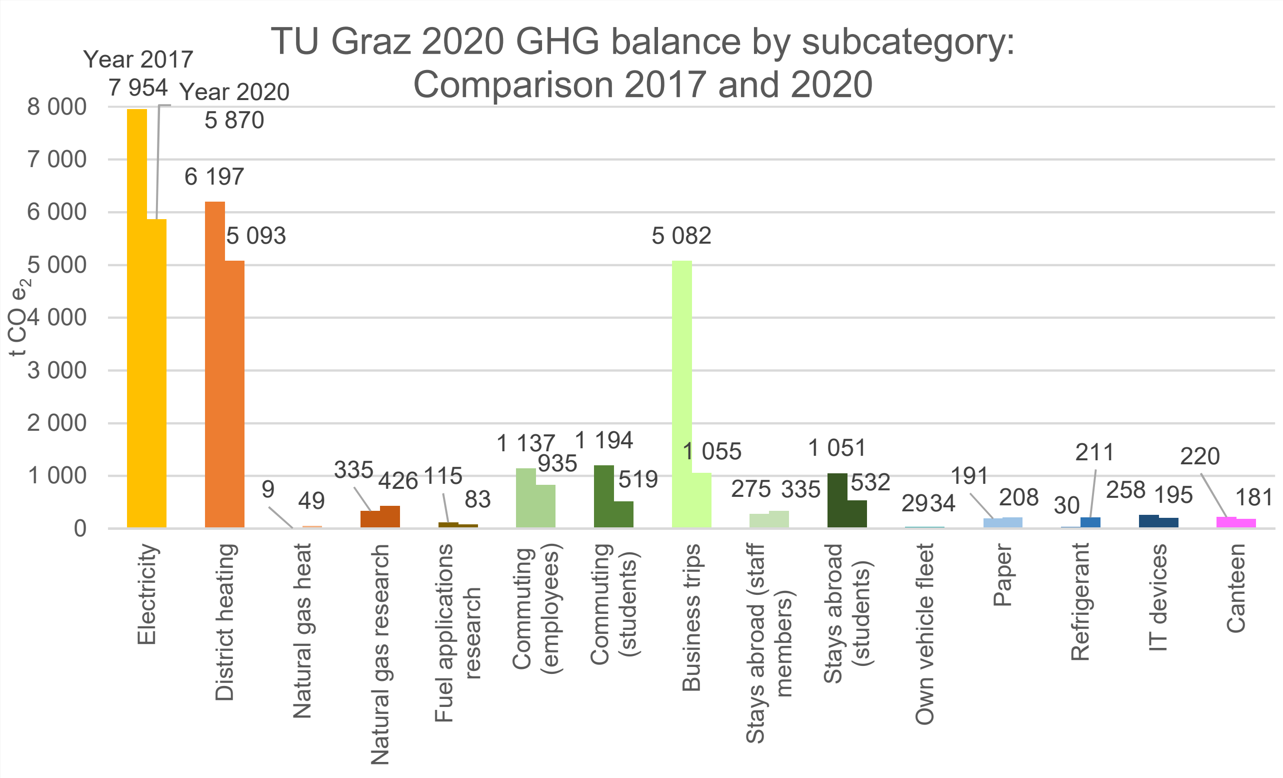


Figure 9: TU Graz 2020 GHG balance by subcategory: Comparison of 2017 and 2020

The following graph shows the emissions by subcategory with a vertical axis extending up to 1,200 tonnes of CO_2e, excluding the subcategories *Electricity* and *District heating*. This makes the values displayed for these subcategories easier to read. The emissions shown in the *Electricity* and *District heating* subcategories exceed these 1,200 tonnes; therefore, they are not shown here (see p. 17).

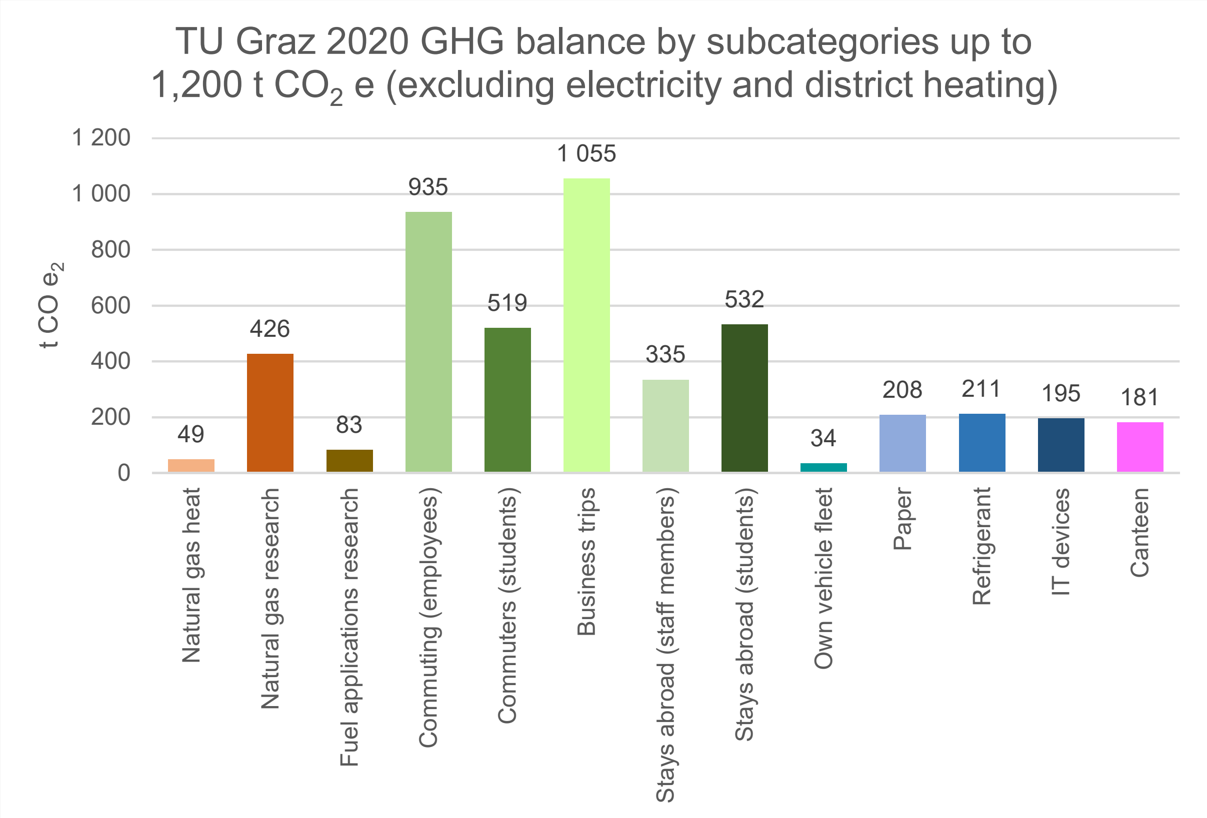


Figure 10: TU Graz 2020 GHG balance by subcategories, extending up to a maximum of 1,200 tonnes of CO_2e (excluding electricity and district heating)

In the comparison between 2020 and 2017, the emissions in the *Business trips* subcategory are also eliminated, as these significantly exceeded 1,200 tonnes of CO_2e in 2017:

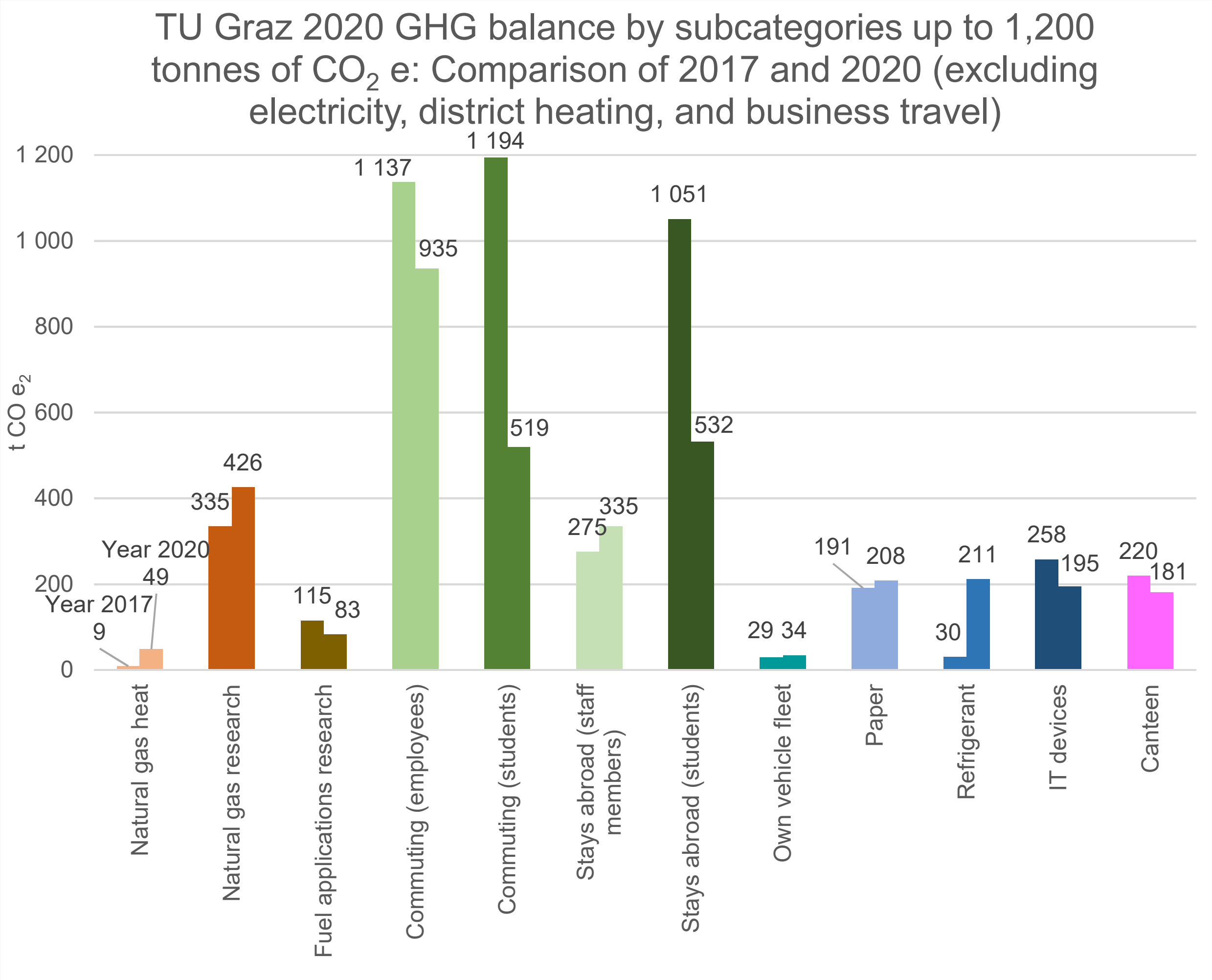


Figure 11: TU Graz 2020 GHG balance by subcategories up to a maximum of 1,200 tonnes of CO_2e (excluding electricity, district heating, and business trips): Comparison between 2017 and 2020

Results by scope category:

The following graph shows the results according to the three scope categories in kg CO_2e. All (sub)categories available in *ClimCalc* are included here:

Zusammenfassung der Berechnungsergebnisse nach Scope-Ebenen (in kg CO_2-Äquivalenten)		
Hauptmodul		2020 (final)
Scope 1		652 521
Scope 2		8 184 417
Scope 3		6 693 971
Summe Hauptmodul	**(kg CO_2 eq.)**	**15 530 909**
Zusatzmodul Mensa		
Scope 3		180 899
Summe Hauptmodul + Zusatzmodul	**(kg CO_2 eq.)**	**15 711 808**

Table 4: Summarised calculation results for the TU Graz GHG balance by scope category (in kg CO_2 equivalents)

3.2 Categories

3.2.1 Energy

The *Energy* category is divided into *electricity* (purchased *electricity* and PV personal generation and consumption), *natural gas heat, natural gas research*, *district heating,* and *fuel applications research*. The division of natural gas into *heat* and *research* was made for the first time in this balance, because the majority of natural gas is used at TU Graz for research and not for heating. As the graphs below show, the natural gas used for research accounts for 426 tonnes of CO_2e, i.e. around 4% of emissions in the *Energy* category, while natural gas used for heating accounts for 0.4% of the emissions or 49 tonnes of CO_2e.
The data for this category were provided by the *Buildings and Technical Support* organisational unit, as well as by the *Institute of Thermal Turbomachinery and Machine Dynamics* in the case of fuel applications.
Most of TU Graz's GHG emissions are caused in the *Energy* category, totalling around 11,520 tonnes CO_2e . This accounts for around 78% of TU Graz's total greenhouse gas emissions. The main share is found in the *electricity* subcategory, namely 5,870 tonnes CO_2e . The second-highest share is found in the *district heating* subcategory with around 5,093 tonnes of CO_2e, followed by *natural gas research* with 426 tonnes of CO_2e, *fuel applications research* with 83 tonnes of CO_2e, and *natural gas heat* with 49 tonnes of CO_2e.

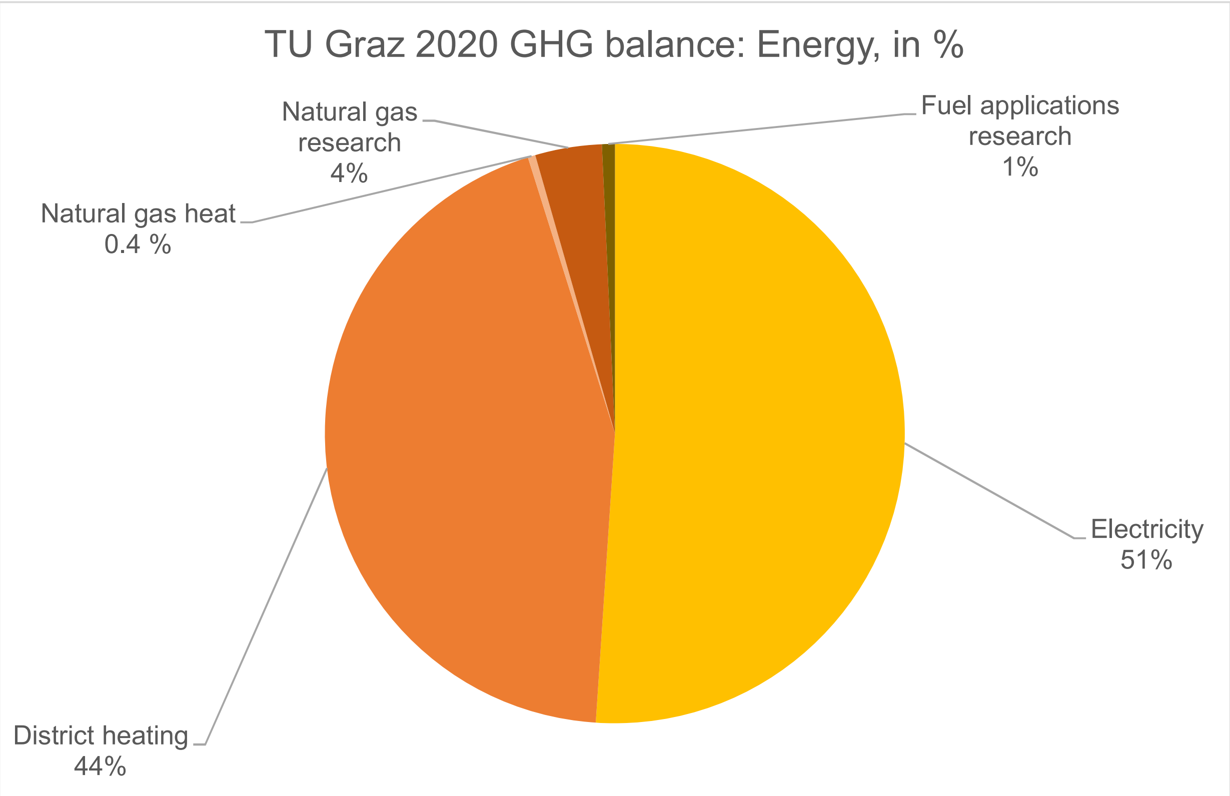


Figure 12: TU Graz 2020 GHG balance: Energy (in %)

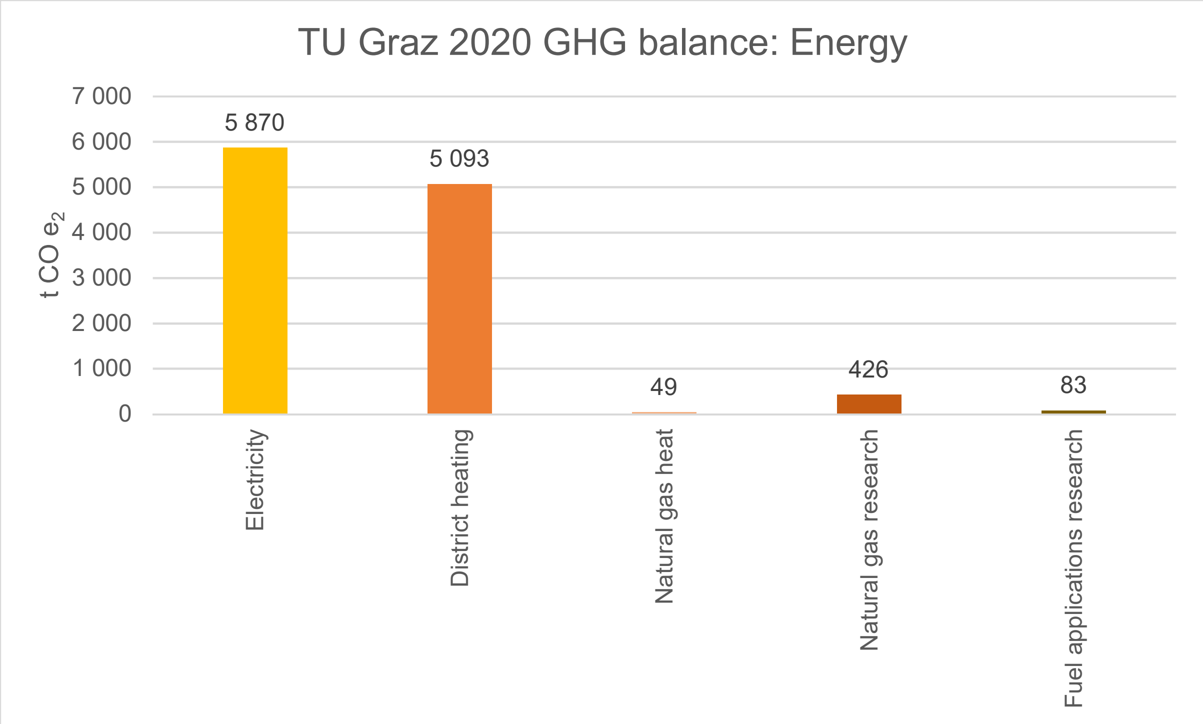


Figure 13: TU Graz 2020 GHG balance – Energy

Comparison of 2020 and 2017

Compared to 2017, emissions in the *Energy* category were around 3,100 tonnes CO_2e lower in 2020 (2017: 14,600 t vs. 2020: 11,520 t). With the exception of natural gas (heating and research), emissions in all energy subcategories in 2020 are lower than in 2017, as the following graph shows:

