Preliminary 2021 greenhouse gas monitoring for TU Graz

and comparison with the 2017 and 2020 GHG balances

Franziska Häller, Günter Getzinger

Last updated: 4 November 2022

STS Science, Technology and Society Unit

ISDS INSTITUTE OF INTERACTIVE SYSTEMS AND DATA SCIENCE

This final report on the 2021 greenhouse gas monitoring for TU Graz (Version_1.0, last updated on 4.11.22) 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 monitoring was created by using the tool *ClimCalc*, version "climcalc_v2.1_EF2019" (Alliance for Sustainable Universities in Austria 2022).

Client: Organisational Unit 9504.0 - Buildings and Technical Support (in German: *Gebäude und Technik*, GuT) Technical Facility Management

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

Subject of the contract: Preparation of the 2021 greenhouse gas monitoring report for TU Graz*,* taking into account the categories of *Energy, Mobility, Material use*, and *Canteen,* collected at the main and secondary locations of TU Graz.

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

Contract period: April to December 2022

Version: Version_1.0

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
    - Institute of Thermal Turbomachinery and Machine Dynamics
    - TU Graz Publishing House
- External organisations
    - Harnisch Gebäudeservice Graz
    - Österreichische Mensen Betriebsgesellschaft mbH
    - Printkultur (HTU Copyshops)

Table of contents

1. Description of methods and system limits

As part of the Climate Neutral TU Graz 2030 project, a decision was made that GHG monitoring would be carried out annually from 2021 and on in addition to the triennial, complete survey of the GHG balance.

This report documents the first GHG monitoring carried out at TU Graz for the year 2021.

Description of methods:

The GHG monitoring performed at TU Graz is carried out to provide a quick annual overview of alterations in the GHG emissions from TU Graz in the categories of energy, mobility, material use, and canteen. This monitoring enables these data to be collected accurately without investing a large amount of time and research resources. The remaining data are extracted from the last complete GHG balance and adjusted, if necessary, in this case from the 2020 GHG balance.
CO_2e emissions were calculated by using the *ClimCalc* tool from the *Alliance of Sustainable Universities in Austria* (Allianz Nachhaltige Universitäten in Österreich 2022). The emission factors used are provided by the Austrian Federal Environment Agency. The emission factors from 2019 that were available in June 2022 were used (version "climcalc_v2.1_EF2019"), which is why this is considered as only the **preliminary** GHG monitoring report for 2021.

The following subcategories were surveyed completely and accurately in 2021:

- Power
- PV company production
- District heating
- Natural gas (research)
- Staff stays abroad
- Student stays abroad
- Refrigerant
- Canteen electricity
- Canteen district heating
- Canteen food

The following subcategories were adopted from the 2020 GHG balance and partly adjusted:

- Natural gas (heat)
- Fuel (research)
- Staff commuting (adjusted to fit the number of staff)
- Student commuting (adjusted to fit the number of students)
- Business trips (adjusted to fit the number of business trips in 2021; these can be accurately recorded annually from 2022 using the CO_2 business trip tool)
- Company vehicle fleet
- Paper
- IT equipment

Not recorded:

- Buildings (new construction, maintenance, demolition)

Applying this method allows us to accurately record data on an annual basis for those subcategories with the highest emissions at TU Graz (electricity, district heating) and to obtain a relatively accurate approximation of the actual emissions in the *mobility* category, which is also an emissions-intensive area.
Therefore, the category *Buildings* was not included in this GHG monitoring process, as no methodology has yet been generally accepted for recording the "grey" GHG emissions from buildings (i.e. GHG emissions that arise due to the production of the relevant building materials) in the emissions balance of organisations (such as universities). However, TU Graz plans to include this category in the next complete GHG balance in 2023.

System limits:

The net floor space at TU Graz in 2021 (cut-off date of 1.10.2021; GuT 2022) is:

Net floor space (total)	255,375 m^2
Net floor area (heated)	231,981 m^2

Table 1: Net floor space (total and heated) at TU Graz 2021

The number of employees and students at TU Graz was obtained from the 2021 Intellectual Capital Statement (TU Graz 2022, p. 17). In addition, the number of staff is enhanced by the number of holdings, which was provided by the Organisational Unit *Rector's Assistance: Statistics and Data Protection.* Holdings are included in the GHG monitoring if they are very closely connected with TU Graz in terms of financial aspects, space, and/or personnel.

	According to the 2021 Intellectual Capital Report	2021 Holdings	Total
Staff			
Individuals (cut-off date: 31.12.2021)	3,914.0	992.0	**4,906.0**
Full-time equivalents (FTE) (2021 annual average)	2,596.7	757.3	**3,354.0**
Students (regular) *(cut-off date: 21.12.2021)*	16,082.0		**16,082.0**

Table 2: Number of staff and students at TU Graz in 2021

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

2. GHG Monitoring

2.1 Summary

In total, around **16,300 tonnes of CO_2e** were produced at TU Graz in **2021.** This is around 1,100 tonnes or around **7% more** GHG emissions than in **2020 with 15,200 tonnes of CO_2e**. This increase as compared to 2020 can be explained by the facts that fewer pandemic-related restrictions applied in 2021 and that the number of heating degree days was higher in 2021 than in 2020, which led to an increase in consumption in the *Energy* category.

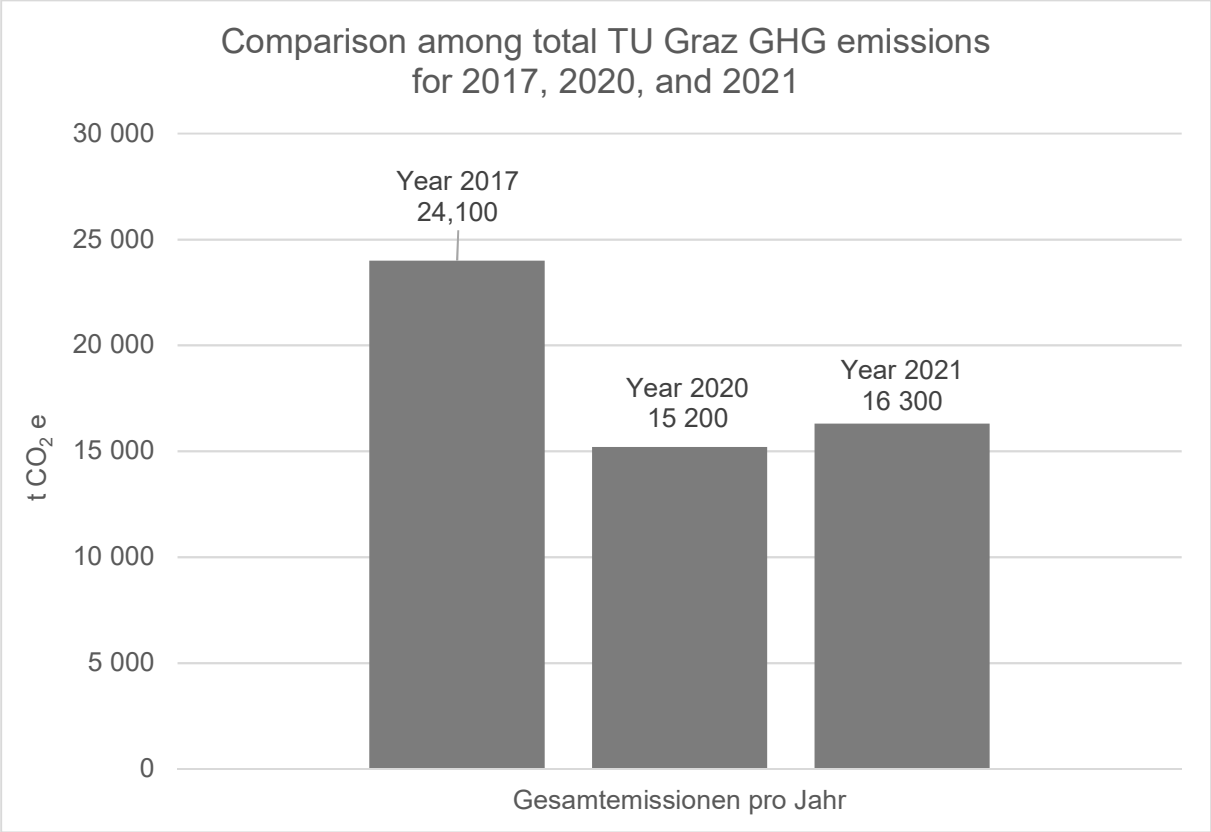


Figure 1: Comparison among total TU Graz GHG emissions for 2017, 2020, and 2021

GHG emissions are divided into three different scope categories: Scope 1 emissions are the emissions directly caused by an organisation, scope 2 emissions are the indirect, energy-related emissions (i.e. these arise from the generation of purchased electricity, steam, and purchased district heating and cooling), scope 3 emissions are also indirect emissions (upstream and downstream, e.g. caused here by mobility or material use). The following graphs show the distribution of the emissions by scope in 2017, 2020, and 2021. While the distribution remained the same from 2020 to 2021, it changed significantly from 2017 to 2020: Scope 1 emissions have slightly increased, scope 2 emissions have also increased (by about 13%), while scope 3 emissions have decreased by 15%. These results can be explained by the fact that consumption in the energy category has increased due to fewer

pandemic-related restrictions and a higher heating degree-day index in 2021, but emissions from mobility are still low (in some subcategories even lower) than in 2020.

