Preliminary TU Graz
2020 Greenhouse Gas Balance
and Comparison with the 2017 Balance

Franziska Häller, Günter Getzinger

Last updated: 28 February 2022

STS Science, Technology and Society Unit

ISDS Institute of Interactive Systems and Data Science

This final report on the TU Graz 2020 greenhouse gas balance was commissioned by TU Graz (Buildings and Technical Support). It provides an overview of the results for the emission categories of energy, mobility, material use, and canteen. The GHG balance was prepared using the *ClimCalc* tool (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, considering the categories *Energy, Mobility, Material use,* and *Canteen,* collected at the TU Graz primary and secondary locations.

Project Management (PL)/Project Processing (PB): Ass.Prof. Dipl.-Ing. Dr.phil. Günter Getzinger (PL) and Franziska Häller, MA (PB)

Contract period: April to September 2021

Data were provided by:

- TU Graz Organisational Units
  - Rector's Assistant: Statistics and Data Protection
  - Purchasing Service
  - Finance and Accounting
  - Building and Technical Support
  - Institutes with official vehicles
  - International Office - Welcome Center
  - Communications and Marketing
  - Human Resources
  - Thermal Turbomachinery and Machine Dynamics
  - TU Graz Publishing House
- External organisations
  - Harnisch Gebäudeservice Graz
  - Österreichische Mensen Betriebsgesellschaft mbH
  - Printkultur (HTU copying services)

Table of Contents

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" (TU Graz 2020) project, which was accepted by the TU Graz Rectorate in 2020. The year 2020, marked by the coronavirus pandemic, was a special one in many respects, which is also reflected in the GHG balance results. Especially in the area of university mobility, this year brought major changes when compared to the 2017 balance. The extent to which 2020 can also be considered to be a special year with regard to the future – as a year that brought structural changes – will already be shown 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.

The issue of climate change is still very much present in the public sphere, and solutions are being sought to avoid and deal with the expected catastrophic consequences of global warming. The Intergovernmental Panel on Climate Change (IPCC) advises that global climate neutrality be 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:

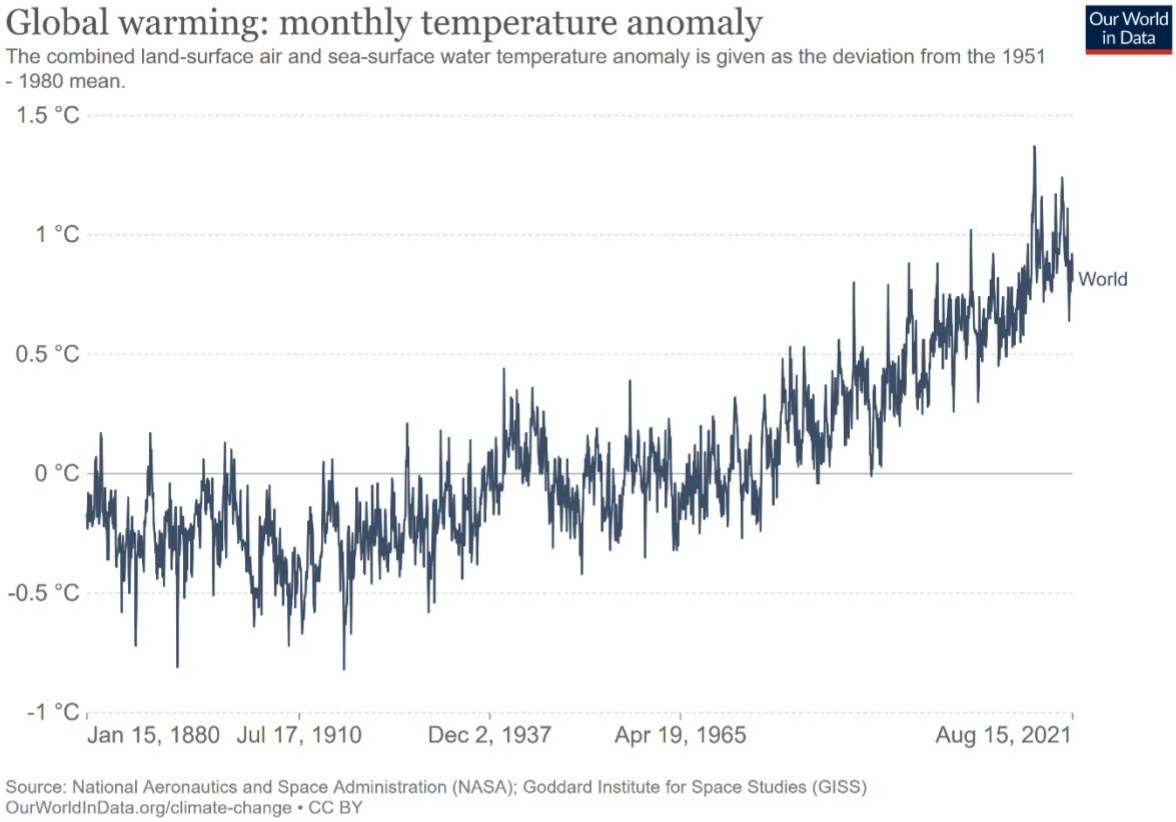


Figure 1: Global warming since 1880 (Our World In Data a))

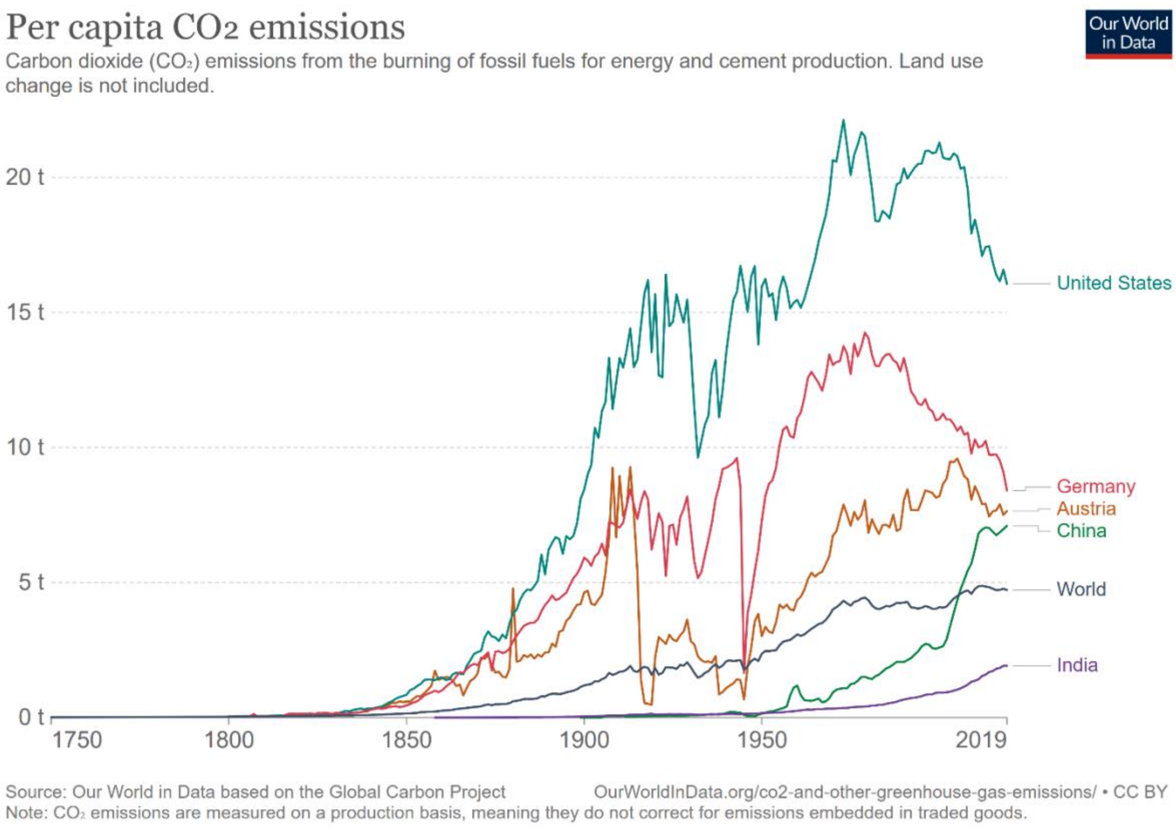


Figure 2: Comparison of per capita CO_2 emissions (Our World In Data b))

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). The implementation of these measures is now (as of December 2021) in full swing.

The 2020 GHG balance should provide information about the current status of progress, but also about where additional efforts can and must be invested, as well as what ideas can be gained for the future from this obligatorily "decelerated" year of 2020 or where readjustments need to be made to certain areas of the "Climate Neutral TU Graz 2030" project, which was decided upon in August 2020. The findings reported in this 2020 GHG balance will also contribute to the biennial evaluation of this project, which will begin 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 customized GHG accounting services to universities since 2015 (Allianz Nachhaltige Universitäten in Österreich 2021). *ClimCalc* was developed on the basis of the *Greenhouse Gas Protocol* (WRI and WBCSD 2004), which sets a globally recognised standard for GHG accounting in companies and organisations. By using this tool, all three scopes of GHG emissions can be recorded: scope 1 emissions, i.e. the emissions directly caused by an organisation; scope 2 emissions, i.e. the emissions indirectly caused by the generation of purchased electricity, steam, and district heating and cooling services; and scope 3 emissions, i.e. emissions that are also indirectly (upstream and downstream) caused, including those from the *Mobility* and *Material use* categories (Getzinger et al. 2019, Allianz Nachhaltige Universitäten in Österreich 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 scopes defined in *ClimCalc*:

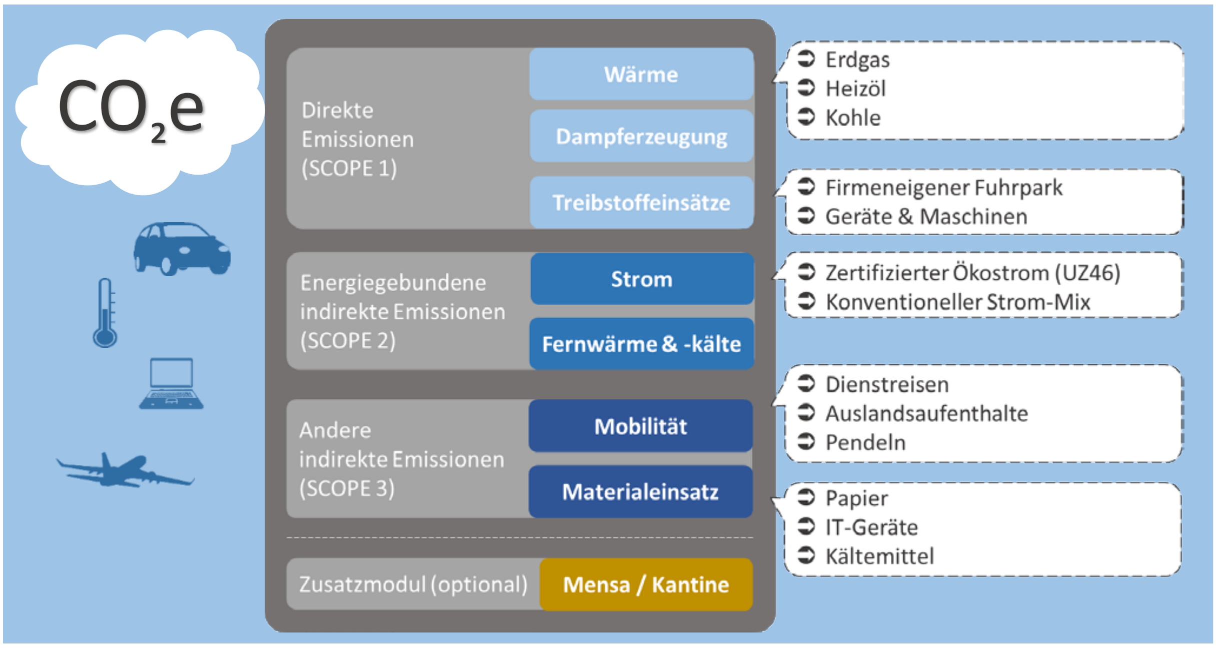


Figure 3: Scope categories defined in ClimCalc (Allianz Nachhaltige Universitäten in Österreich 2021a)

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. Currently, the emission factors from 2019 are used; therefore, this is a **preliminary balance**. As soon as the emission factors for 2020 are announced by the Environment Agency Austria, they will be applied to the balance presented here. This announcement is expected to take place in the summer of 2022.

2.2 Approaches 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 presented in the same categories. The delimitation of the categories collected is based on *ClimCalc*, and these include: *Energy*, *Mobility*, *Material Use*, and the additional module *Canteen*. In addition, TU Graz decided to include the category *Buildings* in the GHG balance, initially as a special category. Data for the following main and sub-categories were recorded:

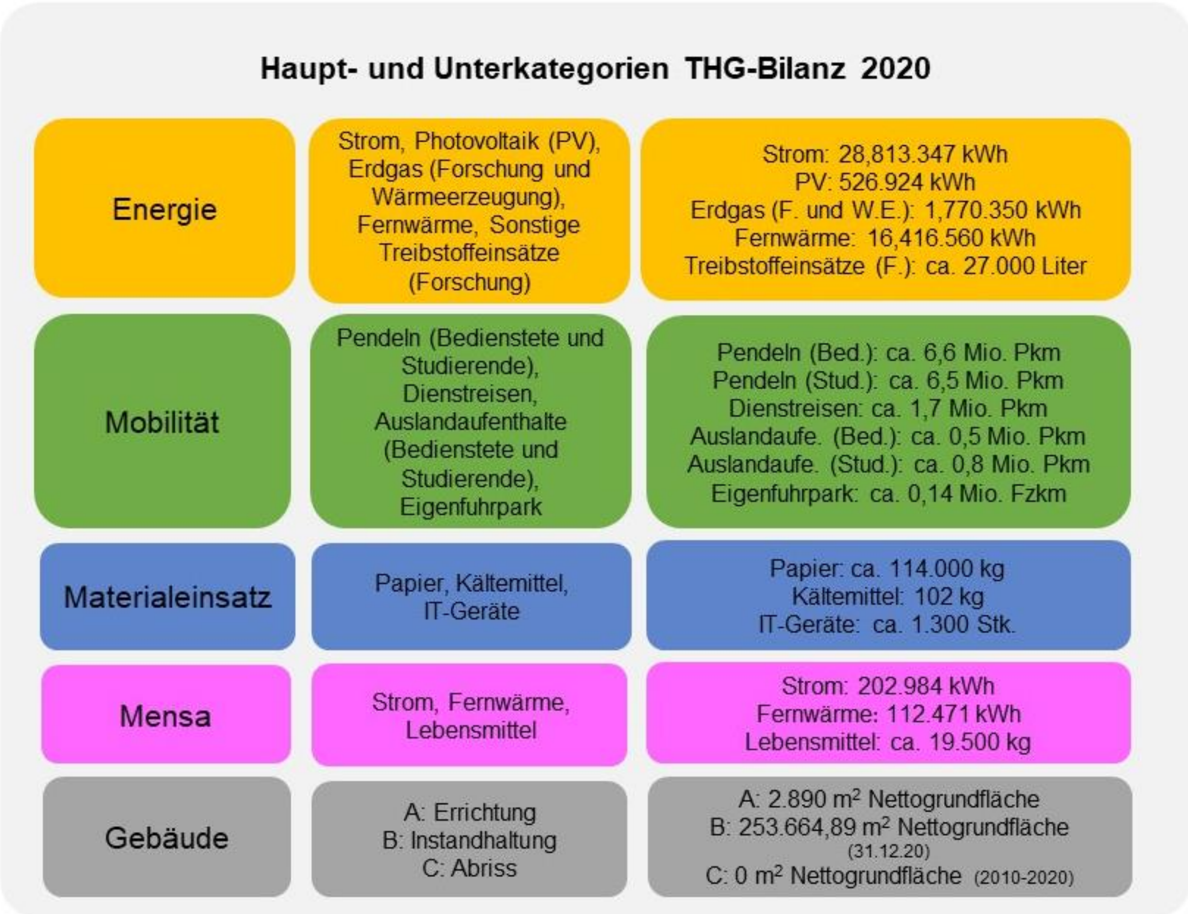


Figure 4: Overview of main and sub-categories included in the TU Graz 2020 GHG balance

In the GHG balance presented here, all TU Graz primary and secondary locations were included.

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

	With canteen	Without canteen
Total net floor space	253,362 m^2	251,586 m^2
Net floor area heated	230,037 m^2	228,261 m^2

Table 1: TU Graz net floor space

The number of employees and students at TU Graz was obtained from the 2020 Intellectual Capital Statement (Wissensbilanz 2020, p. 14). In addition, the number of staff is enhanced by holdings, which was provided by the Organisational Unit *Rector's Assistance: Statistics and Data Protection.* Holdings are included in the GHG balance if they are very closely connected with TU Graz in terms of both space and personnel.

	According to the Intellectual Capital Report 2020	Holdings 2020	Total
Staff			
Individuals (as of: 31.12.2020)	3,852	382	**4,234**
Full-time equivalents (FTE) (annual average)	2,475	291	**2,766**
Students *(as of: 21.12.2020)*	16,091		**16,091**

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

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

	According to the 2017 Intellectual Capital Report	Holdings 2017	Total
Staff			
Individuals (as of: 31.12.2017)	3,326	385	**3,711**
Full-time equivalents (FTE) (annual average)	2,220	298	**2,518**
Students *(as of: 21.12.2017)*	16,816		**16,816**

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

The data for preparing this GHG balance were provided by the TU Graz organisational units and external partners (see p. 2).

The number of kilometres travelled by commuters was obtained from the 2019 traffic survey, which was carried out by the TU Graz Institute of Highway Engineering and Transport Planning for both staff and student commuters as part of a master's thesis (Forstner 2021). The numbers were broken down into the number of staff (4,234 individuals incl. holdings) and students (16,091 individuals) in 2020. In addition, the kilometres travelled by commuters were adjusted with regard to the pandemic-related home office regulations based on certain assumptions. This information is presented in more detail in the chapter on *Mobility*.

When comparing the two balances for 2017 and 2020, it is important to note that the emission factors used are updated annually. This also explains the differences between the two balances. In the following section, 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 in a tabular form for each category. Please also note that the emission factor for district heating provided by Energie Graz was corrected upwards in December 2021 by the Environment Agency Austria for the last few years. Data from 2017 were also affected by this correction, which is why there are now approx. 1,800 t CO_2e more district heating emissions for 2017 than originally reported in the 2017 balance. Here, in the 2020 GHG balance, the corrected values for 2017 have already been applied by using the emission factor 0.3487 and by using 6,197 t CO_2e (see 2017 balance before correction: emission factor 0.2483; emissions: 4,413 t CO_2e).

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

3. GHG balance

3.1 Summary

In total, around **15,200 tonnes of CO_2e** were produced at TU Graz in **2020.** This equals around 8,900 tonnes or around **40% less** GHG emissions than in **2017, when 24,100 tonnes of CO_2e were produced**. The largest share of emissions is assigned to the category of *Energy* (11,900 t CO_2e), followed by *Mobility (*2,540 t CO_2e), then *Material Use* (620 t CO_2e), and finally *Canteen* (170 t CO_2e).

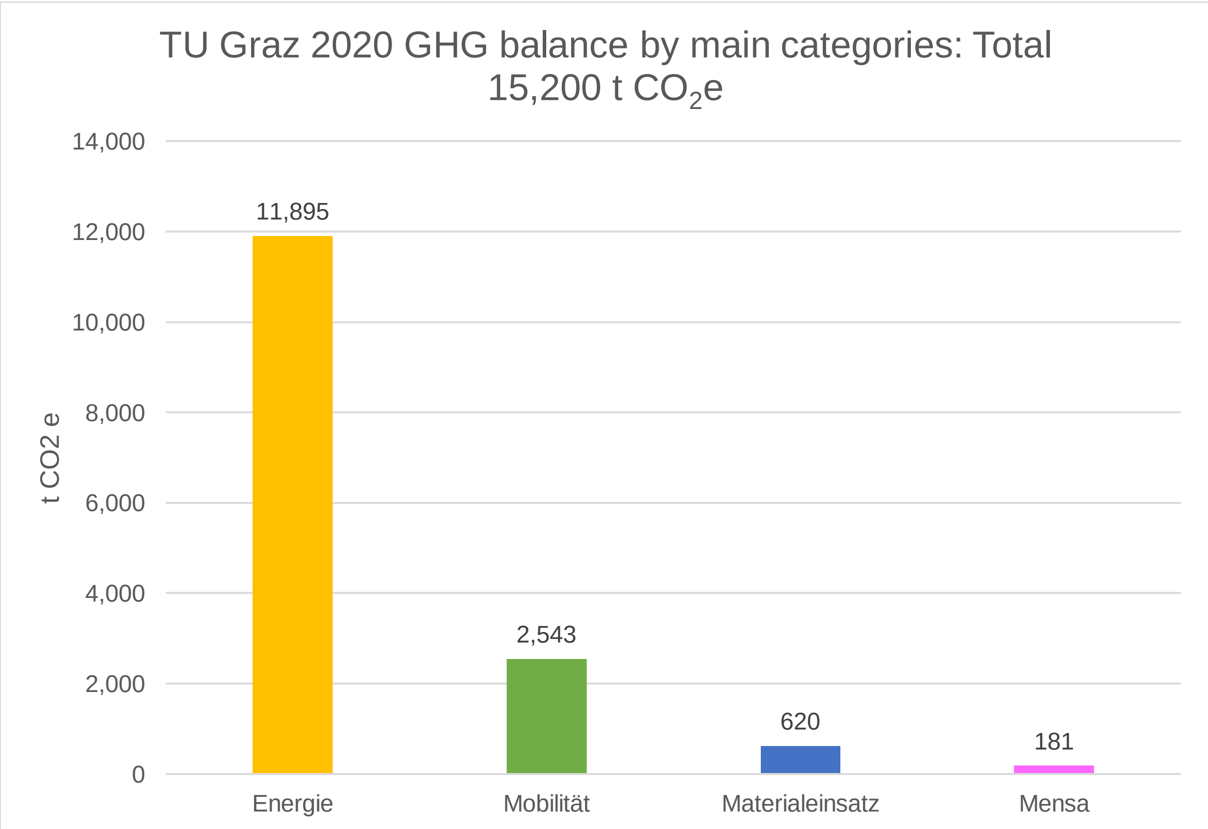


Figure 5: TU Graz 2020 GHG balance by main categories: 15,200 t CO_2e in total

As compared to 2017, a significant decrease in emissions can be seen, which is mainly due to the coronavirus pandemic. In particular, emissions in the *Mobility* category have decreased significantly due to the pandemic.