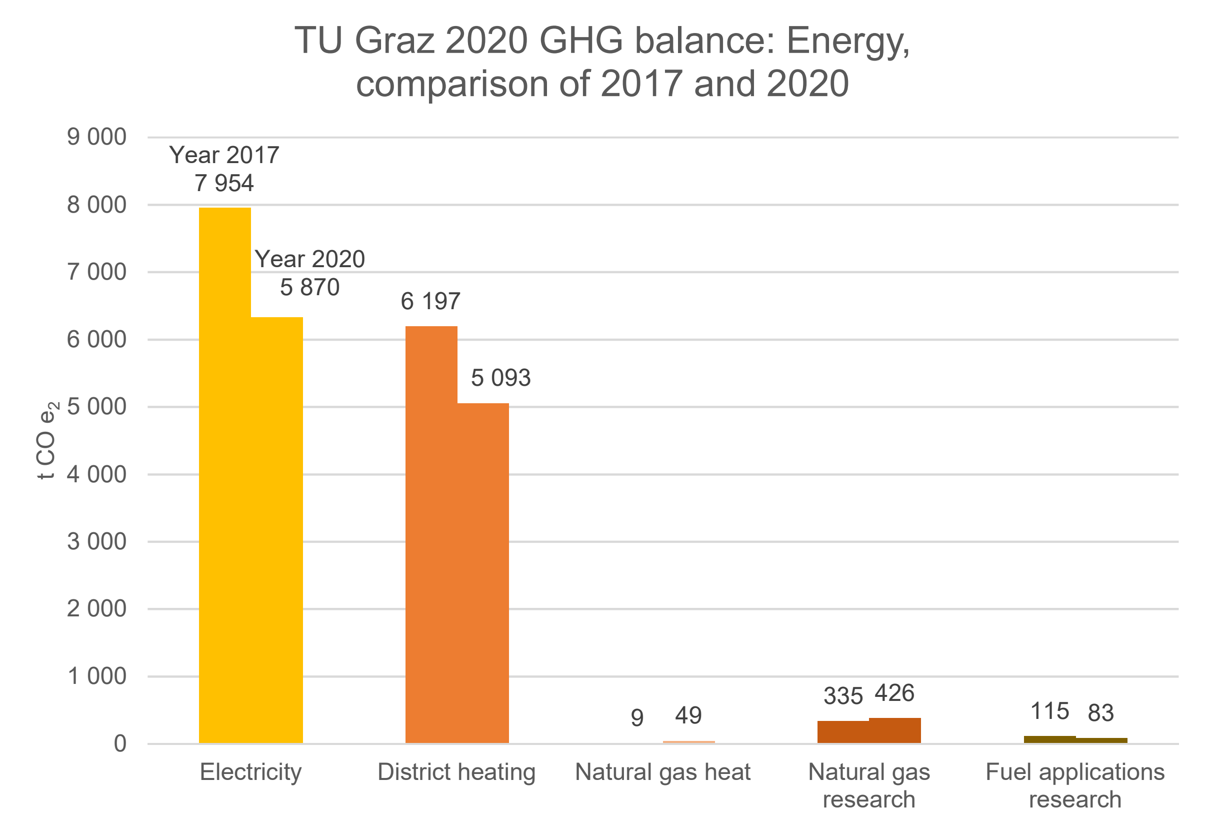


Figure 14: TU Graz 2020 GHG balance – Energy, comparison of 2017 and 2020

The *electricity* subcategory is divided further into *electricity consumption (without UZ 46 certification)* and *own photovoltaic consumption (PV)*. As *ClimCalc* only distinguishes between electricity consumption without certification according to the eco-label RL UZ 46 and electricity consumption with certification according to the eco-label RL UZ 46, the electricity consumption at TU Graz should be evaluated as electricity consumption without the eco-label RL UZ 46 certification. The high location-based emission factor is used for the calculation, so that electricity products purchased by TU Graz are reported according to the emissions they create. The special features of UZ 46-certified electricity products ae that which electricity may be traded under this certificate is clearly defined and that stringent, transparent criteria must be met to sell electricity as 'UZ 46 electricity'. A minimum share of PV electricity also needs to be included, while the remaining shares can come from biomass, geothermal, wind power, or hydropower (Austrian Ecolabel 2018).
Please note that TU Graz already uses 100% green electricity in accordance with Section 5 (1) of the Green Electricity Act and switched to UZ 46-certified electricity in 2022. In the Green Electricity Act, green electricity is defined as "electrical energy from renewable energy sources" under Section 5(1)(22) (ÖSG 2012).
The electricity currently used at TU Graz (EAA Aqua of the Austrian Energy Alliance) is composed of (according to the invoice dated 14 April 2020):

- 68.57% Hydropower
- 15.63% Solid or liquid biomass
- 10.73% Wind power
- 3.40% Biogas

- 1.59% Solar energy
- 0.08% Other green energy

The origin of the electricity is indicated as (according to invoice dated 14/04/2020):

- 39.18% Austria
- 27.42% Norway
- 15.90% and 12.52% France
- 2.27% Slovenia
- 2.27% Finland
- 0.03% Czech Republic
- 0.12% Sweden
- 0.02% Denmark

This electricity consumption also includes the electricity used to run the heat pumps at TU Graz, i.e. for heating and cooling. These data are from 2021, as no data have been collected for 2020. The consumption amounts to around 527,150 kWh, resulting in emissions of 107 tonnes of CO_2e.

Compared to 2017, the figures for *electricity consumption (without certification)* have decreased slightly; the consumption, the emission factor, and therefore also the emissions have dropped. However, the consumption of *PV electricity* from our own generation increased sharply in 2020 (by approx. 300%). This increase can be explained by the expansion of TU Graz's own PV systems, namely from 145 kW_{peak} in 2017 to 605 kW_{peak} in 2020. The PV systems generated the highest amount of electricity in 2020 in the month of July, when over 80,000 kWh of electricity were produced. Compared to this, December 2020 was the month with the lowest *PV electricity* generation at just under 5,500 kWh.

The emission factor for *PV electricity* was 33% lower than that reported for 2017. 100% of the *PV electricity* generated at TU Graz is consumed at the university at all times.

Comparison of 2020 and 2017: Electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes CO_2e
2020 Electricity without UZ 46 certification	28,813,347 of which 527,150 for heat pumps	0.2030	5,849 107 from heat pumps
2020 PV	526,924	0.0400	21
Total	29,340,271		**5,870**
2017 Electricity without UZ 46 certification	30,882,000 of which 379,000 for heat pumps	0.2573	7,946 100 from heat pumps
2017 PV	132,000	0.0600	8
Total	30,414,000		**7,954**

Increase/decrease in % Electricity	- 5%	- 21%	- 26%
Increase/decrease in % PV	+ 299%	- 33%	+ 163%
Total			**- 24%**

Table 5: Comparison of 2020 and 2017 – Electricity

The 2020 emission factor for district heating was also 11% lower than in 2017. The total natural gas consumption (heating + research) increased by around 40% in 2020 compared to 2017, while the district heating consumption decreased slightly. This primarily depends on the number of heating degree days in the respective year. This was 3,852.6 in 2017 and 3,627.3 in 2020 (TU Graz GuT energy statistics).
The increase in natural gas consumption can be explained by the fact that different amounts of natural gas were used for research projects in the two years, and a slightly higher number of rented properties were heated with natural gas in 2020. The fact that staff and students spent a large part of 2020 working from home only had a minor impact in the *Energy* category.

Comparison of 2020 and 2017: Natural gas			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2020	1,770,350 from research: 1,589,292 from heat: 181,292	0.2681	**475** from research: 426 from heat: 49
2017	1,269.946 from research: 1,238.221 from heat: 31.779	0.2703	**343** from research: 335 from heat: 9
Increase/decrease in %	+ 39%	- 1%	+ 38%

Table 6: Comparison of 2020 and 2017 - Natural gas

Comparison of 2020 and 2017: District heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes CO_2e
2020	16,480,900	0.3090	**5,093**
2017	17,773,000	0.3487	**6,197**
Increase/decrease in %	- 7%	- 11%	- 18%

Table 7: Comparison of 2020 and 2017 – District heating

In December 2021, the emission factor for Energie Graz's district heating was corrected upwards by the Environment Agency Austria for recent years. The year 2017 was also affected by this correction, which is why district heating emissions for 2017 are now approx. 1,800 tonnes of CO_2e higher than originally assumed in the 2017 balance. Here, in the 2020 GHG balance report, the corrected values for 2017 have already been applied using the emission factor 0.3487 and 6,197 tonnes of CO_2e (cf. 2017 before the correction: emission factor 0.2483; emissions: 4,413 tonnes of CO_2e).

The category of *fuel applications research* also deserves a second look, as consumption has declined (-26% for diesel and -45% for petrol). This decline can be explained by the fact that different quantities of fuels were used for research purposes in both 2017 and 2020.

Comparison of 2020 and 2017: Fuel applications research			
	Consumption in litres	Emission factor in kg CO_2e/litre	Emissions in tonnes CO_2e
2020			
Diesel	23,084	3.1335	72
Petrol	3,571	2.8840	10
Total	26,655		**82**
2017			
Diesel	31,325	3.1006	97
Petrol	6,543	2.7218	18
Total	37,868		**115**

Increase/decrease in % Diesel	- 26%	+ 1%	- 26%
Increase/decrease in % Petrol	- 45%	+ 6%	- 44%
Total			**- 29%**

Table 8: Comparison of 2020 and 2017 – Fuel applications research

3.2.2 Mobility

The *Mobility* category is subdivided into *staff commuting*, *student commuting*, *business trips*, *staff stays abroad*, *student stays abroad,* and *own vehicle fleet*. The data for this category were provided by the *Human Resources Department*, the *International Office - Welcome Center,* and the respective *institutes with company vehicles.* A list of institutes with company vehicles was provided by the *Finance and Accounting* organisational unit (see Appendix 3). In addition, the traffic survey carried out at TU Graz in 2019 was used (Forstner 2021), i.e. it was assumed that the modal split in terms of kilometres travelled in both the *staff commuting* and *student commuting* subcategories did not change from 2019 to 2020. In addition to daily commuting, the 2019 transport survey also recorded the GHG emissions of family home journeys by staff and students and presented these separately (Forstner 2021). However, according to *ClimCalc*, this special category is not included in the overall TU Graz 2020 GHG balance. More details are provided in the section entitled "Commuting: special category of family home journeys ".

Producing about 3,400 tonnes of CO_2e, the *Mobility* category is the second-highest emitting category at TU Graz after the *Energy* category. The *business trips* subcategory is the most significant one, responsible for around 1,055 tonnes of CO_2e in 2020, followed by *staff commuting* with around 935 tonnes, *student stays abroad* with around 532 tonnes, *students commuting* with around 519 tonnes, *staff stays abroad* with around 335 tonnes, and the *own vehicle fleet* with around 34 tonnes. This report places a particular focus on mobility, as TU Graz can reduce emissions very effectively by taking measures in this area. Some of these measures have already been adopted as described in the "Climate-neutral TU Graz 2030" roadmap, and an implementation plan has been drawn up (TU Graz 2020).
When interpreting all numbers mentioned here, please again note that the coronavirus pandemic had a specific impact on mobility in 2020. Due to lockdowns and travel restrictions, university mobility at TU Graz decreased significantly in 2020. The comparisons between data for the years 2020 and 2017 at the end of the chapter provide more details.

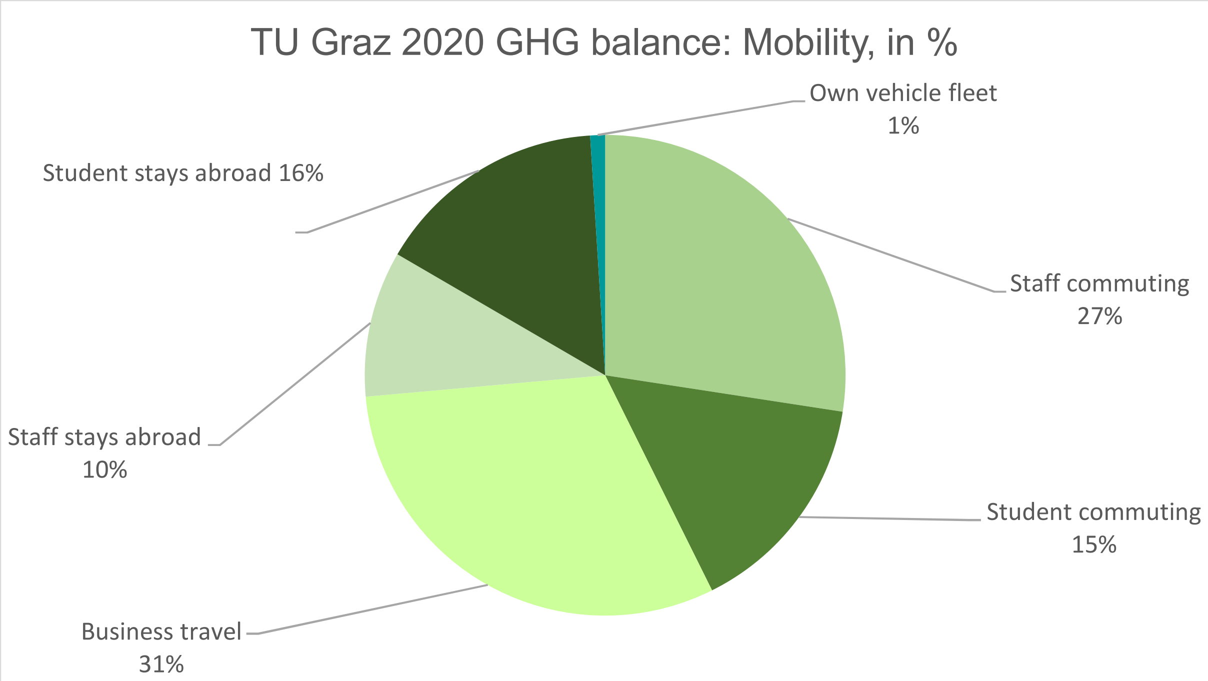


Figure 15: TU Graz 2020 GHG balance – Mobility (in %)

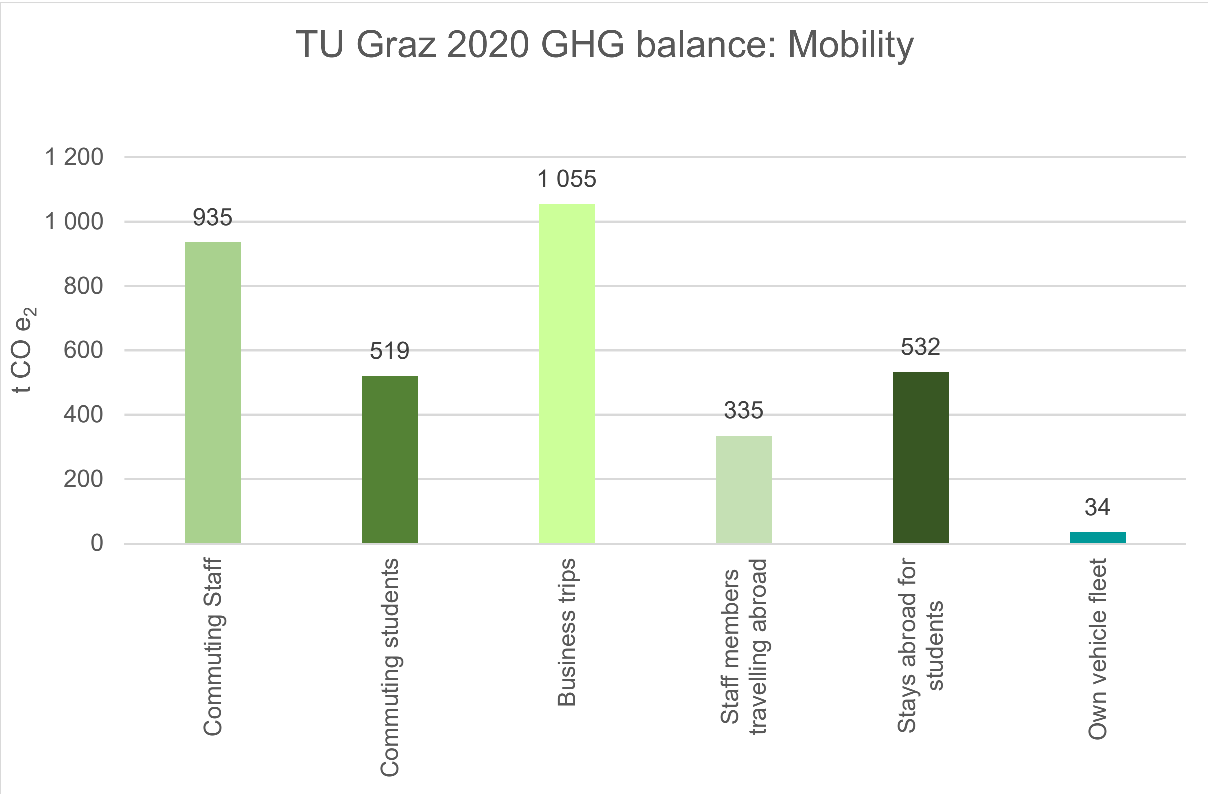


Figure 16: TU Graz 2020 GHG balance – Mobility

Staff and student commuting

The commuting kilometres reported are based on data collected in the 2019 traffic survey carried out by the Institute of Road and Transport Engineering at TU Graz for both staff and students (Forstner 2021). The figures were converted to indicate the number of staff (4,787 individuals incl. those in shareholdings) and students (16,091) in 2020. These figures were extracted from the TU Graz 2020 Intellectual Capital Report and from the organisational unit *Statistics and Data Protection* (shareholdings) (see Intellectual Capital Report 2020, p. 14). As university operations were restricted in the months of March to December due to the pandemic, the commuting kilometres were adjusted (see Annex 4): Minus 60% for staff and minus 80% for students in the period from mid-March to December. The first two and a half months of 2020 were calculated at 100%. These are rough estimates made based on discussions with TU Graz staff and an informal survey of 26 students. In addition, a study by Deloitte conducted in collaboration with University of Vienna and University of Graz found that at least half of the staff in almost 90% of the Austrian companies surveyed worked from home during the lockdown phase from April to May. In 60% of the companies surveyed, all staff, with the exception of a few system administrators, worked from home (Kellner et. al 2020).
In the *commuting* subcategory, both staff and student data show that the car is by far the means of transport causing the most emissions. Therefore, TU Graz would like to promote the use of electric cars, e.g. by installing around 200 charging points for electric cars on the TU Graz campus by 2030 (TU Graz 2020). Currently (as of 2024), 33 charging points are in operation on the TU Graz campuses. The total number of parking spaces at TU Graz in 2020 was around 680.
The following graphs compare the emissions by mode of transport, one for the subcategory of *staff commuting* and one for the subcategory of *student commuting*:

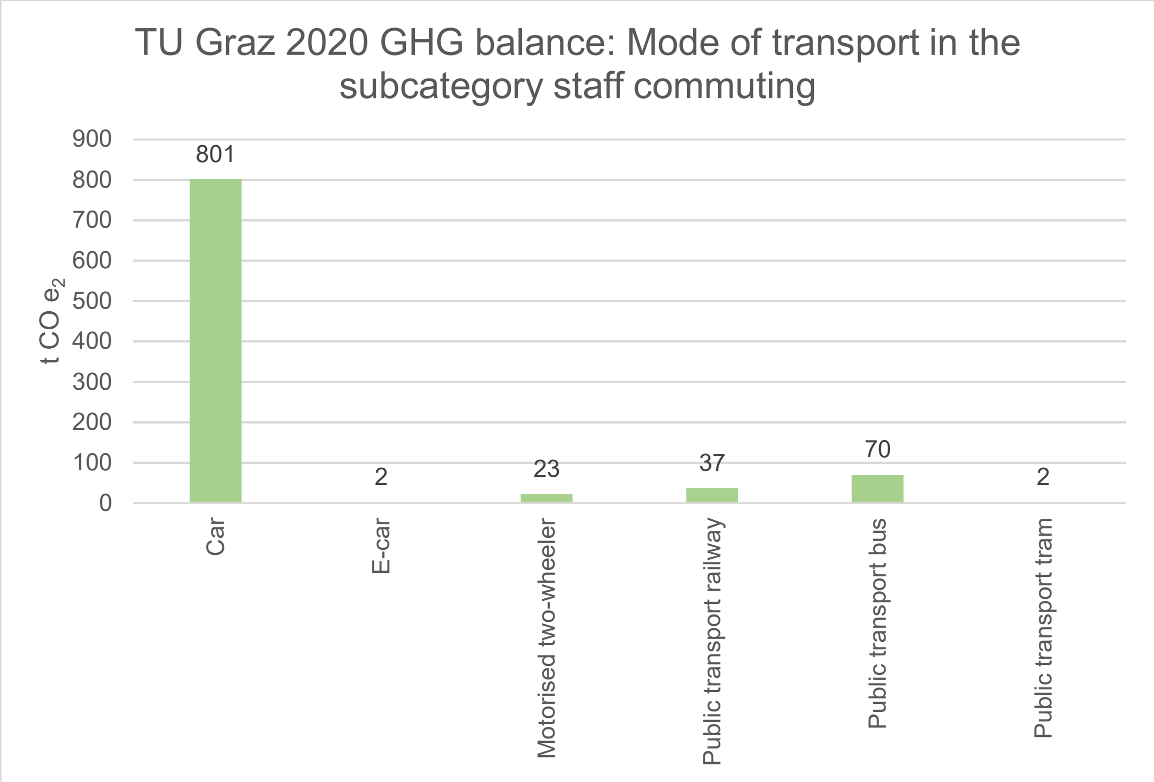


Figure 17: TU Graz 2020 GHG balance – Staff commuting

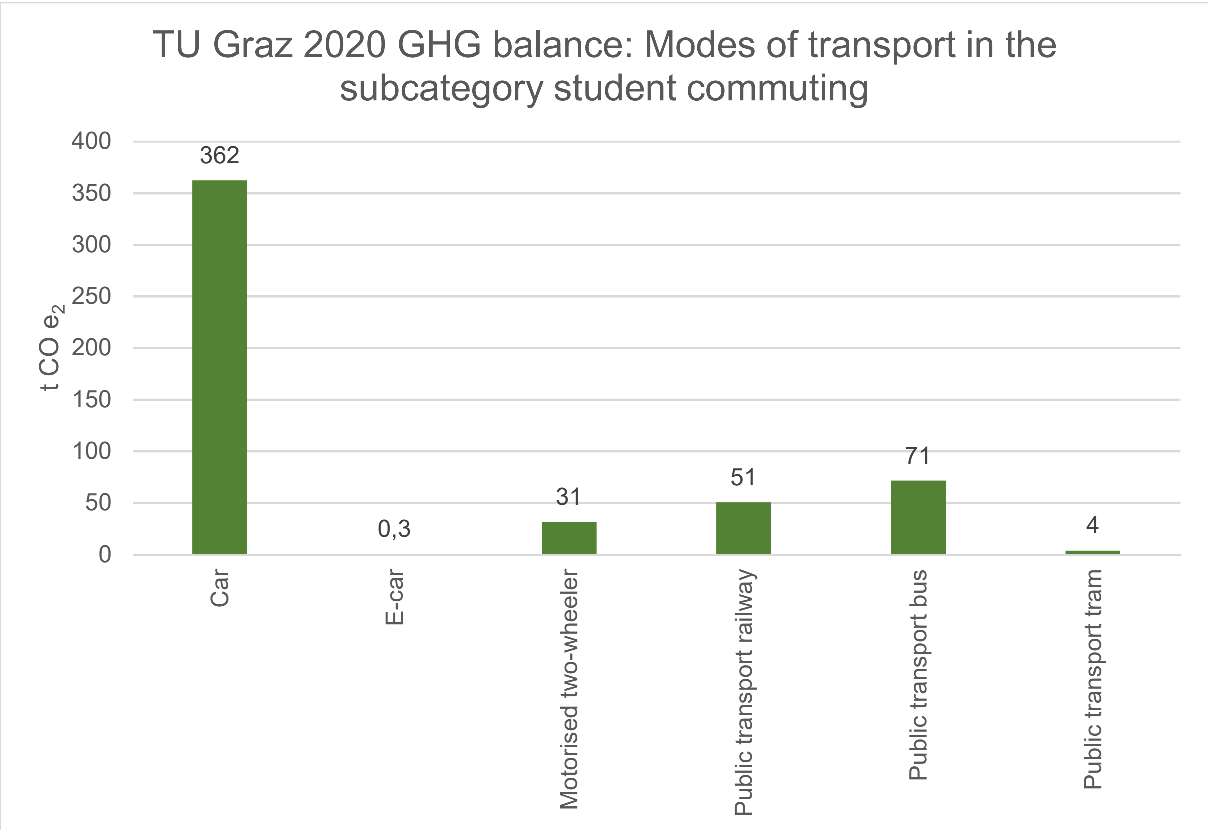


Figure 18: TU Graz 2020 GHG balance – Student commuting

Please note that a high proportion of both TU Graz students and staff report using walking and cycling as modes of transport in the *commuting* category (see 2019 transport survey: Forstner 2021), but these modes are not shown in the GHG balance as they are virtually emission-free.

The following graph from the 2019 transport survey shows the difference in the modal split (i.e. modal split by main mode of transport) for TU Graz commuters compared to those commuting to the city of Graz and to other cities in Austria. It is noticeable that the bicycle is used especially frequently by TU Graz commuters. Both inbound and outbound commuters were considered in this comparison. The modes shown here are *walking* (yellow), *cycling* (green), *motorised private transport* (red), and *public transport* (blue). The data are taken from the TU Graz 2019 traffic survey (Forstner 2021) and based on raw data from a mobility survey by *Österreich unterwegs* (Österreich unterwegs 2013/2014, Forstner 2021, p. 48-75).

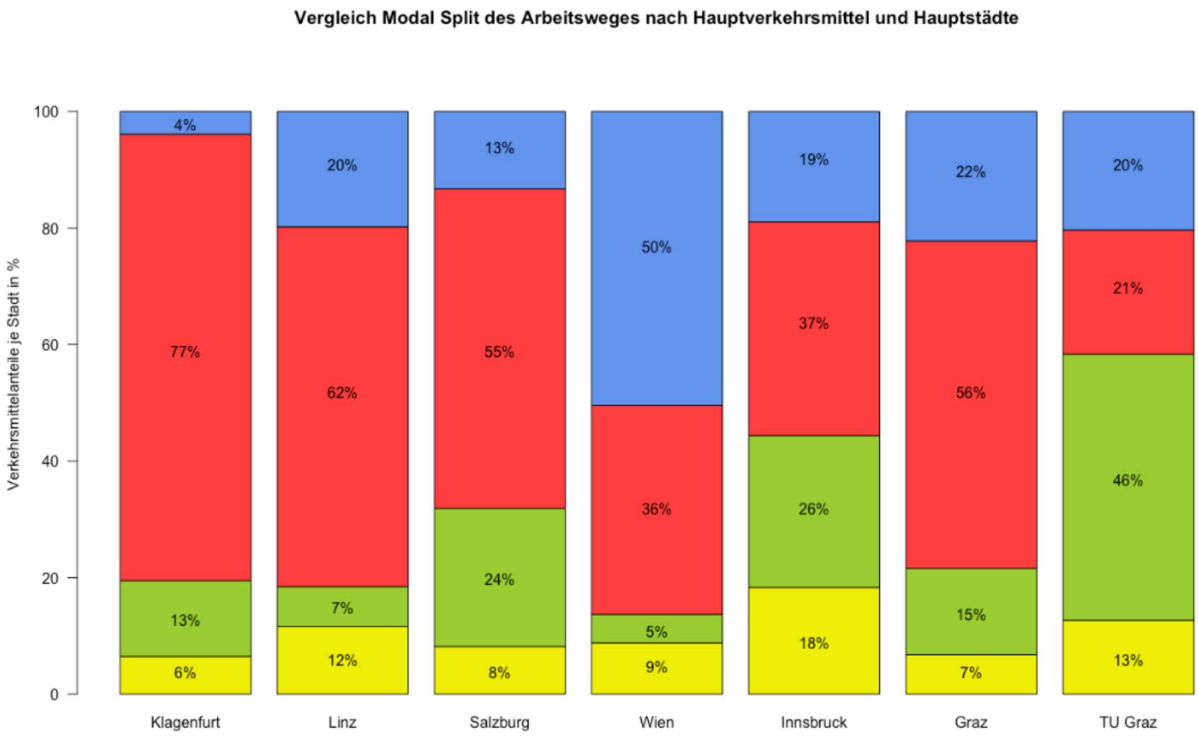


Figure 19: Comparison of modal split for the work commute according to the main mode of transport used by inbound and outbound commuters, to capital cities, and at TU Graz (Forstner 2021, p. 65; raw data: Österreich unterwegs 2013/14)

If only local commuters are taken into account, i.e. only those living in the city of Graz, pedestrians and cyclists are even more strongly represented. Together they make up 76% of the total. Comparing the figures for local and inbound commuters reveals that inbound commuters especially make greater use of private motorised transport and public transport. The following graph shows the modal split for local commuters:

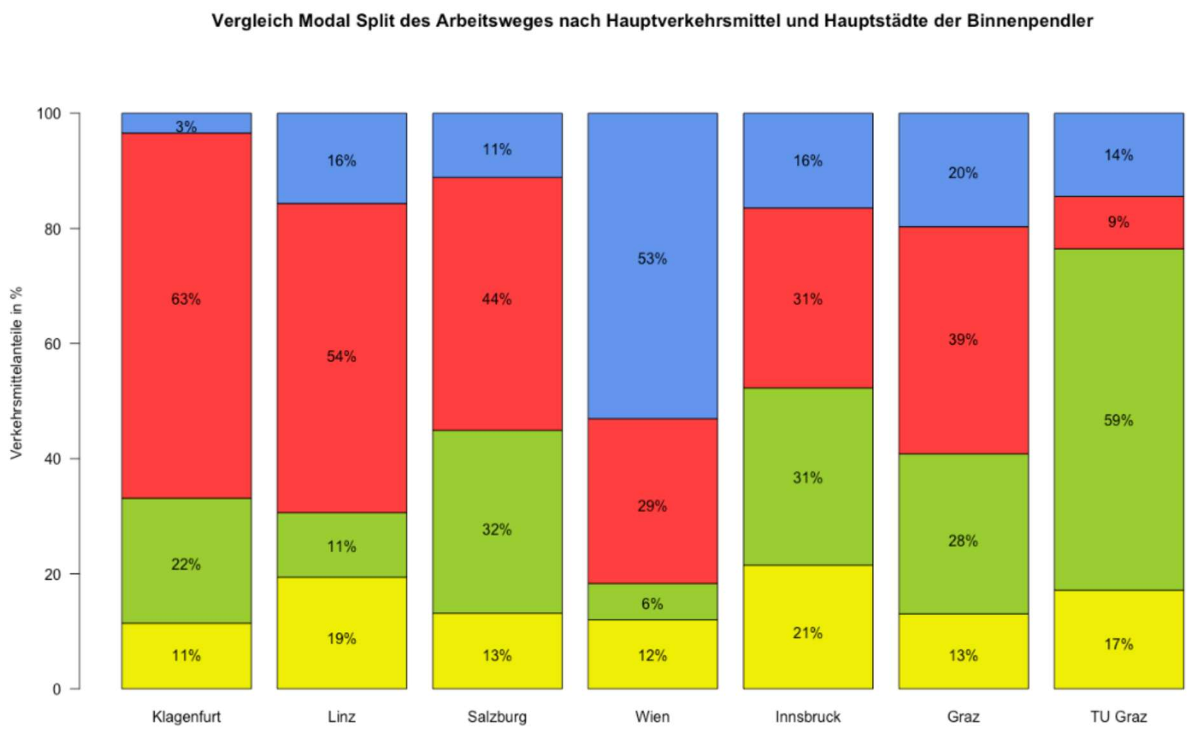


Figure 20: Comparison of modal split for local commuters according to the main mode of transport used by local commuters, to capital cities and at TU Graz (Forstner, p. 69; raw data: Österreich unterwegs 2013/14)

A similar picture also emerges when comparing the modal split for those commuting to reach educational institutions in capital cities with the modal split for commuting students at TU Graz. In the first graph, both inbound and outbound commuters are considered, while only inbound commuters are considered in the second graph. Here, too, an increase is seen in the share of pedestrians and cyclists among internal commuters, while the percentage using motorised private transport and public transport decreases:

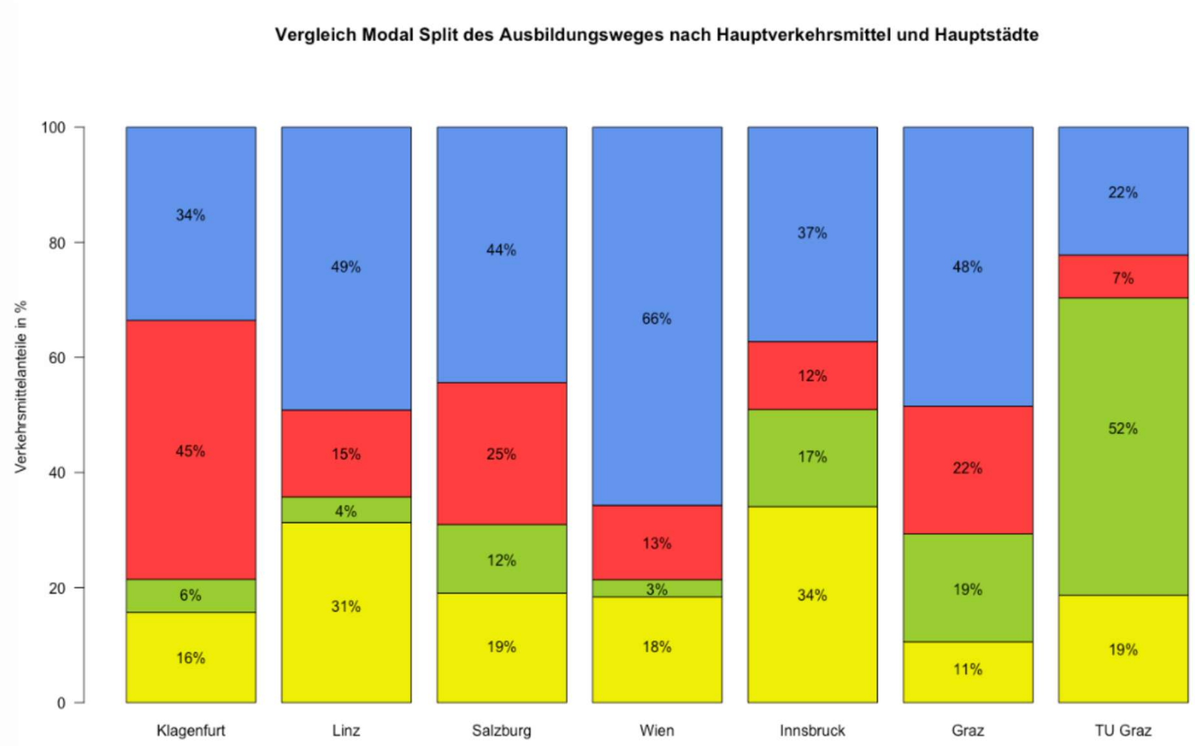


Figure 21: Comparison of the modal split for commuters to reach educational institutions by main mode of transport used by inbound and outbound commuters, for capital cities, and at TU Graz (Forstner 2021, p. 66; raw data: Österreich unterwegs 2013/14)

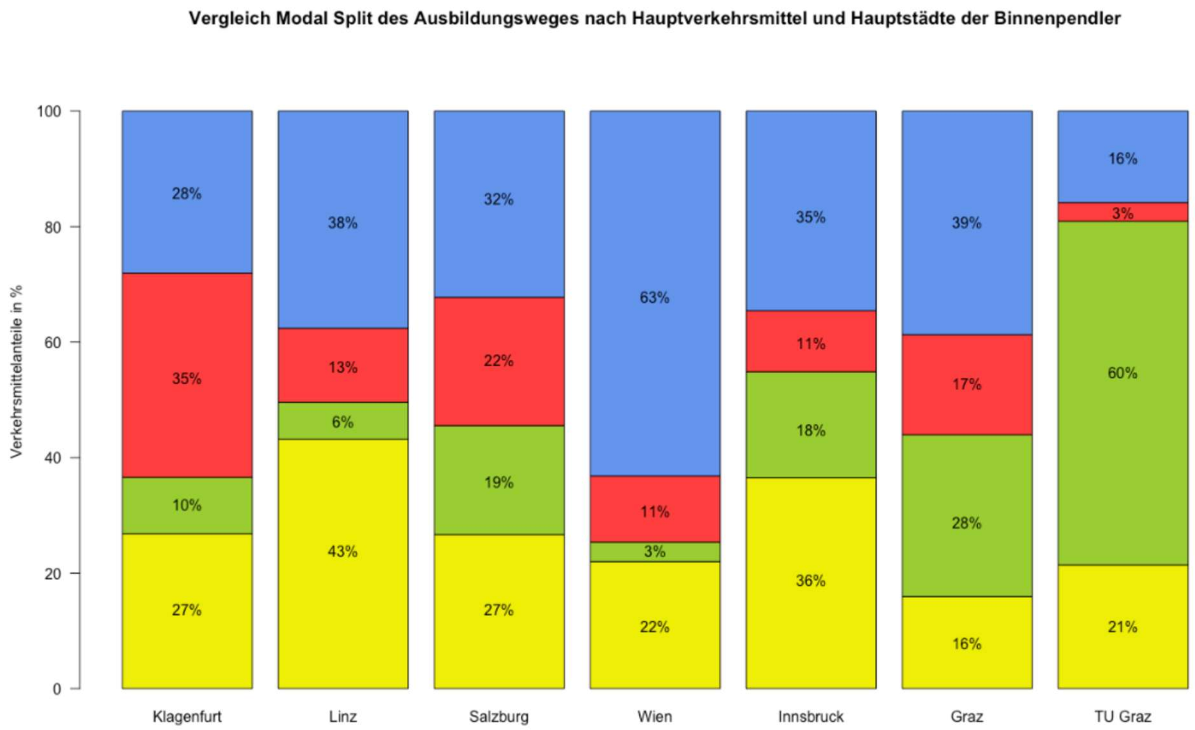
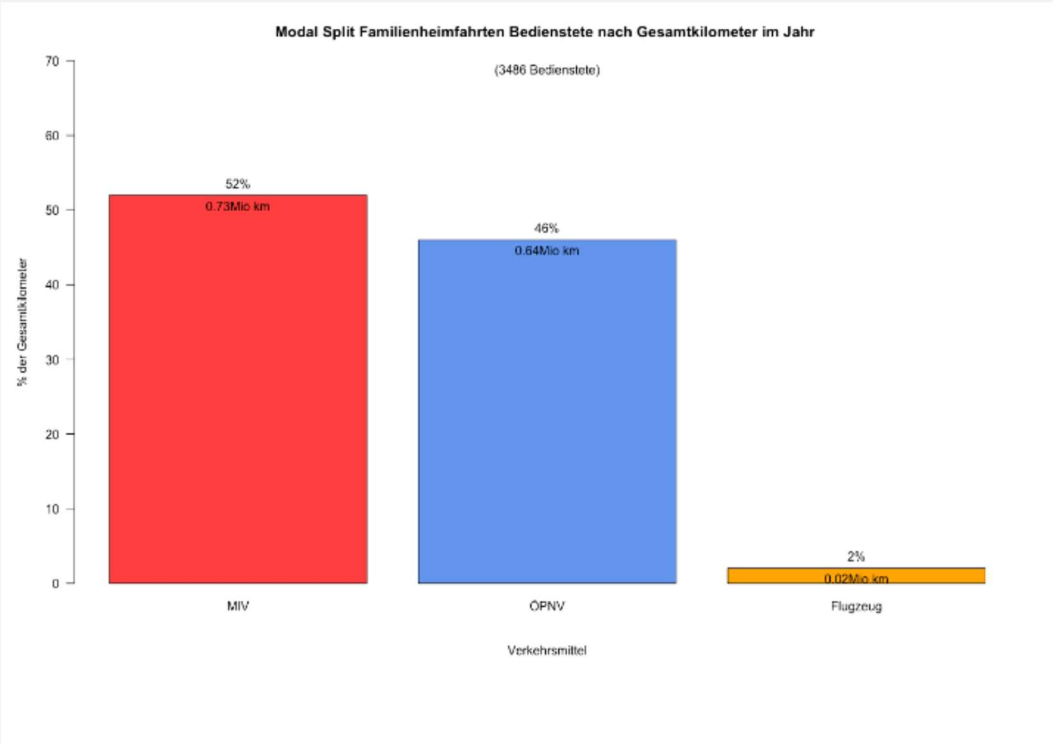