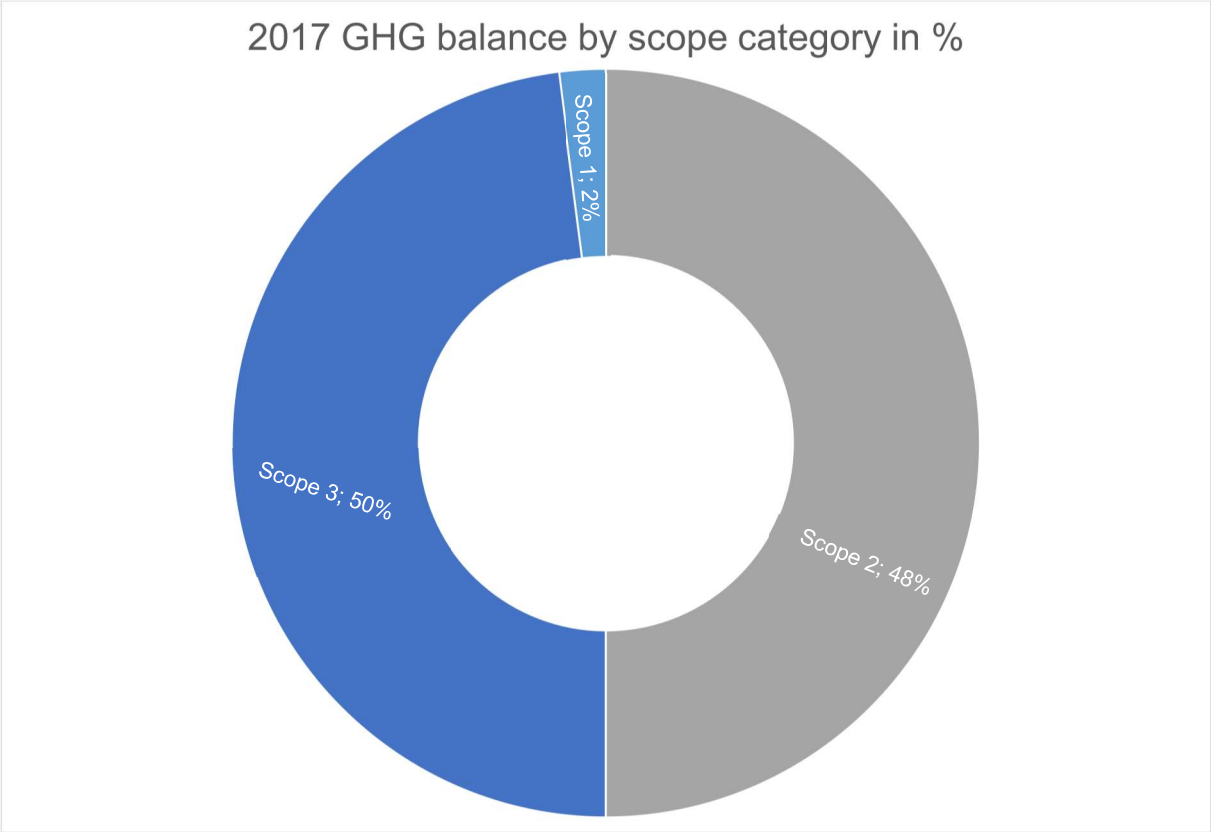


Figure 2: 2017 GHG balance by scope category in %

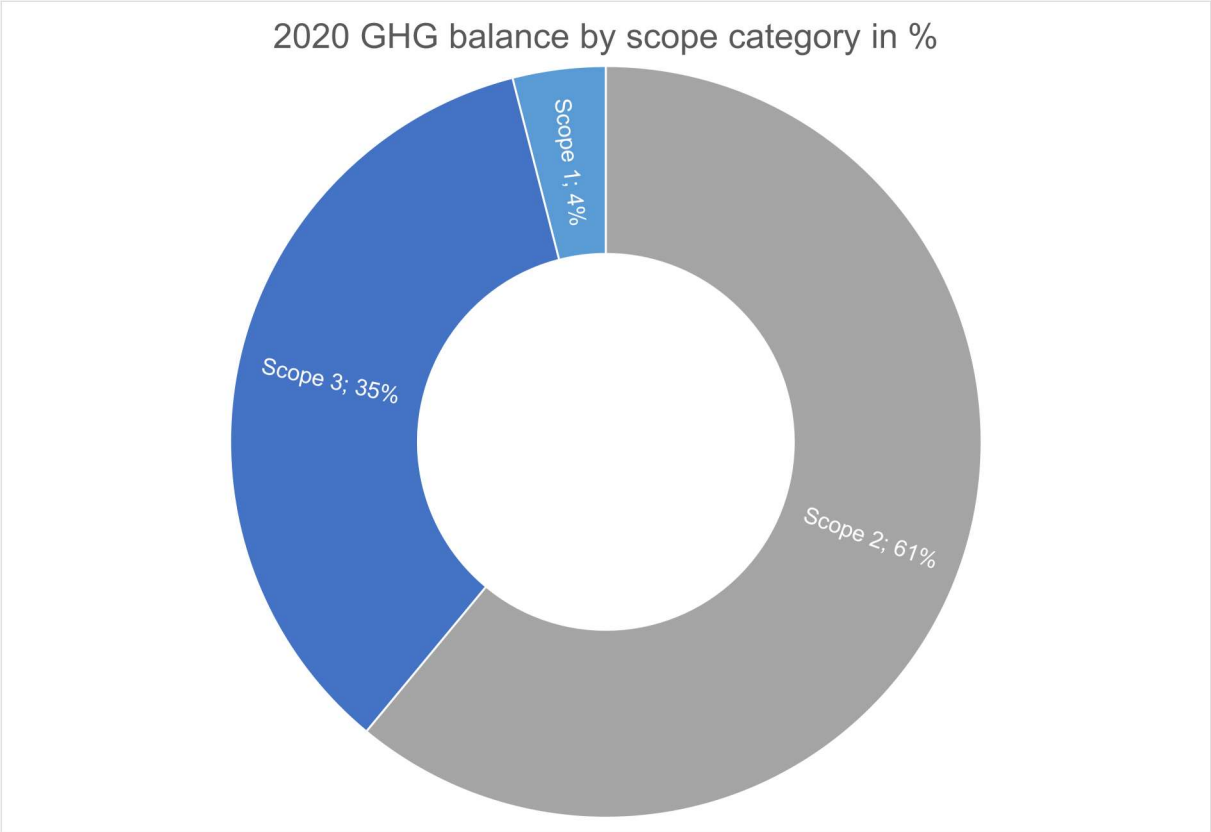


Figure 3: 2020 GHG balance by scope category in %.