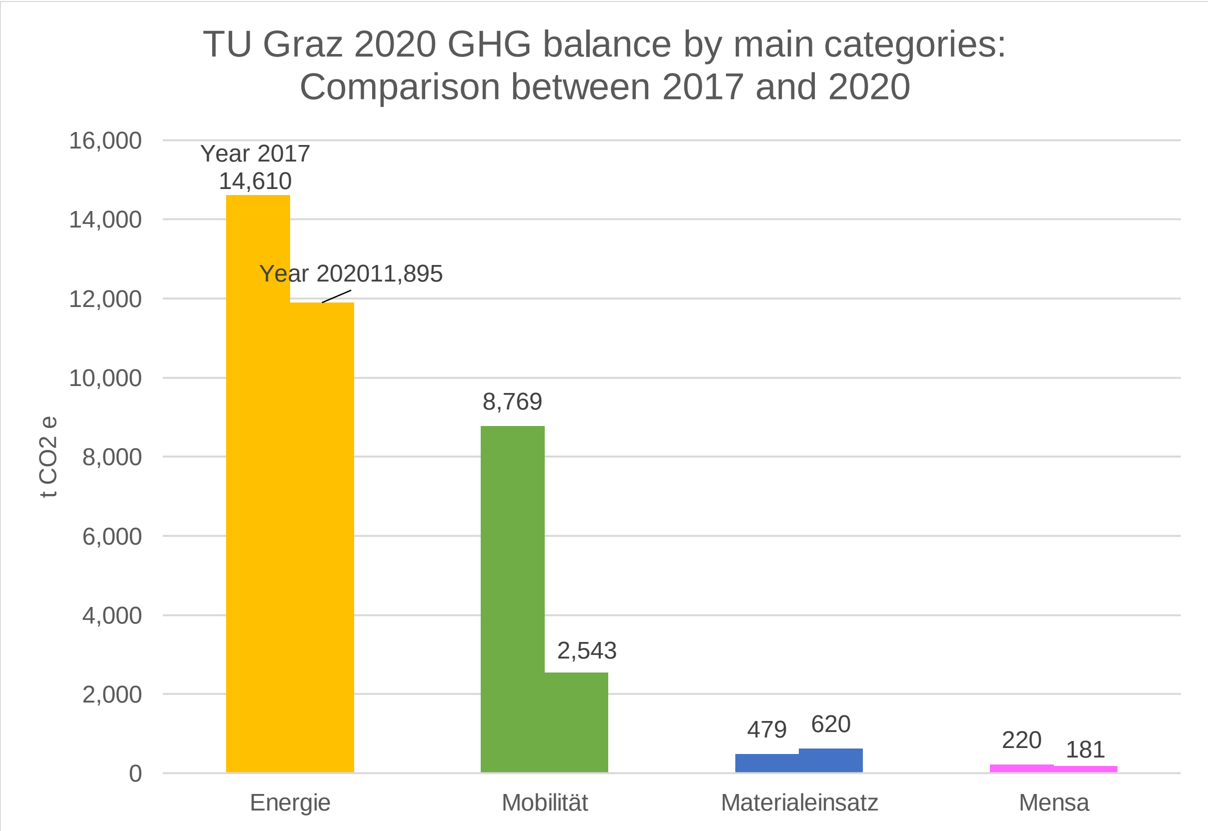


Figure 6: TU Graz 2020 GHG balance by main categories: Comparison between 2017 and 2020

GHG emissions by sub-category are presented below, both for 2020 only and for 2020 as compared to 2017:

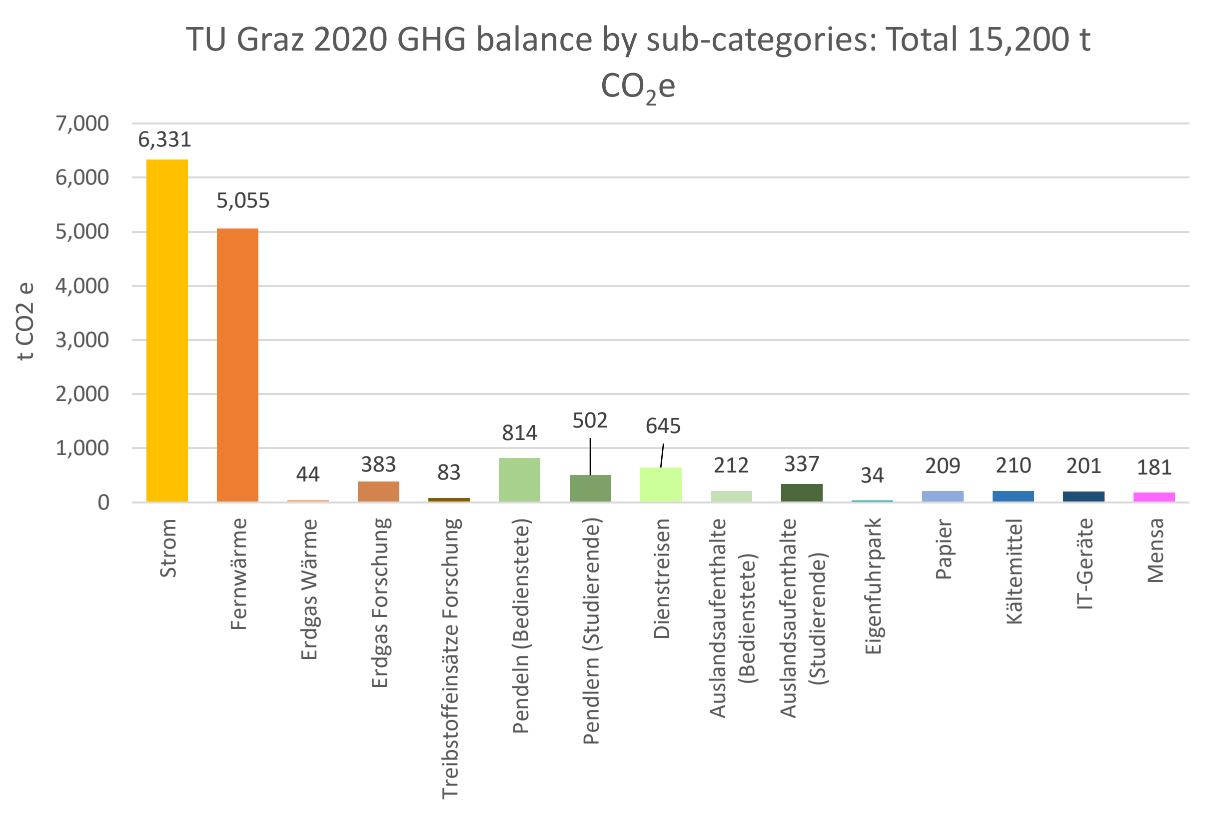


Figure 7: TU Graz 2020 GHG balance by sub-categories: 15,200 t CO_2e in total

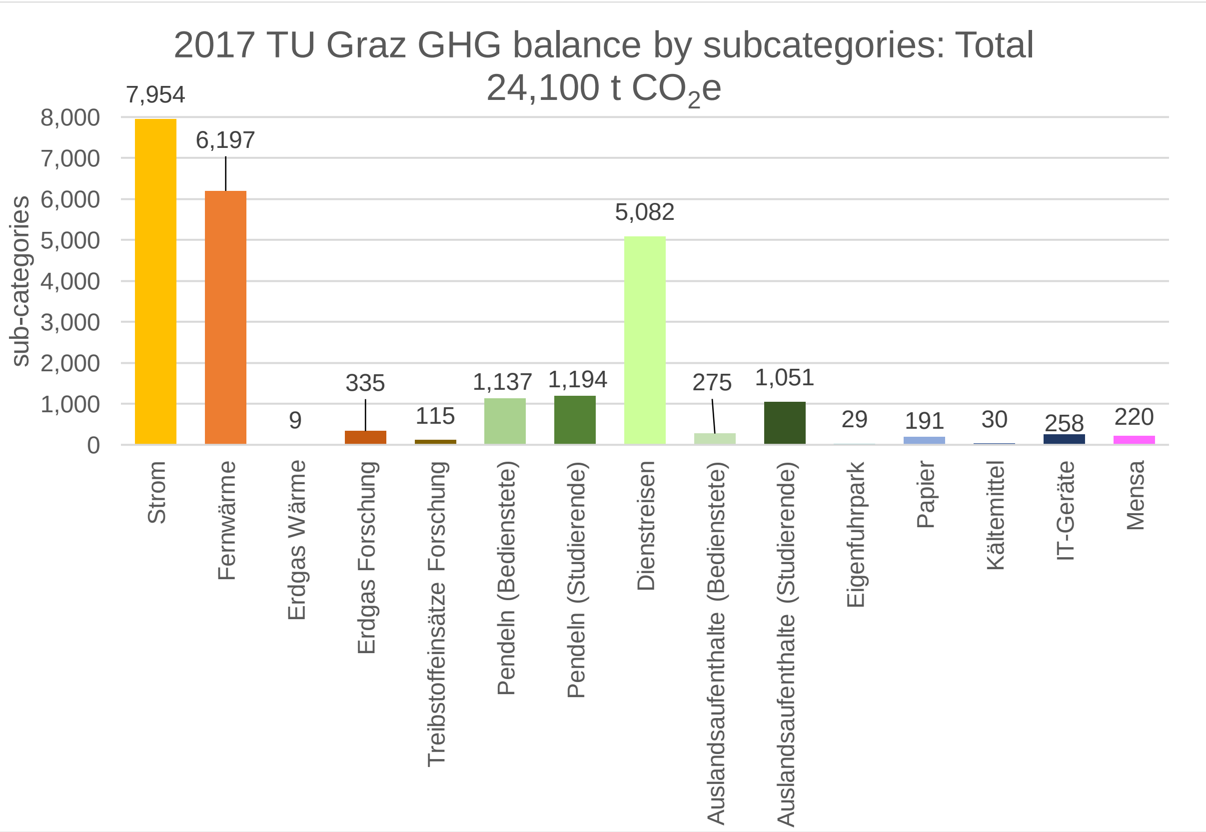


Figure 8: 2017 TU Graz GHG balance by sub-categories: 24,100 t CO_2e in total

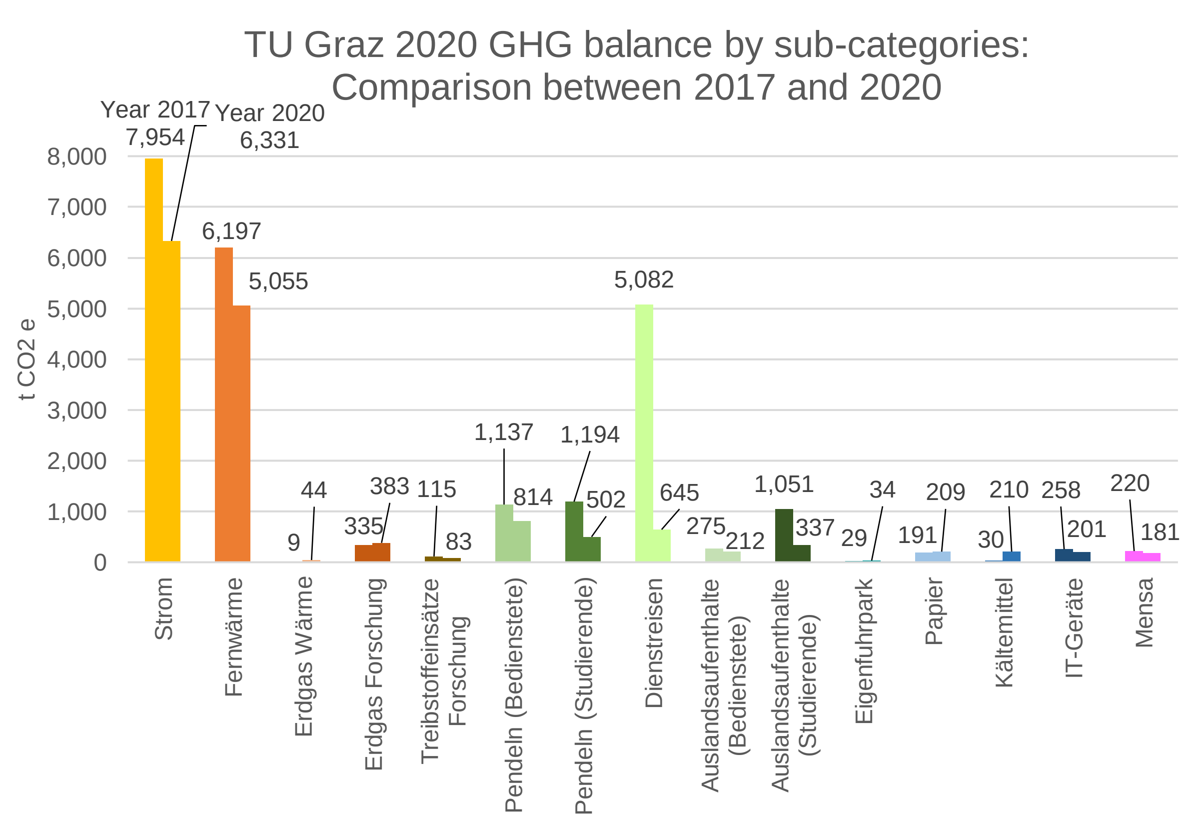


Figure 9: TU Graz 2020 GHG balance by sub-categories: Comparison between 2017 and 2020

The following figure shows the emissions by sub-category with the vertical axis extending up to 1,200 t CO_2e and excluding the sub-categories *electricity* and *district heating*. This makes the values for these sub-categories easier to read. The emissions for the sub-categories *electricity* and *district heating* exceed this 1,200-tonne limit and, therefore, are not shown here (see p.17).

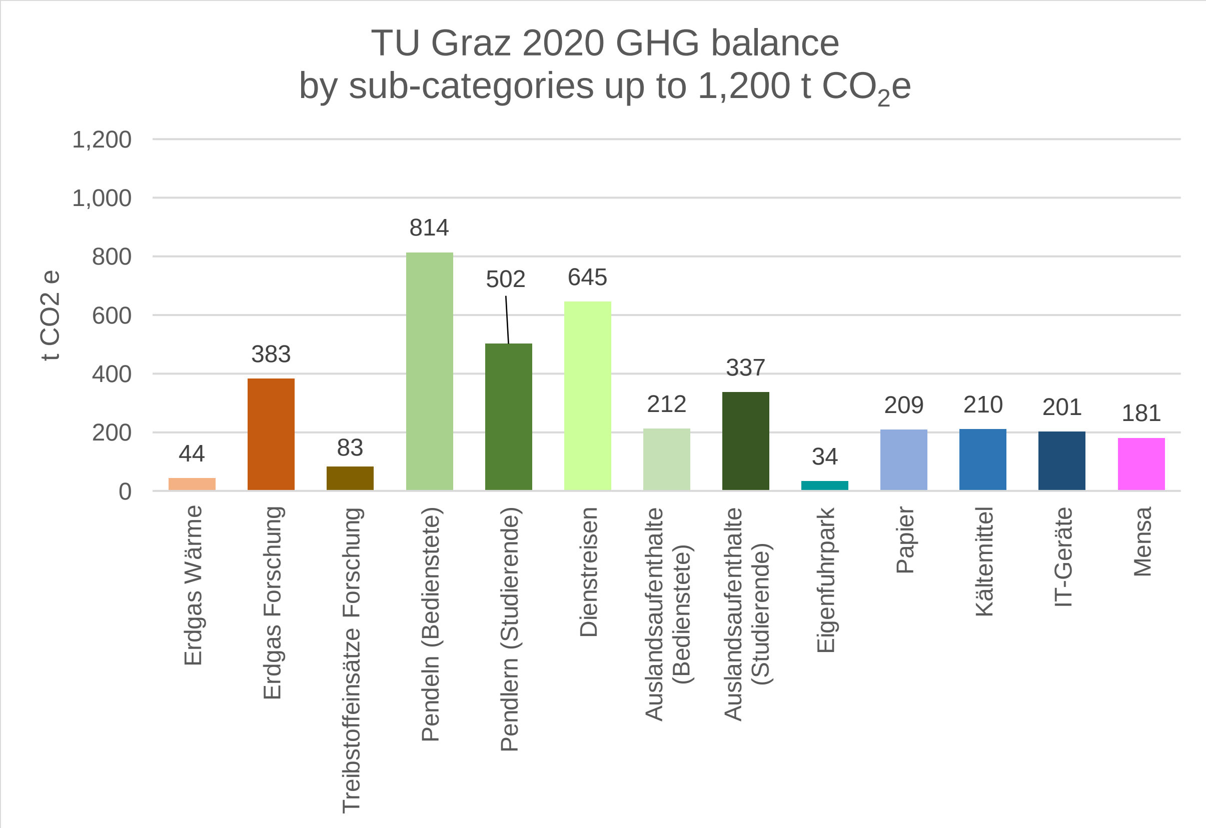


Figure 10: TU Graz 2020 GHG balance by sub-categories in 2020 up to a maximum of 1,200 t CO_2e, excluding electricity and district heating

In the comparison between 2020 and 2017, the emissions from the *business travel* sub-category were also omitted, as these significantly exceeded the 1,200-t limit for CO_2e in 2017:

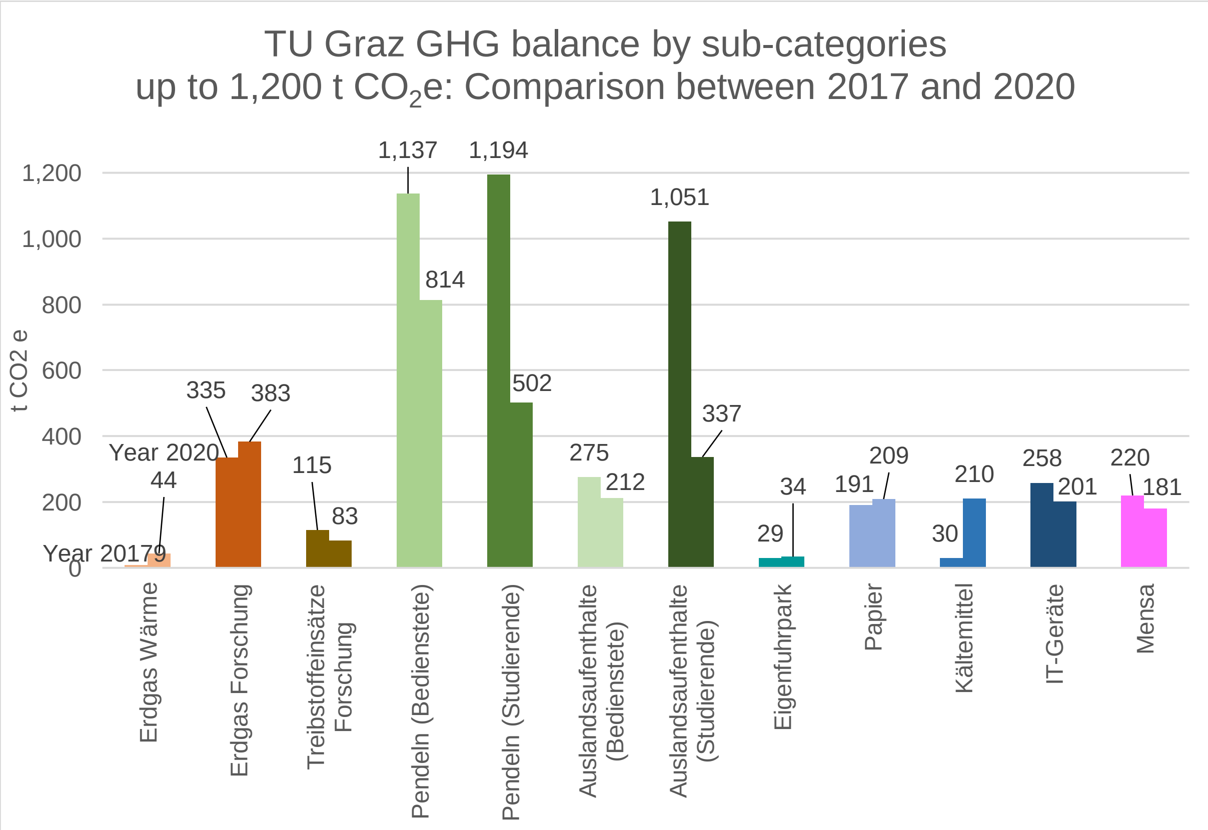


Figure 11: TU Graz GHG balance by sub-categories up to a maximum of 1,200 t CO_2e, excluding electricity, district heating, and business travel, comparison between 2017 and 2020

Results by scope category:

The following table 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		2019
Scope 1		617.139
Scope 2		9.210.580
Scope 3		5.215.481
Summe Hauptmodul	**(kg CO_2 eq.)**	**15.043.199**
Zusatzmodul Mensa		
Scope 3		151.788
Summe Hauptmodul + Zusatzmodul	**(kg CO_2 eq.)**	**15.194.988**

Table 4: Summary of calculation results by scope category (in kg CO_2 equivalents)

3.2 Categories

3.2.1 Energy

The *Energy* category is divided into *electricity* (purchased and personal PV generation and consumption), *natural gas heating, natural gas research*, *district heating,* and *fuel used for research*. The division of the natural gas sub-category into *fuel used for heating* and *fuel used for research* was made for the first time in this balance. This was done because the majority of natural gas used at TU Graz is used for research and not as a heating fuel. As the graphs below show, the natural gas used for research accounts for 380 tonnes of CO_2e and thus around 4% of the emissions in the *Energy* category, while the natural gas used for heating accounts for 45 tonnes of CO_2e and thus only 0.4%.

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 use.

In the category of *Energy,* most GHG emissions are caused by TU Graz, i.e. a total of around 11,900 tonnes CO_2e. This accounts for about 78% of the total GHG emissions from TU Graz. The main share can be assigned to the sub-category *electricity*, namely, 6,300 tonnes CO_2e. The second highest share can be assigned to the sub-category *district heating* with about 5,100 tons of CO_2e, followed by *natural gas research* with 380 tons of CO_2e, *fuel use research* with 80 tons of CO_2e, and *natural gas heating* with 40 tons of CO_2e.

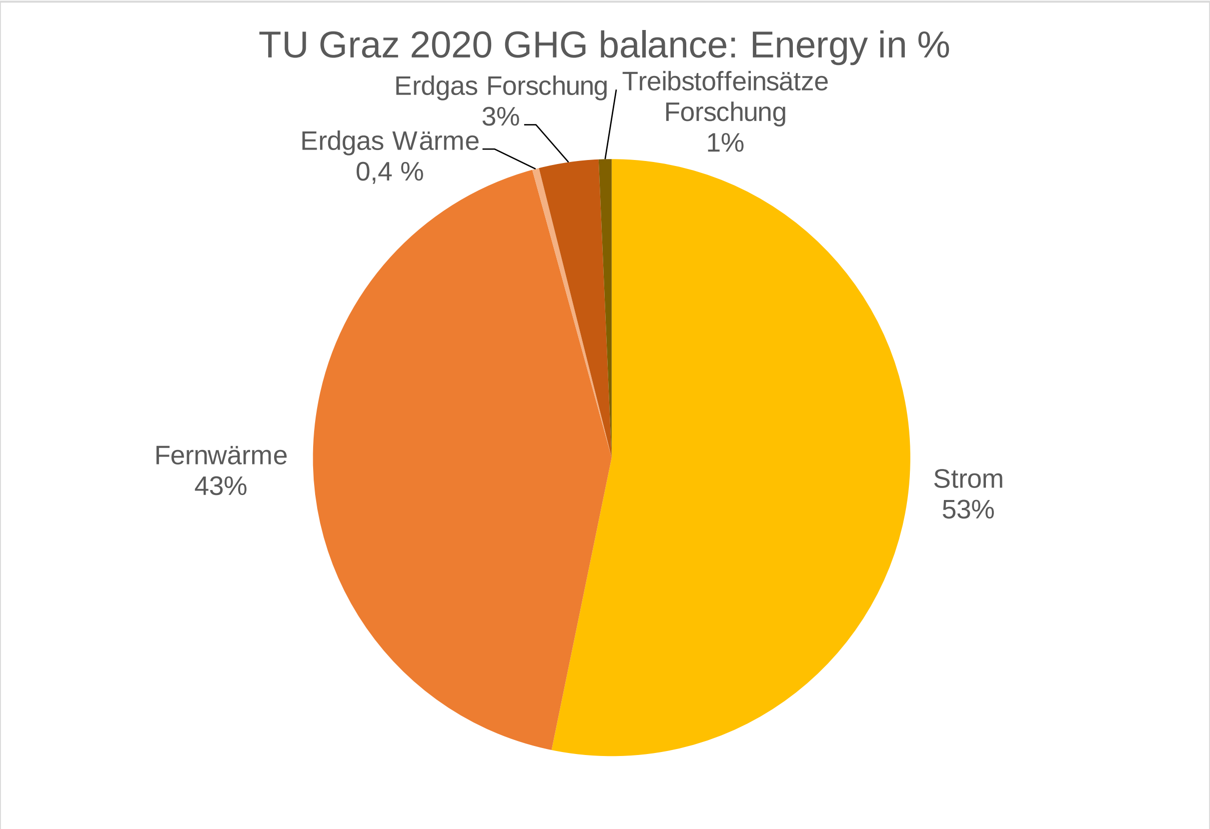


Figure 12: TU Graz 2020 GHG balance - energy (in %)

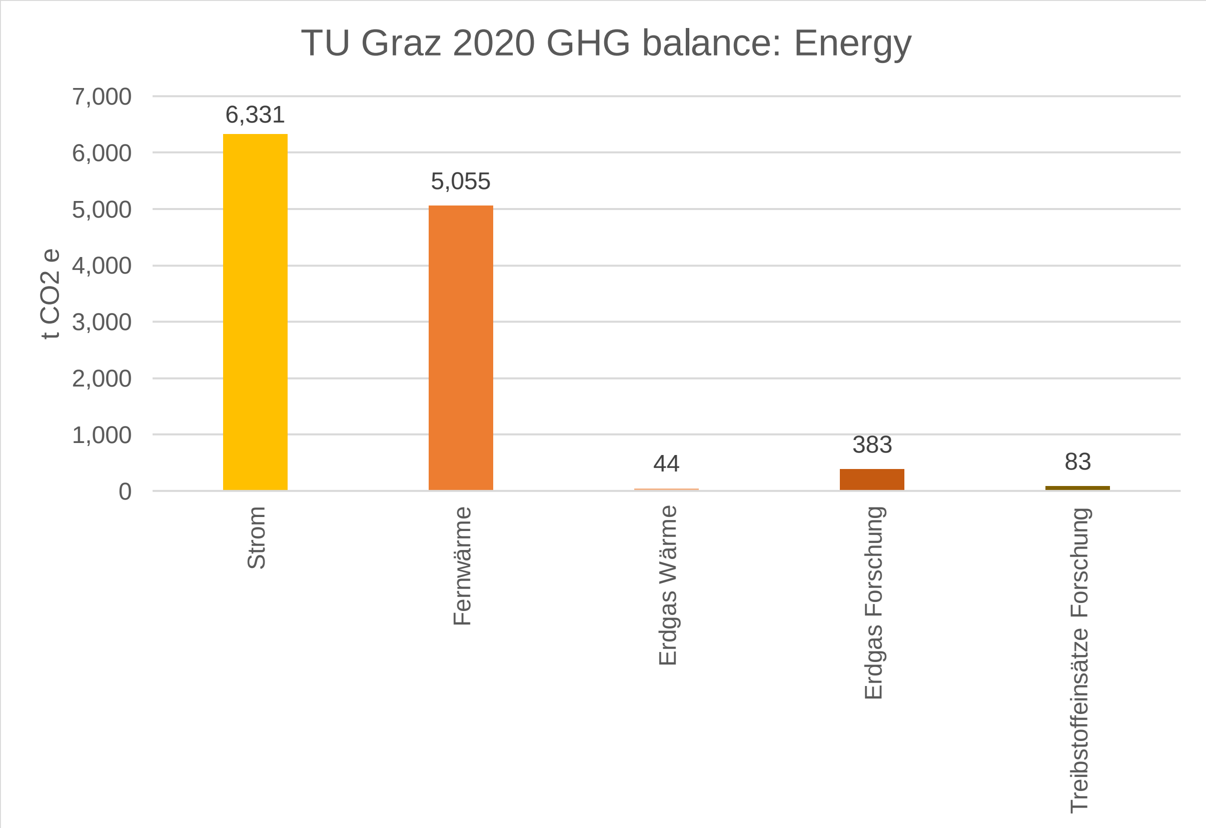


Figure 13: TU Graz 2020 GHG balance - energy

Comparison between 2020 and 2017

As compared to 2017, the 2020 emissions assigned to the *Energy* category have decreased by approximately 2,700 tonnes of CO_2e (2017: 14,600 t vs. 2020: 11,900 t). Apart from natural gas (heating and research), the energy used in all sub-categories has decreased as compared to 2017, as the following graph shows:

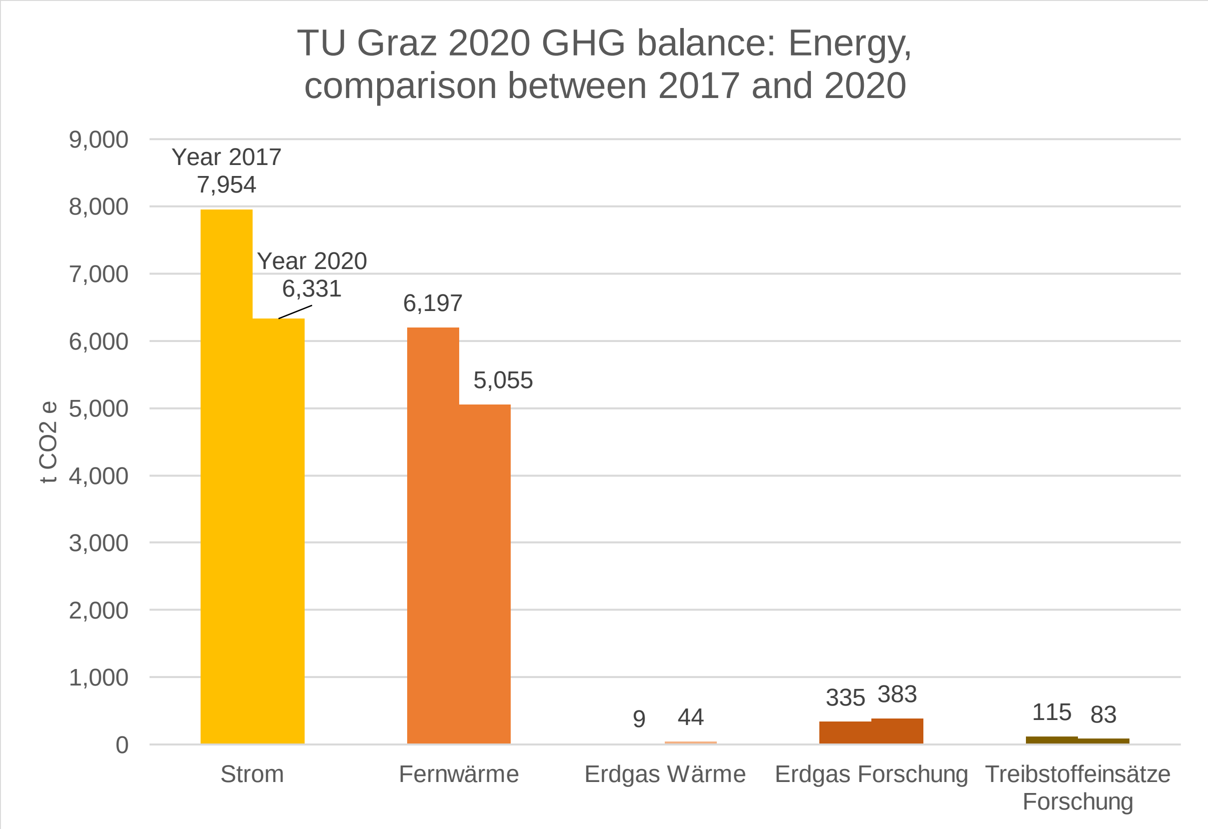


Figure 14: TU Graz 2020 GHG balance - energy, comparison between 2017 and 2020

The sub-category *electricity* is divided into *electricity consumption (without UZ 46 certification)* and *personal photovoltaic consumption (PV)*. Since *ClimCalc* only differentiates between electricity consumption without the Environmental Label RL UZ 46 certification and electricity consumption with the Environmental Label RL UZ 46 certification, electricity consumption at TU Graz should be counted as electricity consumption without the Environmental Label RL UZ 46. The special feature of UZ 46 certification for electricity is that this clearly defines which electricity may be traded using this certificate and that high, transparently set criteria must be fulfilled in order to sell electricity as UZ 46 electricity. A minimum share of PV electricity must also be demonstrated, and the remaining shares can come from biomass, geothermal, wind, or hydropower sources (Österreichisches Umweltzeichen 2018).
It should be noted that TU Graz already purchases 100% green electricity as defined in § 5 para. 1 of the Green Electricity Act and is working to switch to UZ 46-certified electricity. In the Green Electricity Act, green electricity is defined in § 5 para. 1 no. 22 as "electrical energy from renewable energy sources" (ÖSG 2012).
Currently, the electricity used at TU Graz (EAA Aqua from the Energieallianz Austria) comes from the following sources (according to an invoice dated 14.04.2020):

- 68.57% Hydropower
- 15.63% Solid or liquid biomass
- 10.73% Wind energy
- 3.40% Biogas
- 1.59% Solar energy
- 0.08% Other green energy

The origin of the electricity is indicated as (according to an 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 operate the heat pumps at TU Graz, i.e. for heating and cooling. This amounts to around 527,150 kWh and produced emissions of 115 t CO_2e.
As compared to 2017, the data in the area of *Electricity consumption (without certification)* have slightly decreased, and the consumption, emission factors, and emissions have decreased. However, the consumption of personally generated *PV electricity* increased strongly in 2020 (by approx. 300%). This can be explained by the installation of personal PV systems at TU Graz, i.e. from 145 kW_{peak} in 2017 to 605 kW_{peak} in 2020. The highest electricity yield from the PV systems in 2020 was in the month of July, in which over 80,000 kWh of electricity were produced. Compared to this, December 2020 was the month with the lowest yield of *PV electricity* with just under 5,500 kWh.
The emission factor for *PV electricity* fell by 33% as compared to 2017. 100% of the *PV electricity* generated at TU Graz is consumed in the buildings themselves at all times.

Comparison between 2020 and 2017: Electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2020 Electricity without UZ 46 certification	28,813,347 527,150 of this used by heat pumps	0.2190	6,310 115 of this from heat pumps
2020 PV	526,924	0.0400	21
Total	29,340,271		**6,331**
2017 Electricity without UZ 46 certification	30,282,000 379,000 of this used by heat pumps	0.2573	7,792 100 of this from heat pumps
2017 PV	132,000	0.0600	8
Total	30,414,000		**7,800**

Increase/decrease in % Electricity	Minus 5%	Minus 15%	Minus 19%
Increase/decrease in % PV	Plus 299%	Minus 33%	Plus 163%
Total			**Minus 19%**

Table 5: Comparison between 2020 and 2017 - electricity

The 2019 emission factors for *Natural gas* and *District heating* have also decreased as compared to those in 2017 (by 11 and 12%, respectively). The consumption of natural gas in total (heat + research) has increased by approx. 40% in 2020 as compared to 2017, while the consumption of *District heating* has slightly decreased. This is primarily due to the heating degree-day index in the respective year. In 2017, this was 3,852.6 and in 2020, it was 3,627.3 (TUG GuT energy statistics).
The increase in the consumption of natural gas can be explained by the fact that different amounts of natural gas were consumed for research projects in the two years and slightly more rentals will be heated with natural gas in 2020.
The fact that staff and students spent a large part of the year in the home office had only a minor impact on the *Energy* category.

Comparison between 2020 and 2017: Natural gas			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2020	1,770,350 for research: 1,589,292 for heating: 181,292	0.2410	**427** from research: 383 from heating: 44
2017	1,269,946 for research: 1,238,221 for heating: 31,779	0.2703	**343** from research: 335 from heating: 9
Increase/decrease in %	Plus 39%	Minus 11%	Plus 24%

Table 6: Comparison between 2020 and 2017 - natural gas

Comparison between 2020 and 2017: District heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2020	16,416,560	0.3079	**5,055**
2017	17,773,000	0.3487	**6,197**
Increase/decrease in %	Minus 8%	Minus 12%	Minus 18%

Table 7: Comparison between 2020 and 2017- district heating

In December 2021, the emission factor for district heating from Energie Graz was corrected upwards by the Environment Agency Austria for the last few years. The year 2017 was also affected by this correction, which is why there are now approx. 1,800 t CO_2e more district heating emissions for 2017 than originally reported in the 2017 balance. Here, in the GHG balance 2020, the corrected values for 2017 have already been applied by using the emission factor 0.3487 and by using 6,197 t CO_2e (see 2017 balance before correction: emission factor 0.2483; emissions: 4,413 t CO_2e).

It is also worth directing attention toward the category of *Fuel used for research*, where consumption has decreased (-26% for diesel and -45% for petrol). This decrease can be explained by the fact that different amounts of fuel were used for research purposes in 2017 and 2020.

Comparison between 2020 and 2017: Fuel used for research			
	Consumption in litres	Emission factor in kg CO_2e/l	Emissions in t CO_2e
2020			
Diesel	23,084	3.1360	72
Petrol	3,571	2.8910	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	Minus 26%	Plus 1%	Minus 26%
Increase/decrease in % Petrol	Minus 45%	Plus 6%	Minus 44%
Total			**Minus 29%**

Table 8: Comparison between 2020 and 2017 - fuel used for research

3.2.2 Mobility

The *Mobility* category is subdivided into the sub-categories of *staff commuting*, *student commuting*, *business trips*, *staff stays abroad*, *student stays abroad,* and *company vehicle fleet*. The data for this category were provided by the *Human Resources Department*, the *International Office - Welcome Center*, and the respective *institutes with official vehicles.* A list of the institutes with official vehicles was compiled by the *Finance and Accounting* organisational unit. In addition, the transport survey conducted at TU Graz in 2019 was used (Forstner 2021), i.e. it was assumed that the modal split of the means of transport in the sub-categories *commuting staff* and *commuting students* did not change from 2019 to 2020. In addition to daily commuting, the GHG emissions from family home trips made by staff and students were also recorded and presented separately in the 2019 transport survey (Forstner 2021). However, according to *ClimCalc,* this special category is not included in the overall TU Graz 2020 GHG balance. More detailed information about this aspect is provided in the section "Commuting: Special category of family trips home".

With around 2,500 tonnes of CO_2e, the *Mobility* category is the one with the second highest emissions at TU Graz after the *Energy* category. The sub-category *staff commuting* is the most significant, producing around 810 tonnes of CO_2e in 2020, followed by *business trips* with around 650 tonnes, *student commuting* with around 500 tonnes, *student stays abroad* with around 340 tonnes, *staff stays abroad* with around 210 tonnes, and the *company vehicle fleet* with around 30 tonnes. In this report, a special focus will be placed on mobility, as the TU Graz emissions can be reduced effectively by applying measures. Measures in this regard have already been chosen and are shown on the "Climate Neutral TU Graz 2030" roadmap, and an implementation plan has been drawn up (TU Graz 2020).
With reference to all the figures provided here, it should again be noted that the coronavirus pandemic had a particularly strong impact on mobility in 2020. Due to lockdowns and travel restrictions, university mobility at TU Graz decreased significantly in 2020. More detailed information can be found in the comparisons between the years 2020 and 2017 at the end of the chapter.

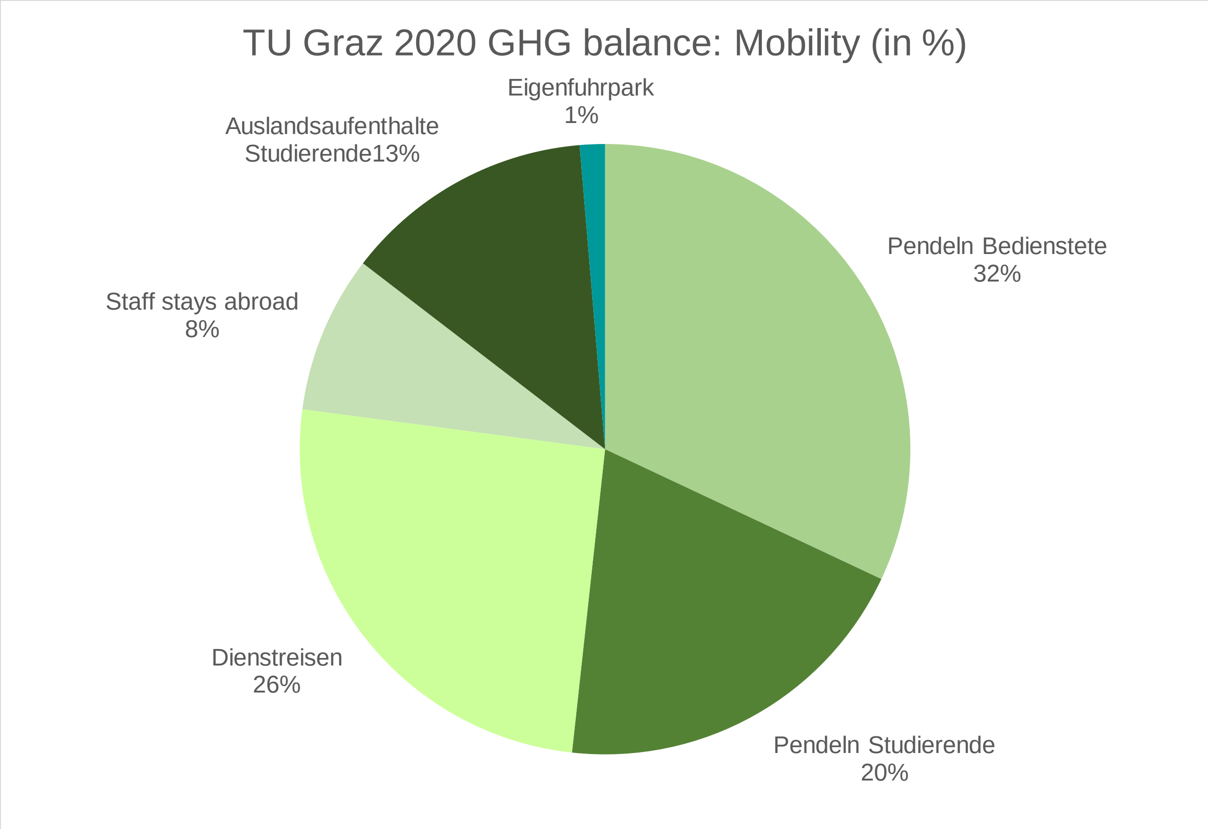


Figure 15: TU Graz 2020 GHG balance - mobility (in %)

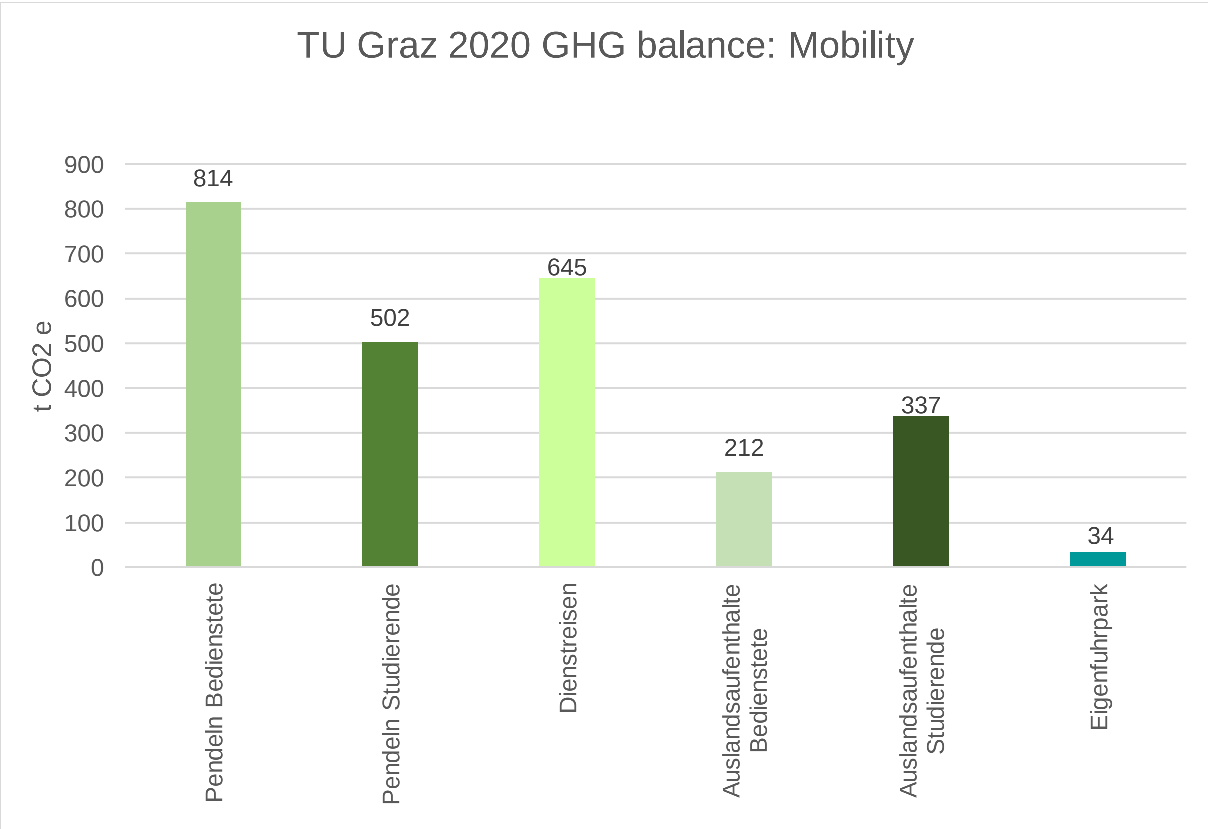


Figure 16: TU Graz GHG balance - mobility

Staff and student commuting

The kilometres travelled for commuting refer to the kilometres recorded in the2019 traffic survey conducted by the TU Graz Institute of Highway Engineering and Transport Planning for both staff and students (Forstner 2021). The figures were broken down into the number of staff (4,234 individuals incl. holdings) and students (16,091) in 2020. These figures were extracted from the TU Graz 2020 Intellectual Capital Report, as well as from the organisational unit *Statistics and Data Protection* (holdings) (see Intellectual Capital Report 2020, p. 14). Since the coronavirus pandemic restricted university operations from March to December, the commuting kilometres were adjusted: a reduction of 60% for staff and of 80% for students for the period of mid-March to December. The first two and a half months of 2020 were calculated at 100%. These are rough estimates, resulting from discussions with TU Graz staff and an informal survey of 26 students. In addition, a study by Deloitte, which was carried out in cooperation with the University of Vienna and the University of Graz, reports that at least half of the staff in almost 90% of the Austrian companies surveyed worked in a home office during the lockdown phase from April to May. In 60% of the companies surveyed, all staff worked from home, with the exception of a few people who maintained systems (Kellner et. al 2020).
In the sub-category *commuting,* both staff and student figures show that the car is the mode of transport that causes the most emissions by far. For this reason, TU Graz would like to promote the use of e-cars by, e.g. installing around 200 charging points for e-cars on the TU Graz premises by 2030 (TU Graz 2020). Currently (2021), 17 charging points are in operation on the TU Graz premises. The total number of parking spaces at TU Graz is around 700.
The following figures compare emissions by means of transport, once in the category of *staff commuting* and once in the category of *student commuting*:

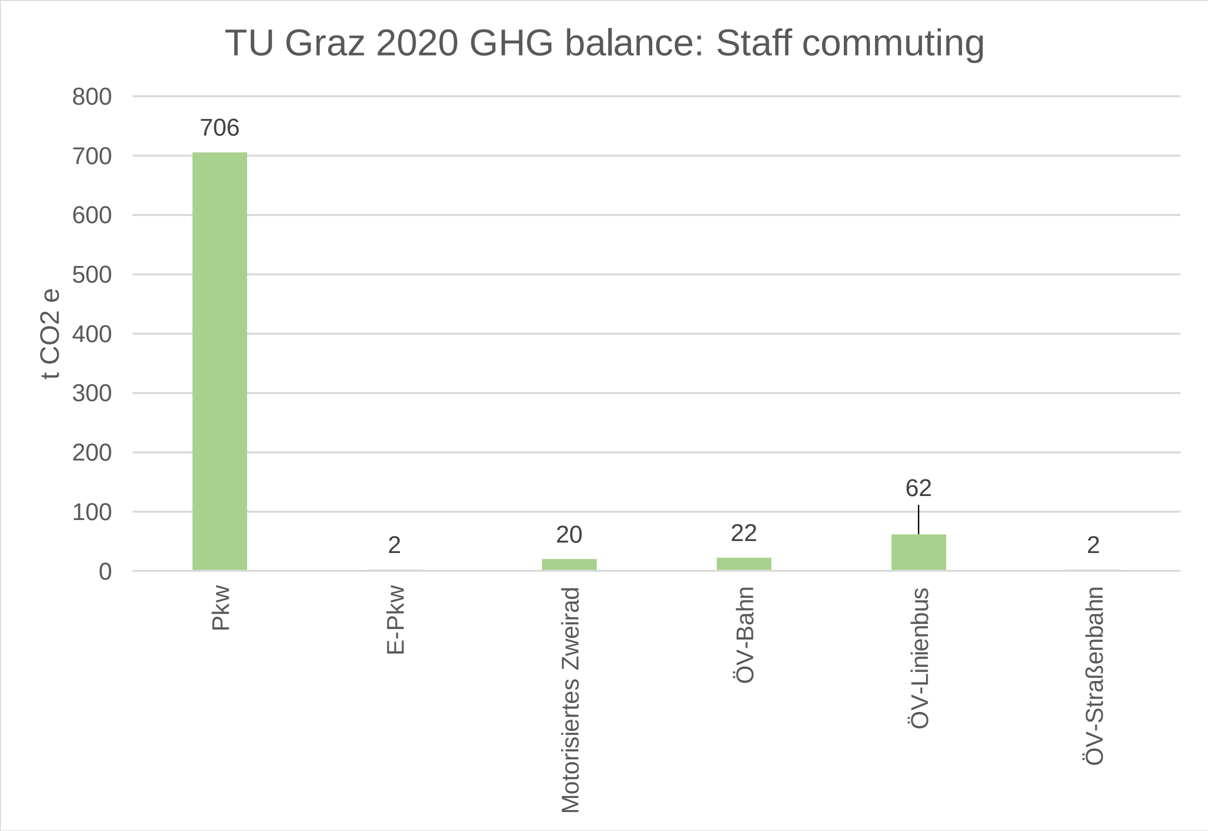


Figure 17: TU Graz GHG balance – staff commuting

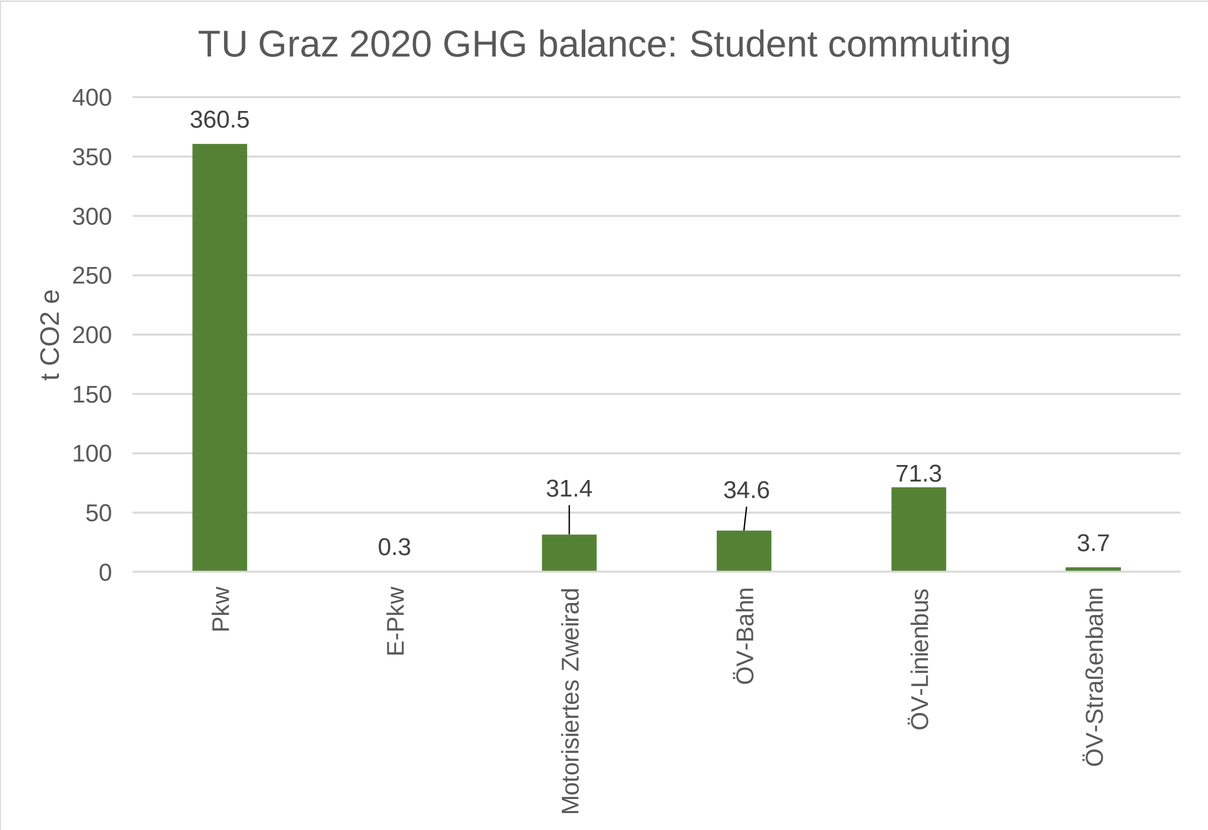


Figure 18: TU Graz GHG balance – student commuting

It should be mentioned at this point that in the *commuting* category, walking and cycling represent a high share for both TU Graz student and staff (see Transport Survey 2019: Forstner 2021), but these modes of transport – as they are almost emission-free – are not shown in the GHG balance.

The following figure from the 2019 transport survey shows the modal split difference (modal split in terms of main means of transport) among TU Graz commuters as compared to the city of Graz commuters and those commuting to other cities in Austria. It is noticeable that TU Graz commuters use the bicycle with remarkable frequency. In this comparative graph, both internal (to and from TU Graz from the elsewhere in the city) and external (to and from TU Graz from outside the city) commuters were taken into account. The modes of *walking* (yellow), *cycling* (green), *private transport (*red), and *public transport (*blue) are shown here. The data are based on the TU Graz 2019 traffic survey (Forstner 2021) and on raw data from a mobility survey by *Österreich unterwegs* (Austria on the Move 2013/2014, Forstner 2021, pp. 48-75).