Figure 22: Comparison of the modal split for local commuters to reach educational institutions by the main mode of transport used, for capital cities, and at TU Graz (Forstner, p. 70; raw data: Österreich unterwegs 2013/14)

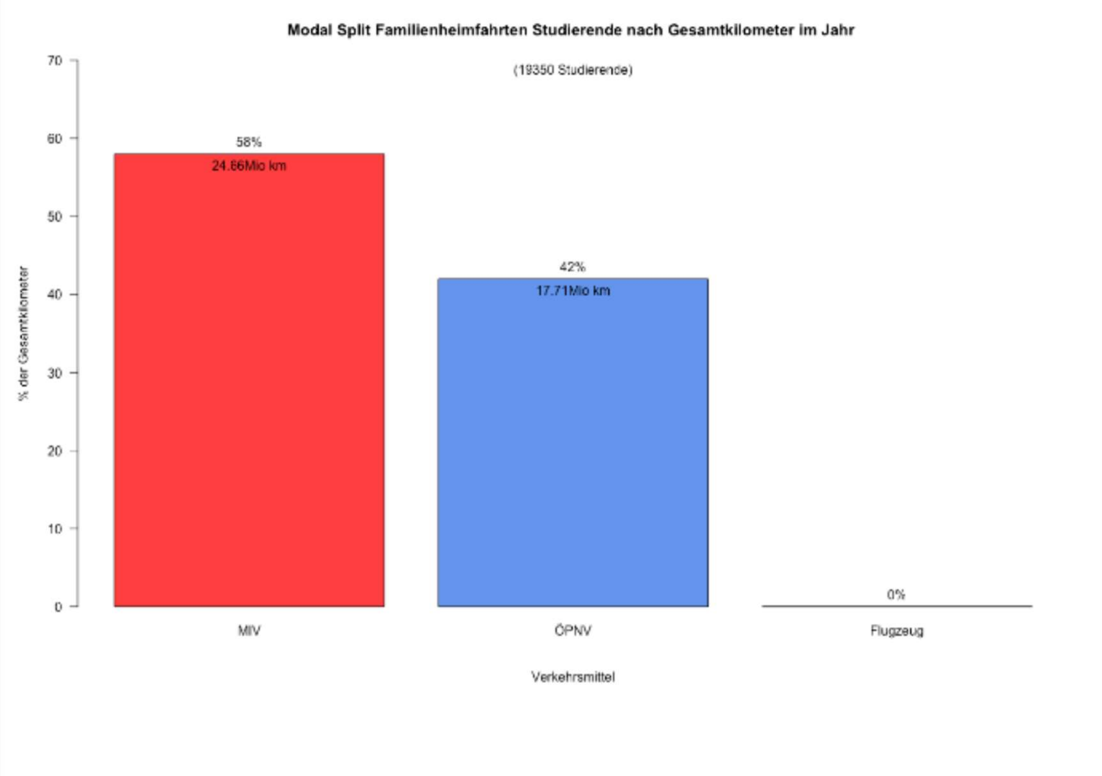
Commuting: special category family home journeys

The 2019 transport survey also addressed commuting for the purpose of travelling home to visit family (Forstner 2021). Family home journeys are journeys back to the main residence or family home if this is not located where a daily commute to TU Graz is possible. An example would be the student from Carinthia who visits his family there once a month, but has his second residence in the city of Graz. However, family home journeys are also possible for TU Graz staff, e.g. for a professor whose family lives in Munich, where she makes a family home journey from Graz every weekend.
The resulting emissions are not included in TU Graz's GHG balance, but should nevertheless be presented here, as family home journeys represent an interesting additional phenomenon related to commuter mobility. The following section provides insights into the results of the 2019 traffic survey on family home journeys.
For both staff and students, the modal split in terms of kilometres travelled on family home journeys in 2019 was dominated by private motorised transport, followed by public transport, and finally air travel, which plays a subordinate role (Forstner 2021). These figures show that students travel significantly more total kilometres in the private and public transport categories than staff. This is also reflected in the resulting total emissions, which are discussed at the end of this special chapter.



[Motorised individual transport (MIV): 0.73 million km, 52%; public transport (ÖPNV): 0.64 million km, 46%; air transport: 0.02 million km, 2%]

Figure 23: Modal split for family home journeys by staff by total kilometres travelled in 2019 (Forstner 2021, p. 40)

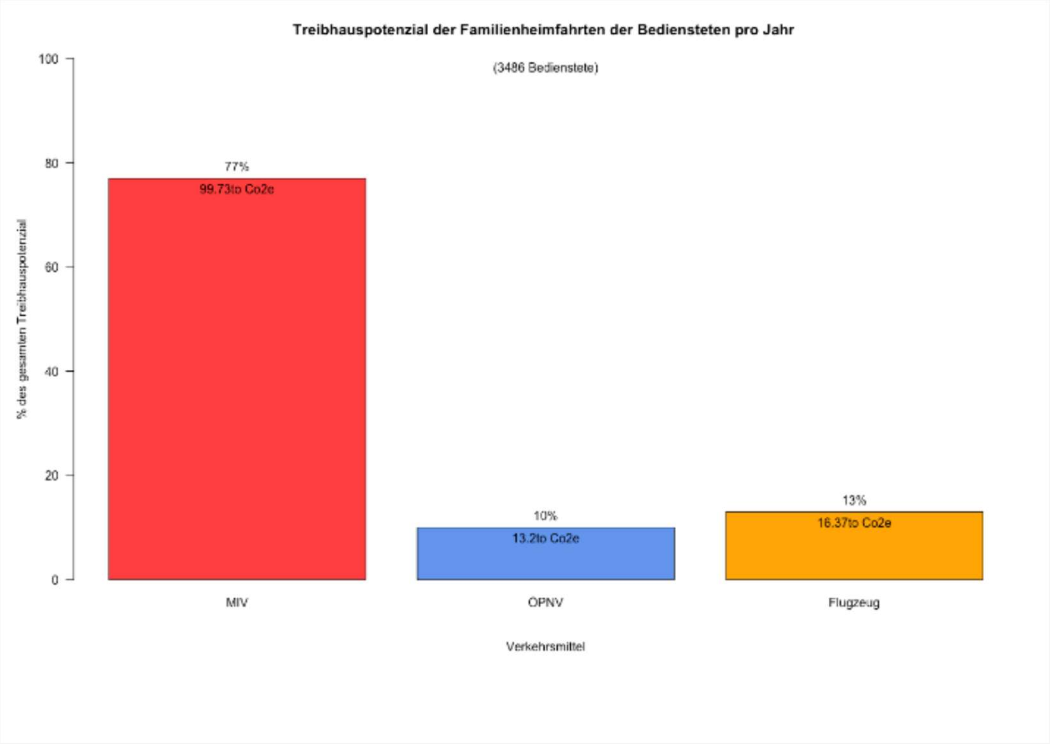


(Motorised individual transport (MIV): 24.66 million km, 58%; public transport (ÖPNV): 17.71 million km, 42%; air transport: 0.11 million km, 0.3%)

Figure 24: Modal split for students' family home journeys by total kilometres travelled in 2019 (Forstner 2021, p. 41)

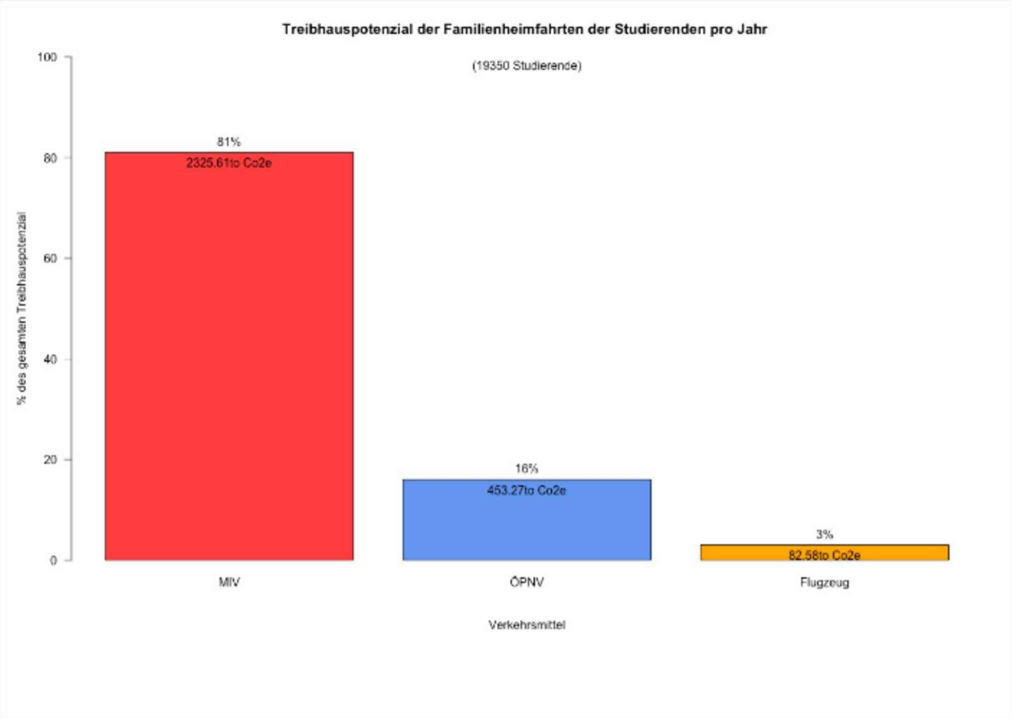
In 2019, emissions from family home journeys amounted to around 130 tonnes of CO_2e for staff and around 2,900 tonnes of CO_2e for students. Private motorised transport is responsible for the most emissions by both staff and student travel. This is followed by air transport for staff – although this accounts for the fewest kilometres – and finally by public transport. Public transport is responsible for the second highest emissions for students, followed by air travel.

The following graphs present the GHG emissions by mode of transport:



[Motorised individual transport (MIV) 99.73 t CO_2e, 77%; public transport (ÖPNV): 13.2 t CO_2e, 10%; air transport: 16.37 t CO_2e, 13%]

Figure 25: Emissions from family home journeys by staff in 2019 in tonnes of CO_2e (Forstner 2021, p. 42)



(Motorised individual transport (MIT) 2,325.61 t CO_2e, 81%; public transport (ÖPNV): 453.27 t CO_2e, 16%; air transport: 82.58 t CO_2e, 3%)

Figure 26: Emissions from family home journeys by students in 2019 in tonnes of CO_2e (Forstner 2021, p. 43)

Business trips

As the following graph shows, most emissions in the business trips subcategory are caused by air transport, with long-haul flights in first place, followed by short-haul flights, then cars, and finally trains and long-distance buses.
In 2020, a distinction had not yet been made between electric cars and fossil-fuelled cars. However, this distinction is already reflected in the new CO_2 monitoring system for business trips at TU Graz ("**CO_2e app**") for **2022** data. This is also important because TU Graz has a car sharing system (*Family of Power*) that allows e-cars to be borrowed for business trips.

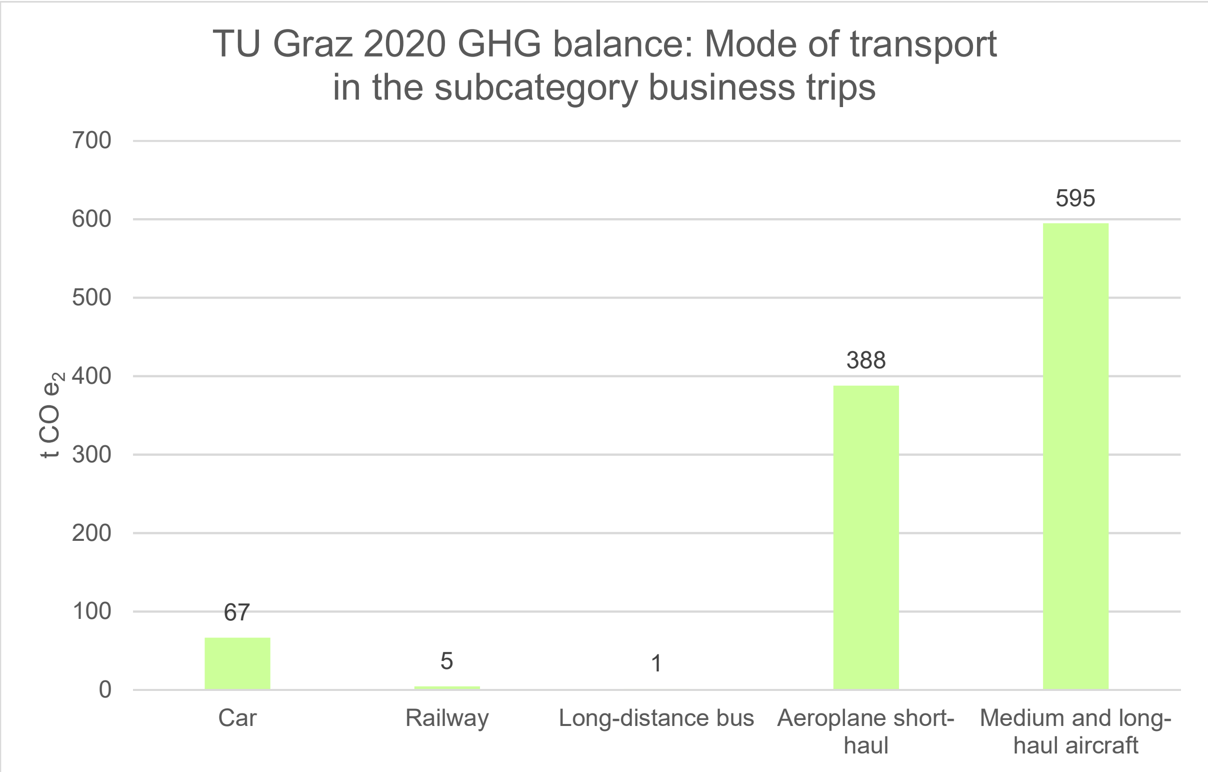


Figure 27: TU Graz 2020 GHG balance – Business trips

These emissions have also been broken down into the following categories of passenger kilometres:

Modes of transport: pkm business trips, 2020	
Modes of transport	Passenger kilometres (pkm)
Car	305,596
Railway	240,918
Long-distance bus	21,470
Short-haul flight	194,120
Medium- and long-haul flights	979,800
Total	1,741,904

Table 9: Modes of transport by passenger kilometres (pkm), business trips, 2020

This shows, for example, that more passenger kilometres were travelled by car or train than by short-haul flights, but that the emissions from short-haul flights are many times higher than those from cars or trains due to the significantly higher emission factor (see p. 36). A list with an overview of the most frequent destinations for business trips is found in the appendix (see Appendix 5).

Stays abroad by staff and students

The stays abroad carried out by staff and students whose home university is TU Graz, i.e. outgoing staff and students, are recorded in this subcategory.
Since the modes of transport used in the subcategory *stays abroad* (both for staff and students) were not systematically recorded at TU Graz in 2020, a highly simplified assumption was made that long-distance buses were used to travel distances of up to 750 km each way – for a total of two ways (outbound and inbound trips) – and that aeroplanes were used to travel distances of over 750 km. As these flights are already considered long-haul flights, one short-haul flight per journey was also assumed for the Graz-Vienna distance. Applying this assumption gave the following results:

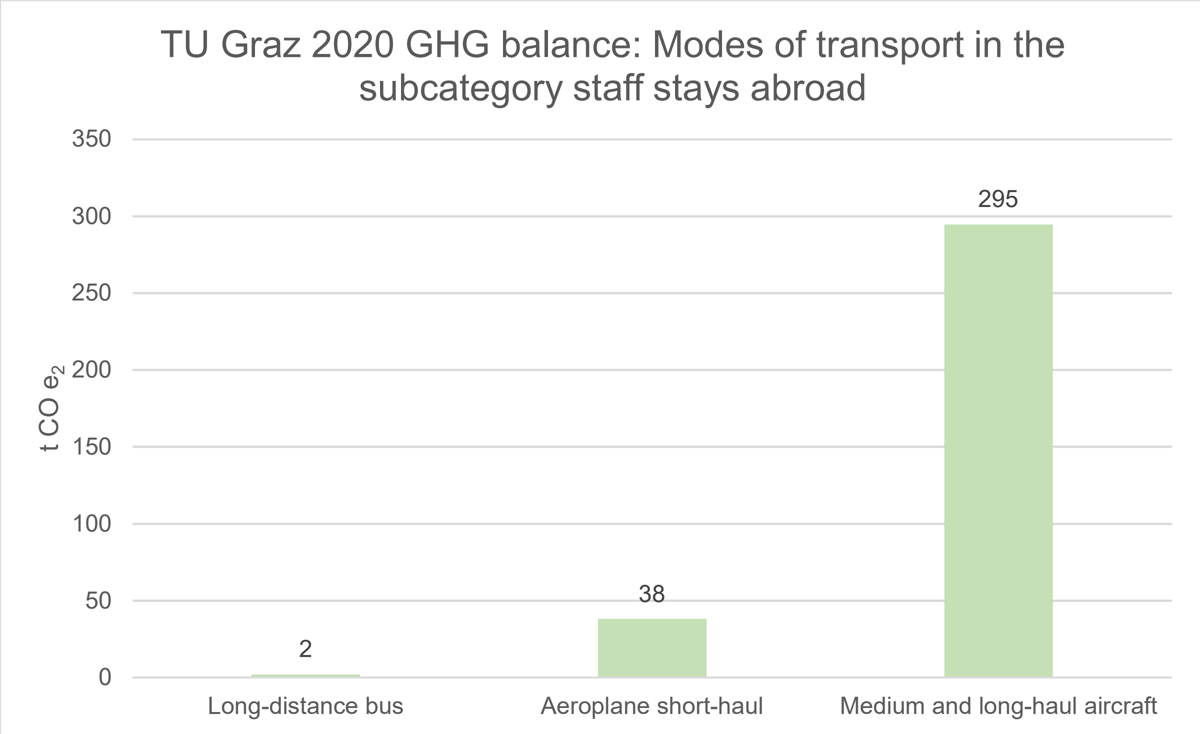


Figure 28: TU Graz 2020 GHG balance – Staff stays abroad

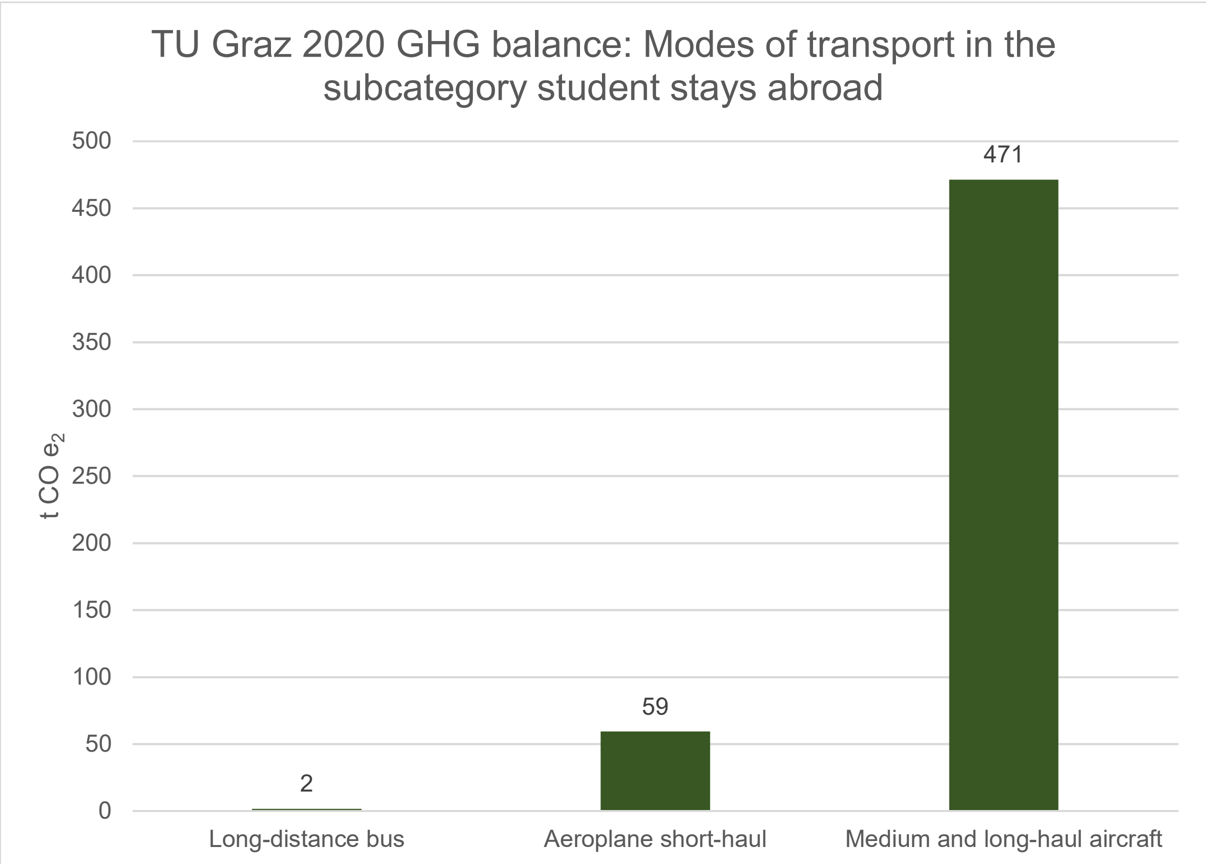


Figure 29: TU Graz 2020 GHG balance – Student stays abroad

Once again, it is clear that flights contribute significantly to emissions in this subcategory. Medium- and long-haul flights are particularly significant contributors. A list providing an overview of the most frequent destinations for staff and students travelling abroad in 2021 is found in the appendix (see Appendix 6).