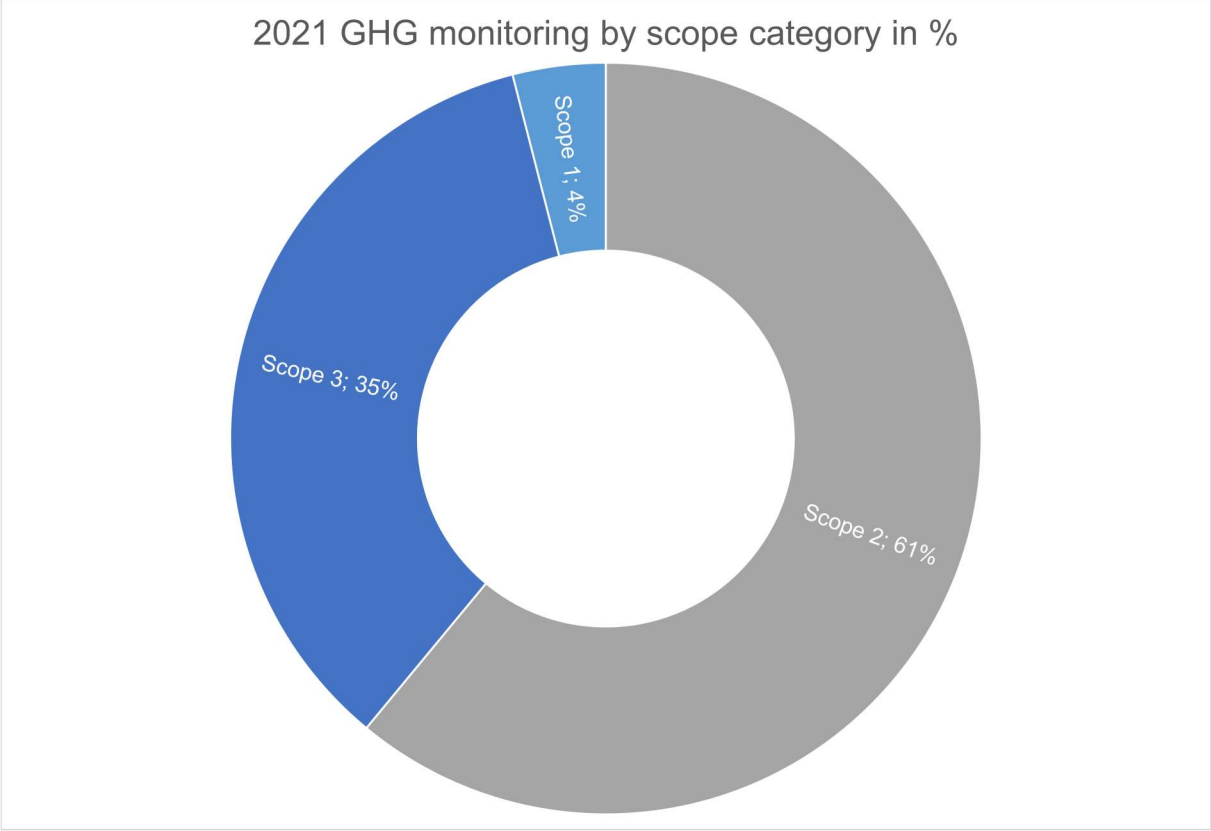


Figure 4: 2021 GHG monitoring by scope category in %.

The largest share of emissions is in the *Energy* category (12,970 t CO_2e), followed by the *Mobility* (2,550 t CO_2e), *Material use* (610 t CO_2e), and finally *Canteen* (190 t CO_2e) categories.

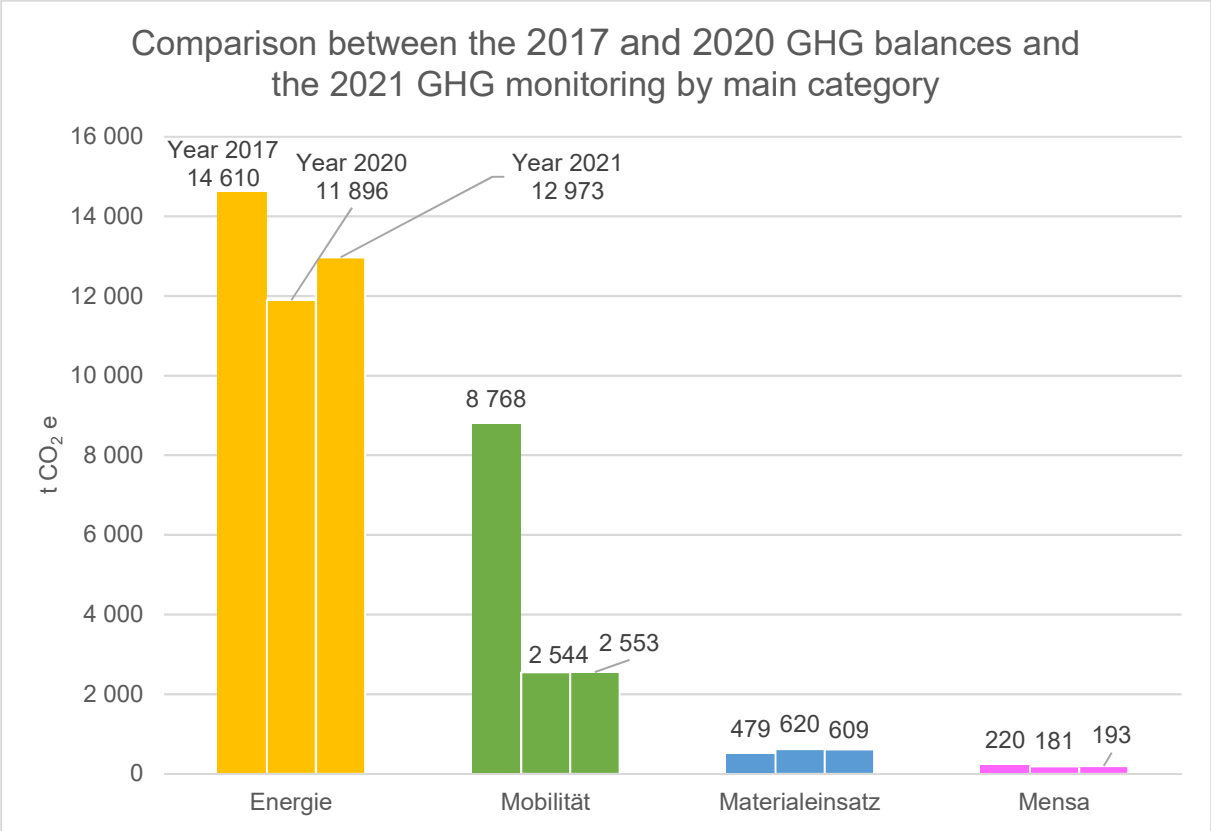


Figure 5: Comparison between the 2017 and 2020 GHG balances and the 2021 GHG monitoring by main category