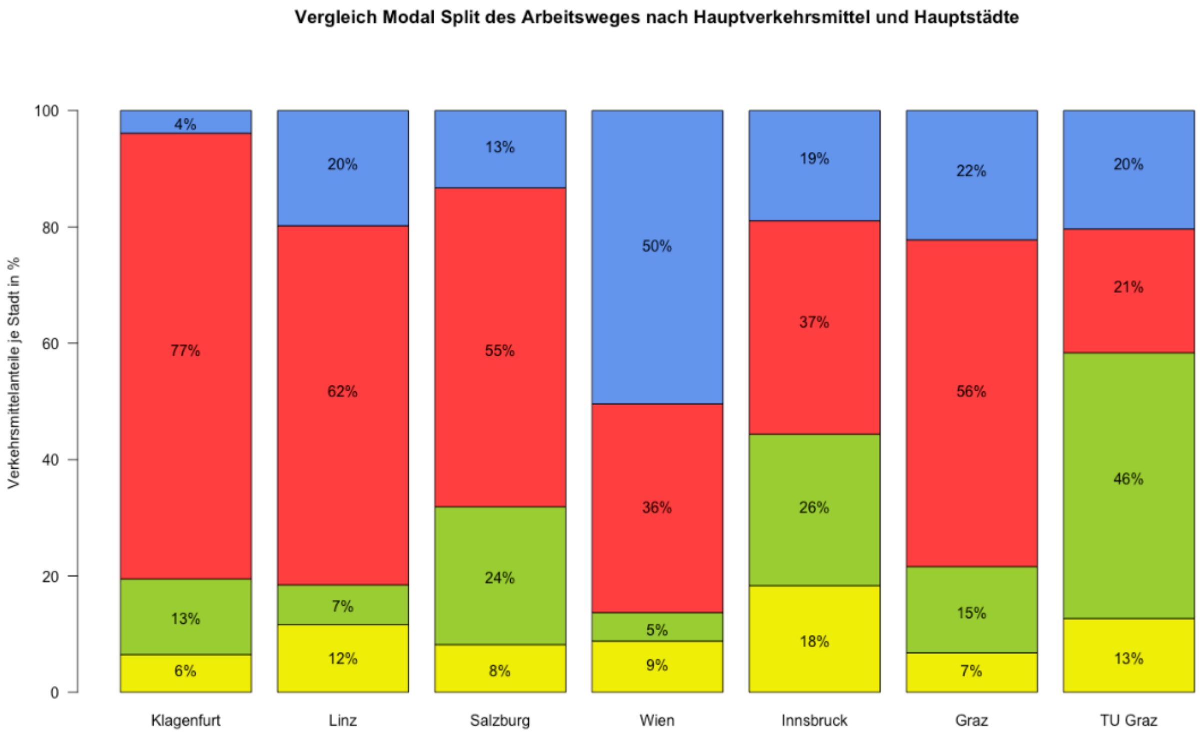


Figure 19: Comparison of modal splits of the work commute regarding the main means of transport used by within-city and inbound commuters, the main cities, and TU Graz (Forstner 2021, p. 65; raw data: Österreich unterwegs 2013/14)

If only within-city commuters are taken into account, i.e. only those commuters who live within the city of Graz, pedestrians and cyclists are even more strongly represented. Together, these make up 76% of all commuters. The comparison with the figures for within-city and external commuters shows that external commuters in particular make greater use of private and public transport. The following graph shows the modal split for within-city commuters:

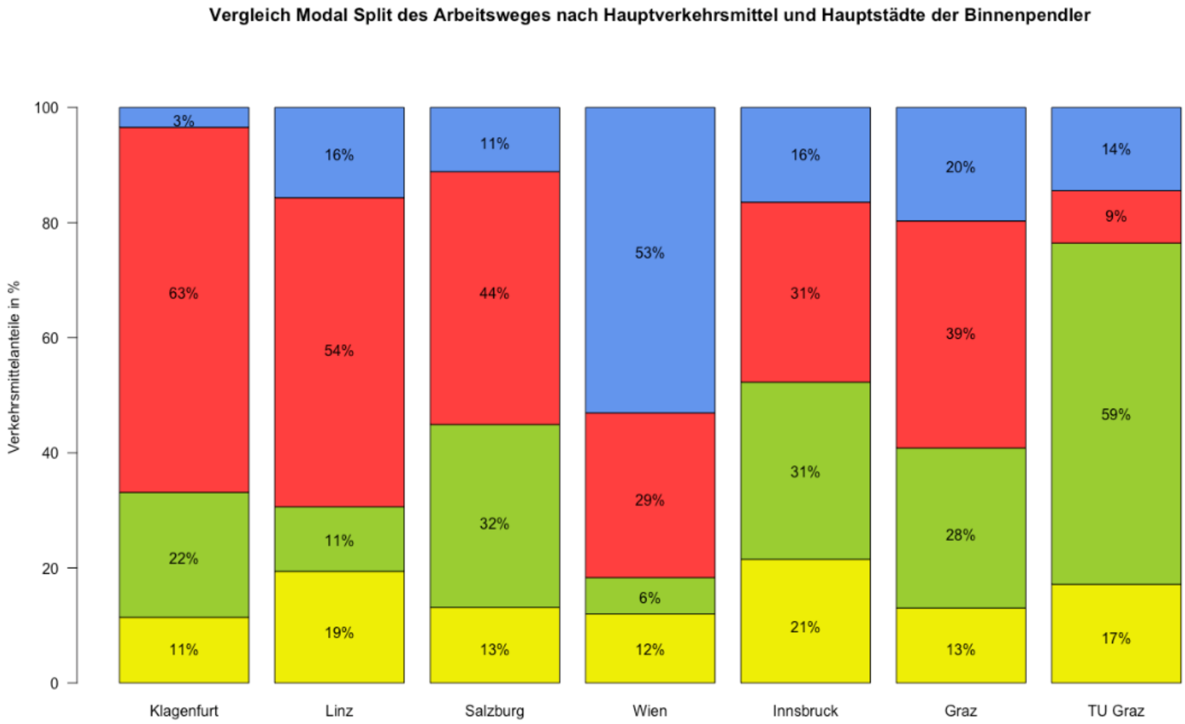


Figure 20: Comparison of the modal splits for within-city and inbound commuters based on their main means of transport, the main cities, and TU Graz (Forstner, p. 69; raw data: Österreich unterwegs 2013/14)

A similar picture emerges when comparing the modal splits of student commuters in main cities with the modal split of TU Graz student commuters. In the first graph, both commuters inside the city and to/from the city are considered, while in the second graph, only commuters inside the city are considered. Here, too, an increase in the number of pedestrians and cyclists is observed among commuters inside the city, while the share of commuters using private and public transport decreases:

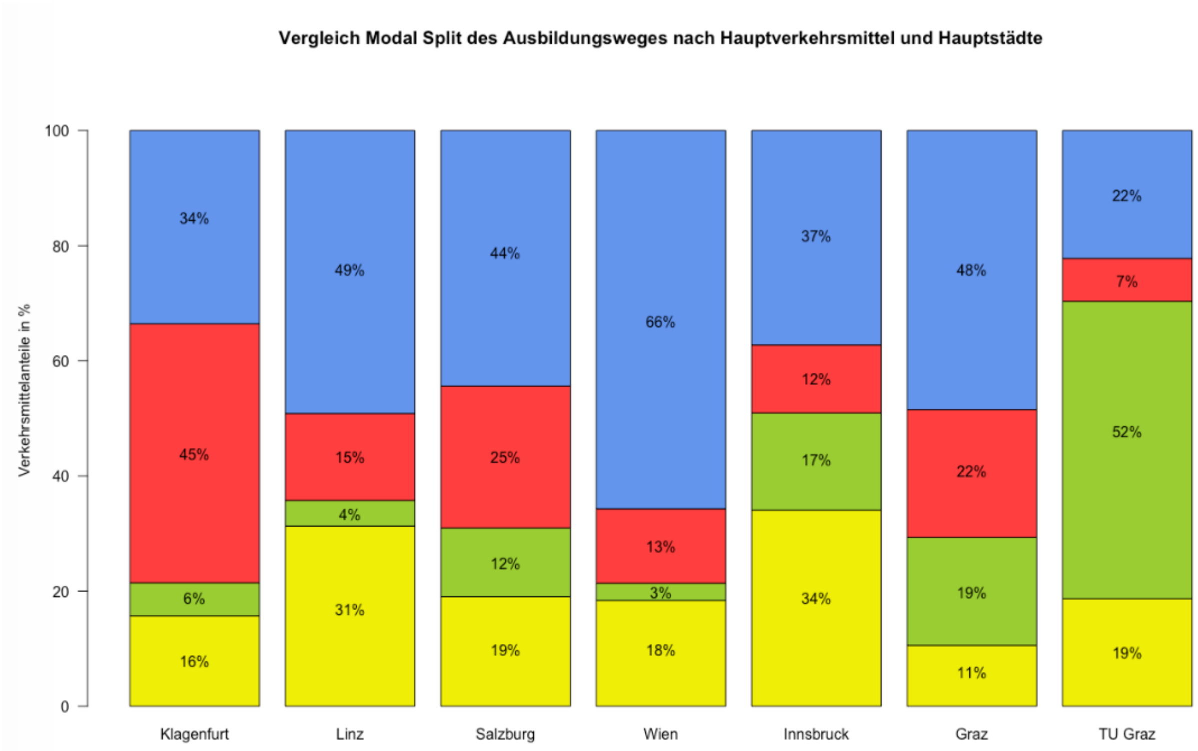


Figure 21: Comparison of the modal splits for student commuters based on their main means of transport used within the city and to/from the city, the main cities, and TU Graz (Forstner 2021, p. 66; raw data: Österreich unterwegs 2013/14)

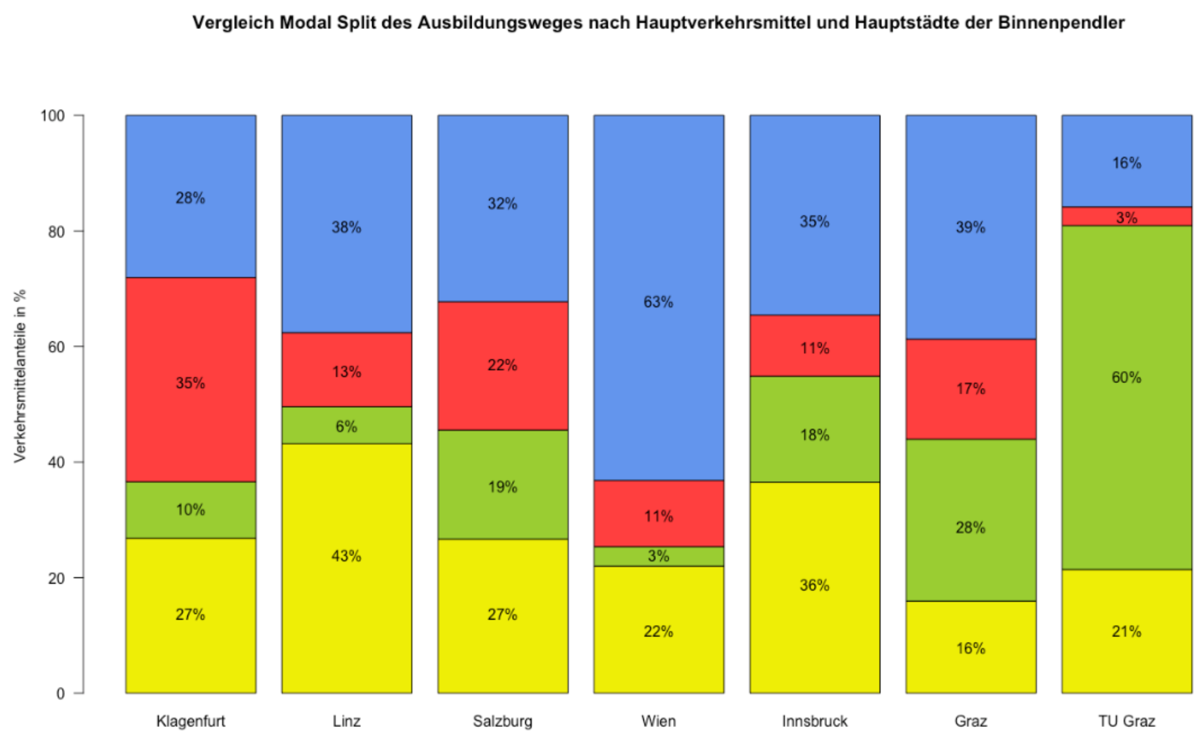
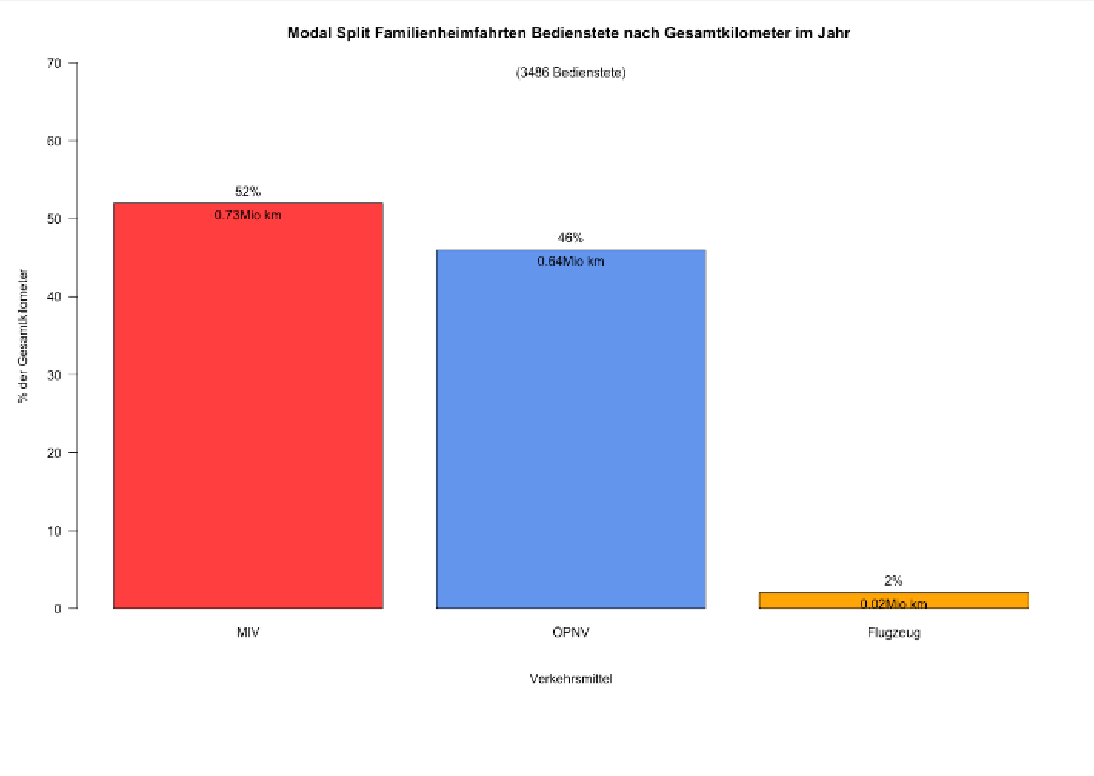


Figure 22: Comparison of the modal splits for student commuters based on their main means of transport, the main cities, and TU Graz (Forstner, p. 70; raw data: Österreich unterwegs 2013/14)

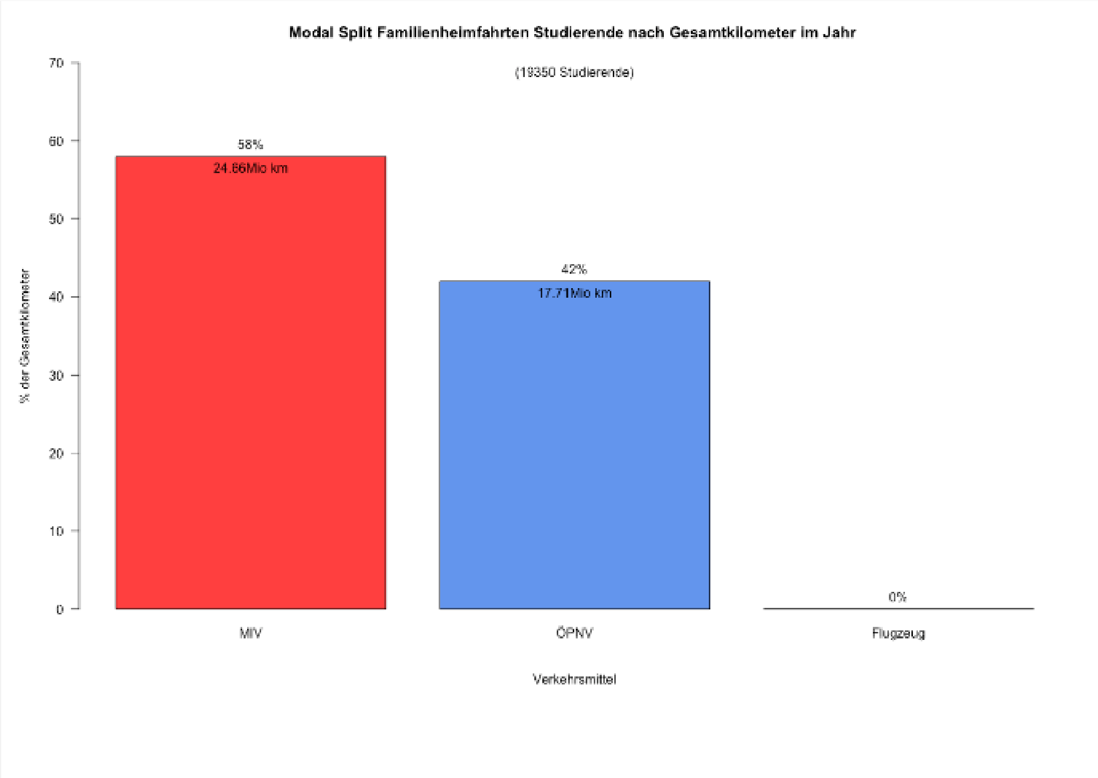
Commuting: special category of family home trips

The commuting traffic that occurs when people travel back to their family home was also surveyed in the 2019 traffic survey (Forstner 2021). Family home trips are trips taken to reach the main residence or the family residence, if this is not located somewhere that makes a daily commute to TU Graz 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, some TU Graz staff also make family trips home; an example here would be a professor whose family lives in Munich, where she makes a family trip home from Graz every weekend. The resulting emissions are not included in the TU Graz GHG balance but should, nevertheless, be presented here, as family trips home represent an interesting additional phenomenon with respect to commuting mobility. In the following section, insights will be provided into the family home trip results from the 2019 traffic survey. For both staff and students, the modal split of family home trips in 2019 is dominated by private transport, followed by public transport, and finally by air travel, this, however, plays a subordinate role (Forstner 2021). These results already clearly show that students travel many more total kilometres in the categories of public and private transport modes than staff. This finding is also reflected in the resulting total emissions, which are discussed at the end of this special chapter.



[MIV 0.73 million km, 52%; ÖPNV 0.64 million km, 46%; air travel 0.02 million km, 2%]

Figure 23: Modal split for staff members' family trips home based on total kilometres travelled in 2019 (Forstner 2021, p. 40)

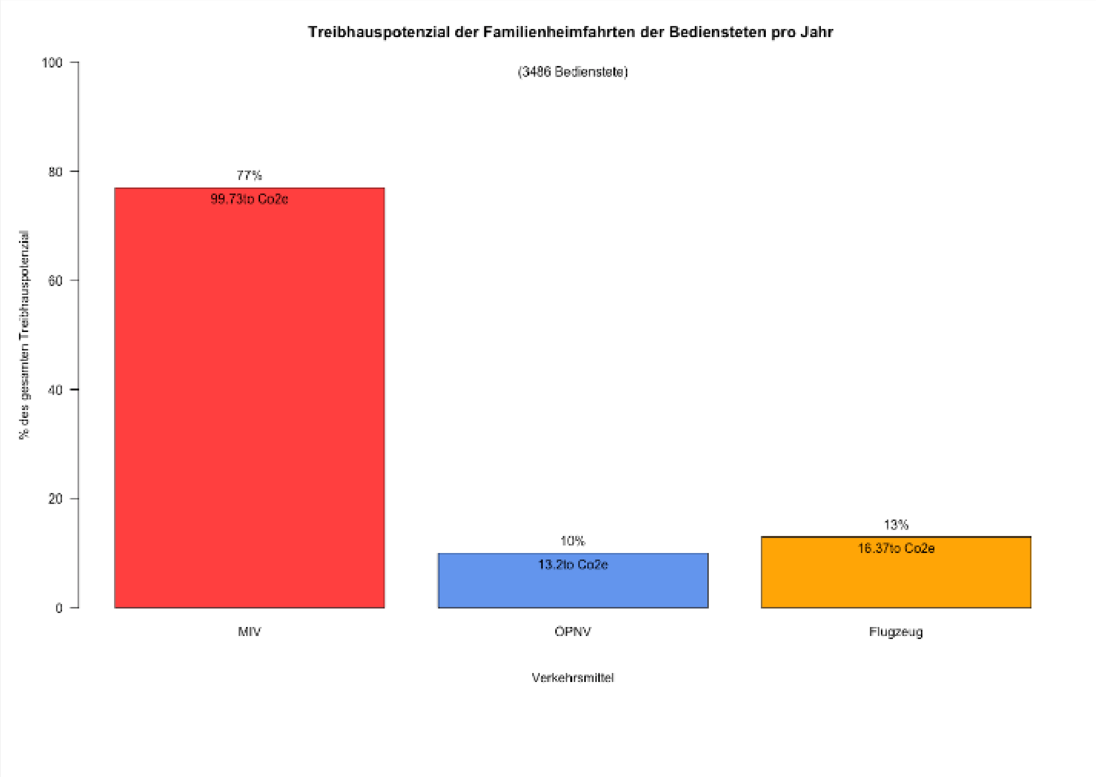


[MIV 24.66 million km, 58%; ÖPNV 17.71 million km, 42%; air travel 0.11 million km, 0.3%]

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

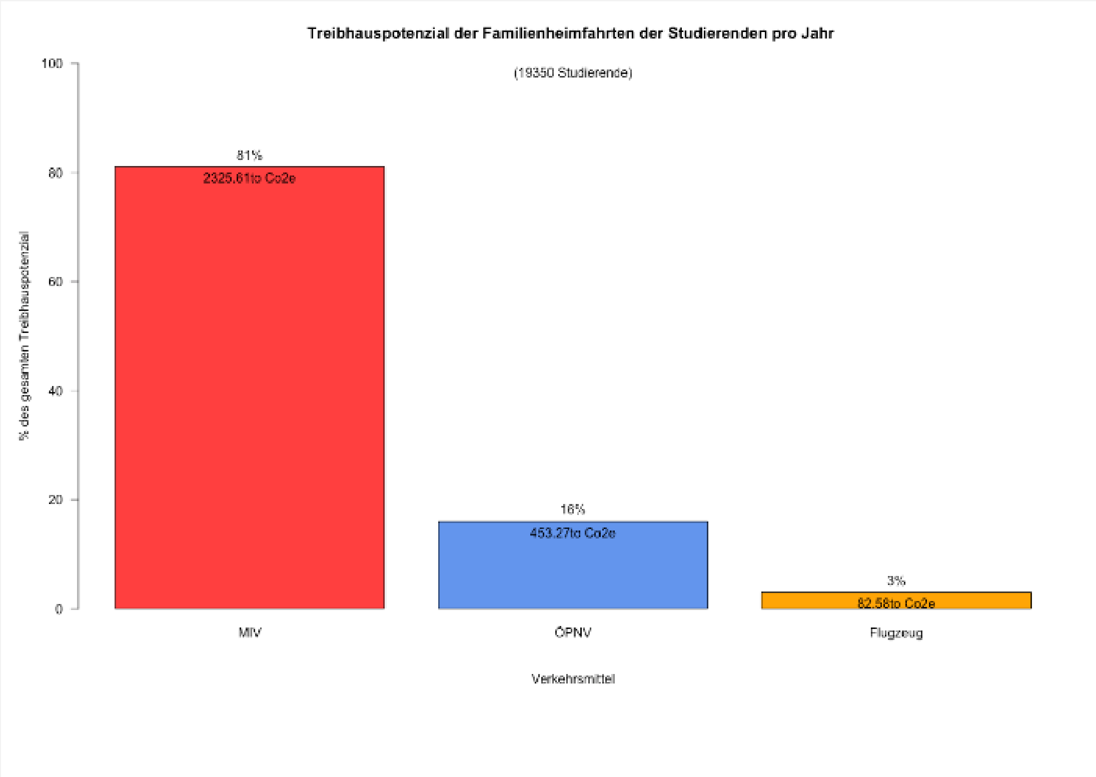
Emissions from family home trips in 2019 amounted to around 130 t CO_2e for staff and around 2,900 t CO_2e for students. MIV is responsible for the most emissions for both staff and students. This is followed by air travel for staff – even though they travel the fewest kilometres – and finally public transport. For students, public transport is responsible for the second most emissions, followed by air travel.

The following graphs show the breakdown of GHG emissions by mode of transport:



[MIT 99.73 t CO_2e, 77%; ÖPNV 13.2 t CO_2e, 10 %; air travel 16.37 t CO_2e, 13%]

Figure 25: Emissions from staff members' family home trips in 2019 in t CO_2e (Forstner 2021, p. 42)



[MIT 2,325.61 t CO_2e, 81%; ÖPNV 453.27 t CO_2e, 16%; air travel 82.58 t CO_2e, 3%]

Figure 26: Emissions from students' family home trips in 2019 in t CO_2e (Forstner 2021, p. 43)

Business trips

As the following figure shows, in the sub-category *business trips*, most emissions are caused by air travel, with long-haul flights in first place, followed by short-haul flights, then by car travel, and finally by rail and long-distance bus travel.
The means of transport *car* has not yet been differentiated into e-cars and fossil-fuelled cars. However, this distinction will made in the new CO_2 monitoring system for TU Graz business trips from 2022 and on. This is also important, because TU Graz has an available car sharing system (*Family of Power*), which can be used to borrow e-cars for business trips.