From **2021 onwards**, the modes of transport used for stays abroad have been systematically recorded at TU Graz. This will enable more precise mapping of the modes of transport used and the emissions generated in future GHG balances. Initial data for the academic year beginning with the 2020/2021 winter semester show that aircraft and fossil-fuelled cars are the most frequently used modes of transport for stays abroad (by staff and students). Out of a total of 124 trips recorded (staff and students), 80 were made by plane, 30 by car (fossil-fuelled), 10 by train or overnight train, and none by long-distance bus. Therefore, the actual emissions from staff and students travelling abroad are likely to be higher than the emissions calculated for the 2020 GHG balance.

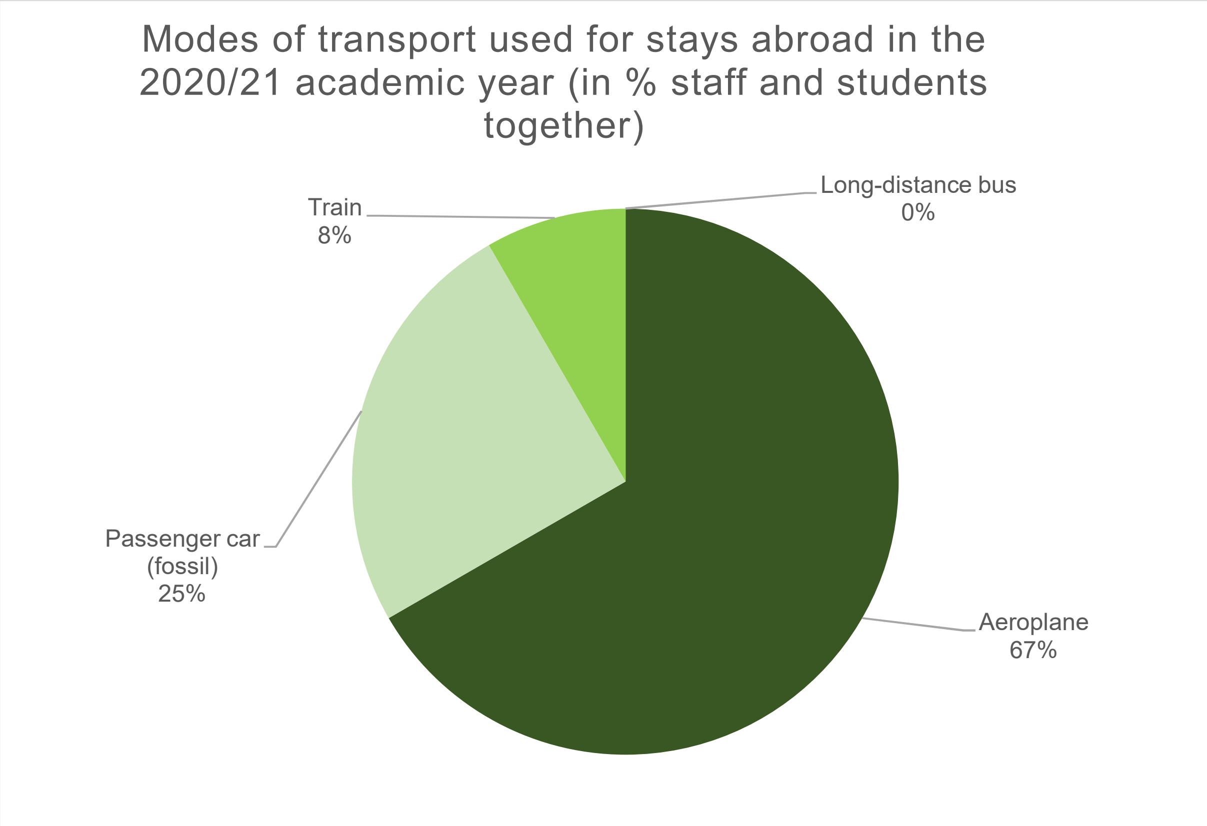


Figure 30: Modes of transport used for stays abroad in the academic year 2020/21 (in %, staff and students together)

Comparison of 2020 and 2017

Compared to 2017, emissions in the *Mobility* category dropped sharply in 2020. This is due to the pandemic-related reduction in passenger kilometres travelled, as both passenger transport and the transport services offered were reduced in 2020 due to the pandemic measures. Overall, emissions are 62% lower than those in 2017.

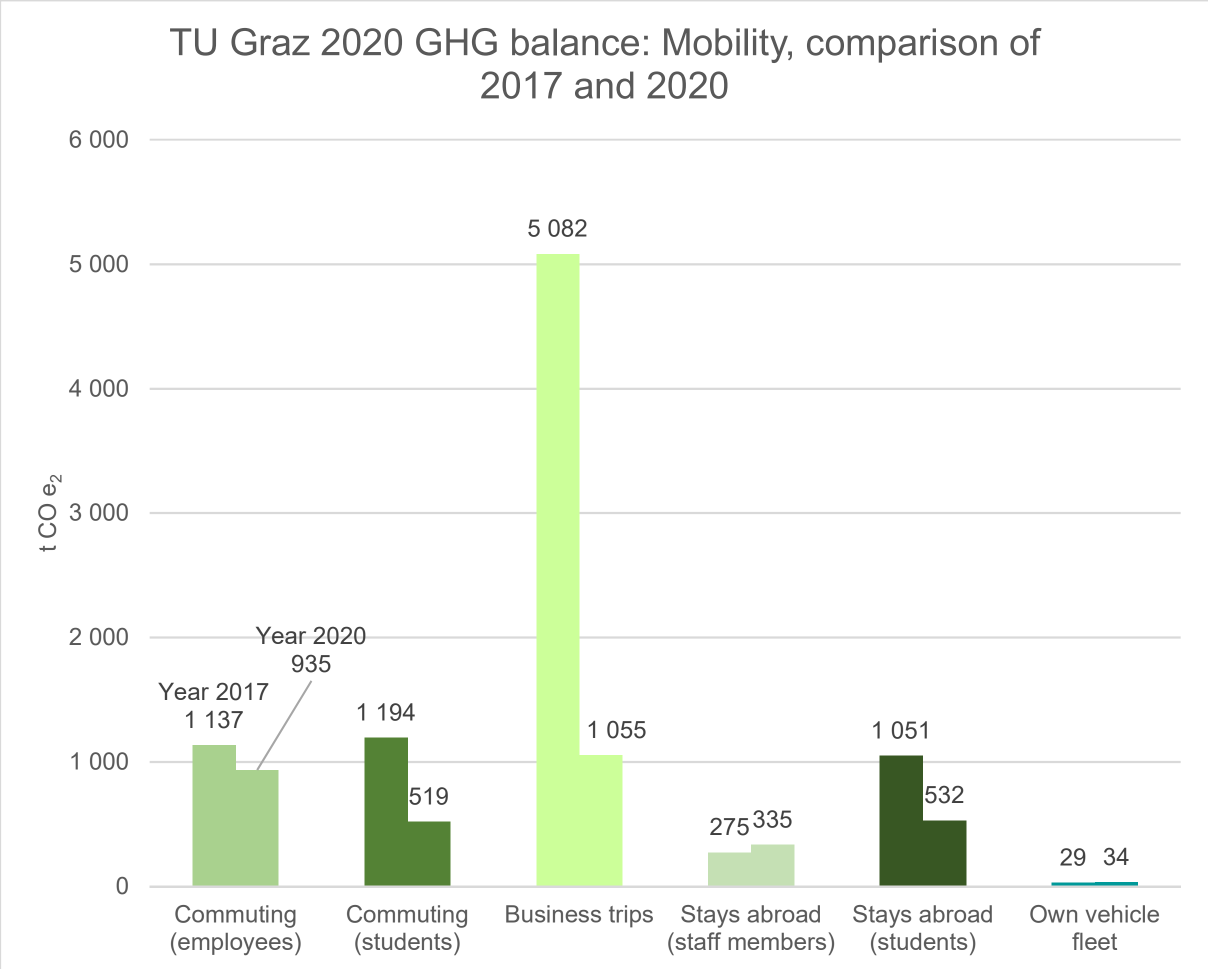


Figure31 : GHG balance of TU Graz 2020: Mobility, comparison 2017 and 2020

Flights

In general, the GHG emissions caused by air travel are particularly significant. By 2030, TU Graz aims to reduce flight emissions from staff and students (business trips and stays abroad) by 50%. (These calculations will be based on the emission factors for 2017, which will remain unchanged until 2030; increases in efficiency through aircraft or changes in occupancy levels, therefore, were not taken into account when setting this target.) Due to the pandemic, these emissions were much lower in 2020 than in 2017. While around 5,200 tonnes of CO_2e were emitted as a result of TU Graz staff air travel in 2017, this figure fell to around 1,316 tonnes of CO_2e in 2020. Emissions from staff air travel have been reduced by 75%.

Commuting

As the 2017 GHG balance is also based on the 2019 transport survey, which was also used to calculate the passenger kilometres and GHG emissions in 2020, the same reduction in passenger kilometres for all modes of transport is seen for 2020, i.e. 49% for staff and 65% for students. It was assumed that the modal split had not changed. Compared to 2017, the emission factors for 2020 increased for the *car*, *rail,* and *public transport buses* subcategories. In contrast, they decreased for the subcategory *public transport tram*, and the biggest change was recorded for the *tram* at around minus 81%. This is due to the fact that the emission factor was revised and that a significantly higher occupancy rate of trams was used for the recalculation. Overall, emissions in the *commuting* subcategory dropped by 27% for staff and 56% for students.

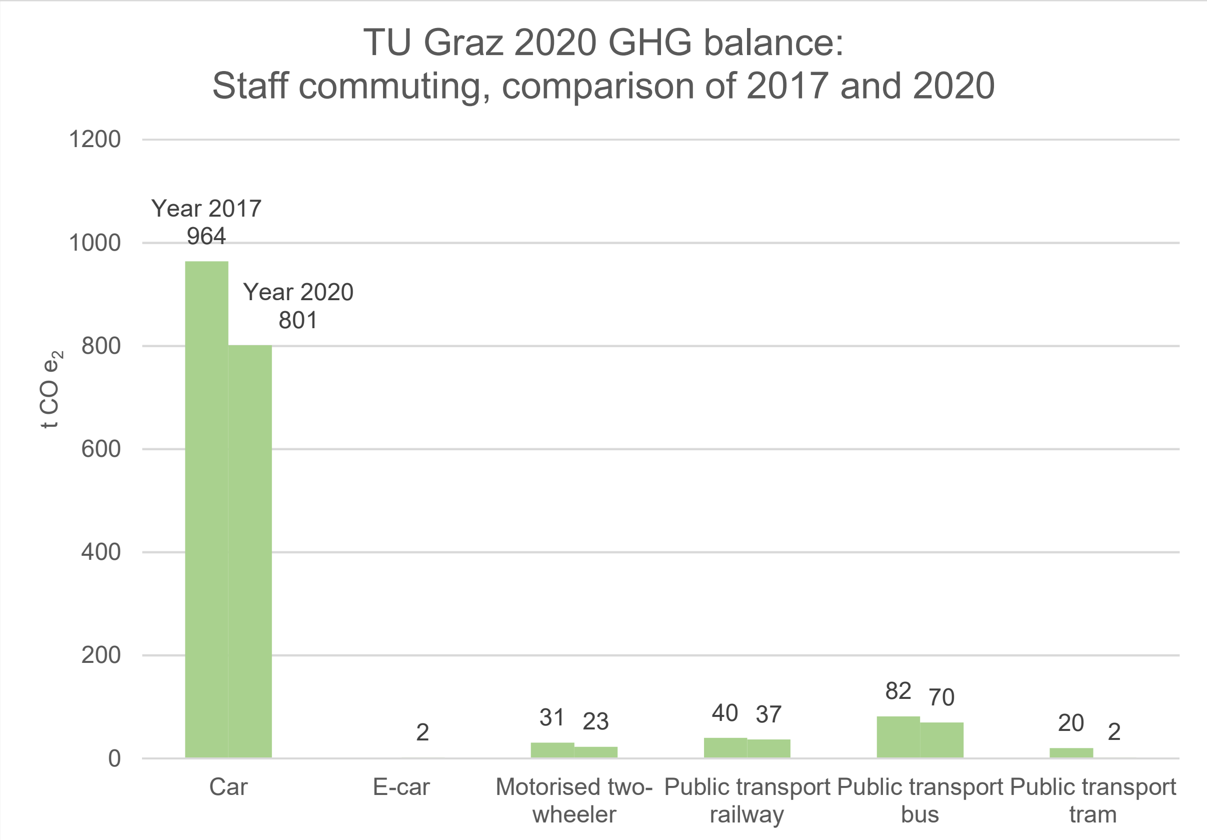


Figure 32: TU Graz 2020 GHG balance – Staff commuting, comparison of 2017 and 2020

Comparison of 2020 and 2017: Staff commuting			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2020			
Car	3,676,041	0.2180	801
E-car	21,628	0.0940	2
Motorised two-wheeler	156,443	0.1450	23
Public transport railway	1,939.,12	0.0190	37
Public transport bus	1,163,587	0.0600	70
Public transport tram	475,095	0.0050	2
Total	7,432,106		**935**
2017			
Car	5,425,184	0.1777	964
E-car	-	Not in ClimCalc 2017	-
Motorised two-wheeler	230,882	0.1356	31
Public transport railway	2,862,080	0.0140	40
Public transport bus	1,717,248	0.0479	82
Public transport tram	739,459	0.0265	20
Total	10,974,853		**1,137**
Increase/decrease in % *Staff commuting*			
Car	-32%	+23%	-17%
Motorised two-wheeler	-32%	+7%	-28%
Public transport railway	-32%	+36%	-8%
Public transport bus	-32%	+25%	-15%
Public transport tram	-36%	-81%	-88%
Total	-32%		**-18%**

Table 10: Comparison 2020 and 2017 – Staff commuting

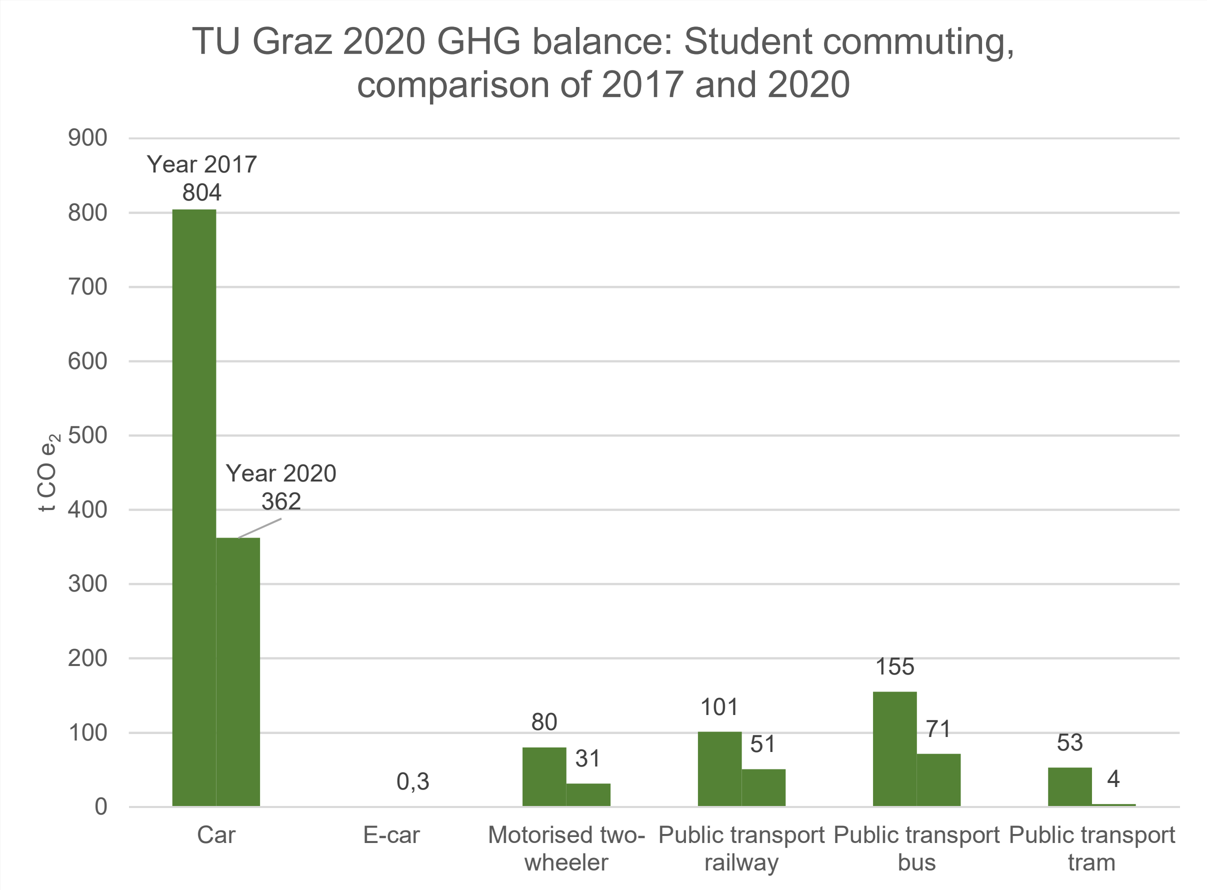


Figure 33: TU Graz 2020 GHG balance – Student commuting, Comparison of 2017 and 2020

Comparison of 2020 and 2017: Student commuting			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2020			
Car	1,661,249	0.2180	362
E-car	3,509	0.0940	0.3
Motorised two-wheeler	216,629	0.1450	31
Public transport railway	2,659,529	0.0190	51
Public transport bus	1,189,067	0.0600	71
Public transport tram	738,581	0.0050	4
Total	6,468,564		**519**
2017			
Car	4,525,112	0.1777	804
E-car	-	Not in ClimCalc 2017	-

Motorised two-wheeler	590,081	0.1356	80
Public transport railway	7,244,350	0.0140	101
Public transport bus	3,238,927	0.0479	155
Public transport tram	2,011,837	0.0265	53
Total	17,610,307		**1,194**
Increase/decrease in % *Commuting Stud.*			
Car	-63%	+23%	-55%
Motorised two-wheeler	-63%	+7%	-61%
Public transport railway	-63%	+36%	-50%
Public transport bus	-63%	+25%	-54%
Public transport tram	-63%	-81%	-93%
Total			**-56%**

Table 11: Comparison of 2020 and 2017 – Student commuting

Business trips

In the *business travel* subcategory, both passenger kilometres and tonnes of CO_2e have decreased. The sharpest decline here was recorded for long-distance buses, with a 94% reduction in passenger kilometres and emissions observed. The emission factors for 2020 increased for all modes of transport, with the exception of long-distance buses, as compared to 2017, and the sharpest increase of 161% was recorded for short-haul flights.