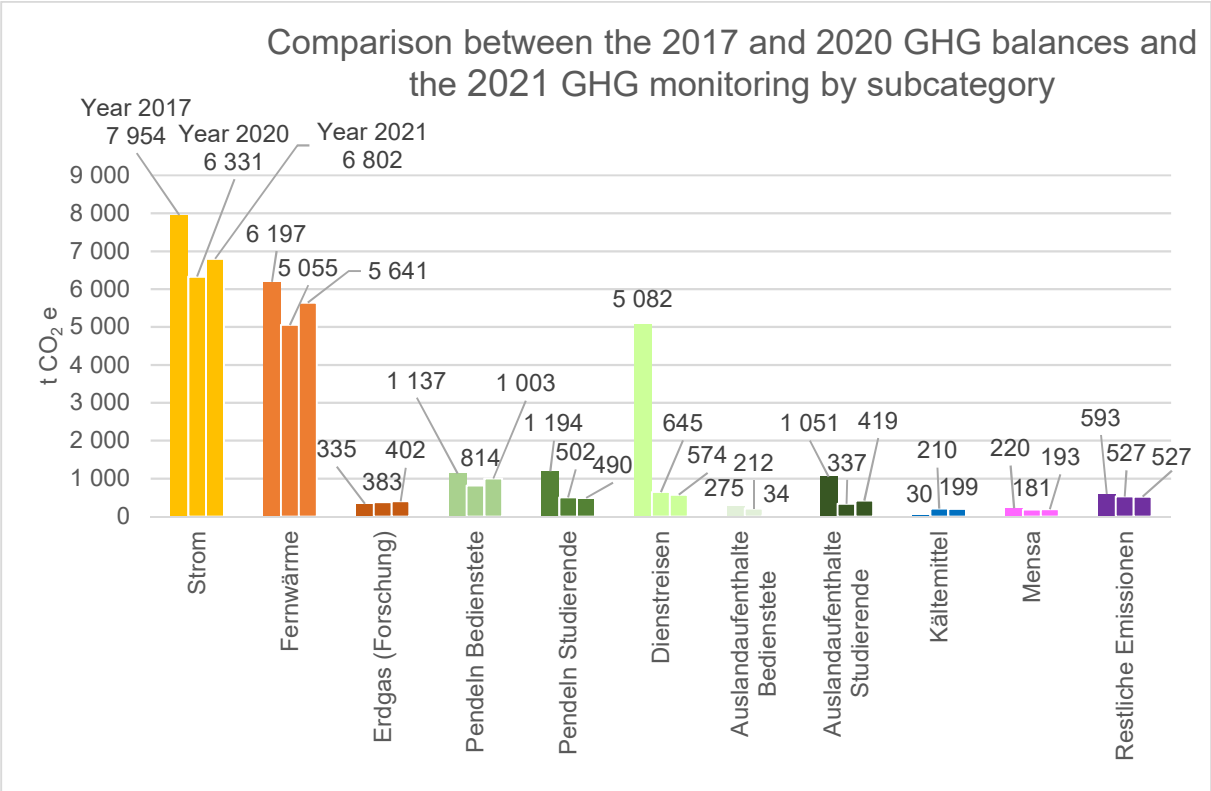
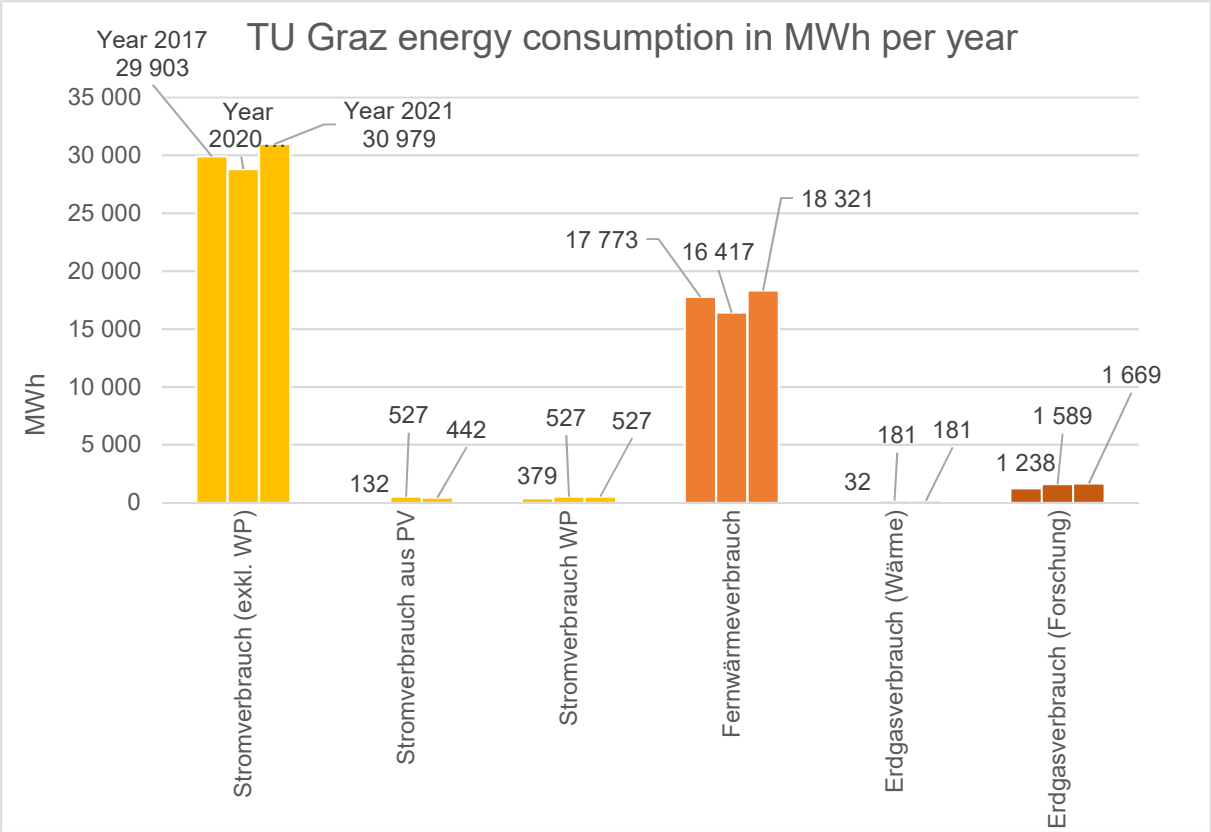


Figure 6: Comparison between the 2017 and 2020 GHG balances and the 2021 GHG monitoring by subcategory

2.2 Energy

The GHG emissions from the area of energy are calculated and assigned to the subcategories of *electricity, district heating, natural gas (heating), and natural gas (research)* by collecting the consumption data (kWh or MWh), which are then multiplied by the corresponding emission factor. The following chart provides an overview of the consumption in these subcategories in 2017, 2020, and 2021. The *electricity* subcategory was divided into *electricity consumption (excl. HP*, where HP stands for heat pump), *electricity consumption from PV (photovoltaics)*, and *electricity consumption from HP*. The presentation of the consumption data is important, because it shows whether TU Graz is becoming more efficient in the electricity and heating areas (regardless of its output of emissions). Starting on page 11, the energy consumption data are also presented in tabular form. When interpreting the figures, the reader must also take into account the fact that TU Graz has been growing continuously since 2017, i.e. that it has also grown in terms of staff and m^2 net floor space, and that influencing factors such as pandemic-related restrictions and the heating degree-day index affected consumption.



In the energy category, a total of 12,970 t CO_2e were emitted in 2021.
Here, the three most emission-intensive subcategories – electricity (consisting of electricity consumption without UZ 46 certification and electricity consumption from the company PV system), district heating, and natural gas (research) – were surveyed in detail during the 2021 GHG monitoring process. The data for natural gas (heating) and fuel (research) were extracted from the last complete 2020 GHG balance.

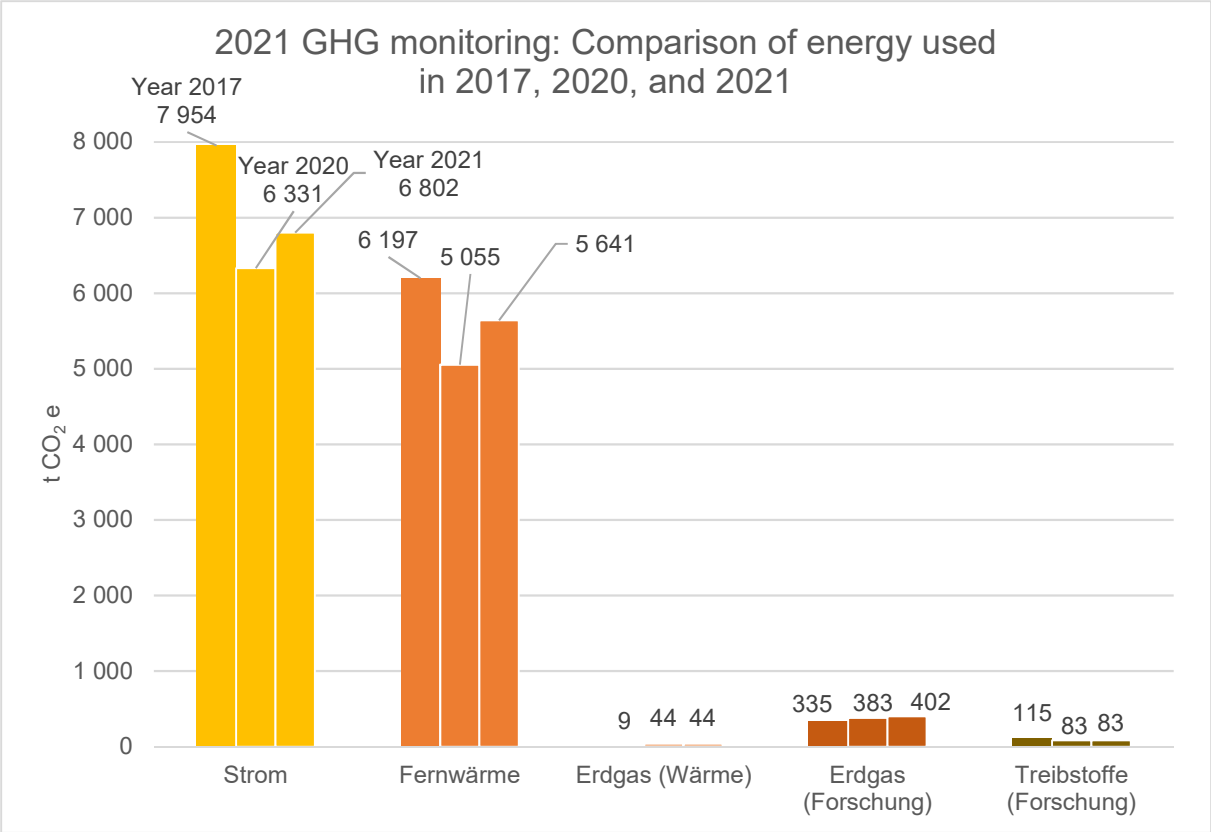


Figure 7: 2021 GHG monitoring - comparison of energy used in 2017, 2020, and 2021