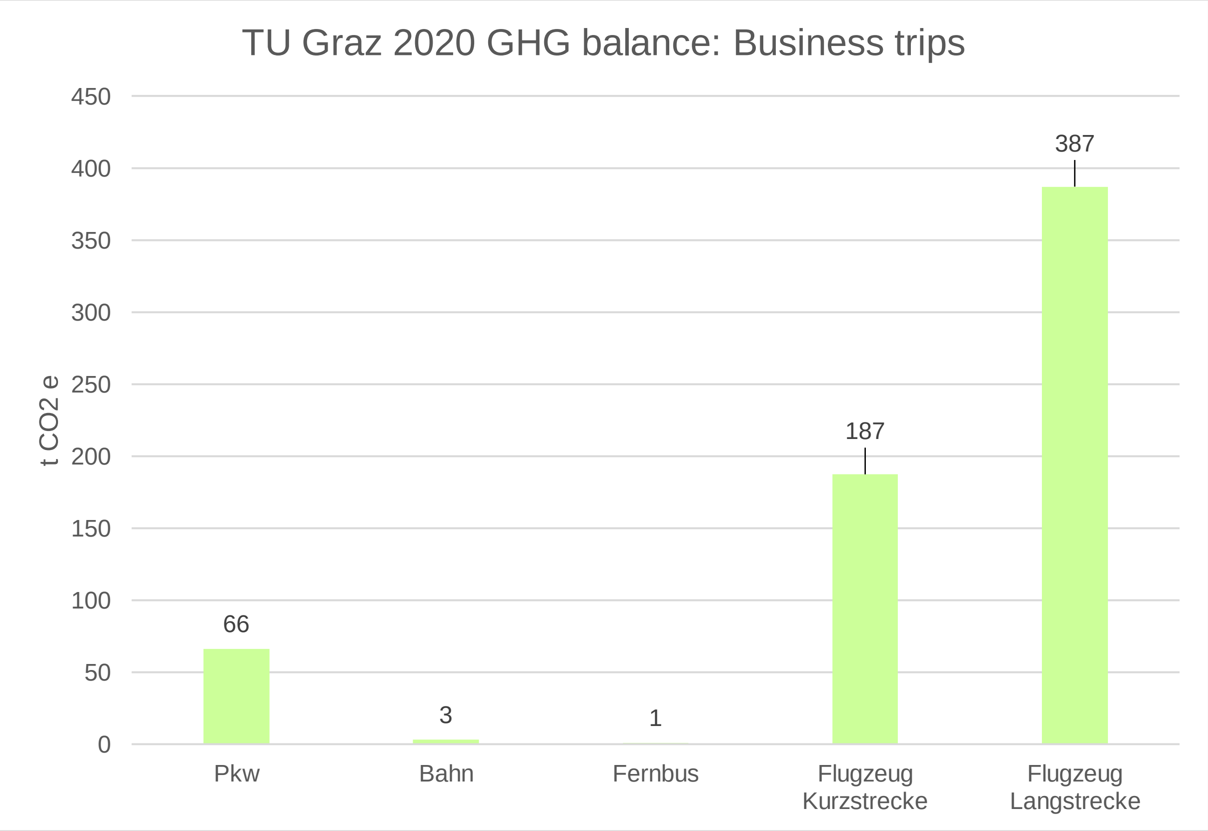


Figure 27: TU Graz 2020 GHG balance - business trips

These emissions are broken down into the following categories of kilometres travelled by passengers (i.e. passenger kilometres):

Means of transport (pkm): Business trips	
Means of transport	Passenger kilometres (pkm)
Car	305,596
Railway	240,918
Long-distance bus	21,470
Short-haul flight	194,120
Long-haul flight	979,800
Total	1,741,904

Table 9: Means of transport by passenger kilometres (pkm) – business trips

These results show that, for example, more passenger kilometres were travelled by car or train than by short-haul flights, but the emissions from short-haul flights – due to the significantly higher emission factor – are many times higher than those of cars or trains (see p. 36).

Stays abroad by staff and students

This sub-category records the stays abroad carried out by staff and students whose home university is TU Graz, i.e. outbound staff and students.
Because the means of transport used in the sub-category stays *abroad* (both staff and students) at TU Graz was not recorded in 2020, a highly simplified assumption was made that the long-distance bus was used for distances of up to 750 km per trip – for a total of two trips (outbound and return) – and the plane was used for distances of more than 750 km. Since these flights are already considered long-distance flights, an additional short-haul flight was assumed each way for the stretch between Graz and Vienna. This yielded the following results:

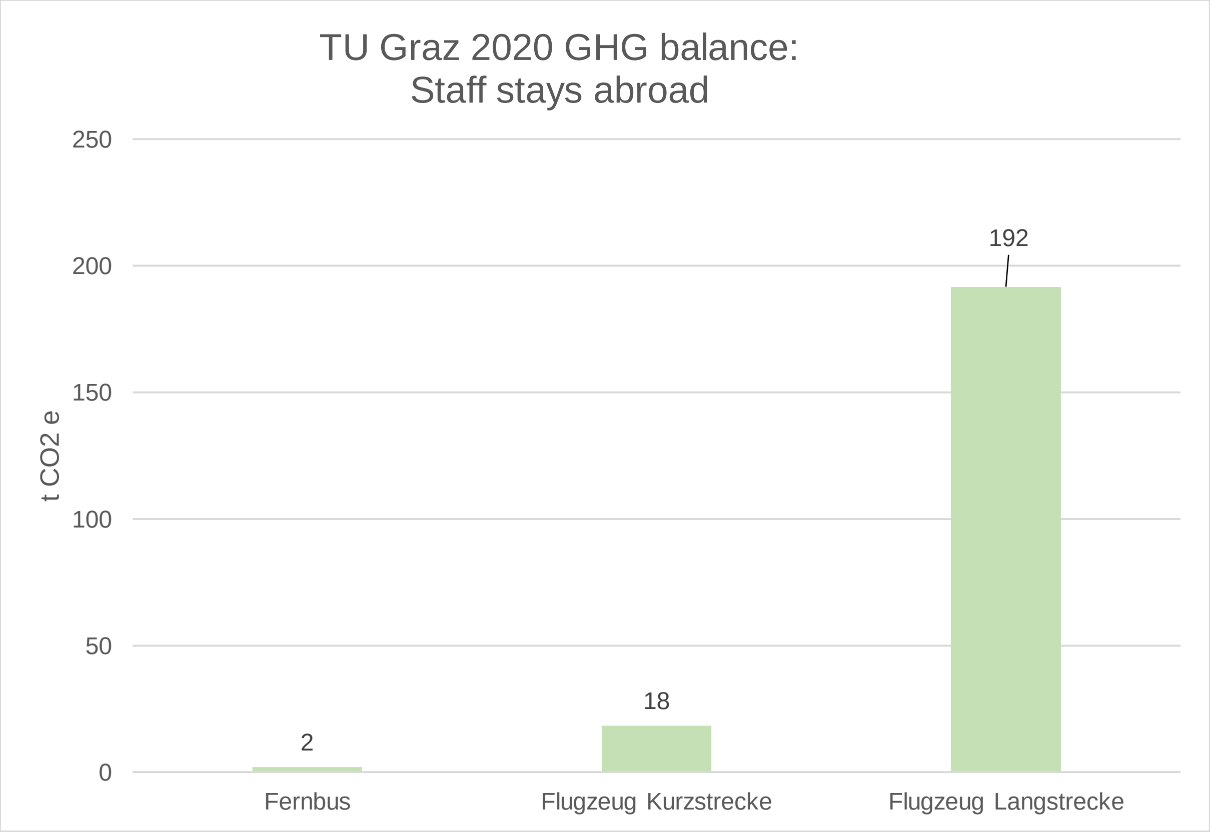


Figure 28: TU Graz 2020 GHG balance - staff stays abroad

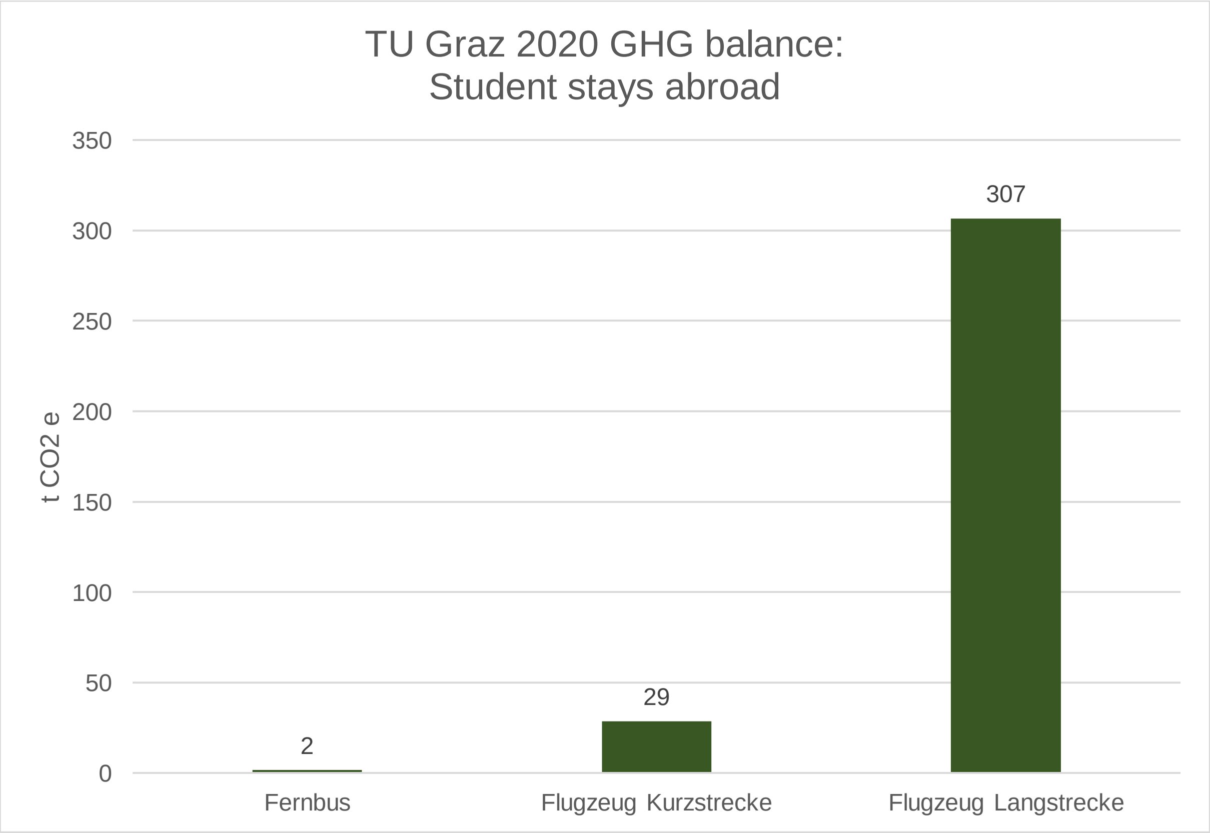


Figure 29: TU Graz 2020 GHG balance - student stays abroad

Again, it can be seen that flights are the main contributors to emissions in this sub-category. Long-haul flights are particularly significant.

From 2021 and on, the means of transport for stays abroad will be systematically recorded at TU Graz, and this will enable the means of transport used and the emissions generated to be more accurately represented in future GHG balances. Initial data for the academic year starting in the winter semester 2020/2021 show that aeroplanes and fossil-fuelled cars are the most frequently used means of transport for stays abroad (by staff and students). Of a total of 124 trips recorded (staff and students), 80 were made by plane, 30 by car (fossil-fuelled), 10 by train or by overnight train, and none by long-distance bus. The actual emissions from staff and students travelling abroad, therefore, are likely to be higher than the emissions calculated for the 2020 GHG balance.

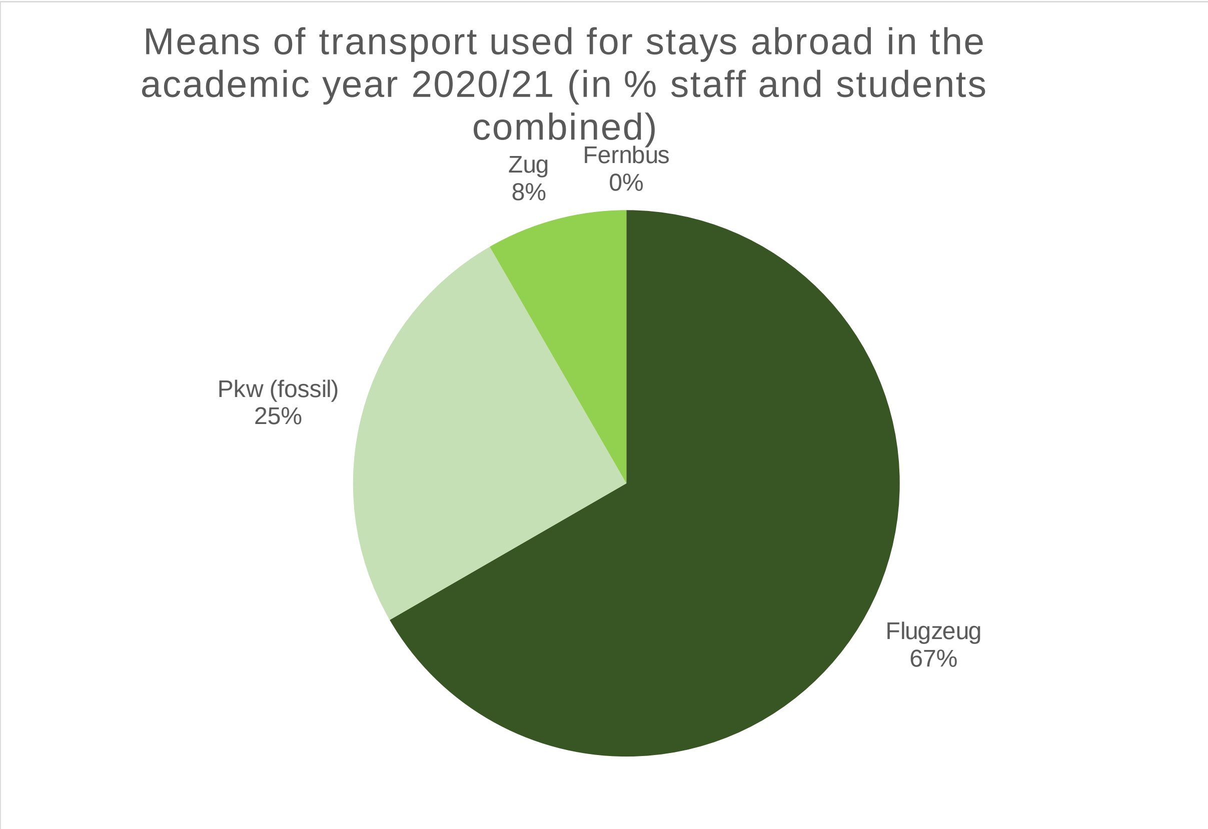


Figure 30: Means of transport used for stays abroad in the academic year 2020/21 (in %, staff and student data combined)

Comparison between 2020 and 2017

As compared to 2017, emissions in the *Mobility* category have decreased significantly due to the pandemic-related decrease in terms of passenger kilometres travelled, as both passenger transport and available transport were reduced in 2020 as a result of the pandemic measures. Overall, emissions in 2020 are 43% lower than those in 2017.

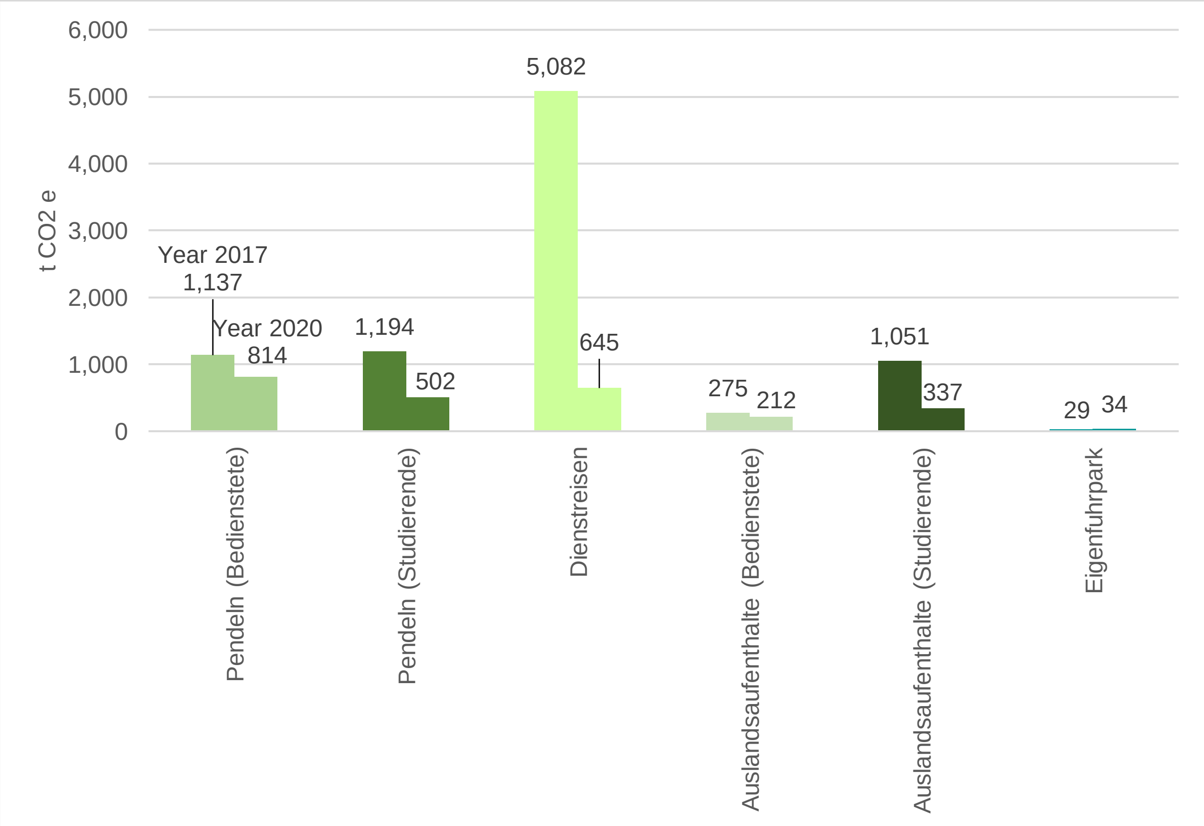


Figure 31: TU Graz 2020 GHG balance - mobility, comparison between 2017 and 2020

In general, the GHG emissions caused by air travel are particularly significant. By 2030, TU Graz aims to reduce staff and student flight emissions (business trips and stays abroad) by 50%. Due to the pandemic, these fell sharply in 2020 as compared to 2017. While in 2017 around 5,200 t CO_2e were emitted due to TU Graz staff air travel, in 2020 the figure is around 800 t CO_2e. Staff air travel emissions have been reduced by 85%. However, it is assumed that significantly higher GHG emissions from air travel by TU Graz staff and students can be expected again as early as 2021.

Commuting

Since the GHG balance 2017 is also based on the 2019 transport survey, which is also used to calculate the passenger kilometres and GHG emissions in 2020, the same reduction of 49% for staff and 65% for students is seen regarding the passenger kilometres associated with all means of transport in 2020. It was assumed that the modal split had not changed. The 2019 emission factors, which are currently still used for the 2020 GHG balance, have increased as compared to 2017 for the modes of transport *car*, *motorised two-wheel vehicle*, and *public transport - bus. In* contrast, they have decreased for the public transport modes of *public transport - train* and *public transport - tram*, with the results for tram transport showing the largest change, i.e. a reduction of around 80%. This is due to the fact that the emission factor was revised, and a significantly higher occupancy rate for trams was used for the recalculation.
Overall, the emissions associated with the *commuting* sub-category have decreased by 31% for staff and by 60% for students.

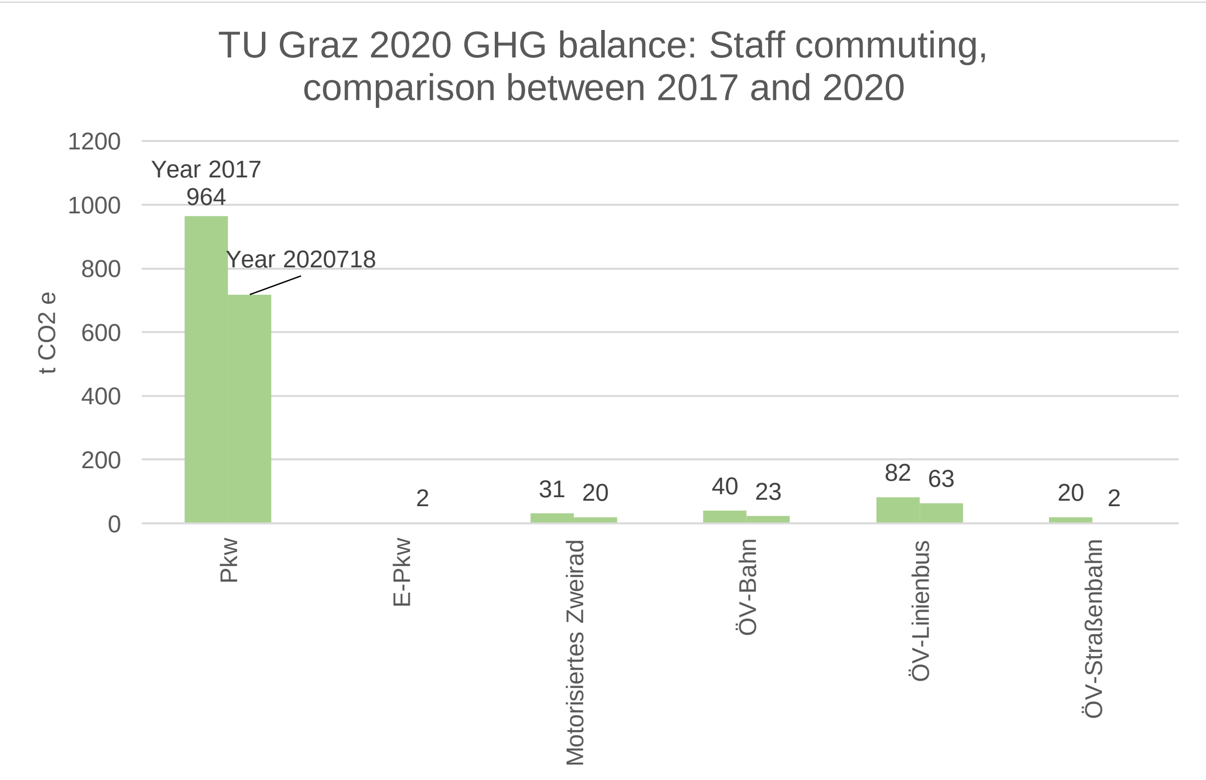


Figure 32: TU Graz 2020 GHG balance – staff commuting, comparison between 2017 and 2020

Comparison between 2020 and 2017: Staff commuting			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2020			
Car	3,306,671	0.2170	718
E-car	19,455	0.0880	2
Motorised two-wheel vehicle	140,723	0.1450	20
Public transport - train	1,744,449	0.0130	23
Public transport - bus	1,046,669	0.0600	63
Public transport - tram	450,703	0.0050	2
Total	6,708,670		**827**
2017			
Car	5,425,184	0.1777	964
E-car	-	Not in *ClimCalc* 2017	-
Motorised two-wheel vehicle	230,882	0.1356	31
Public transport – train	2,862,080	0.0140	40
Public transport - bus	1,717,248	0.0479	82
Public transport - tram	739,459	0.0265	20
Total	27,250,405		**1,137**
Increase/decrease in % *staff commuting*			
Car	Minus 49%	Plus 22%	Minus 26%
Motorised two-wheel vehicle	Minus 49%	Plus 7%	Minus 35%
Public transport - train	Minus 49%	Minus 7%	Minus 43%
Public transport - bus	Minus 49%	Plus 25%	Minus 24%
Public transport - tram	Minus 49%	Minus 81%	Minus 88%
Total			**Minus 31%**

Table 10: Comparison between 2020 with 2017 - staff commuting

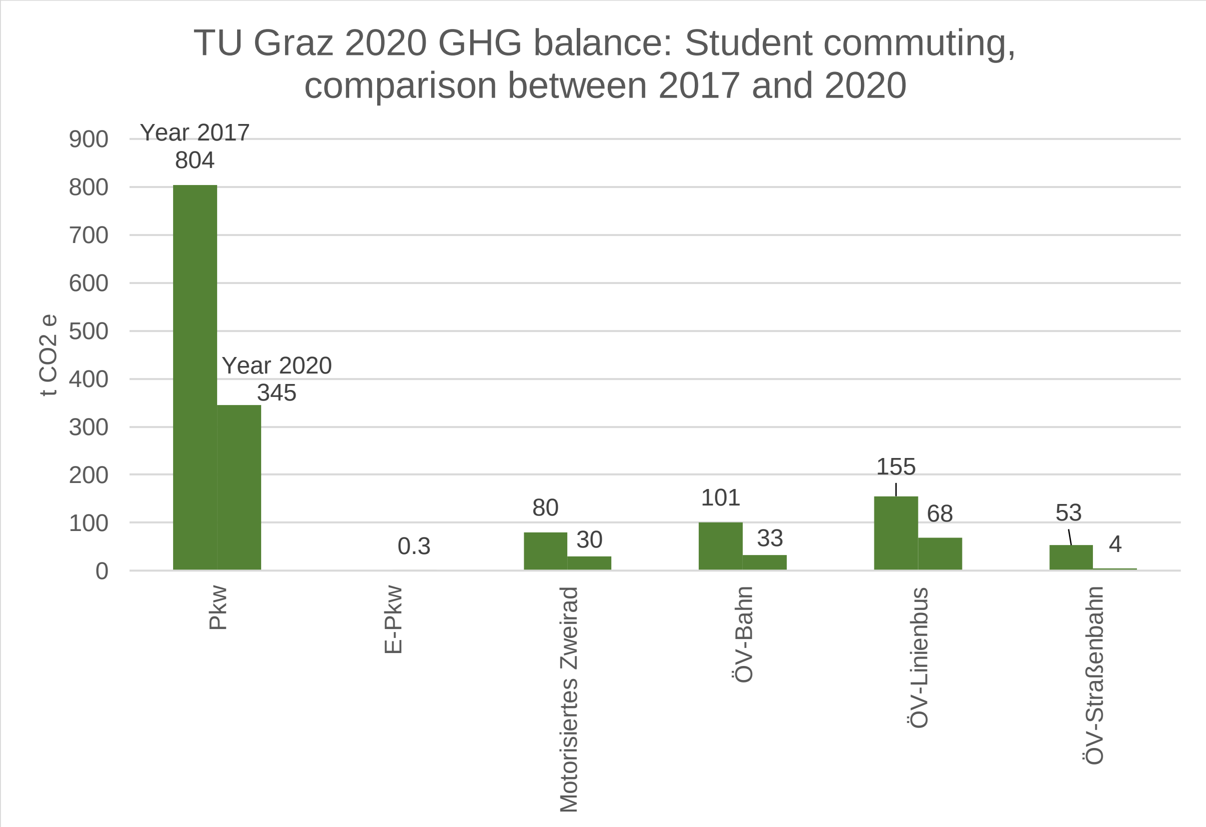


Figure 33: TU Graz 2020 GHG balance - student commuting, comparison between 2017 and 2020

Comparison between 2020 and 2017: Student commuting			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2020			
Car	1,587,673	0.2170	345
E-car	3,354	0.0880	0.3
Motorised two-wheel vehicle	207,035	0.1450	30
Public transport - train	2,541,740	0.0130	33
Public transport - bus	1,136,404	0.0600	68
Public transport - tram	705,870	0.0050	4
Total	6,182,076		**480**
2017			

Car	4,525,112	0.1777	804
E-car	-	Not in *ClimCalc* 2017	-
Motorised two-wheel vehicle	590,081	0.1356	80
Public transport - train	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	Minus 65%	Plus 22%	Minus 57%
Motorised two-wheel vehicle	Minus 65%	Plus 7%	Minus 62%
Public transport - train	Minus 65%	Minus 7%	Minus 67%
Public transport - bus	Minus 65%	Plus 25%	Minus 56%
Public transport - tram	Minus 65%	Minus 81%	Minus 93%
Total			**Minus 60%**

Table 11: Comparison between 2020 and 2017 - student commuting

Business trips

In the sub-category *business travel*, both passenger kilometres and tonnes of CO_2e have decreased. The strongest decrease is seen here for the *long-distance bus* mode of transport, with a 94% reduction in passenger kilometres and emissions. The 2019 emission factors for train and long-distance bus travel have decreased as compared to those for 2017, while those for car and aeroplane travel (for both short- and long-haul flights) have increased.