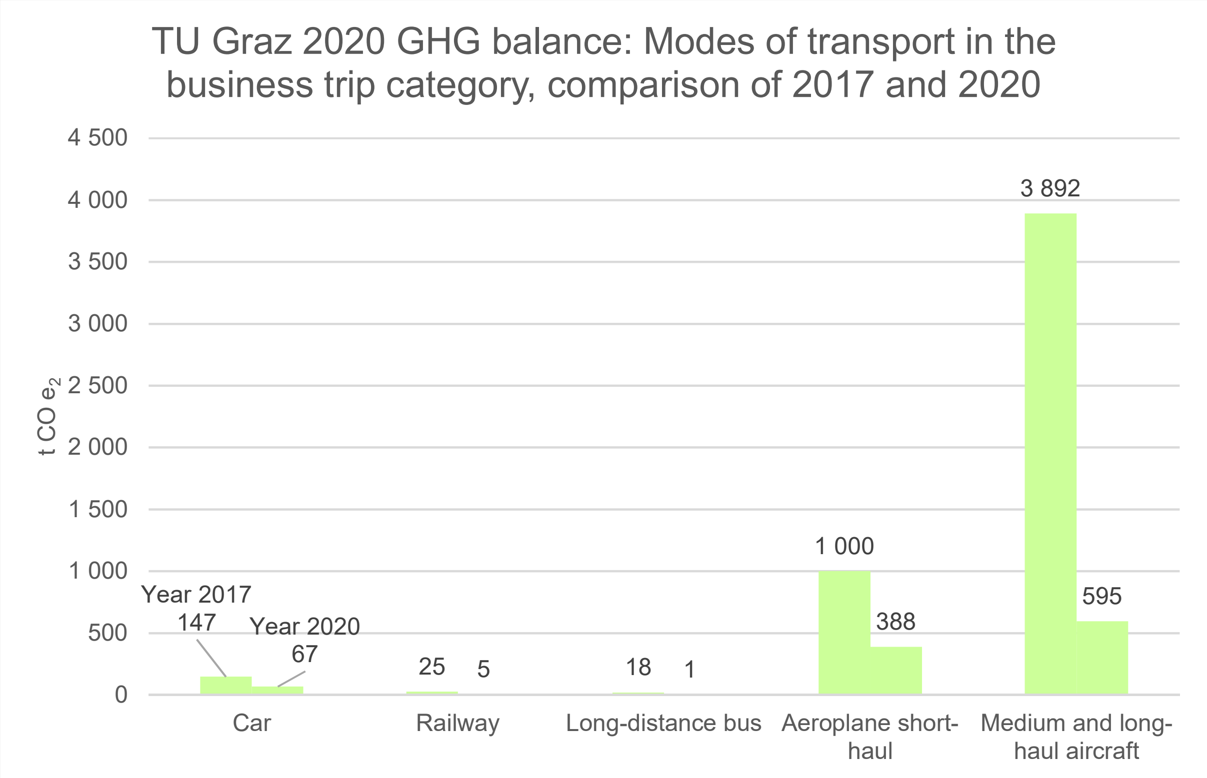


Figure 34 : GHG balance of TU Graz 2020: Business trips, Comparison 2017 and 2020

Comparison of 2020 and 2017: Business trips			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2020			
Car	305,596	0.2180	67
Railway	240,918	0.0190	5
Long-distance bus	21,470	0.0510	1
Short-haul flight	194,120	1.9980	388
Medium- and long-haul flights	979,800	0.6070	595
Total	1,741,904		**1,055**
2017			
Car	826,954	0.1777	147
Railway	1,760,801	0.0140	25
Long-distance bus	352,202	0.0521	18
Short-haul flight	1,304,408	0.7669	1,000
Medium- and long-haul flights	9,972,138	0.3903	3,892
Total	14,216,503		**5,082**

Increase/decrease in %			
Car	-63%	+23%	-55%
Railway	-86%	+36%	-82%
Long-distance bus	-94%	-2%	-94%
Short-haul flight	-85%	+161%	-61%
Medium- and long-haul flights	-90%	+56%	-85%
Total			**-79%**

Table 12: Comparison of 2020 and 2017 – Business trips

Stays abroad

Emissions in the subcategory *stays abroad* also decreased in 2020 compared to 2017 due to the coronavirus pandemic. While the decrease in passenger kilometres for staff ranges from 13 to 26%, it is greater for students, i.e. 66 to 69%. The 2020 emission factors rose very sharply for air travel, resulting in an up 161% increase for short-haul flights and 56% for medium- and long-haul flights. While the emission factor for long-distance buses fell by 2%. Emissions from students travelling abroad decreased by 49%, while those from staff increased.

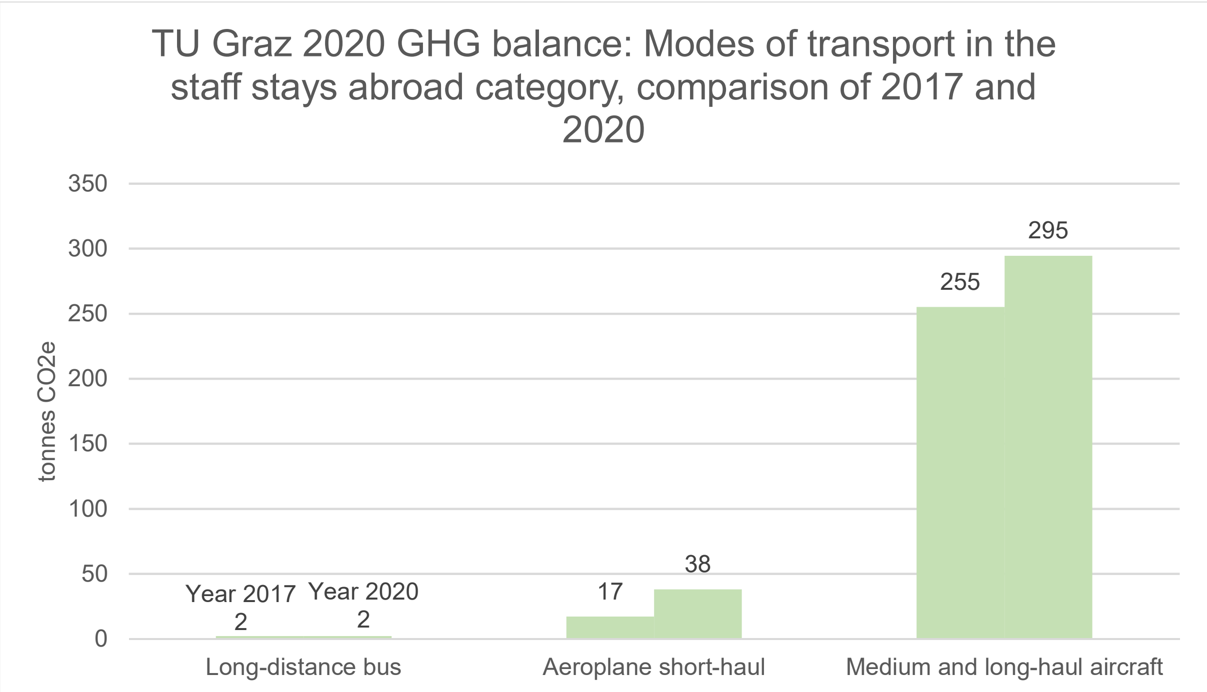


Figure 35: TU Graz 2020 GHG balance – Staff stays abroad, comparison of 2017 and 2020

Comparison of 2020 and 2017: Staff stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2020			
Long-distance bus	39,218	0.0510	2
Short-haul flight	19,040	1.9980	38
Medium- and long-haul flights	485,260	0.6070	295
Total	543,518		**335**
2017			
Long-distance bus	47,640	0.0521	2
Short-haul flight	21,978	0.7669	17
Medium- and long-haul flights	654,509	0.3903	255
Total	724,127		**274**
Increase/decrease in %			
Long-distance bus	-18%	-2%	0%
Short-haul flight	-13%	+161%	+124%
Medium- and long-haul flights	-26%	+56%	+16%
Total			**+22%**

Table 13: Comparison of 2020 and 2017 – Staff stays abroad

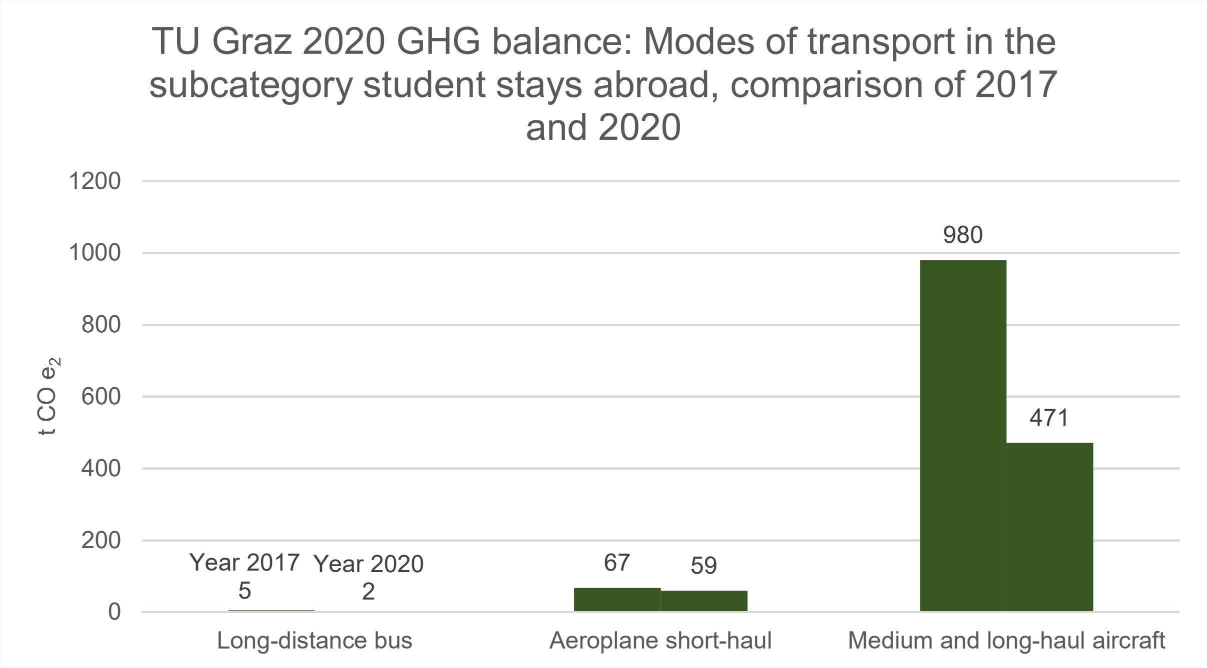


Figure 36: TU Graz 2020 GHG balance – Student stays abroad, comparison of 2017 and 2020

Comparison of 2020 and 2017: Student stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2020			
Long-distance bus	31,832	0.0510	2
Short-haul flight	29,680	1.9980	59
Medium- and long-haul flights	776,360	0.6070	471
Total	837,872		**532**
2017			
Long-distance bus	93,537	0.0521	5
Short-haul flight	87,043	0.7669	67
Medium- and long-haul flights	2,510,470	0.3903	980
Total	2,691,050		**1,052**
Increase/decrease in %			
Long-distance bus	-66%	-2%	-68%
Short-haul flight	-66%	+161%	-11%
Medium- and long-haul flights	-69%	+56%	-52%
Total			**-49%**

Table 14: Comparison of 2020 and 2017 – Student stays abroad

Own vehicle fleet

Overall, emissions in 2020 were lower in almost all subcategories of the *Mobility* category than those in 2017, with the exception of the subcategory *"Staff stays abroad*" and "*Own vehicle fleet".* In the latter, emissions increased by 19%. However, this can be explained by the fact that more institutes with company vehicles were included in the reporting in 2020 than in 2017; therefore, the survey was more complete. In addition to the institutes and organisational units where company vehicles had been surveyed in 2017:

- Buildings and Technical Support
- Institute for Technology and Testing of Construction Materials with affiliated TVFA for strength and materials testing
- Institute of Hydraulic Engineering and Water Resources Management
- Institute for Rock Mechanics and Tunnelling
- Virtual Vehicle

the company vehicles of the following institutes and organisational units were also recorded in 2020:

- Urban Water Management and Landscape Water Engineering
- Thermodynamics and Sustainable Propulsion
- Automotive Engineering
- Vehicle Safety
- Central Information Technology

While all vehicles surveyed in 2017 were diesel-powered, vehicles powered by petrol or electricity are now also shown in for the year 2020. According to the 2020 vehicle inventory list (*Finance and Accounting*), the following vehicles are found at TU Graz:

- 9 cars
- 4 lorries
- 3 delivery vans
- 2 multi-purpose vehicles
- 1 tractor
- 1 motorbike
- 1 electric scooter

The number of kilometres driven by diesel-powered vehicles in 2020 was 44% lower than in 2017, while the 2020 emission factor for diesel vehicles increased by 22%.

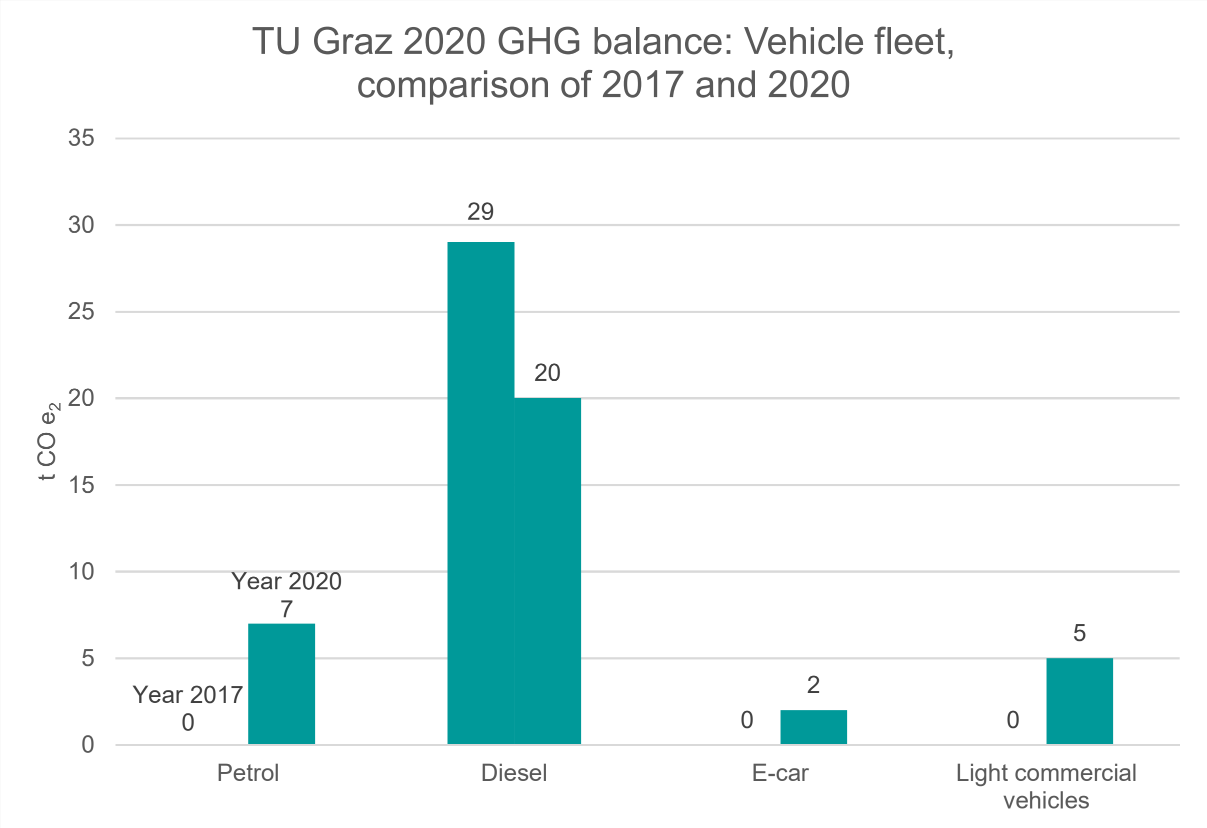


Figure 37: TU Graz 2020 GHG balance – Vehicle fleet, comparison of 2017 and 2020

Comparison of 2020 and 2017: Vehicle fleet			
	Vehicle kilometres (Fzkm)	Emission factor in kg CO_2e/vehicle kilometre	Emissions in tonnes of CO_2e
2020			
Petrol	27,875	0.2560	7
Diesel	79,676	0.2470	20
E-car	15,004	0.1070	2
Light commercial vehicles	18,107	0.3110	6
Total	142,319		**34**
2017			
Diesel	141,203	0.2023	**29**
Increase/decrease in %			
Diesel	-44%	+22%	-31%
Total			**+19%**

Table 15: Comparison of 2020 and 2017 – Vehicle fleet

3.2.3 Material use

The subcategories of *paper*, *refrigerants,* and *IT equipment* are recorded in the *Material use* category at TU Graz. Data were provided for this purpose by the organisational units *Purchasing Services, Finance and Accounting, Buildings and Technical Support, Communication and Marketing, Publishing*, as well as the external units *Print Culture (HTU Copyshops),* and *Harnisch Gebäudeservice Graz*. Emissions in the *Material use* category totalled 614 tonnes in 2020. All subcategories fall within the range of 195–211 tonnes of CO_2e; therefore, each subcategory accounts for around one-third of the emissions in this category.