The following table shows how the consumption, emission factor (EMF), and emissions from electricity without UZ 46 certification and PV electricity have changed from 2017 to 2020 and 2021. In addition, the consumption and emissions from heat pumps are shown. These values are the same for 2021 and 2020, as no exact values were available for 2020; therefore, the data from 2021 were used as an estimate when the 2020 GHG balance was prepared.
The increased consumption of electricity is due to the fact that, as compared to 2020, there was more activity at TU Graz, and the number of staff increased. The yield from the PV systems in 2021 is somewhat lower than in 2020, as no new systems were added in this period, and the weather decreased the yield. The highest monthly yield (i.e. 79,498 kWh) was achieved when using the PV system in 2021 in the month of June. 100% of the PV electricity generated at TU Graz is consumed on-site.

Comparison of 2021 with 2020 and 2017: Electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2021 Electricity without UZ 46 certification	30,979,438 of which 527,150 were for heat pumps	0.2190	6,784 of which 115 were from heat pumps
2021 PV	441,582	0.0400	18
Total	31,421,020		**6,802**

2020 Electricity without UZ 46 certification	28,813,347 of which 527,150 were for heat pumps	0.2190	6,310 of which 115 were from heat pumps
2020 PV	526,924	0.0400	21
Total	29,340,271		**6,331**
2017 Electricity without UZ 46 certification	30,882,000 of which 379,000 were for heat pumps	0.2573	7,946 of which 100 were from heat pumps
2017 PV	132.000	0.0600	8
Total	30,414.000		**7,954**
Increase/decrease in % electricity (2020 to 2021)	Plus 7%	Same EMF used	Plus 7%
Increase/decrease in % PV (2020 to 2021)	Minus 16%	Same EMF used	Minus 16%
Total			**Plus 7%**

Table 3: Comparison of electricity in 2017, 2020, 2021

District heating consumption and emissions increased by 12% in 2021 as compared to 2020. The increase can mainly be attributed to the increased heating degree-day index in 2021, which was 3,948.8 in 2021, while in 2020, it was 3,627.3, and 2017, 3,852.6 (GuT 2022). The increased consumption in 2021 as compared to 2017 is due to the number of heating degree days, but also due to the growth of TU Graz.

Comparison of 2021 with 2020 and 2017: District heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2021	18,321,200	0.3079	**5,641**
2020	16,416,560	0.3079	**5,055**
2017	17,773,000	0.3487	**6,197**
Increase/decrease in % (2020 to 2021)	Plus 12%	Same EMF used	Plus 12%

Table 4: Comparison of district heating in 2017, 2020, 2021

The consumption of natural gas used for research increased by 4% in 2021 as compared to the consumption in 2020, as more natural gas was used for experiments. The data for natural gas used for heat consumption were extracted from the 2020 GHG balance.

Comparison of 2021 with 2020 and 2017: Natural gas			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2021	1,850,579 due to research: 1,669,287 due to heating: 181,292	0.2410	**446** from research: 402 from heating: 44
2020	1,770,350 due to research: 1,589,292 due to heating: 181,292	0.2410	**427** from research: 383 from heating: **44**
2017	1,269,946 due to research: 1,238,221 due to heating: 31,779	0.2703	**343** from research: 335 from heating: 9
Increase/decrease in % (2020 to 2021)	Plus 4%	Same EMF used	Plus 4%

Table 5: Comparison of natural gas in 2017, 2020, 2021

2.3 Mobility

The total emissions in the mobility category amount to 2,550 t CO_2e in 2021.
In this category, the subcategories of staff stays abroad and student stays abroad were completely surveyed for the 2021 GHG monitoring period.
Regarding the subcategories staff commuting and student commuting, the 2019 transport survey (Forstner 2021) was referred to, and data were adjusted to git the number of staff and students, as well as to consider the pandemic-related restrictions (lockdowns, distance learning, home office). For this purpose, the assumptions were made that staff commuted 60% less to TU Graz during the 2.5 months of lockdown in 2021 and 40% less during the remaining 9.5 months as compared to 2019. The number of staff increased from 3,486 individuals in 2019 to 4,906 individuals in 2021, and the emissions were increased proportionally. Regarding the students, the assumptions were made that they commuted 80% less during the 2.5 months of lockdown and that they commuted 60% less as compared to 2019 due to distance learning the rest of the time (9.5 months). The number of students in 2021 is 16,082, and the emissions from the 2019 traffic survey were adjusted proportionally. The next TU Graz traffic survey will be carried out in 2023.
In 2021, around 250 fewer business trips were made than in 2020. The business trip emissions extracted from the 2020 GHG balance were adjusted proportionally for 2021.
The data for the company vehicle fleet was taken from the 2020 GHG balance.

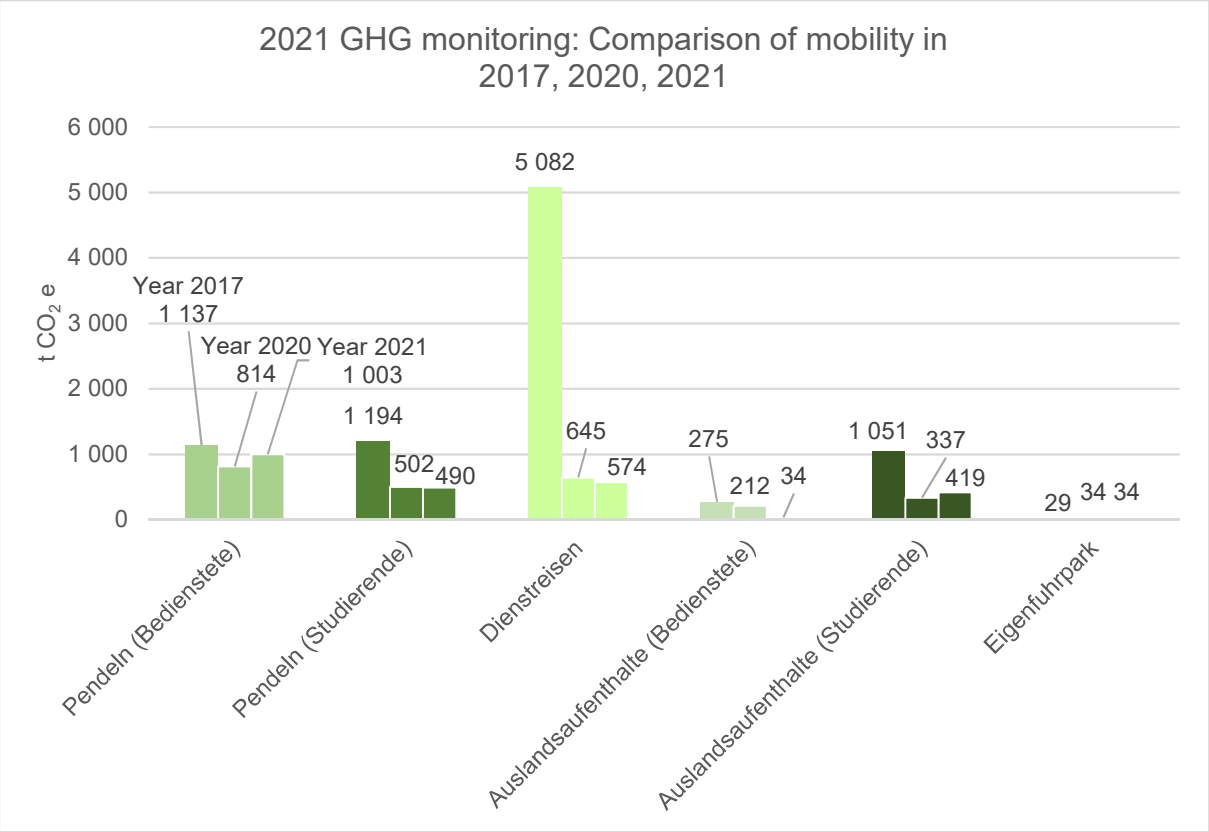


Figure 8: 2021 GHG monitoring 2021 - comparison of mobility in 2017, 2020, 2021

Since data assigned to the subcategories of stays abroad (staff and students) were precisely surveyed in 2021, the following tables show the passenger kilometres, emission factors, and emissions in each case as compared to those for the years of 2020 and 2017. It should be