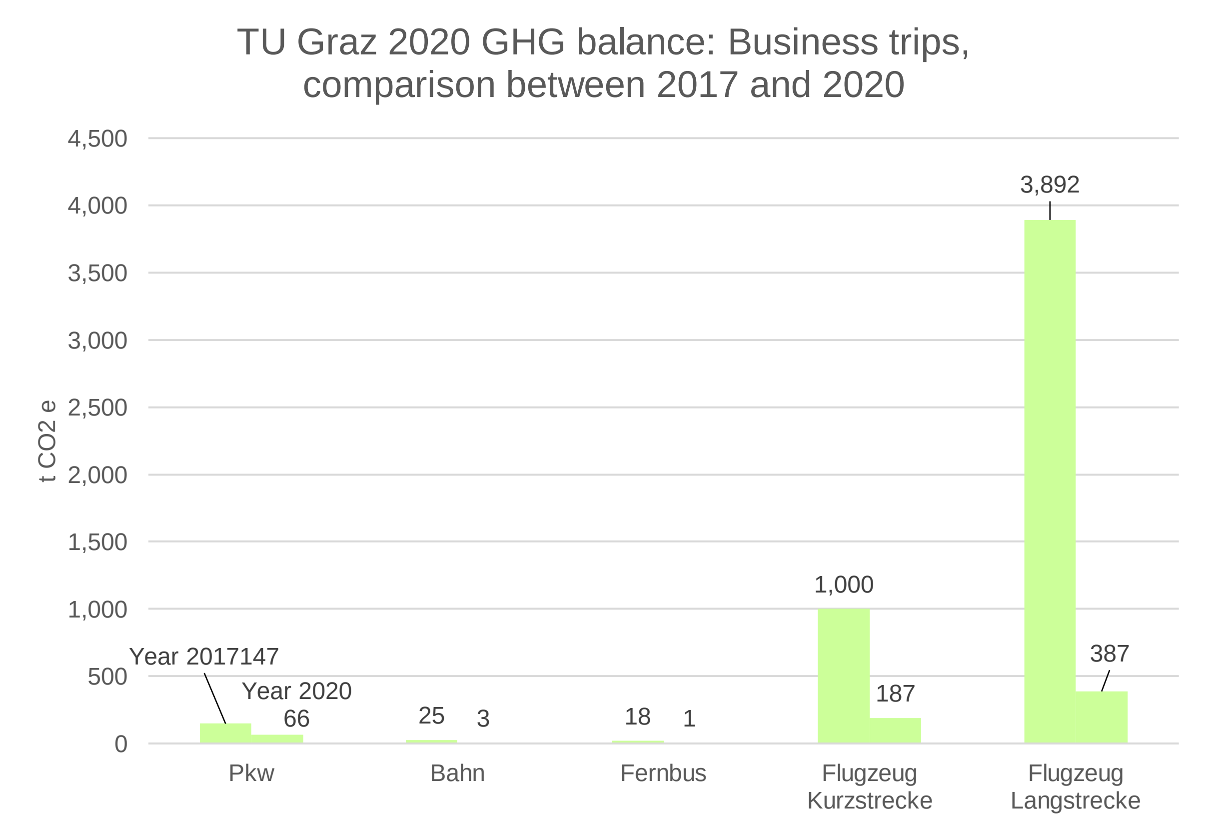


Figure 34: TU Graz 2020 GHG balance - business trips, comparison between 2017 and 2020

Comparison between 2020 and 2017: Business trips			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2020			
Car	305,596	0.2170	66
Train	240,918	0.0130	3
Long-distance bus	21,470	0.0490	1
Short-haul flight	194,120	0.9650	187
Long-haul flight	979,800	0.3950	387
Total	1,741,904		**645**
2017			
Car	826,954	0.1777	147
Train	1,760,801	0.0140	25
Long-distance bus	352,202	0.0521	18
Short-haul flight	1,304,408	0.7669	1.000
Long-haul flight	9,972,138	0.3903	3,892
Total	14,216,503		**5,082**

Increase/decrease in %			
Car	Minus 63%	Plus 22%	Minus 55%
Train	Minus 86%	Minus 7%	Minus 87%
Long-distance bus	Minus 94%	Minus 6%	Minus 94%
Short-haul flight	Minus 85%	Plus 26%	Minus 81%
Long-haul flight	Minus 80%	Plus 1%	Minus 90%
Total			**Minus 87%**

Table 12: Comparison between 2020 and 2017 - business trips

Stays abroad

In the sub-category *stays abroad,* emissions have also decreased as compared to those in 2017 due to the coronavirus pandemic. While the decrease in passenger kilometres is between 13 and 26% for staff, it is larger for students, namely, between 66 and 69%. The 2019 emission factors increased for air travel, up 26% for short-haul and up 1% for long-haul flights, while the emission factor for long-distance bus travel has decreased by 6%. The emissions associated with students' stays abroad are significantly lower, i.e. 68% lower, than those of staff.

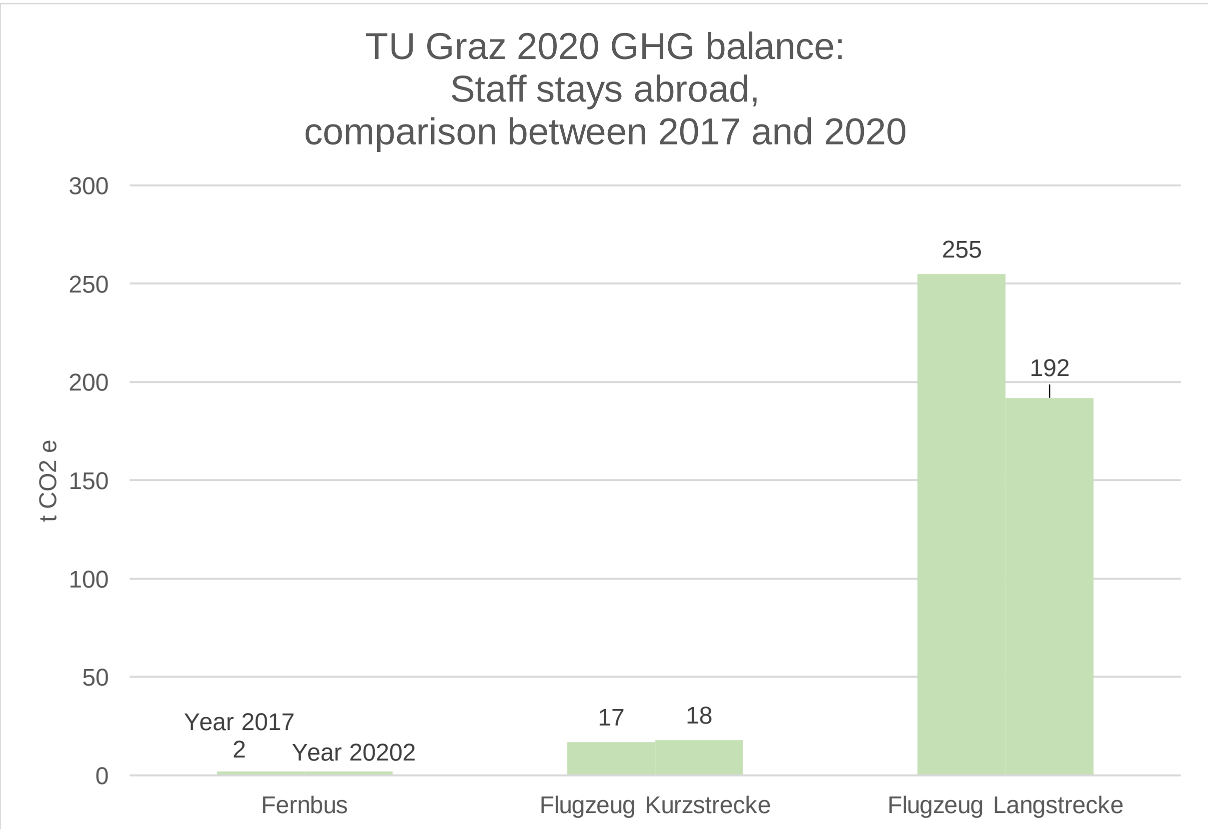


Figure 35: TU Graz 2020 GHG balance - staff stays abroad, comparison between 2017 and 2020

Comparison between 2020 and 2017: Staff stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2020			
Long-distance bus	39,218	0.0490	2
Short-haul flight	19,040	0.9650	18
Long-haul flight	485,260	0.3950	192
Total	543,518		**212**
2017			
Long-distance bus	47,640	0.0521	2
Short-haul flight	21,978	0.7669	17
Long-haul flight	654,509	0.3903	255
Total	724,127		**274**
Increase/decrease in %			
Long-distance bus	Minus 18%	Minus 6%	Minus 4%
Short-haul flight	Minus 13%	Plus 26%	Plus 8%
Long-haul flight	Minus 26%	Plus 1%	Minus 25%
Total			**Minus 23%**

Table 13: Comparison between 2020 and 2017 - staff stays abroad

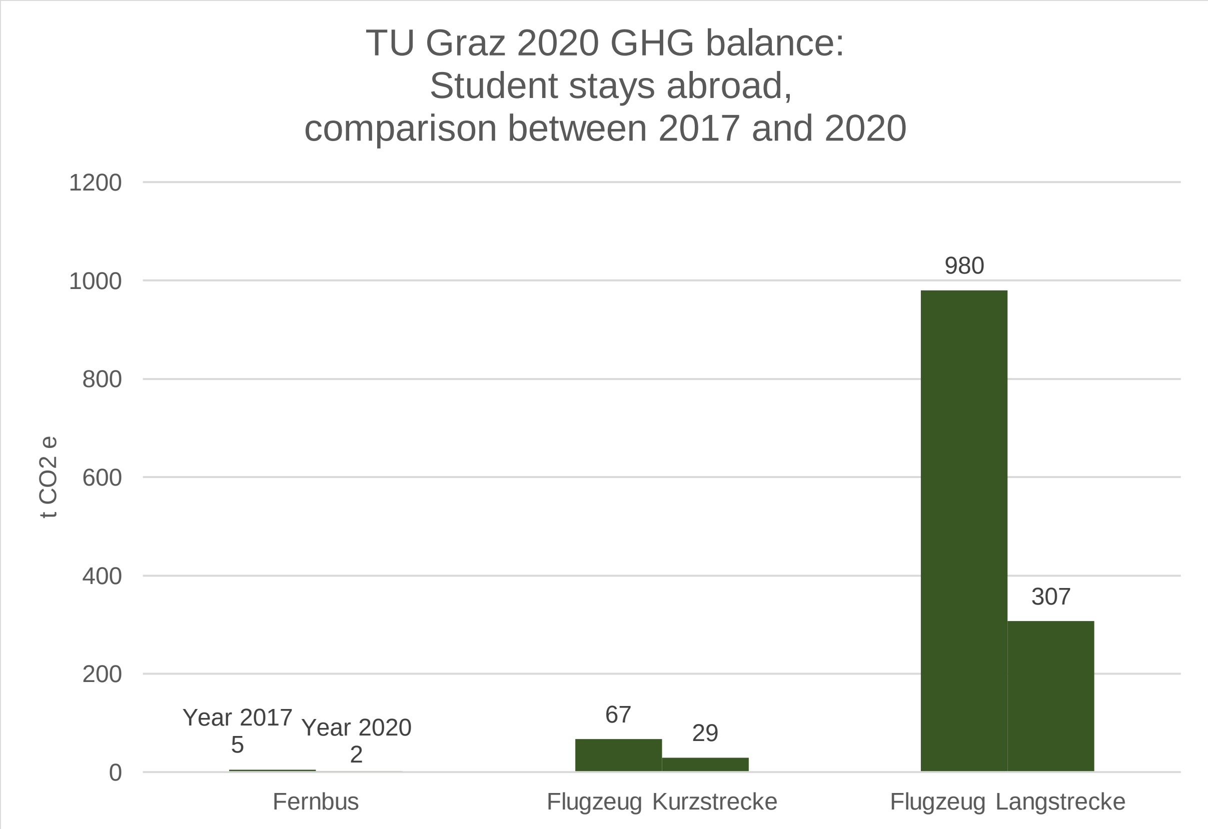


Figure 36: TU Graz 2020 GHG balance - student stays abroad, comparison between 2017 and 2020

Comparison between 2020 and 2017: Student stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2020			
Long-distance bus	31,832	0.0490	2
Short-haul flight	29,680	0.9650	29
Long-haul flight	776,360	0.3950	307
Total	837,872		**337**
2017			
Long-distance bus	93,537	0.0521	5
Short-haul flight	87,043	0.7669	67
Long-haul flight	2,510,470	0.3903	980
Total	2,691,050		**1,052**
Increase/decrease in %			
Long-distance bus	Minus 66%	Minus 6%	Minus 69%
Short-haul flight	Minus 66%	Plus 26%	Minus 57%
Long-haul flight	Minus 69%	Plus 1%	Minus 69%
Total			**Minus 68%**

Table 14: Comparison between 2020 with 2017 - student stays abroad

Company vehicle fleet

Overall, emissions have decreased in all sub-categories of the *Mobility* category as compared to 2017, with the exception of the *company vehicle fleet* sub-category, where emissions have increased by 18%. However, this increase can be explained by the fact that more institutes with company vehicles were recorded in 2020 than in 2017; thus, the survey was conducted more thoroughly. In addition to the institutes and organisational units for which company vehicles had already been surveyed in 2017:

- Building and Technical Services
- Institute of Technology and Testing of Construction Materials with affiliated TVFA for Strength and Material Testing
- Institute of Hydraulic Engineering and Water Management
- Institute for Rock Mechanics and Tunnelling
- Virtual Vehicle

In 2020, the company vehicles associated with the following institutes and organisational units were also recorded:

- Hydraulic Engineering and Water Resources Management
- Institute of Thermodynamics and Sustainable Propulsion Systems
- Automotive Engineering
- Vehicle Safety Institute
- IT Services

While all vehicles surveyed in 2017 were diesel-powered, vehicles powered by petrol or electricity in 2020 are now also shown. According to the 2020 vehicle inventory list (*Finance and Accounting*), the total encompasses:

- 9 passenger cars
- 4 trucks
- 3 delivery vans
- 2 multipurpose vehicles
- 1 tractor
- 1 motorbike
- 1 electric scooter

Diesel consumption has decreased by 64% as compared to 2017, while the 2019 emission factor for diesel has increased by 21%.

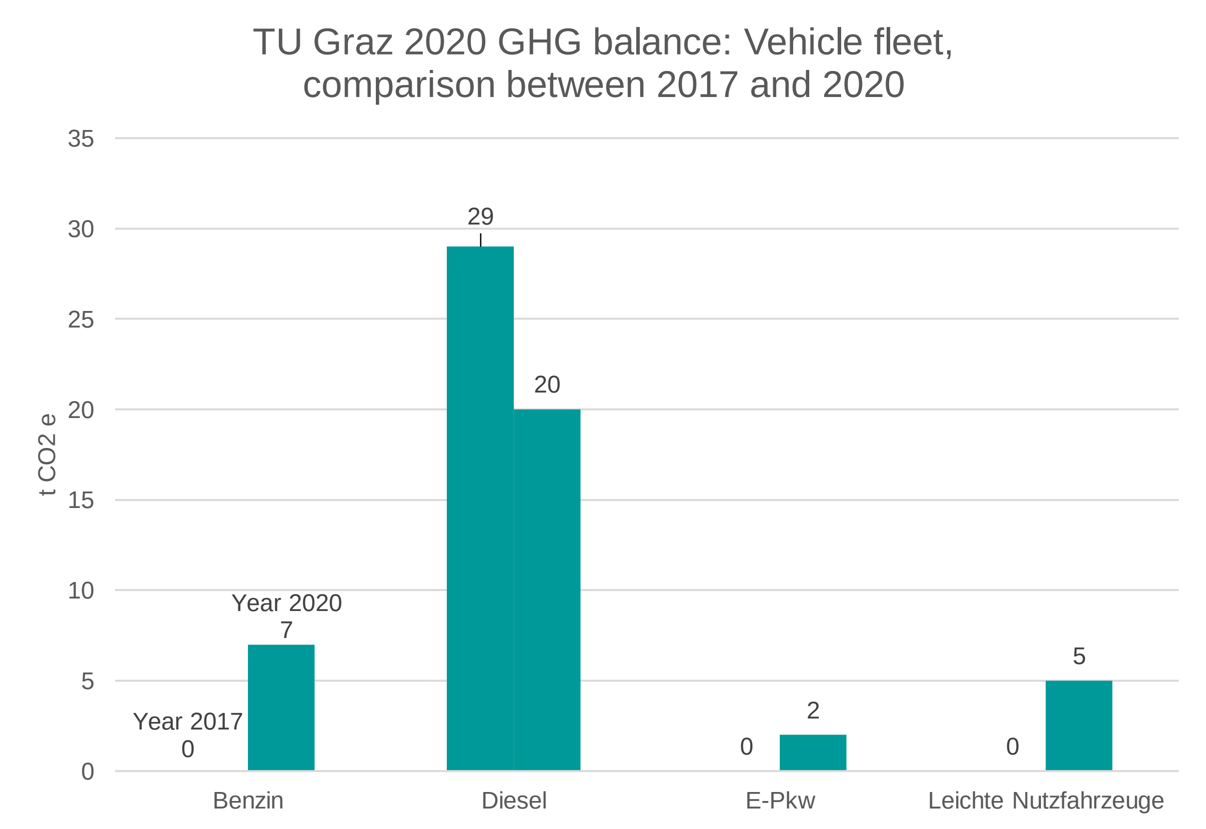


Figure 37: TU Graz 2020 GHG balance - vehicle fleet, comparison between 2017 and 2020

Comparison between 2020 and 2017: Vehicle fleet			
	Vehicle kilometres (Fzkm)	Emission factor in kg CO_2e/vehkm	Emissions in t CO_2e
2020			
Petrol	27,875	0.2600	7
Diesel	79,676	0.2450	20
E-car	15,004	0.1000	2
Light commercial vehicles	18,107	0.3020	5
Total	142,319		**34**
2017			
Diesel	141,203	0.2023	**29**
Increase/decrease in %			
Diesel	Minus 64%	Plus 21%	Minus 32%
Total			**Plus 18%**

Table 15: Comparison between 2020 and 2017 - vehicle fleet

3.2.3 Material use

In the category *Material use,* information assigned to the sub-categories *Paper*, *Refrigerants*, and *IT equipment* is collected at TU Graz. For this purpose, data were provided from the organisational units *Purchasing Services, Finance and Accounting, Buildings and Technical Support, Communication and Marketing, Publishing,* as well as the external units *Printkultur (HTU copying services)*, and *Harnisch Gebäudeservice Graz*. The emissions associated with the category *Material Use* are 620 tonnes in 2020. All sub-categories range from 200-210 tonnes of CO_2e, and thus each sub-category accounts for about one-third of the emissions in this category.