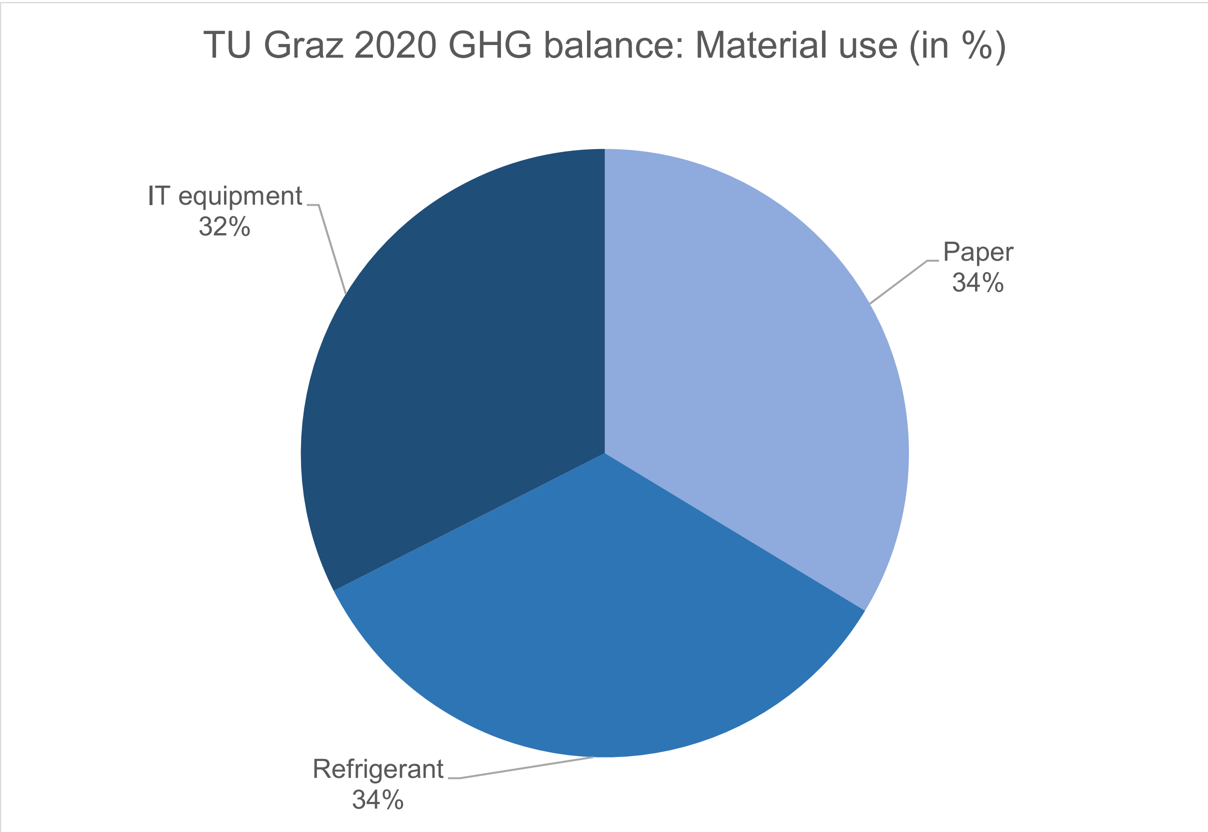


Figure 38: TU Graz 2020 GHG balance – Material use (in %)

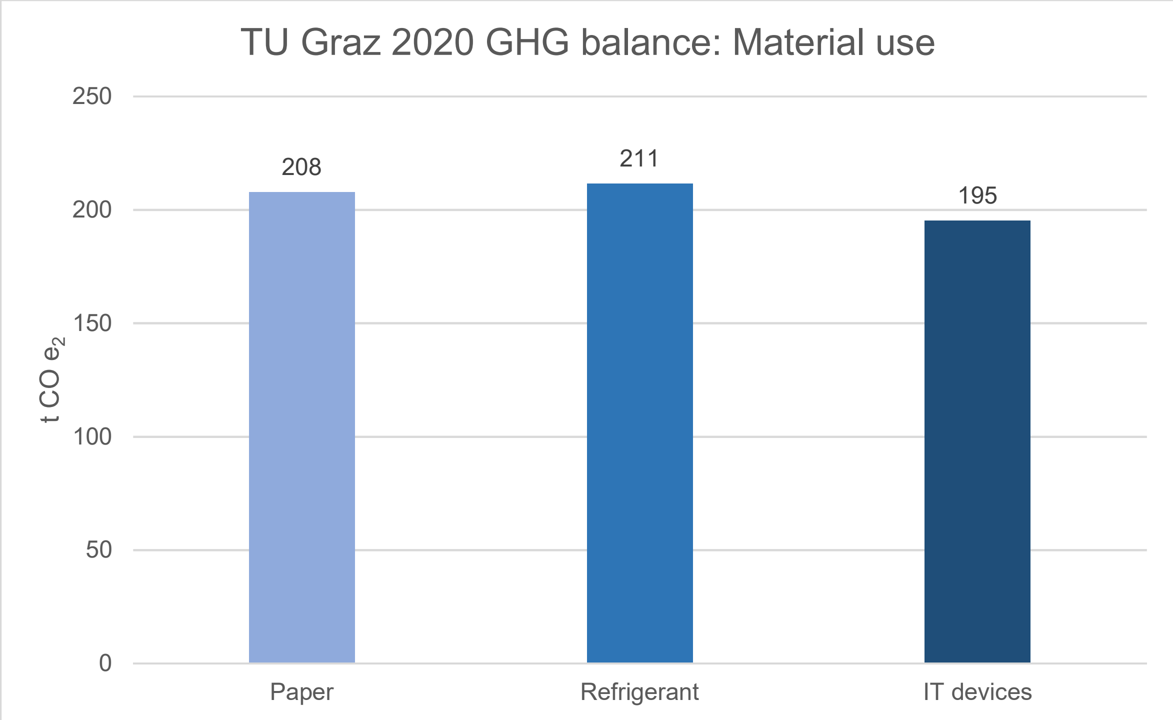


Figure 39: TU Graz 2020 GHG balance – Material use

Comparison of 2020 and 2017

Compared to 2017, total emissions in the *paper* and *refrigerants* subcategories increased in 2020, while those in the *IT equipment* subcategory decreased, as the following graph shows:

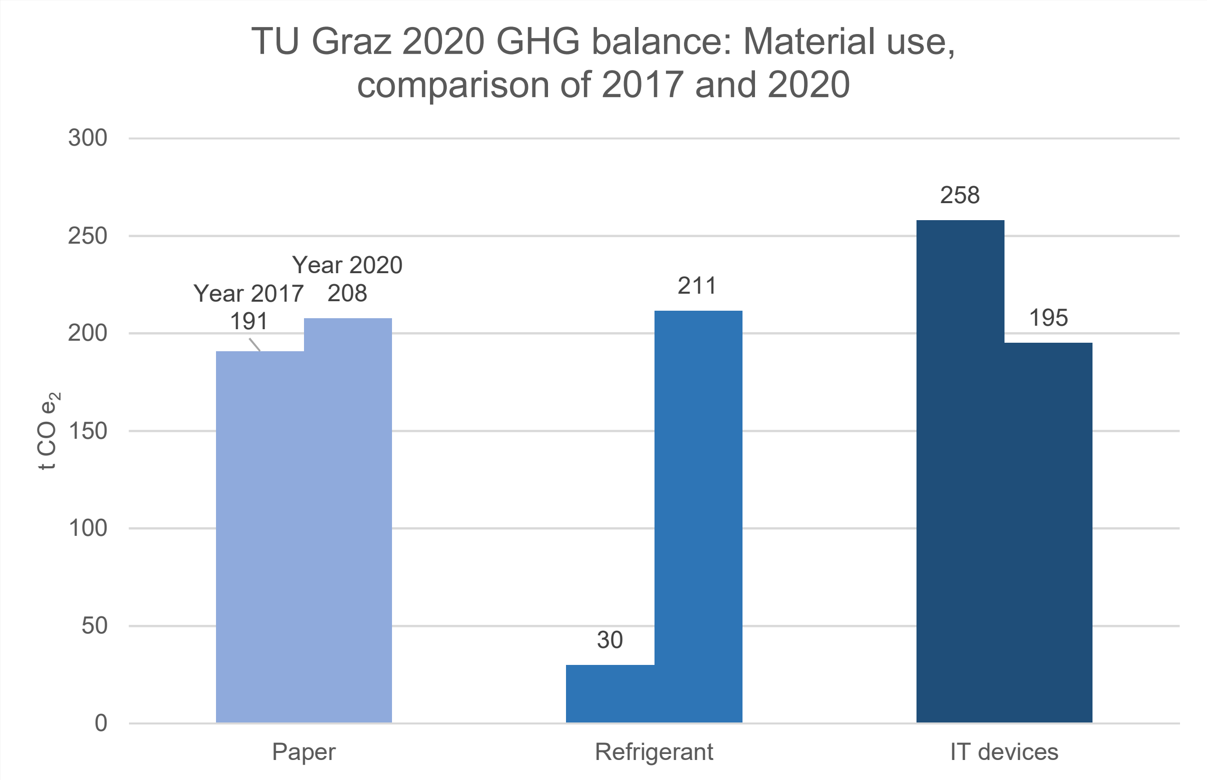


Figure 40: TU Graz 2020 GHG balance – Material use, comparison of 2017 and 2020

In the case of *paper*, the consumption of copy paper and the production of printed products increased in 2020 compared to 2017. However, this can be explained by the fact that consumption data from the *Purchasing Service* and *HTU Printkultur* (copyshops), as well as for printed products from the *Communication and Marketing* organisational unit and the *Verlag der TU Graz* (publishing house), were also collected in 2020. The only slight decrease in the use of sanitary paper in 2020 – although staff and students were absent in certain phases due to the pandemic - compared to 2017 can be explained by the increase in hand washing as a hygienic measure in 2020.
The emission factors changed only slightly from 2017 to 2020. Emissions rose for copy paper and printed products (by 16% and 90%, respectively) but dropped for sanitary paper (minus 7% and 5%, respectively). The sharp increase in emissions from printed products can be explained by the fact that the process of categorising these as copy paper or printed products differed between 2020 and 2017, resulting in an increase in the consumption of printed products in 2020 compared to 2017. Overall, 9% more emissions were recorded in the *paper* subcategory in 2020 than in 2017.

Comparison of 2020 and 2017: Paper			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in tonnes CO_2e
2020			
Copy paper	31,383	1.0000	31
Sanitary paper toilet	12,194	3.0000	37
Sanitary paper towels	32,267	3.0000	97
Printed products	38,036	1.1300	43
Total	113,880		**208**
2017			
Copy paper	25,827	1.0461	27
Sanitary paper toilet	12,611	3.1088	39
Sanitary paper towels	32,894	3.1088	102
Printed products	20,315	1.1109	23
Total	91,647		**191**
Increase/decrease in %			
Copy paper	+22%	-4%	+16%
Sanitary paper toilet	-3%	-3%	-7%
Sanitary paper towels	-2%	-3%	-5%
Printed products	+87%	+2%	+90%
Total			**+9%**

Table 16: Comparison of 2020 and 2017 – Paper

The consumption of *refrigerants* rose sharply in 2020, from a total of 8 kg in 2017 to 102 kg in 2020, resulting in a 616% increase in emissions in this subcategory in 2020 compared to 2017. This increase can be explained by the fact that damage occurred to a refrigeration system in 2020, resulting in a refrigerant leak. This system is already being dismantled. In general, the process of switching from gas-filled systems to water-filled systems is being accelerated. In the future, water will be used as the refrigerant instead of gas, and, if the pipes leak, only water will escape instead of the climate-damaging gas. However, refrigerants will still be used for the cooling process itself.

Comparison of 2020 and 2017: Refrigerants			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in tonnes CO_2e
2020			
R410A	17	2,102.5000	36
R407c	74	1,788.8500	132
R404a	11	3,936.6000	43
Total	102		**211**
2017			
R410A	1	2,087.5000	2
R404a	7	3,922.0000	27
Total	8		**30**
Increase/decrease in %			
R410A	+1,600%	+1%	+1,612%
R404a	+57%	0	+58%
			+616%

Table 17: Comparison of 2020 and 2017 – Refrigerants

The reduction in the GHG emissions seen in 2020 in the *IT equipment* subcategory is primarily due to the fact that fewer desktop PCs, toner for laser and inkjet printers, multifunctional devices, and monitors were purchased and used. The majority of emission factors for this subcategory have increased, e.g. mobile phones by +143% and beamers and projectors by +174%. The increase in emission factors can be explained by the fact that these are constantly being updated, and additional emissions are being recorded as part of these updates which are then included in the emission factor. Mobile phones are especially becoming ever larger and more powerful, which is reflected in the emissions associated with their manufacture. Overall, emissions in the *IT equipment* subcategory fell by 24% in 2020.

Comparison of 2020 and 2017: IT equipment			
	Purchase in pieces	Emission factor in kg CO_2e/piece	Emissions in tonnes of CO_2e
2020			
Multifunctional devices	1	300.0000	0,3
Laser printers and inkjet printers	11	63.6000	1
Notebooks	458	172.0000	79
Desktop PCs	209	226.0000	47
Screens	127	350.0000	44
Beamers and projectors	12	172.0000	2
Internal servers	65	226.0000	15
Mobile phones	36	38.8000	1
Laser printers with toner and inkjet printers	198	14.1000	3
Multifunctional devices with toner	198	14.1000	3
Total	1,315		**195**
2017			
Multifunctional devices	2	313.9600	1
Laser printers and inkjet printers	8	62.7920	1
Notebooks	280	141.3700	40
Desktop PCs	517	270.2200	140
Screens	204	336.3900	69
Beamers and projectors	38	62.7920	2
Internal servers	Included in desktop PC	-	-
Mobile phones	49	16.0000	1
Laser printers with toner and inkjet printers	313	10.0150	3
Multifunctional devices with toner	313	10.0150	3
Total	1,724		**258**
Increase/decrease in %			
Multifunctional devices	-50	-4%	-52%
Laser printers and inkjet printers	+38%	+1%	+39%
Notebooks	+64%	+22%	+99%
Desktop PCs	-60%	-16%	-66%

Screens	-38%	+4%	-35%
Beamers and projectors	-68%	+174%	-13%
Internal server	-	-	-
Mobile phones	-27%	+143%	+78%
Laser printers with toner and inkjet printers	-37%	+41%	-11%
Multifunctional devices with toner	-37%	+41%	-11%
Total			**-24%**

Table 18: Comparison of 2020 and 2017 – IT equipment

3.2.4 Additional canteen module

At TU Graz, the additional module *Canteen* is subdivided into the subcategories *electricity*, *district heating,* and *food*. The data for this module were provided by the *Buildings and Technical Support* organisational unit (electricity, district heating) and by *Österreichische Mensen Betriebsgesellschaft mbH* (food). The total emissions for this additional module amount to 181 tonnes of CO_2e for 2020, with the highest percentage of emissions coming from the *food* subcategory, followed by *electricity,* and finally *district heating*.

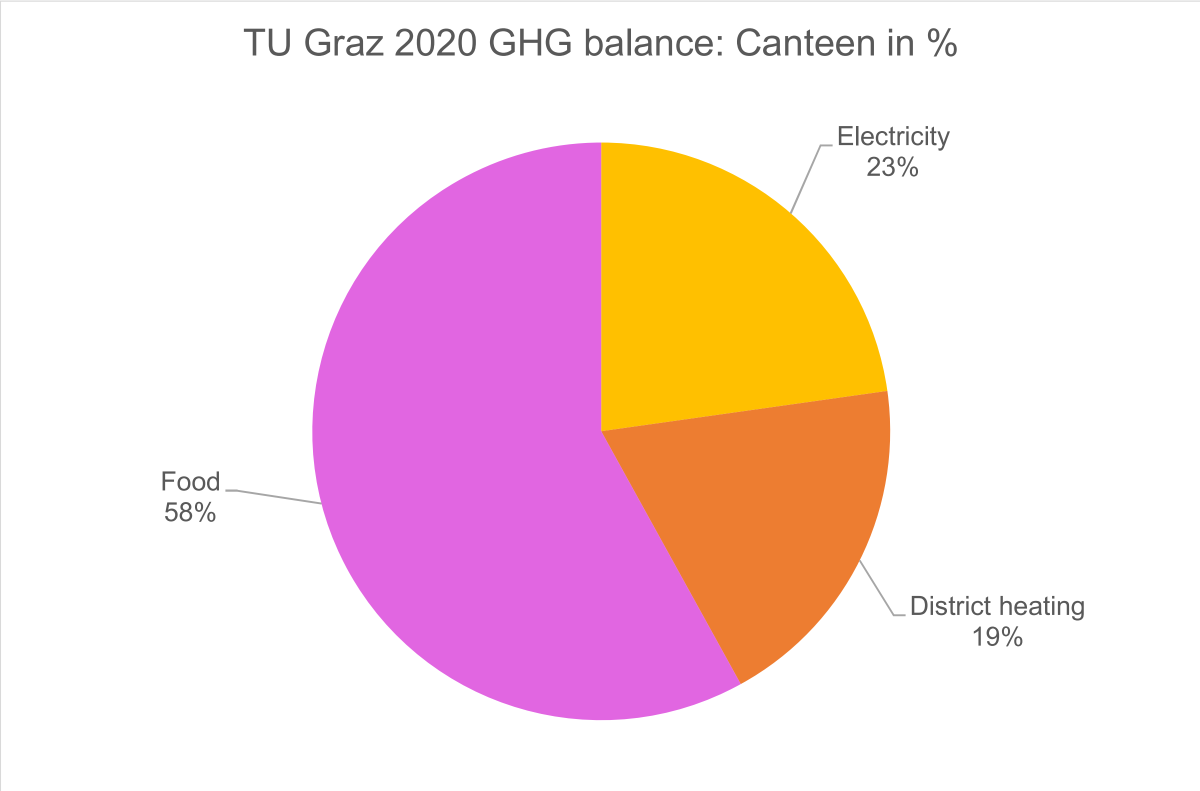


Figure 41: TU Graz 2020 GHG balance – Canteen (in %)

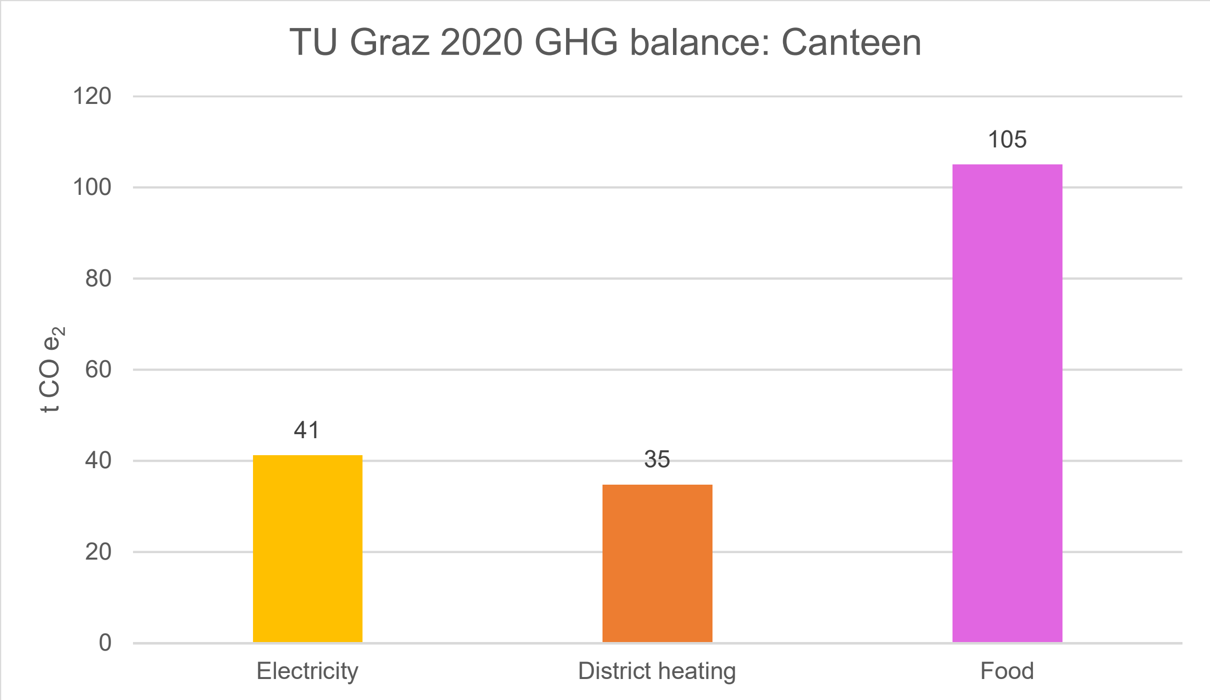


Figure 42: TU Graz 2020 GHG balance – Canteen

Comparison of 2020 and 2017

Compared to 2017, total emissions in the *Canteen* category fell from 220 tonnes of CO_2e to 181 tonnes of CO_2e in 2020. While emissions from electricity and food decreased, those from district heating consumption increased.