mentioned here that the means of transport were not surveyed up until 2020, but the allocation was based on estimates (long-distance bus travel of up to 750 km, flights from 750 km and more). The means of transport were only collected as part of the integration process from 2021 and on in the form of a questionnaire sent out after the stay abroad, which is why more precise data are now available for 2021. The analysis of survey data shows that the long-distance bus plays only a minor role, while the car and train are used much more often. Medium- and long-haul flights (i.e. > 750 km) were usually used to reach more distant destinations, which have by far the greatest influence on emissions in this subcategory.
As an emission factor for train travel, *ClimCalc* currently uses the national value assigned to train travel in Austria. This seems appropriate, since those using trains during stays abroad usually only travel to neighbouring countries, and mostly on electrified railway tracks.

Comparison of 2021 with 2020 and 2017: staff stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2021			
Car	6,960	0.2170	2
Train	3,056	0.0130	(0.04) = 0
Long-distance bus	0	0.0490	0
Short-haul flight	7,540	0.9650	7
Medium-/Long-haul flight	63,780	0.3950	25
Total	81,336		**34**
2020			
Long-distance bus	39,218	0.0490	2
Short-haul flight	19,040	0.9650	18
Medium-/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
Medium-/Long-haul flight	654,509	0.3903	255
Total	724,127		**274**
Increase/decrease in % (2020 to 2021)			
Long-distance bus	Minus 100%	Same EMF used	Minus 100%
Short-haul flight	Minus 60%	Same EMF used	Minus 60%
Long haul flight	Minus 87%	Same EMF used	Minus 87%

Total			**Minus 84%**

Table 6: Comparison of staff stays abroad in 2017, 2020, 2021

Comparison of 2021 with 2020 and 2017: student stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/pkm	Emissions in t CO_2e
2021			
Car	53,674	0.2170	12
Train	35,400	0.0130	(0.46) = 0
Long-distance bus	3,740	0.0490	(0.18) = 0
Short-haul flight	36,080	0.9650	35
Medium-/Long-haul flight	940,370	0.3950	371
Total	1,069,264		**419**
2020			
Long-distance bus	31,832	0.0490	2
Short-haul flight	29,680	0.9650	29
Medium-/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
Medium-/Long-haul flight	2,510,470	0.3903	980
Total	2,691,050		**1,052**
Increase/decrease in % (2020 to 2021)			
Long-distance bus	Minus 88%	Same EMF used	Minus 88%
Short-haul flight	Plus 22%	Same EMF used	Plus 22%
Medium-/Long-haul flight	Plus 21%	Same EMF used	Plus 21%
Total			**Plus 24%**

Table 7: Comparison of student stays abroad in 2017, 2020, 2021

2.4 Material use

In the category of material use, the data for refrigerants were recorded accurately as part of the 2021 GHG monitoring process, and the data for paper and IT equipment were extracted from the 2020 GHG balance. In total, the emissions in this category amount to 610 t CO_2e.

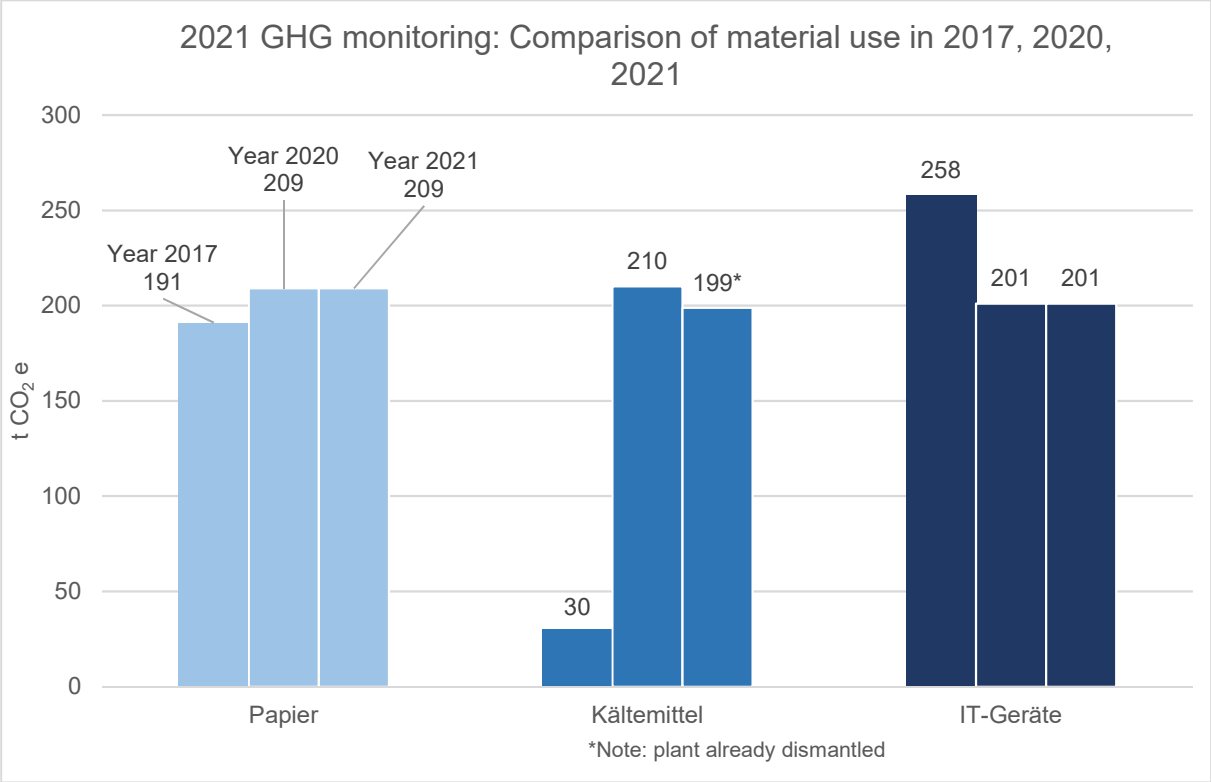


Figure 9: 2021 GHG monitoring - comparison of material use in 2017, 2020, 2021

The refrigerant emissions were still very high in 2021, as they were in 2020, which is due to a system defect that caused refrigerants to leak out. However, the plant has now been dismantled.

Comparison of 2021 with 2020 and 2017: Refrigerants			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in t CO_2e
2021			
R410A	3	2,087.50	6
R407c	108.5	1,773.85	193
Total	111.5		**199**
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	Minus 82%	Same EMF used	Minus 82%
R407c	Plus 47%	Same EMF used	Plus 47%
			Minus 5%

Table 8: Refrigerant comparison in 2017, 2020, 2021

2.5 Canteen

Data assigned to the canteen category were completely recorded as part of the 2021 GHG monitoring process, including all subcategories. Total emissions increased slightly as compared to those in 2020 from 181 t CO_2e in 2020 to 193 t CO_2e in 2021.
Emissions from electricity consumption remained the same as those recorded in 2020, while those from district heating increased slightly (again due to the increased heating degree-day index), while the emissions from food consumption also remained the same. In comparison, the very low district heating emissions recorded in 2017 are due to the renovation work performed in the winter months of 2017.