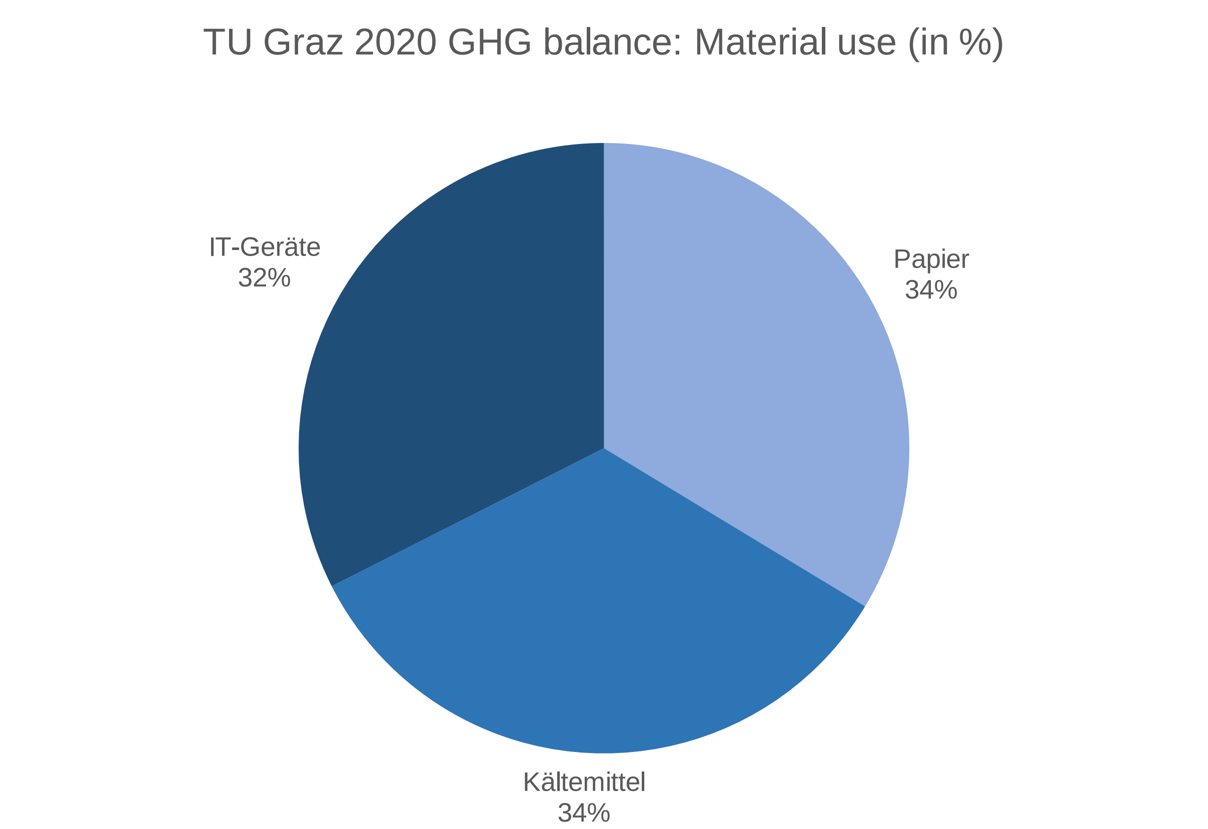


Figure 38: TU Graz 2020 GHG balance - material use (in %)

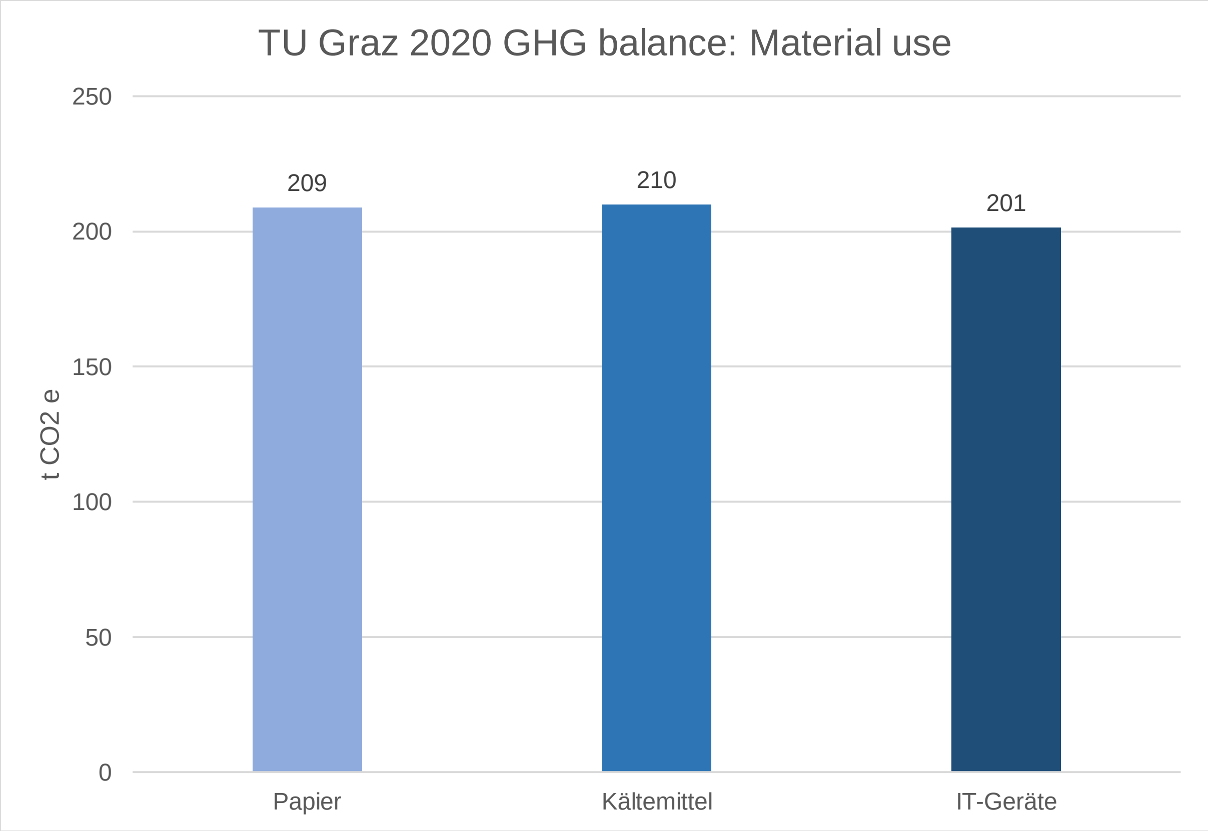


Figure 39: TU Graz 2020 GHG balance - material use

Comparison between 2020 and 2017

As compared to 2017, the total emissions in the sub-categories *paper* and *refrigerants* have increased, while those in the sub-category *IT equipment* have decreased, as the following graph shows:

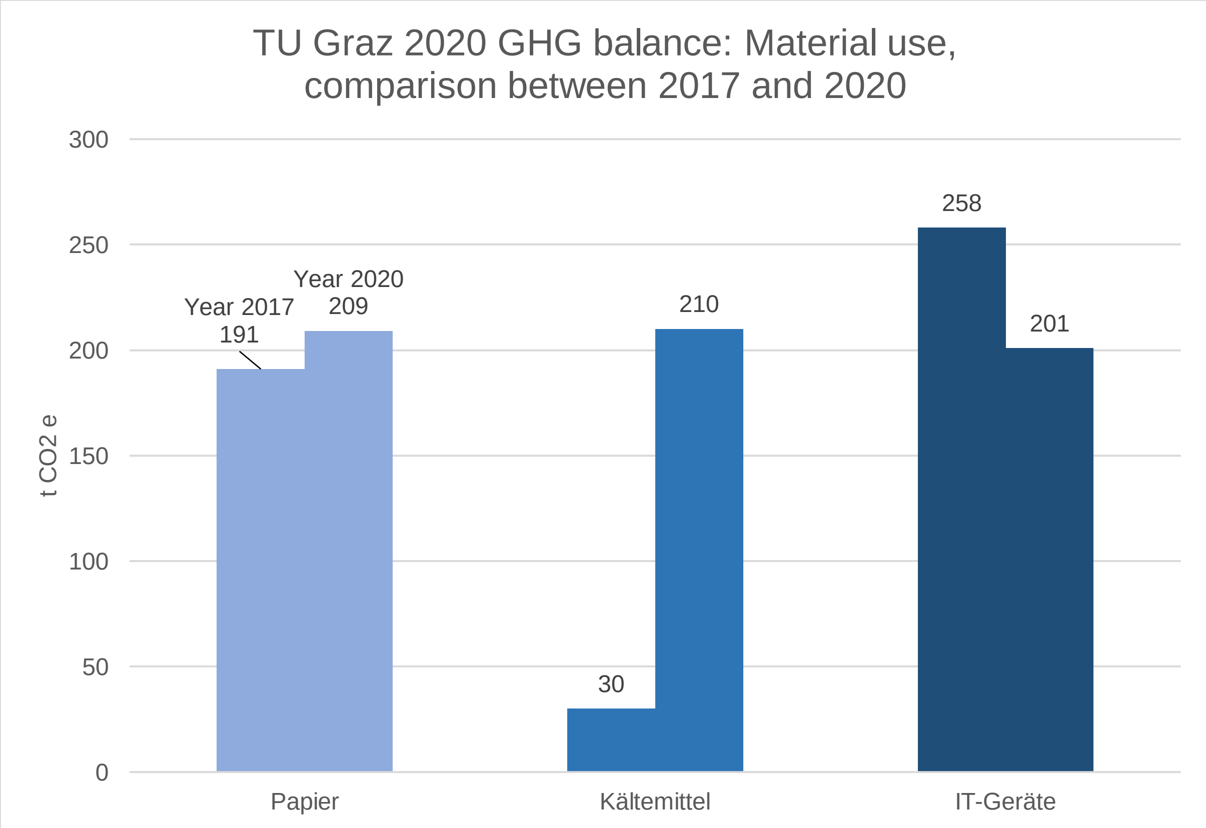


Figure 40: TU Graz 2020 GHG balance - material use, comparison between 2017 and 2020

In the case of *paper,* the consumption of copying paper and the production of printed products has increased as compared to 2017. However, this result can be explained by the fact that in 2020, in addition to the consumption data from the *Purchasing Service* and the *HTU copying services,* the production data for printed products from the organisational unit *Communication and Marketing,* as well as the *TU Graz Publishing House*, were also collected. The only slight decrease in the use of paper for hygienic purposes – despite the absence of staff and students in certain phases due to the pandemic – as compared to 2017 can be explained by the increase in hand washing as a hygiene measure in 2020.

The emission factors have changed only slightly from 2017 to 2020. Emissions associated with copy paper and the production of printed products have increased (by 21% and 97%, respectively), while they have decreased regarding the use of paper for hygienic purposes (a reduction of 7% and 8%, respectively). The large increase in emissions associated with the production of printed products can be explained by the fact that the proportion of paper used for copying and the production of printed products differed in 2020 from that in 2017; this results in an increase in the consumption of printed products as compared to 2017.

Overall, 9% more emissions were recorded in the *paper* sub-category in 2020 than in 2017.

Comparison between 2020 and 2017: Paper			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in t CO_2e
2020			
Copy paper	31,383	1.0400	33
Toilet tissue paper	12,194	2.9600	36
Sanitary paper towels	32,267	2.9600	96
Printed matter	38,036	1.1700	45
Total	113,880		**209**
2017			
Copy paper	25,827	1.0461	27
Toilet tissue paper	12,611	3.1088	39
Sanitary paper towels	32,894	3.1088	102
Printed matter	20,315	1.1109	23
Total	91,647		**191**
Increase/decrease in %			
Copy paper	Plus 22%	Minus 1%	Plus 21%
Toilet tissue paper	Minus 3%	Minus 5%	Minus 8%
Sanitary paper towels	Minus 2%	Minus 5%	Minus 7%
Printed matter	Plus 87%	Plus 5%	Plus 97%
Total			**Plus 9%**

Table 16: Comparison between 2020 and 2017 - paper

The consumption of *refrigerants* has increased sharply, from a total of 8 kg in 2017 to 102 kg in 2020. This increases the emissions associated with this sub-category by of 611% over those recorded in 2017. This increase can be explained by the fact that in 2020, a refrigeration system was damaged, resulting in a refrigerant leak. This system is currently being dismantled. In general, the switch from gas-filled systems to water-filled systems is being encouraged. This means that water will be used as the coolant instead of gas in the future, and, if a pipe leak occurs, only water will escape rather than the climate-damaging gas. However, refrigerants will still be used for the cooling process itself.

Comparison between 2020 and 2017: Refrigerants			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in t CO_2e
2020			
R410A	17	2,087.50	35
R407c	74	1,773.85	131
R404a	11	3,922.00	43
Total	102		**210**
2017			
R410A	1	2,087.50	2
R404a	7	3,922.00	27
Total	8		**30**
Increase/decrease in %			
R410A	Plus 1,600%	Plus/minus 0%	Plus 1,600%
R404a	Plus 57%	Plus/minus 0%	Plus 57%
			Plus 611%

Table 17: Comparison between 2020 and 2017 - refrigerants

The reduction in GHG emissions in the *IT equipment* sub-category is mainly due to the fact that fewer desktop PCs, toner for laser and inkjet printers, as well as multifunctional devices and monitors were purchased and put into operation in 2020. The majority of the emission factors in this sub-category have increased, for example by +280% for mobile phones or by +180% for beamers and projectors. The observed increase in the emission factors can be explained by the fact that these are continuously being updated, and additional emissions were recorded during these updates, which are included in the emission factors. Mobile phones in particular are becoming larger and more powerful, a fact that is reflected in the emissions associated with their manufacture.
Overall, the emissions associated with the *IT equipment* sub-category have decreased by 22%.

Comparison between 2020 and 2017: IT devices			
	Purchase (items)	Emission factor in kg CO_2e/item	Emissions in t CO_2e
2020			
Multifunction devices	1	300.000	0.3
Laser printers and inkjet printers	11	61.590	1
Notebooks	458	173.000	79
Desktop PCs	209	235.000	49
Screens	127	370.000	47
Beamers and projectors	12	173.000	2
Internal servers	65	235.000	15
Mobile phones	36	61.000	2
Toner laser printers and inkjet printers	198	13.770	3
Multifunction devices using toner	198	13.770	3
Total	1,315		**201**
2017			
Multifunction devices	2	313.960	1
Laser printers and inkjet printers	8	62.792	1
Notebooks	280	141.370	40
Desktop PCs	517	270.220	140
Screens	204	336.390	69
Beamers and projectors	38	62.792	2
Internal servers	Has been considered for desktop PCs	-	-
Mobile phones	49	16.000	1
Toner laser printers and inkjet printers	313	10.015	3
Multifunction devices using toner	313	10.015	3
Total	1,724		**258**
Increase/decrease in %			
Multifunction devices	Minus 50%	Minus 4%	Minus 52%
Laser printers and inkjet printers	Plus 38%	Minus 2%	Plus 35%
Notebooks	Plus 64%	Plus 22%	Plus 100%

Desktop PCs	Minus 60%	Minus 13%	Minus 65%
Screens	Minus 38%	Plus 10%	Minus 32%
Beamers and projectors	Minus 68%	Plus 176%	Minus 13%
Internal servers	-		
Mobile phones	Minus 27%	Plus 281%	Plus 180%
Toner laser printers and inkjet printers	Minus 37%	Plus 37%	Minus 13%
Multifunction devices using toner	Minus 37%	Plus 37%	Minus 13%
Total			**Minus 22%**

Table 18: Comparison between 2020 and 2017 - IT devices

3.2.4 Additional module - canteen

The additional module *Canteen* is divided into the sub-categories *electricity*, *district heating*, and *food at* TU Graz. 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 are 181 tonnes of CO_2e for the year 2020. In terms of their proportions, most emissions come from the sub-category *food,* followed by that of *electricity* and finally *district heating*.

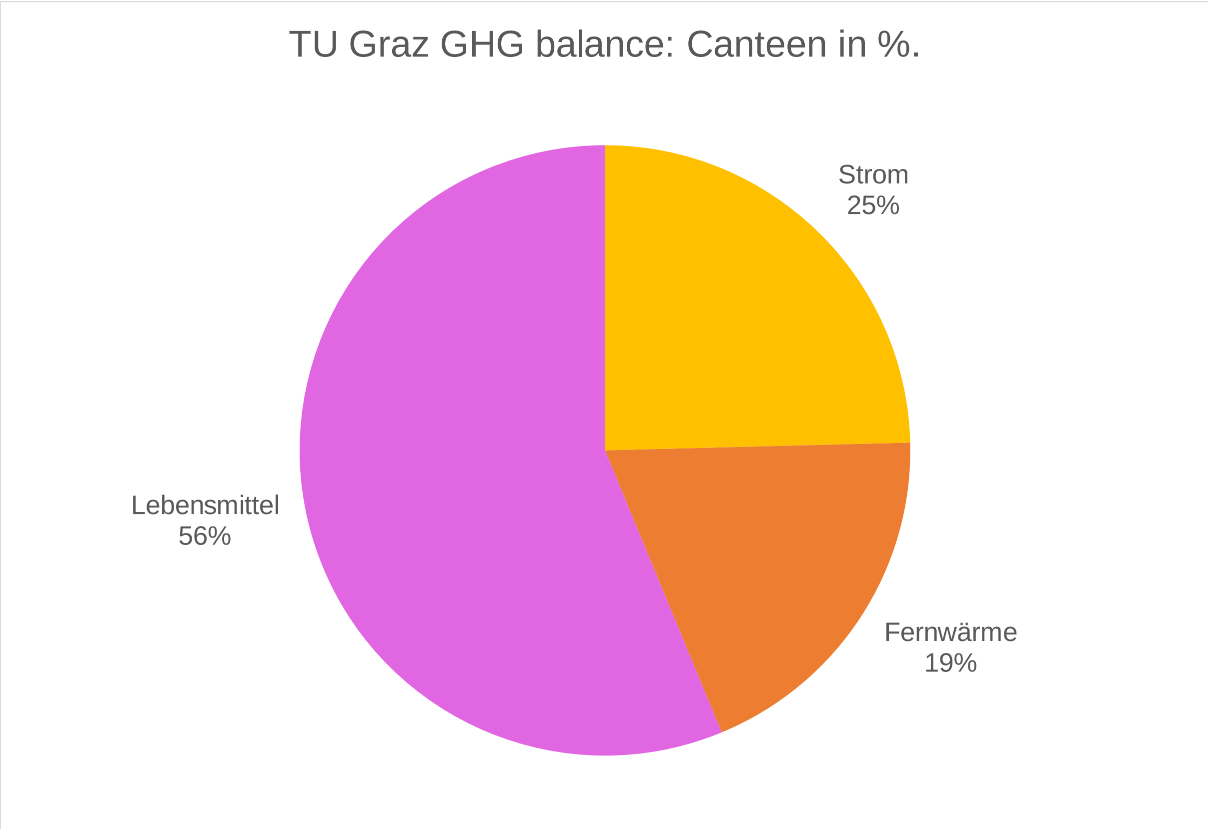


Figure 41: TU Graz 2020 GHG balance - canteen (in %)

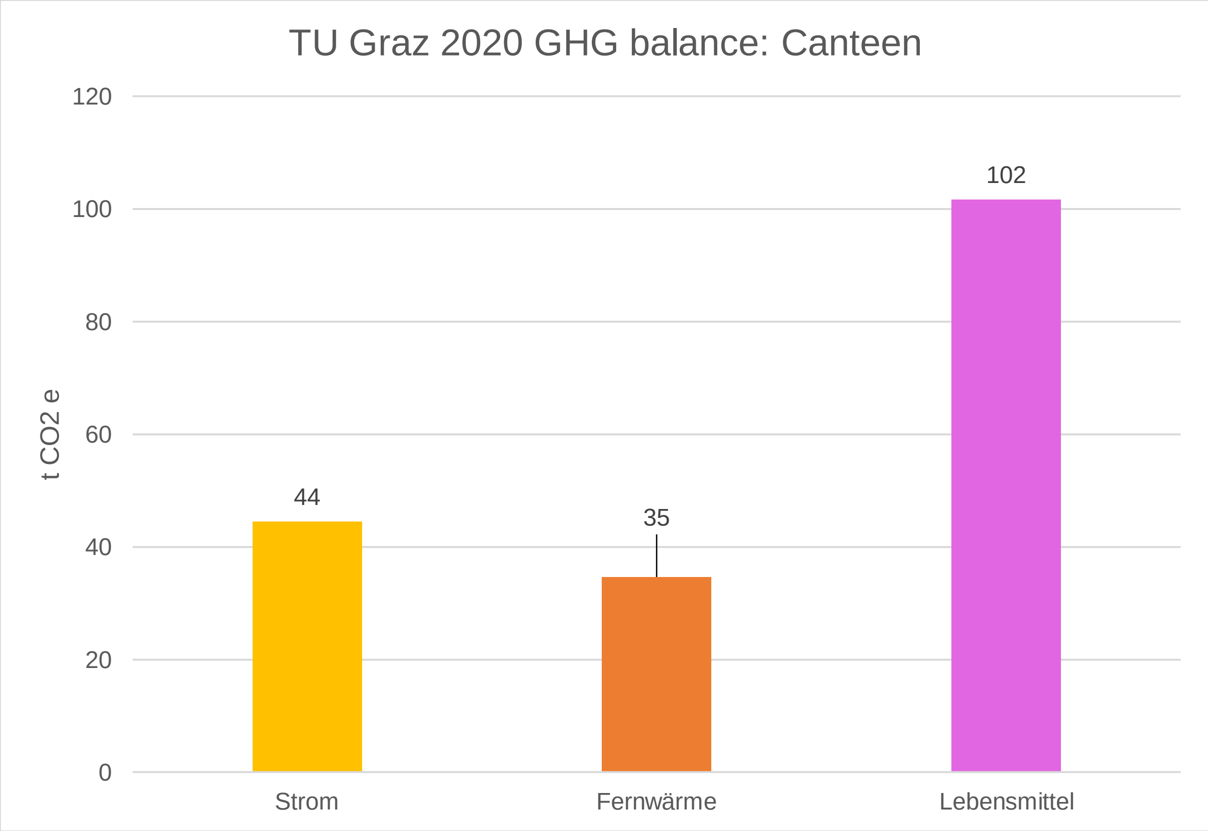


Figure 42: TU Graz 2020 GHG balance - canteen

Comparison between 2020 and 2017

As compared to 2017, the total emissions associated with the *Canteen* category decreased from 220 t CO_2e to 181 t CO_2e. While emissions associated with electricity and food decreased, those associated with district heating use increased.

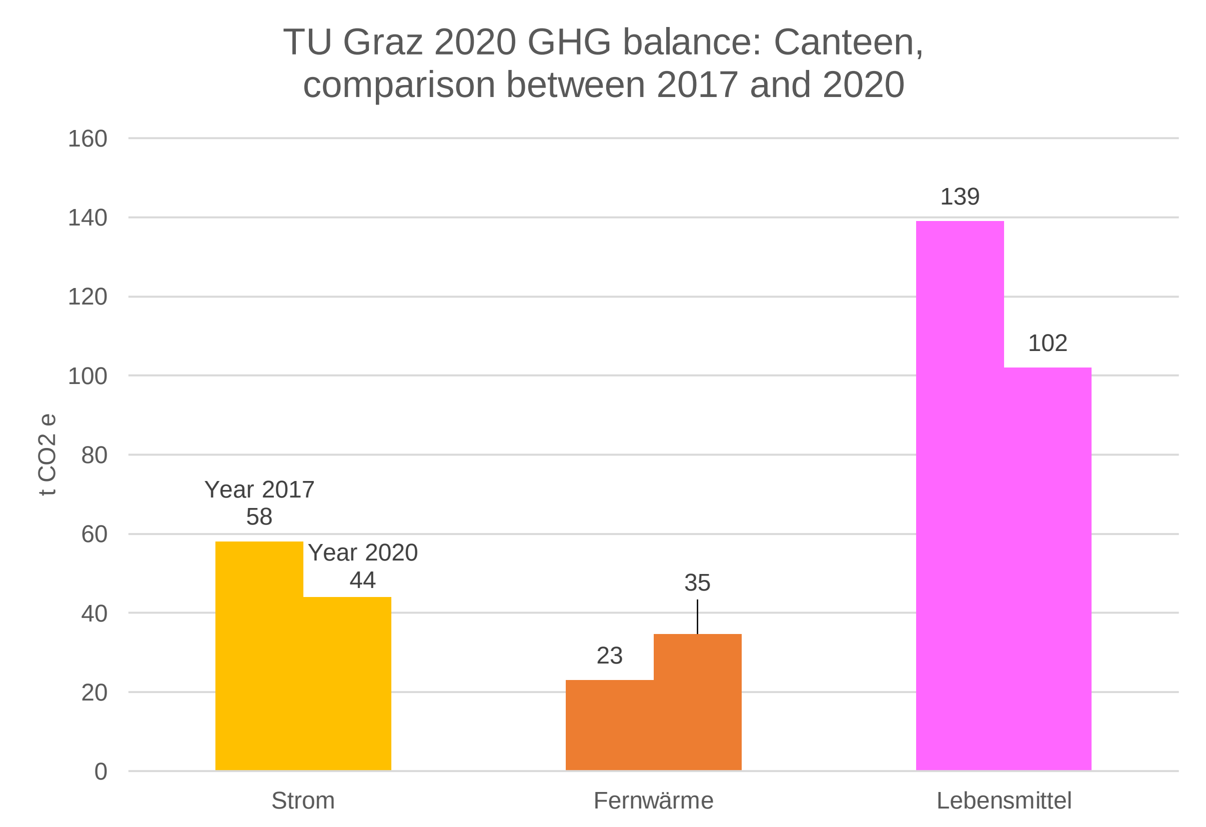


Figure 43: TU Graz 2020 GHG balance - canteen, comparison between 2017 and 2020

The sub-category *electricity (without certification)*, shows a decrease in emissions of about 20% - due to a 10% decrease in consumption and a 15% decrease in the emission factor.

Comparison between 2020 and 2017: Canteen electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2020	202,984	0.2190	44
2017	225,000	0.2573	58
Increase/decrease in %	Minus 10%	Minus 15%	Minus 23%

Table 19: Comparison between 2020 and 2017 – canteen electricity

The use of district heating and emissions increased as compared to 2017 (+50% emissions), but the emission factor decreased by 12%. This change in consumption can also be explained by the fact that part of the canteen was closed in 2020 from January to May for renovation work, which resulted in less district heating use.

Comparison between 2020 and 2017: Canteen district heating

	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2020	112,471	0.3079	35
2017	66,000	0.3487	23
Increase/decrease in %	Plus 70%	Minus 12%	Plus 50%

Table 20: Comparison between 2020 and 2017 – canteen district heating

The biggest difference is seen in the *food* sub-category. Emissions here have decreased by around 30%. This can be explained by the fact that the consumption of most food has been reduced due to the coronavirus pandemic. Only the consumption of poultry has increased. The emission factors have remained unchanged in the period from 2017 to 2019. Of particular note is the emission factor associated with beef, which is clearly the highest among all food groups, i.e. 13.3 kg CO_2e/kg.

Comparison between 2020 and 2017: Canteen food			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in t 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	Minus 35%	Plus/minus 0%	Minus 35%
Pork	Minus 65%	Plus/minus 0%	Minus 65%
Poultry	Plus 49%	Plus/minus 0%	Plus 49%
Fish	Minus 36%	Plus/minus 0%	Minus 36%
Fats and oils	Minus 28%	Plus/minus 0%	Minus 28%

Total			**Minus 27 %**

Table 21: Comparison between 2020 and 2017 – canteen food

In terms of the proportion of use, the highest emissions in 2020 in the *food* sub-category are associated with poultry consumption (30%), followed by beef consumption and fats and oils (23% each), fish (14%), and finally pork (10%).