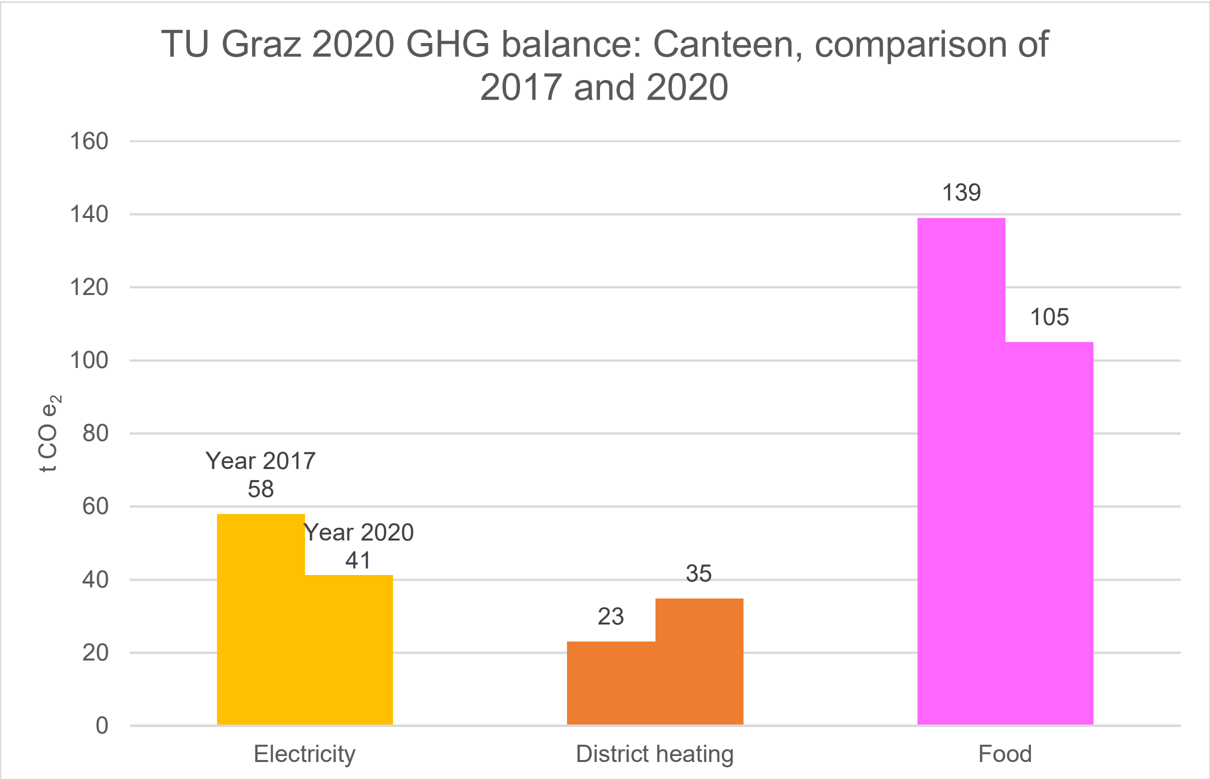


Figure 43: TU Graz 2020 GHG balance – Canteen, comparison of 2017 and 2020

The *electricity* subcategory *(without certification)* shows a reduction in emissions of around 30%; these can be attributed to a 10% reduction in consumption and a 21% reduction in the emission factor.

Comparison of 2020 and 2017: Canteen electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2020	202,984	0.2030	41
2017	225,000	0.2573	58
Increase/decrease in %	-10%	-21%	**-29%**

Table 19: Comparison of 2020 and 2017 – Canteen electricity

District heating consumption and emissions increased in 2020 compared to 2017 (+50% emissions), although the emission factor fell by 11%. This change in consumption can also be explained by the fact that part of the canteen was closed for renovation work from January to May in 2017, resulting in lower district heating consumption.

Comparison of 2020 and 2017: Canteen district heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2020	112,471	0,3090	35
2017	66,000	0.3487	23
Increase/decrease in %	+70%	-11%	**+51%**

Table 20: Comparison of 2020 and 2017 – Canteen district heating

The biggest difference was recorded in the *food* subcategory. Emissions fell in 2020 by around 30%. This can be explained by the fact that the consumption of most foods dropped due to the pandemic. Only the consumption of poultry increased. The emission factors remained unchanged in the period of 2017 to 2020. It is particular important to note that the emission factor for beef is clearly the highest of all food groups at 13.3 kg CO_2e/kg.

Comparison of 2020 and 2017: Canteen food			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in tonnes of CO_2e
2020			
Beef	1,813	13.3000	24
Pork	1,768	5.5000	10
Poultry	9,834	3.2000	31
Fish	2,092	6.5000	14
Fats and oils	3,948	5.7592	23
Total	19,455		**102**
2017			
Beef	2,799	13.3000	37
Pork	5,063	5.5000	28
Poultry	6,616	3.2000	21
Fish	3,295	6.5000	21
Fats and oils	5,447	5.7592	31
Total	23,220		**139**
Increase/decrease in %			
Beef	-35%	0	-35%
Pork	-65%	0	-65%
Poultry	+49%	0	+49%
Fish	-36%	0	-36%
Fats and oils	-28%	0	-28%
Total			**-27%**

Table 21: Comparison of 2020 and 2017 – Canteen food

In 2020, the highest percentage of emissions in the *food* subcategory were caused by poultry consumption at 33%, followed by beef consumption and fats and oils at 23% each, fish at 13%, and finally pork at 8%.

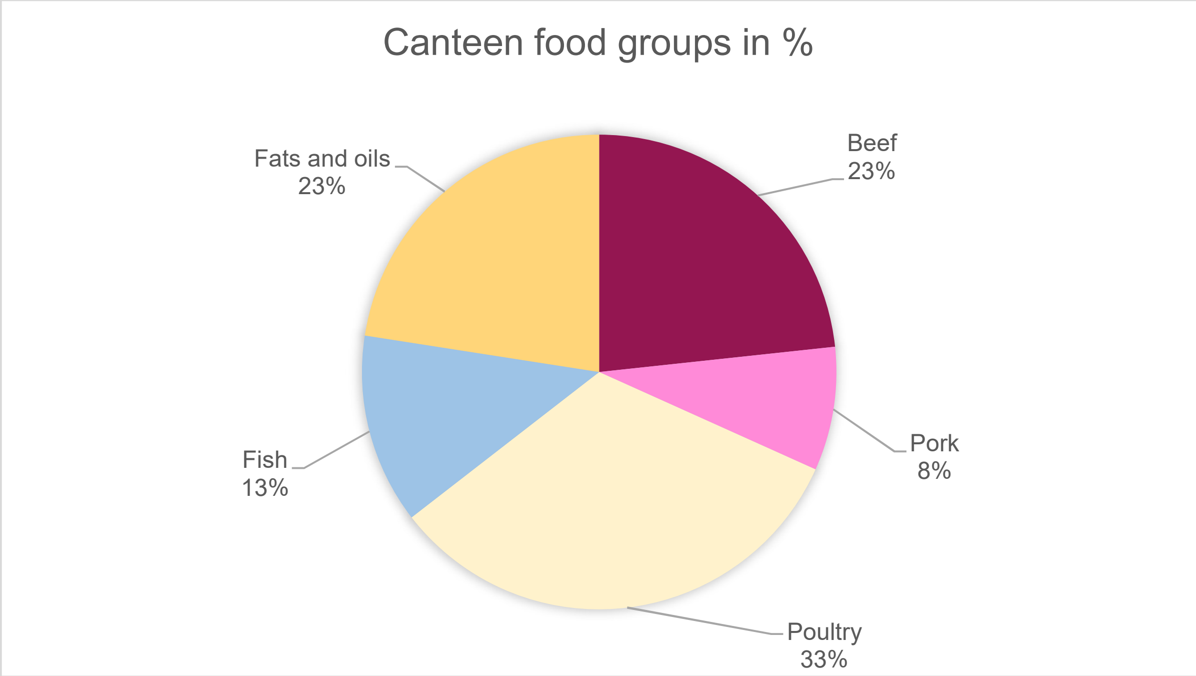


Figure 44: TU Graz 2020 GHG balance – Canteen food groups (in %)

A comparison of 2020 and 2017 reveals the following picture in terms of the food groups:

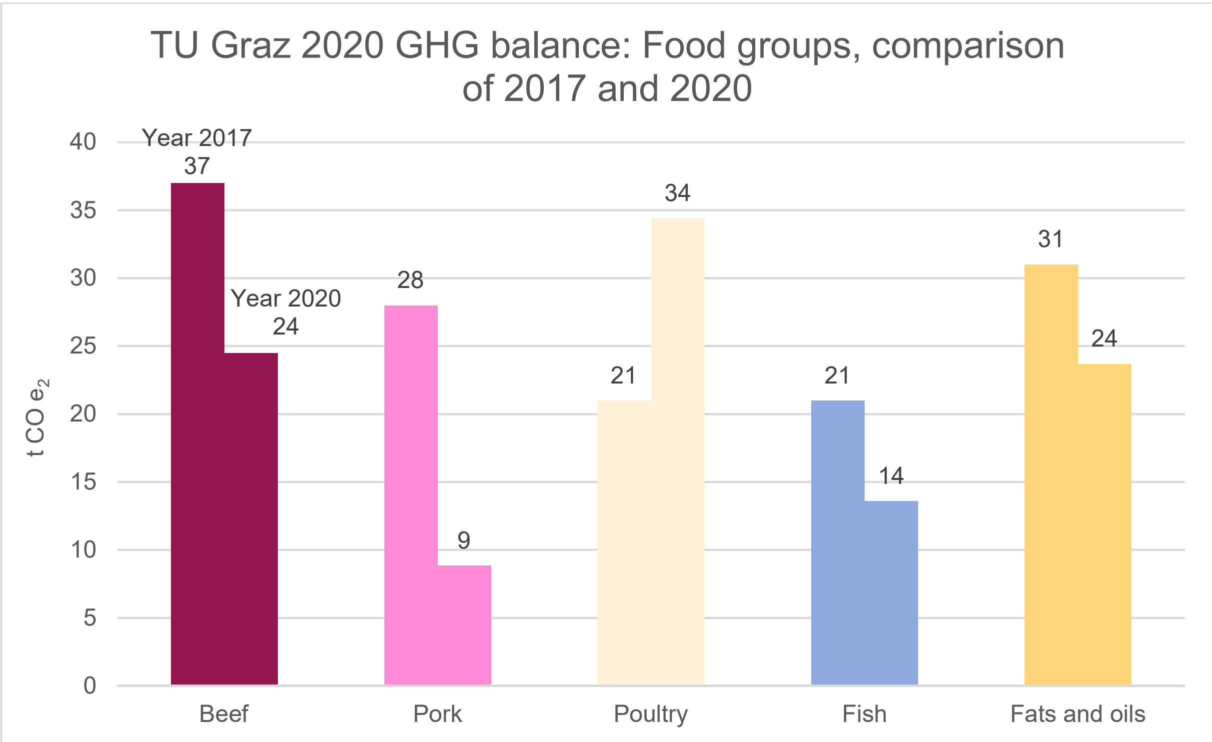


Figure 45: TU Graz 2020 GHG balance – Food groups, comparison of 2017 and 2020

4. Key figures

Compared to 2017, TU Graz's key figures for 2020 are lower across the board. This is mainly due to the decline in emissions caused by the pandemic, but also due to a reduction in many emission factors.

The key figures were rounded off to one or two decimal places or to the nearest hundredth. The following table compares the key figures for both 2017 and 2020:

Key figures		
1. TU Graz electricity consumption (excl. heat pumps + charging stations; incl. PV) per staff member (individual)		
2020	**6,050**	kWh per individual
2017	**8,240**	kWh per individual
2. TU Graz electricity consumption (excl. heat pumps + charging stations; incl. PV) per staff member (FTE)		
2020	**9,076**	kWh per FTE
2017	**12,130**	kWh per FTE
3. TU Graz electricity consumption from own PV per staff member (FTE)		
2020	**165**	kWh per FTE
2017	**52**	kWh per FTE
4. TU Graz emissions from electricity (excl. heat pumps; incl. PV) per staff member (FTE)		
2020	**1,806**	kg CO_2e per FTE
2017	**3,120**	kg CO_2e per FTE
5. TU Graz heat consumption (incl. heat pumps) per m^2 net floor area heated		
2020	**75**	kWh per m^2
2017	**91**	kWh per m^2
6. TU Graz emissions from heat per m^2 net floor area heated		
2020	**23**	kg CO_2e per m^2
2017	**21**	kg CO_2e per m^2
12. TU Graz emissions per student		

2020	**1,065**	kg CO_2e per individual
2017	**1,630**	kg CO_2e per individual
13. TU Graz emissions per staff member (individual)		
2020	**3,285**	kg CO_2e per individual
2017	**7,390**	kg CO_2e per individual
14. TU Graz emissions per staff member (FTE)		
2020	**4,928**	kg CO_2e per FTE
2017	**10,880**	kg CO_2e per FTE
15. TU Graz emissions per m^2 total net floor area		
2020	**62**	kg CO_2e per m^2
2017	**114**	kg CO_2e per m^2
16. TU Graz emissions per m^2 net floor area heated		
2020	**68**	kg CO_2e per m^2
2017	**126**	kg CO_2e per m^2

Table 22: Key figures, comparison of 2020 and 2017

The following table with key figures on mobility was also created. Some of these relate to data from 2019, but where possible – as in the table above – data from the years of 2020 and 2017 were compared.

Key figures for mobility		
1. Modal split for **TU Graz staff commuting** in 2019, inbound and outbound commuters (Forstner 2021, p. 65)		
On foot	**13**	%
Bicycle	**46**	%
Motorised individual transport (MIV)	**21**	%
Public transport (ÖPNV)	**20**	%
1a. Modal split for **work commuters to the city of Graz in** 2013/14, local and inbound commuters (Forstner 2021, p. 65, raw data: Österreich unterwegs 2013/14)		
On foot	**7**	%
Bicycle	**15**	%
Motorised individual transport (MIV)	**56**	%

Public transport (ÖPNV)	**22**	%
2. Modal split for **TU Graz students commuting** in 2019, local and inbound commuters (Forstner 2021, p. 66)		
On foot	**18**	%
Bicycle	**49**	%
Motorised individual transport (MIV)	**7**	%
Public transport (ÖPNV)	**21**	%
2a. Modal split for **commuters travelling to educational institutions in the city of Graz** in 2013/14, inbound and outbound commuters (Forstner 2021, p. 66, raw data: Österreich unterwegs 2013/14)		
On foot	**11**	%
Bicycle	**19**	%
Motorised individual transport (MIV)	**22**	%
Public transport (ÖPNV)	**48**	%
3. Modal split for business trips by total kilometres in 2018 (Forstner 2021, p. 41)		
Motorised individual transport (MIV)	**5**	%
Public transport (ÖPNV)	**16**	%
Air transport	**79**	%
4. Flight missions of staff (stays abroad and business trips) per staff member (individual)		
2020	**275**	kg CO_2e per capita
2017	**1,392**	kg CO_2e per capita
5. Parking spaces per staff member (individual), total 681 parking spaces		
2020	**0.14**	Parking spaces per capita
2017	**0.17**	Parking spaces per capita
6. Parking spaces per staff member (FTE), total 632 parking spaces		
2020	**0.21**	Parking spaces per FTE
2017	**0.25**	Parking spaces per FTE

Table 23: Key figures for mobility

5. Final recommendations based on the provisional 2020 balance (as of 28 February 2022)

Ultimately, it is important to point out once again that the 2020 balance presented here is a special one. 2020 was the first year of the coronavirus pandemic, in which university operations were temporarily restricted due to lockdowns. This aspect must be considered when interpreting the results, including the comparison with the 2017 GHG balance and future balances.

Based on the 2017 GHG balance, which serves as the reference balance for the "Climate-neutral TU Graz 2030" project, a series of measures were adopted by the Rectorate in August 2020 in an effort to make TU Graz climate-neutral by 2030 (TU Graz 2020). Therefore, recommendations based on this GHG balance only address aspects that are **not part** of the measures already adopted by TU Graz.
The following proposals for further measures are made based on the 2020 GHG balance:

1. No emission-reducing measures have yet been decided upon or taken for the *natural gas* subcategory. As this subcategory was divided into *natural gas heating* and *natural gas research* in the current 2020 balance, it is clear that natural gas is primarily used for research at TU Graz (see section 4.2.1 Energy). Where possible, natural gas used for research should be replaced by green methane or green hydrogen. Natural gas used for research at TU Graz is primarily used at the Institute of Thermal Engineering and the LEC (Large Engines Competence Center). Of course, the needs of the clients and project managers of the respective research projects would need to be considered.

2. Proposals for mobility
   As the mobility of staff and students contributes significantly to the TU Graz GHG emissions, and TU Graz can take effective action here by altering framework conditions, creating subsidies, etc., the existing measures to reduce emissions in the *Mobility* category could be supplemented.

   a. Regarding commuting: Commuters who commute to Graz every day from outside the city often travel longer distances by car; thus, TU Graz could take further measures to promote the use of alternative transport. Promoting the Styrian climate ticket together with demanding the further expansion of Park&Ride and Bike&Ride options at railway stations near the commuters' homes, as well as promoting the use of e-bikes, could achieve the desired effects here. Ideally, a commute would look like this: By (e-)bike from home to the nearest train station, by train to Graz (possibly with bike transport), and finally by bike or tram and bus to TU Graz. Consideration should also be given to subsidising the purchase of folding bikes. In any case, commuting routes should be analysed for staff who have access to the TU Graz car parks to encourage more use of public transport.

b. Regarding business trips: The most common destination for staff travelling by car on business trips in 2020 was Vienna (see Appendix 4). As the majority of these journeys could also be made by public transport, the business travel policy could be adapted, e.g. so that cars can be used to transport heavy goods or if no reasonable public transport connection is available, but otherwise public transport should be used. Another way to reduce car travel would be to establish a rule that business trips should always be carried out using rented cars or company cars (e-cars from *Family of Power*). TU Graz could also encourage the use of a taxi from the train station near a business trip destination to travel the last few kilometres if this destination is difficult or impossible to reach by public transport.
The most common destinations for business trips by plane in 2020 include many destinations in Europe. TU Graz could encourage the use of (night) trains to the most common destinations (e.g. Berlin and Brussels) particularly strongly and, in dialogue with the ÖBB, advocate for more offers for TU Graz related to the most important routes. According to estimates, the flight from Graz to Vienna is a frequently used part of the route for TU Graz staff continuing on subsequent long-haul flights. Measures could be taken here to make travelling to and from Vienna Airport by train more attractive, e.g. through agreements with ÖBB so that rail services between Graz and Vienna are also well developed at off-peak times.

c. Regarding stays abroad: When travelling abroad, climate-friendly rail travel within Europe could be promoted for both staff and students, e.g. by subsidising day and night train tickets or Interrail tickets. The subsidies for staff could be modelled on the subsidies for business trips. Funding for students could be organised in addition to the funding for sustainable travel for stays abroad from "Erasmus+ Green".

3. Another proposal relates to IT equipment. The roadmap for the Climate Neutral TU Graz 2030 project already states that the minimum utilisation period for IT equipment should be increased to 6 years (TU Graz 2020). To extend the useful lifetime, if necessary, equipment could be procured that can be repaired more easily. For example, TU Graz could offer the *Fairphone* as a company mobile phone. The *Fairphone* advertises the fact that defective parts can be replaced quickly and easily, which significantly extends the useful lifetime of a device. The *Fairphone* company also pays attention to fair and sustainable procurement of the materials used, as well as to social aspects of production. The manufacturer is planning a presentation on the *Fairphone*'s

emissions (Fairphone 2020). The use of the *Fairphone* as a work mobile phone at TU Graz would have a strongly symbolic effect, illustrating a commitment to greater sustainability, and offer benefits due to the extended service life.
Another option would be to purchase equipment that already has been used and refurbished ("refurbed"). However, how exactly the CO_2e savings can be calculated and how long the equipment could then still be used by TU Graz would need to be considered.

4. To calculate the emissions from building construction projects and renovations, for example, a student dissertation could be assigned to examine TU Graz area B (maintenance) in more detail. This would allow the emissions from this category to be more precisely assessed, and specifically those related to TU Graz.

5. To achieve the goal of climate neutrality by 2030, students could also be more closely involved, e.g. via the HTU. The HTU could be supported in further expanding its sustainable projects, such as the cargo bike hiring scheme or the urban gardening project, and in promoting the application of new ideas from students.

6. To review the success of the measures, a rapid assessment ("monitoring") should be performed annually at TU Graz. Results for categories in which the data can be collected quickly through processes that are partially automated (e.g. data for energy, business trips, refrigerants) could be accurately produced, while the remaining data could be taken from the last complete balance. This would provide an even clearer picture of the development of GHG emissions at TU Graz. This measure was implemented for the first time in 2021 in consultation with of the *Buildings and Technical Support* organisational unit.

7. Another area that is not currently included in TU Graz's GHG balance is the possibility of investing financial resources sustainably. In this way, TU Graz could also promote ecological and ethical progress through its financial investments and – at least indirectly – reduce GHG emissions.

8. TU Graz could also take further measures to improve sustainable procurement. To this end, a strategy for procuring sustainable goods, such as office materials, could be developed in cooperation with the TU Graz Central Purchasing Service, or the strategy of the *Alliance for Sustainable Universities in Austria* could be declared as binding.

6. List of figures and tables

6.1 List of illustrations

6.2 List of tables

7. Bibliography

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