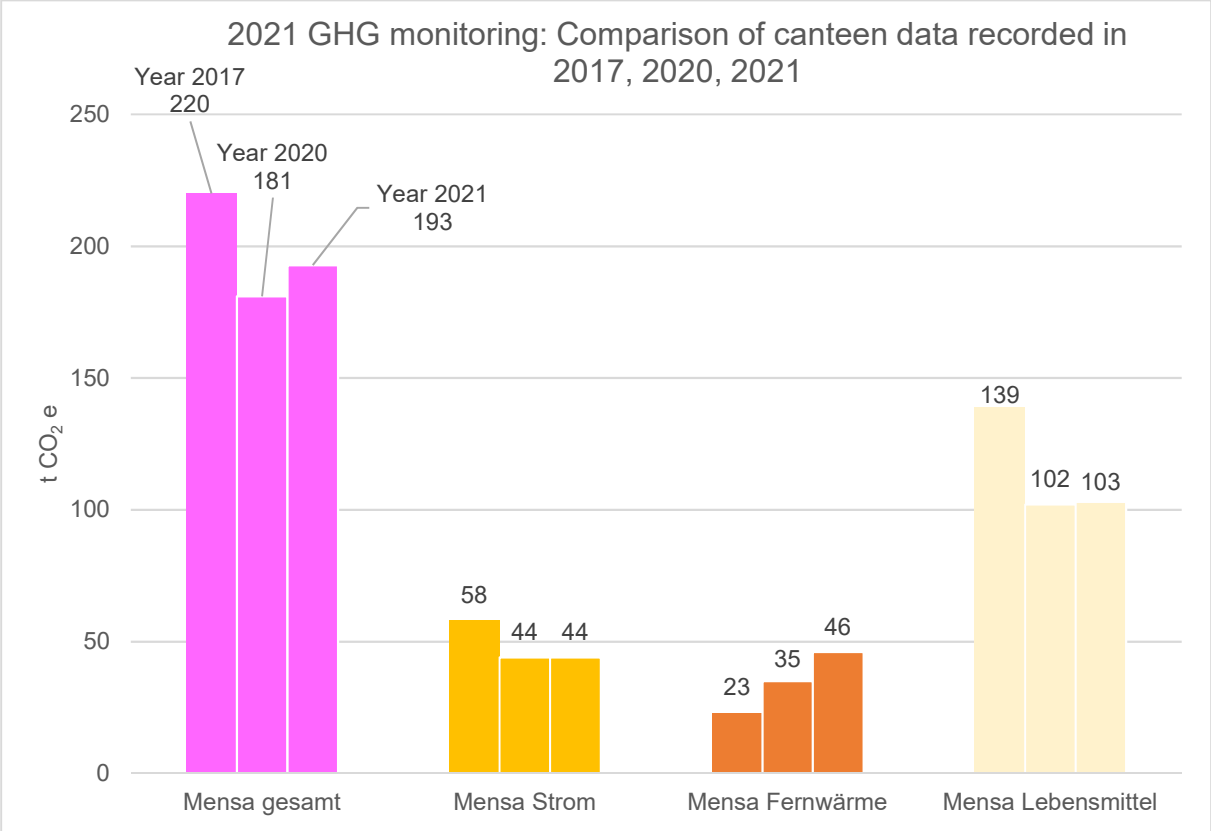


Figure 10: 2021 GHG monitoring - comparison of canteen data in 2017, 2020, 2021

Comparison of 2021 with 2020 and 2017: Canteen electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2021	199,342	0.2190	**44**
2020	202,984	0.2190	**44**
2017	225,000	0.2573	**58**
Increase/decrease in % (2020 to 2021)	Minus 2%	Same EMF used	Minus 2% and approximately equivalent when rounded

Table 9: Comparison of canteen electricity use in 2017, 2020, 2021

Comparison of 2021 with 2020 and 2017: Canteen district heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in t CO_2e
2021	149,000	0.3079	**46**
2020	112,471	0.3079	**35**
2017	66,000	0.3487	**23**
Increase/decrease in % (2020 to 2021)	Plus 32%	Same EMF used	Plus 32%

Table 10: Comparison of canteen district heating use in 2017, 2020, 2021

As compared to 2020, more beef (+15%), pork (+102%), fish (+12%) and fats and oils (+8%) were consumed in 2021. Only poultry consumption decreased by about half (-51%). Nevertheless, total food emissions in 2021 remained roughly the same as those recorded in 2020.

Comparison of 2021 with 2020 and 2017: Canteen food			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in t CO_2e
2021			
Beef	2,088	13.3000	28
Pork	3,585	5.5000	20
Poultry	4,838	3.2000	15
Fish	2,340	6.5000	15
Fats and oils	4,280	5.7592	25

Total	17,131		**103**
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 % (2020 to 2021)			
Beef	Plus 15%	Same EMF used	Plus 15%
Pork	Plus 102%	Same EMF used	Plus 102%
Poultry	Minus 51%	Same EMF used	Minus 51%
Fish	Plus 12%	Same EMF used	Plus 12%
Fats and oils	Plus 8%	Same EMF used	Plus 8%
Total			**Plus 1%**

Table 11: Comparison of canteen food in 2017, 2020, 2021

3. Key figures

The key figures were rounded to one or two decimal places or to one significant digit. The following table compares the key figures for the years of 2017, 2020, and 2021.
As compared to the 2020 GHG balance report, the following key figures are presented for the first time: "5. Electricity consumption at TU Graz (excl. heat pumps + charging stations, incl. PV + canteen) per m^2 net floor area total", "6.a District heating consumption at TU Graz per m^2 net floor area heated with district heating, adjusted for heating degree days (mean value for 2011–2019), 15/23 °C". The following key figures for mobility are also presented for the first time: "1a. For comparison: Modal split for commuters to the city of Graz in 2013/14, commuters within the city and to the city, main means of transport (Forstner 2021, p. 65, Österreich Unterwegs 2013/14)", "2. Modal split for TU Graz staff commuters in 2019, commuters within the city, main means of transport (Forstner 2021, p. 69)", and "2a. For comparison: Modal split for those commuting for work to the city of Graz 2013/14, commuters within Graz, main means of transport (Forstner 2021, p. 69, Österreich Unterwegs 2013/14)".

Key figures		
1. Electricity consumption at TU Graz (excl. heat pumps + charging stations, incl. PV + canteen) per staff member (individual)		
2021	**6,306**	kWh per capita
2020	**6,840**	kWh per capita
2017	**8,240**	kWh per capita
2. Electricity consumption at TU Graz (excl. heat pumps + charging stations, incl. PV + canteen) per staff member (FTE)		
2021	**9,224**	kWh per FTE
2020	**10,470**	kWh per FTE
2017	**12,130**	kWh per FTE
3. Electricity consumption at TU Graz generated by PV, per staff member (FTE)		
2021	**132**	kWh per FTE
2020	**191**	kWh per FTE
2017	**52**	kWh per FTE
4. Emissions from electricity at TU Graz (excl. heat pumps, incl. PV + canteen) per staff member (FTE)		
2021	**2,010**	kg CO_2e per FTE
2020	**2,250**	kg CO_2e per FTE
2017	**3,120**	kg CO_2e per FTE

5. Electricity consumption at TU Graz (excl. heat pumps + charging stations, incl. PV + canteen) per m^2 net floor area total		
2021	**121**	kWh per m^2
2020	**116**	kWh per m^2
2017	**127**	kWh per m^2
6. Heat consumption at TU Graz (incl. heat pumps) per m^2 net floor area heated		
2021	**83**	kWh per m^2
2020	**77**	kWh per m^2
2017	**91**	kWh per m^2
6.a District heating consumption at TU Graz per m^2 of net floor area heated with district heating, adjusted for heating degree days (mean value 2011–2019), 15/23 °C[1]		
2021	**87.9**	kWh per m^2
2020	**84.6**	kWh per m^2
2019	**85.3**	kWh per m^2
2018	**92.3**	kWh per m^2
2017	**87.5**	kWh per m^2
2016	**90.5**	kWh per m^2
2015	**91.0**	kWh per m^2
2014	**90.5**	kWh per m^2
2013	**98.9**	kWh per m^2
7. Emissions from heat at TU Graz per m^2 net floor area heated		
2021	**25**	kg CO_2e per m^2
2020	**16**	kg CO_2e per m^2
2017	**21**	kg CO_2e per m^2
8. Emissions at TU Graz per student		
2021	**1,015**	kg CO_2e per capita
2020	**1,170**	kg CO_2e per capita
2017	**1,630**	kg CO_2e per capita

[1] The calculation of the heating degree-day adjusted key figure for district heating was carried out at TU Graz in the years 2013–2021 as follows: If the average daily temperature was below 15 °C, heating was set to 23 °C at TU Graz. Depending on how far the average daily temperature was below 15 °C, a higher or lower heating degree-day index was entered for this day. An average value per year was calculated from these figures summed up over the years of 2011–2019. By using this average value and the following calculation, "Heating degree-day index for the year divided by the average value, multiplied by the current district heating consumption in kWh", the district heating consumption for the current year can be adjusted to fit the heating degree days. To obtain the key figure, this value is now divided by the m^2 net floor area heated with district heating in the respective year.