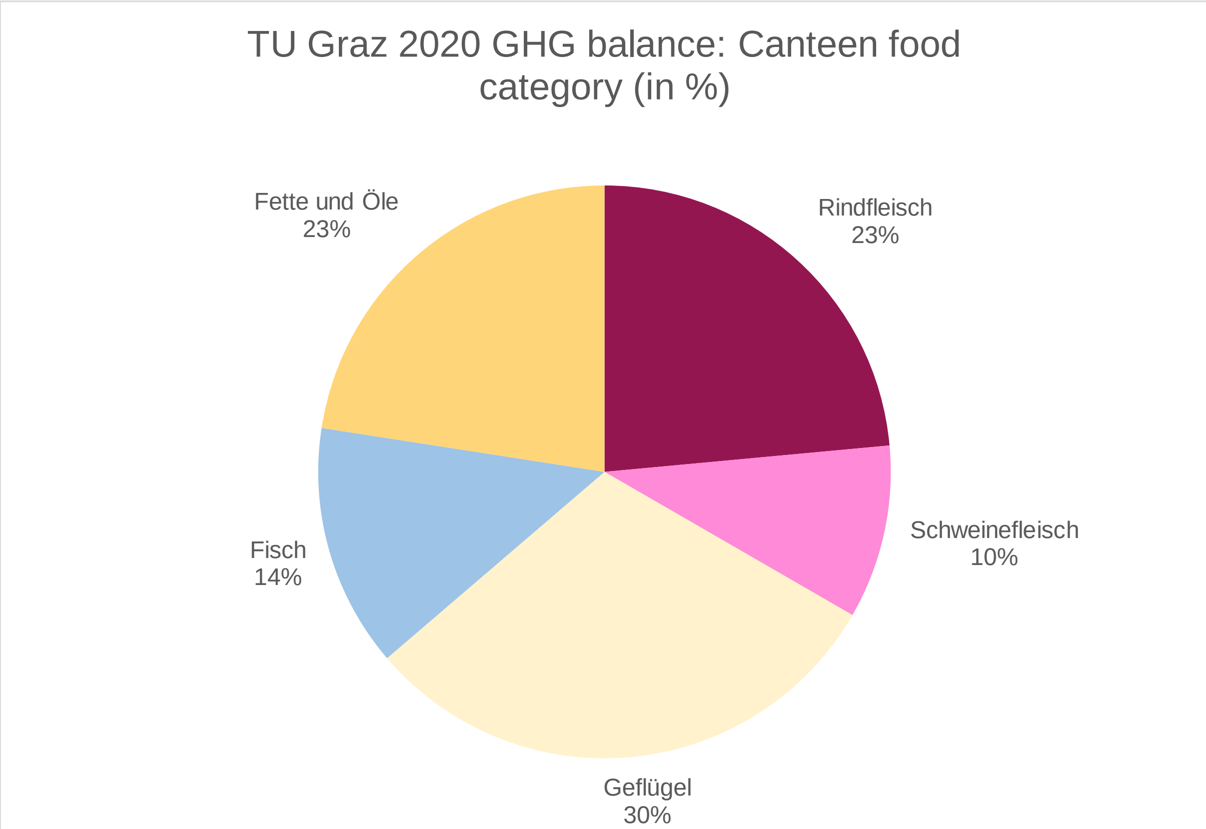


Figure 44: TU Graz 2020 GHG balance - canteen food category (in %)

Comparing 2020 with 2017, the following picture emerges in the *food* sub-category:

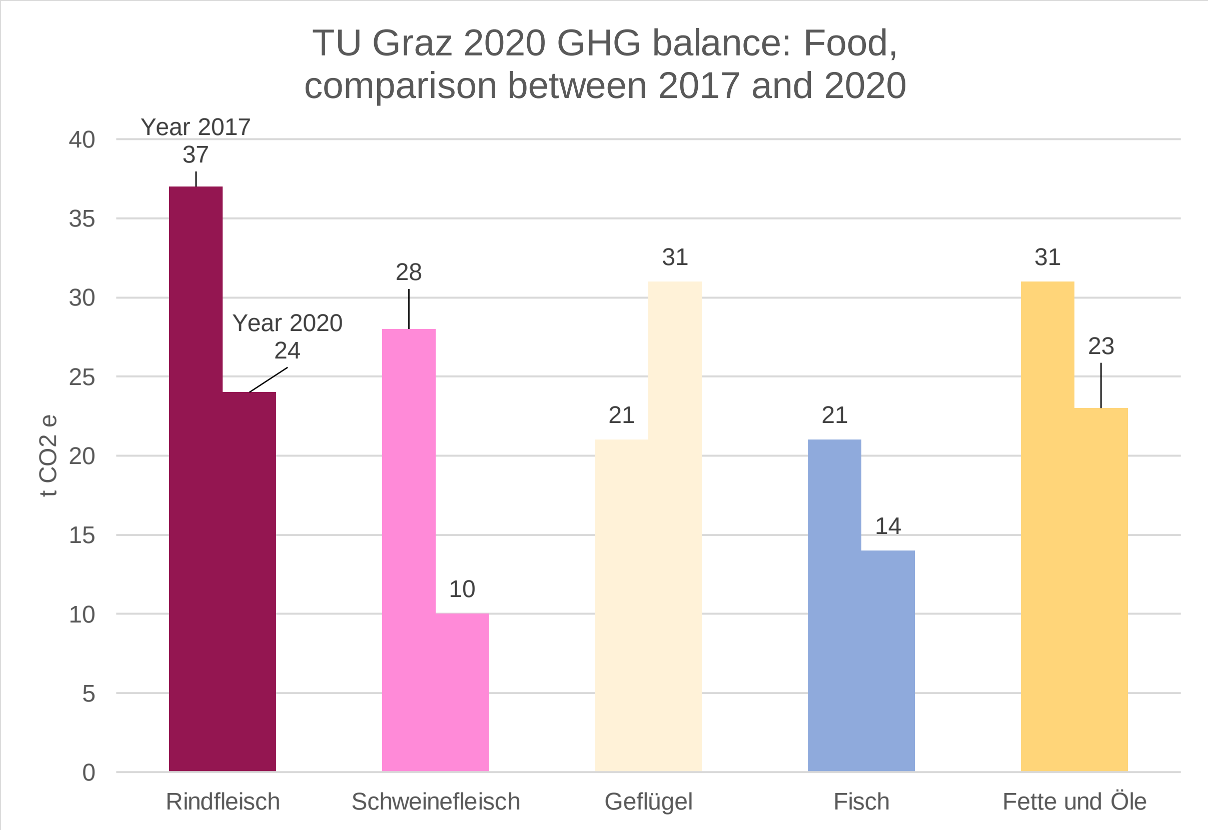


Figure 45: TU Graz 2020 GHG balance - food, comparison between 2017 and 2020

3.2.5 Special category – buildings

Although the category *Buildings* is not included in *ClimCalc*, TU Graz has decided to include it as a special category in its GHG balance. This category is listed as a special category in the TU Graz GHG balance, because there is no generally accepted method for including the "grey" GHG emissions associated with buildings (i.e. GHG emissions associated with the production of the relevant components and building materials) in the emissions balances of organisations (such as universities). Furthermore, no official emission factors are currently published by the Austrian Federal Environment Agency. This section, therefore, should be interpreted as an additional approach to calculating GHG emissions assigned to the *Buildings* category.

The calculations for GHG emissions associated with university buildings are assigned to three sub-areas:
A = Emissions resulting from the construction of a building
B = Emissions resulting from the maintenance and repair of buildings
C = Emissions resulting from the demolition of buildings and disposal of material

Currently, it is possible to show the results for emissions from sub-area A and sub-area C in the 2020 GHG balance.
In order to calculate the emissions associated with sub-area A, i.e. emissions that result from the construction of a building, an average annual floor area for additions with 2,890 m^2 of net floor area was calculated. This figure is derived from the around 28,900 m^2, which were added at TU Graz over the years 2011-2020 (see BiDok 2010-2020, cut-off date of 31.12. in each case). In order to calculate the GHG emissions from these annual additions, an emission factor of 486.63 kg CO_2 e/m^2 net floor area was used. This factor was calculated and provided by the Sustainable Building Working Group at TU Graz (Hoxha, Maierhofer, Saade, Passer 2021).
To calculate the emissions associated with sub-area C, i.e. emissions that result from the demolition of buildings and disposal of material, the buildings actually demolished in the last 10 years were used, and an annual average was calculated. The emission factor to be used needed to be calculated separately in each case, as it strongly depended on the respective building type. This was then multiplied by the m^2 net floor area of the demolished building. However, since no building at TU Graz was demolished in the last 10 years (2011 to 2020), the emissions in this area for the 2020 GHG balance are zero (see BiDok 2011-2020).
Results for sub-area B, i.e. the emissions resulting from building maintenance and repair, are not shown in this balance, as too few data are currently available regarding the maintenance activities at TU Graz as a whole. However, the exact process of collecting these data for 2020 is being planned and will be completed as soon as possible.

The following table shows how the total emissions assigned to the special category *Buildings* are calculated for 2020:

Calculation of emissions assigned to the special category *Buildings* for 2020			
	Area in m^2	Emission factor in kg CO_2 e/m^2	Emissions in t CO_2 e
Sub-area A: Construction	2,890	486.63	1,406
Sub-area B: Maintenance		still open	still open
Sub-area C: Demolition	0	still open	0
Total			still open

Table 22: Calculation of emissions assigned to the category Buildings (New) *for 2020*

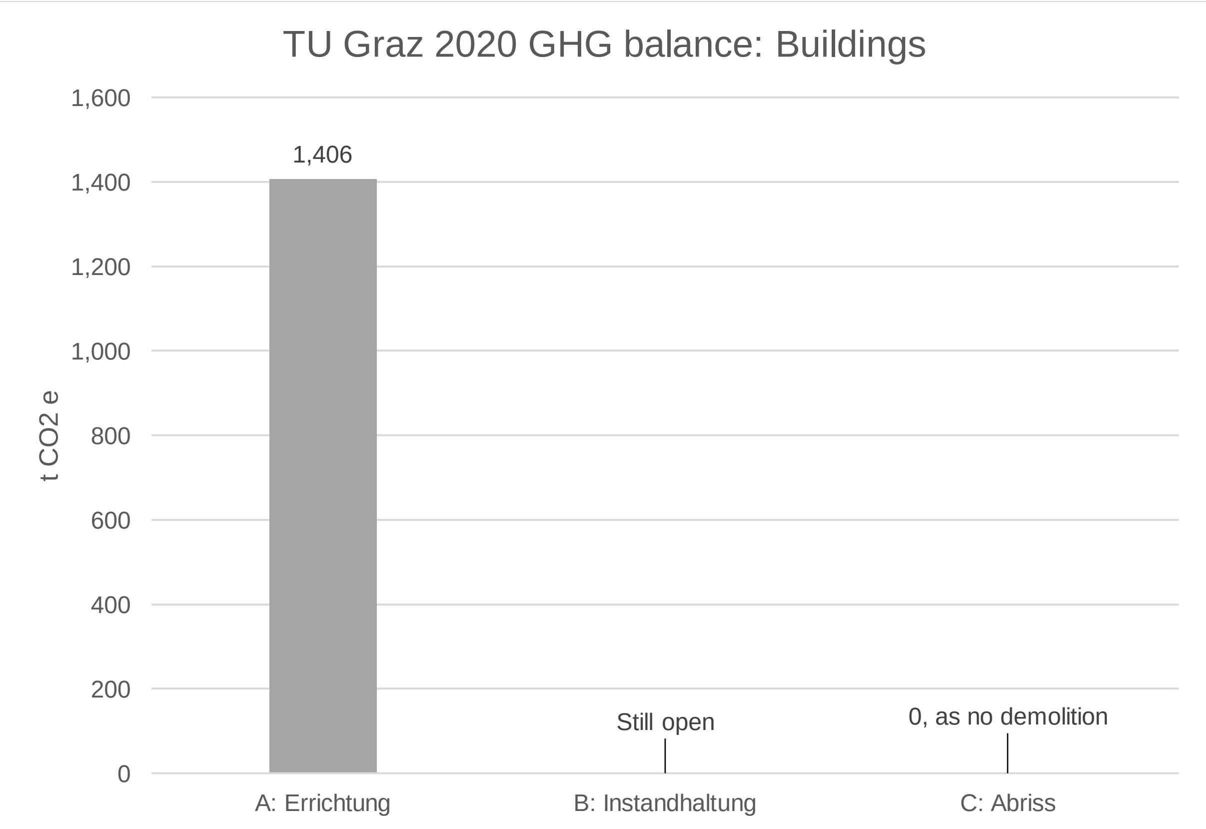


Figure 46: TU Graz 2020 GHG balance - buildings

Comparison between 2020 and 2017

It is not currently possible to compare data for the years of 2017 and 2020 due to the different data collection methods used. However, this comparison will be provided as soon as possible.

4. Key figures

As compared to 2017, the TU Graz key figures for 2020 have consistently decreased. This is mainly due to the decrease in emissions due to the coronavirus pandemic, but also is due to a decrease in most emission factors.

The key figures were rounded to one or two decimal places or to the hundredths decimal place. The following table shows the comparison of the key figures for the two years of 2017 and 2020:

Key figures		
1. TU Graz electricity consumption (excl. heat pumps + charging stations; incl. PV) per employee* (individual)		
2020	**6,840**	kWh per capita
2017	**8,240**	kWh per capita
2. TU Graz electricity consumption (excl. heat pumps + charging stations; incl. PV) per employee* (FTE)		
2020	**10,470**	kWh per FTE
2017	**12,130**	kWh per FTE
3. TU Graz electricity consumption from company PV per employee* (FTE)		
2020	**191**	kWh per FTE
2017	**52**	kWh per FTE
4. TU Graz emissions from electricity (excl. heat pumps; incl. PV) per employee* (FTE)		
2020	**2,250**	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	**77**	kWh per m^2
2017	**91**	kWh per m^2
6. TU Graz emissions from heat per m^2 net floor area heated		
2020	**16**	kg CO_2e per m^2
2017	**21**	kg CO_2e per m^2
12. TU Graz emissions per student		
2020	**1,170**	kg CO_2e per capita
2017	**1,630**	kg CO_2e per capita
13. TU Graz emissions per employee* (individual)		

2020	**4,440**	kg CO_2e per capita
2017	**7,390**	kg CO_2e per capita
14. TU Graz emissions per employee (FTE)		
2020	**6,800**	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	**74**	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	**82**	kg CO_2e per m^2
2017	**126**	kg CO_2e per m^2

Table 23: Key figures - comparison between 2020 and 2017

In addition, the following table with key figures on mobility was created. These are based in part on data from the year 2019. Where possible, data from the years of 2020 and 2017 were compared, as in the table above.

Key figures for mobility		
1. Modal split for **commuting TU Graz staff** in 2019, within-city and inbound commuters (Forstner 2021, p. 65)		
On foot	**13**	%
Bicycle	**46**	%
Motorised vehicle	**21**	%
Public transport	**20**	%
2 Modal split for **commuting to work in the city of Graz** in 2013/14, within-city and inbound commuters (Forstner 2021, p. 65, raw data: Österreich unterwegs 2013/14)		
On foot	**7**	%
Bicycle	**15**	%
Motorised vehicle	**56**	%
Public transport	**22**	%
3. Modal split for commuting **TU Graz students** in 2019, within-city and inbound commuters (Forstner 2021, p. 66)		
On foot	**18**	%
Bicycle	**49**	%
Motorised vehicle	**7**	%
Public transport	**21**	%

4. Modal split **commuting to study in the city of Graz** in 2013/14, within-city and inbound commuters (Forstner 2021, p. 66, raw data: Österreich unterwegs 2013/14)		
On foot	**11**	%
Bicycle	**19**	%
Motorised vehicle	**22**	%
Public transport	**48**	%
5. Modal split for business trips by total kilometres 2019 (Forstner 2021, p. 41)		
Motorised vehicle	**5**	%
Public transport	**16**	%
Aeroplane	**79**	%
6. Flight emissions from staff members (stays abroad and business trips) per staff member (per individual)		
2020	**185**	kg CO_2e per capita
2017	**1,392**	kg CO_2e per capita
7. Parking spaces per staff member (individual)		
2020	**0.17**	Parking spaces per capita
2017	**0.19**	Parking spaces per FTE
8. Parking spaces per staff member (FTE)		
2020	**0.25**	Parking spaces per FTE
2017	**0.28**	Parking spaces per FTE

Table 24: Key figures on mobility

5. Final recommendations

Finally, it should be pointed out once again that the 2020 balance presented here is a special one. The year 2020 was the first year of the coronavirus pandemic, during which university operations were temporarily restricted due to lockdowns. This aspect must be taken into account when interpreting the results, and also when comparing these results with those on the 2017 balance and with future balances.

Based on the 2017 balance, i.e. the reference balance for the project "Climate Neutral TU Graz 2030", a series of measures were adopted by the Rectorate in August 2020, which aim to ensure that TU Graz achieves climate neutrality by 2030 (TU Graz 2020). Recommendations based on the balance presented here, therefore, only address areas that are **not** included in the measures that have already been adopted by TU Graz.
The following recommendations for further measures can be made based on the 2020 GHG balance:

1. Regarding the sub-category *natural gas,* no measures to reduce emissions have yet been decided upon or taken. As this sub-category was differentiated into *natural gas heating* and *natural gas research* in the current 2020 balance, it becomes clear that natural gas is primarily used for research at TU Graz (see section 4.2.1 Energy). If possible, natural gas for research should be replaced by green methane or green hydrogen. Natural gas for research at TU Graz is mainly used at the Institute of Thermal Engineering and at the LEC (Large Engines Competence Centre). Of course, the needs of the clients in the respective research projects would have to be taken into account.

2. Recommendations for mobility
   Since the mobility of staff and students contributes greatly to the GHG emissions from TU Graz, and TU Graz can intervene here by establishing framework conditions, subsidies, etc., the existing measures for reducing emissions in the mobility category could be extended.

    a. Commuting: Since commuters who commute into the city of Graz every day often cover a longer distance by car, TU Graz could create further supportive measures. Continuing to promote the Styrian Climate Ticket and meet the demand to further expand Park&Ride and Bike&Ride areas at stations near the commuters' homes, as well as promoting e-bikes, could achieve the desired effects here. Ideally, a commute would look like this: The commuter would travel by (e-)bike from their residence to the nearest train station, then by train to Graz (or possibly by bicycle), and finally by bike or tram and bus to TU Graz. Promoting the purchase of folding bicycles should also be considered. In any case, possible commuting routes that intersect or approach public transport routes should be analysed for those employees who have access authorisation to the TU Graz car parks.

b. Regarding business trips: The most frequent destination regarding staff members' car journeys for business trips in 2020 was Vienna. Since most of these journeys could also be made by using public transport, the business travel guidelines could be adapted as followed: For the transport of heavy goods or if no reasonable connection to public transport exists, the car can be used for the business trip, but public transport should otherwise be used. Another way to reduce the number of journeys by car would be to establish a regulation that business trips must always be carried out with rented cars or company cars (i.e. e-car from *Family of Power*). In addition, it could be communicated that TU Graz encourages staff to take a taxi from the station near a business trip destination to travel the last few kilometres, if the business trip destination is difficult or impossible to reach by using public transport. The most common destinations for business trips by plane in 2020 included many destinations within Europe. Here, TU Graz could inform staff of the possibility of using (night) trains to reach the most important destinations (e.g. Berlin and Brussels) and encourage them strongly to use these means of transport and, in collaboration with the ÖBB (Austrian Federal Railways), to lobby for more offers along the routes that are most important for TU Graz staff.
According to the estimates, the flight from Graz to Vienna is a short-haul flight route frequently used by TU Graz staff to connect to subsequent long-haul flights. Measures could be taken here to make travelling to and from the Vienna Airport by train more attractive, for example, could include making arrangements with ÖBB to ensure that good rail services between Graz and Vienna are also offered at off-peak times.

c. Regarding stays abroad: During stays abroad, climate-friendly travel by train within Europe could be promoted among both staff and students, for example, by providing subsidies for day and night train tickets or possibly Interrail tickets. The subsidies for staff could be based on the subsidies provided for business trips. The subsidies for students could be designed to complement the subsidies provided for sustainable travel to perform stays abroad by "Erasmus+ Green".

3. Another recommendation is related to IT equipment. The roadmap for the Climate Neutral TU Graz 2030 project states that the minimum useful lifetime for IT equipment will be increased to 6 years (TU Graz 2020). In order to extend the useful lifetime if necessary, it is recommended to procure equipment that can be repaired more easily and effectively. For example, TU

Graz could offer the *Fairphone* as a service mobile phone. The *Fairphone* advertises that defective parts can be replaced quickly and easily, which significantly extends the useful life of a device. In addition, the *Fairphone* company ensures the fair and sustainable procurement of the materials used and emphasises social aspects. A report of the *Fairphone*'s emissions is being prepared by the manufacturer (Fairphone 2020). The use of the *Fairphone* as a business mobile phone at TU Graz would have a strong symbolic effect with regard to the commitment to promote sustainability, in addition to the extended service life.
Another possibility would be to purchase equipment that has already been used and refurbished ("refurbed"). Here, however, it would have to be considered exactly how the CO_2e savings can be calculated and how long the equipment could then still be used by TU Graz.

4. In order to perform a more precise calculation of the emissions associated with the special category *Buildings,* a student thesis could be assigned, for example, which deals in detail with sub-area B (maintenance) at TU Graz. This would allow a more precise assessment to be made of the emissions resulting specifically from TU Graz and assigned to this category.

5. In order to achieve the goal of climate neutrality by 2030, students could also be involved more strongly, for example, through the HTU. It is recommended to support the HTU in expanding its sustainable projects, such as the cargo bike rental or the urban gardening project and to promote the implementation of new ideas contributed by students.

6. In order to determine the success of the measures, it is recommended that a quick balance be calculated annually at TU Graz. Categories for which the data can be collected quickly as they are partly automated (e.g. energy, business trips, refrigerants) could be reproduced exactly, and the remaining data could be taken from the last complete balance. This would provide an even more detailed picture of how GHG emissions are changing at TU Graz. This measure will be implemented for the first time in 2021 in consultation with the *Buildings and Technical Support* organisational unit.

7. Another area that is currently not considered in TU Graz's GHG balance is the possibility of investing financial resources sustainably. Thus, TU Graz could also promote ecological and ethical progress through its financial investments and thus indirectly reduce GHG emissions.

8. In addition, TU Graz could take further measures to improve sustainable procurement. For this purpose, a procurement strategy for sustainable goods (e.g. office materials) could be developed in cooperation with the TU Graz Purchasing Service or the strategy recommended by the *Allianz Nachhaltiger Universitäten in Österreich* could be declared as binding.

6. List of figures and tables

6.1 List of figures

6.2 List of tables

7. Bibliography

Allianz Nachhaltige Universitäten in Österreich 2021a. „Arbeitsgruppe ‚Klimaneutrale Universitäten & Hochschulen'". Factsheet system limits on the website of the Allianz Nachhaltige Universitäten in Österreich. Available online: http://nachhaltigeuniversitaeten.at/wp-content/uploads/2017/05/Factsheet-Systemgrenzen.pdf Accessed on: 17.9.21

Allianz Nachhaltige Universitäten in Österreich 2021b. „Arbeitsgruppe ‚Klimaneutrale Universitäten & Hochschulen'". On the website of the Allianz Nachhaltige Universitäten in Österreich. Available online: http://nachhaltigeuniversitaeten.at/arbeitsgruppen/co2-neutrale-universitaeten/ Accessed on: 13.9.21

Fairphone 2020. „Fairphone's Impact 2020" *A challenge to the industry*. Available online: https://www.fairphone.com/wp-content/uploads/2021/06/Fairphone_Impact-report_2020.pdf Accessed on: 20.9.21

Forstner, Jürgen 2021. „Vergleich der Mobilität zwischen der TU Graz und österreichischen Städten". Masterarbeit vorgelegt am Institut für Straßen- und Verkehrswesen der TU Graz.

Getzinger, Günter; Schmitz, Domini; Mohnke, Sascha; Steinwender, David; Lindenthal, Thomas 2019. „Treibhausgasbilanz von Universitäten in Österreich" *Methode und Ergebnisse der Bilanzierung und Strategien zur Reduktion der Treibhausgasemissionen*. *In*: GAIA 28/4 (2019): 389-391 Available online: https://boku.ac.at/fileadmin/data/H05000/H13000/GAIA/GAIA_4_19_Treibhausgasbilanz_von_Universitaeten_in_OEsterreich_Getzinger_et_al..pdf Accessed on: 13.9.21

GuT 2020. „Flächen Energie 2020 10 01". Excel-Sheet der GuT (Gebäude und Technik)

Hoxha, E., Maierhofer, D., Saade M.R.M. und Passer, A. 2021: „Influence of technical and electrical equipment in life cycle assessments of buildings: case of a laboratory and research building". In: The International Journal of Life Cycle Assessment (2021) 26:852-863. Available online: https://doi.org/10.1007/s11367-021-01919-9

IPCC 2018. "Summary for Policymakers". *In*: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [Masson- Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma- Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. Available online: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf Accessed on: 16.4.21

Kellner, Barbara; Korunka, Christian; Kubicek, Bettina; Wolfsberger, Juliana 2020. „Wie COVID-19 das Arbeiten in Österreich verändert" *Flexible Working Studie 2020*. Hrsg.:

Deloitte Consulting GmbH. Available online: https://www2.deloitte.com/content/dam/Deloitte/at/Documents/presse/Deloitte-Flexible-Working-Studie-2020.pdf Accessed on: 27.9.21

ÖSG 2012. Ökostromgesetz 2012 § 5 Abs. 1 Ziffer 22. Available online: https://www.jusline.at/gesetz/oesg_2012/paragraf/5 Accessed on: 27.9.21

Österreich Unterwegs 2013/14. „Österreich unterwegs 2013/2014: Methodenbericht zum Arbeitspaket ‚Datenverarbeitung, Hochrechnung und Analyse'" Available online: https://www.bmk.gv.at/dam/jcr:106bc97e-b03f-4e38-9c6b-bf57680616dc/oeu_2013-2014_Methodenbericht_AP_Datenverarbeitung-Hochrechnung-Analyse.pdf

Österreichisches Umweltzeichen 2018. „Grüner Strom" *Richtlinie UZ 46*. Ausgabe vom 1. Jänner 2018, geändert mit 1. Juli 2019 und 1. Jänner 2021. Available online: https://www.umweltzeichen.at/file/Richtlinie/UZ%2046/Long/Uz46_R5.2a_Richtlinie_Gruener%20Strom_2018.pdf Accessed on: 29.10.21

Our World In Data a). „Average temperature anomaly, Global". Website of the *Our World In Data*. Available online: https://ourworldindata.org/grapher/temperature-anomaly?country=~Global Accessed on: 27.9.21

Our World In Data b). "Per Capita CO_2 Emissions". Website of the *Our World In Data*. Available online: https://ourworldindata.org/co2/country/austria?country=USA~DEU~AUT~CHN~IND#citation Accessed on: 27.9.21

TU Graz 2020. Rectorate's decision on „Roadmap Klimaneutrale TU Graz 2030". Submitted: 28.08.2020

WIR (World Resources Institute) und WBCSD (World Business Council for Sustainable Development) 2004. „The Greenhouse Gas Protocol" A corporate accounting and reporting standard. Revised Edition. Washington, D.C.: WRI, WBCSD. Available online: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf Accessed on: 13.9.21

Wissensbilanz 2020. „Wissensbilanz 2020" *Vom Universitätsrat der TU Graz genehmigt im April 2021*. Hrsg. Der Rektor Harald Kainz. Available online: https://www.tugraz.at/fileadmin/public/Studierende_und_Bedienstete/Information/TU_Graz/Wissenbilanzen/Wissensbilanz_TU_Graz_2020.pdf Accessed on: 13.9.21