9. Emissions TU Graz per staff member (individual)		
2021	**3,328**	kg CO_2e per capita
2020	**4,440**	kg CO_2e per capita
2017	**7,390**	kg CO_2e per capita
10. Emissions at TU Graz per staff member (FTE)		
2021	**4,868**	kg CO_2e per FTE
2020	**6,800**	kg CO_2e per FTE
2017	**10,880**	kg CO_2e per FTE
11. Emissions at TU Graz per m^2 total net floor area		
2021	**64**	kg CO_2e per m^2
2020	**74**	kg CO_2e per m^2
2017	**114**	kg CO_2e per m^2
12. Emissions at TU Graz per m^2 net floor area heated		
2021	**70**	kg CO_2e per m^2
2020	**82**	kg CO_2e per m^2
2017	**126**	kg CO_2e per m^2

Table 12: Key figures

Key figures for mobility		
1. Modal split TU Graz staff commuters in 2019, commuters within the city and to the city, main means of transport (Forstner 2021, p. 65)		
On foot	**13**	%
Bicycle	**46**	%
Personal motorised vehicle	**21**	%
Public transport	**20**	%
1a. For comparison: Modal split for commuters to the city of Graz in 2013/14, commuters within the city and to the city, main means of transport (Forstner 2021, p. 65, Österreich Unterwegs 2013/14)		
on foot	**7**	%
Bicycle	**15**	%
Personal motorised vehicle	**56**	%
Public transport	**22**	%

2. Modal split for TU Graz staff commuters in 2019, commuters within the city, main means of transport (Forstner 2021, p. 69)		
On foot	**17**	%
Bicycle	**59**	%
Personal motorised vehicle	**9**	%
Public transport	**14**	%
2a. For comparison: Modal split for commuters to work in the city of Graz in 2018, commuters within Graz, main means of transport (City of Graz 2019)		
On foot	**10**	%
Bicycle	**21**	%
Personal motorised vehicle	**49**	%
Public transport	**20**	%
3. Modal split for students commuting to TU Graz 2019, commuters within the city and to the city, main means of transport (Forstner 2021, p. 66)		
On foot	**19**	%
Bicycle	**52**	%
Personal motorised vehicle	**7**	%
Public transport	**22**	%

4. Modal split for students commuting in the city of Graz 2013/14, commuters within the city and to the city, main means of transport (Forstner 2021, p. 66, Österreich Unterwegs 2013/14)		
On foot	**11**	%
Bicycle	**19**	%
Personal motorised vehicle	**22**	%
Public transport	**48**	%
5. Modal split business trips by total kilometres 2018 (Forstner 2021, p. 41)		
Personal motorised vehicle	**5**	%
Public transport	**16**	%
Aeroplane	**79**	%
6. Flights taken by staff (stays abroad and trips) per staff member (per capita)		
2021	**124**	kg CO_2e per capita
2020	**185**	kg CO_2e per capita
2017	**1.392**	kg CO_2e per capita

7. Parking spaces per staff member (individual)		
2021	**0.14**	Parking spaces per capita
2020	**0.17**	Parking spaces per capita
2017	**0.19**	Parking spaces per capita
8. Parking spaces per staff member (FTE)		
2021	**0.21**	Parking spaces per FTE
2020	**0.25**	Parking spaces per FTE
2017	**0.28**	Parking spaces per FTE

Table 13: Key figures for mobility

4. Recommendations: Measures and projects

1. Monitoring commuting by car

As part of developing the GHG monitoring process, a plan was made to record the emissions from staff commuting by car on an aggregated monthly basis by using the anonymised entry data of the parking permit holders. This process of collecting anonymised data each month is currently under development. From the 2022 GHG monitoring and on, it is expected that the emissions due to commuting by car will be able to be recorded and presented in this way.

2. Erasmus+ Green

As the 2021 GHG monitoring report shows, the emissions from students' stays abroad increased from 2020 to 2021. The EU programme Erasmus+ Green offers students a subsidy of € 50 if they choose a climate-friendly means of transport when travelling to and from their stays abroad (e.g. by bus, train, carpooling). TU Graz could potentially double this contribution to € 100 to offer students a clearer incentive to use more climate-friendly means of transport.

The following recommendations were made based on the 2020 GHG balance; the initial implementation steps taken are described in italics:

1. **Use of green hydrogen instead of natural gas for research**
   The natural gas currently used for research purposes should be replaced by green methane or green hydrogen. At TU Graz, natural gas is mainly used for research at the Institute of Thermal Engineering and the LEC (Large Engines Competence Center). Of course, the clients' needs for each of the respective research projects would have to be taken into account.
   The chances for this conversion to occur may currently have increased due to plans to construct an electrolyser on the TU Graz grounds, which is currently under discussion.

2. **Expansion of Park&Ride/Bike&Ride areas and promotion of e-bikes and folding bikes**
   Since commuters who commute into the city of Graz every day often have to cover a longer distance by car, TU Graz could promote further supportive measures for these commuters. Promoting the Climate Ticket Styria and helping to meet the further demand for expanded Park&Ride and Bike&Ride areas at stations near the commuters' homes, as well as promoting the use of e-bikes, could achieve the desired effects here. The promotion of folding bicycle purchases could also be considered. In any case, the commuting routes used by staff who have access authorisation to the TU Graz parking spaces should be analysed to determine alternative public transport possibilities.
   The recommendation to promote various types of bicycles was implemented in May 2022. The purchase of a folding bike, an e- bike, or a cargo bike is subsidised by TU Graz (€150 per subsidised item).

3. **Amendment of the business travel guidelines to reduce the attractiveness of using private cars**

When staff members made trips by car on business trips, the most frequent destination in 2020 was Vienna. Since these trips can – in most cases – also be made by public transport, measures such as the business travel guidelines could be adapted to promote more climate-friendly travel. Specifically, if heavy goods need to be transported or if no reasonable connection to public transport exists, the car can be used to carry out the business trip. Otherwise, public transport should be used. Another way to reduce the number of trips by car would be to establish a regulation stating that business trips should always be carried out with rented (e-)cars or with the e-cars available from *Family of Power.* In addition, it could be communicated that TU Graz encourages staff to take an (e)taxi from the station near a business trip destination in order to cover the last few kilometres, if the business trip destination is difficult or impossible to reach by public transport.
The TU Graz Business Travel Guidelines were amended in March 2021 to indicate that rail travel should be preferred over air and car travel when taking trips within Europe. In addition, on the newly established page entitled "My climate-friendly business trip" accessed via the TU Graz intranet (TU4U), a reference was made to the fact that a taxi can be used (and the costs reimbursed) to cover the last kilometres of a business trip, if the destination cannot be reached or can only be reached with difficulty by public transport.

4. **Subsidies for stays abroad**
   Regarding stays abroad, climate-friendly travel by rail within Europe could be promoted among both staff and students, for example, by offering subsidies for day and night train tickets or possibly Interrail tickets. The subsidies for staff could be based on the subsidies for business trips.
   In 2022, TU Graz discussed the topic of climate-friendly business trips and travel in the context of leaves of absence and developed a funding model that is expected to come into force at the beginning of 2023.

5. **Fairphone**
   Another proposal relates to IT equipment. The roadmap for the project Climate Neutral TU Graz 2030 clearly states that the minimum service life for IT equipment should be increased to 6 years. In order to extend the useful lifetime of such equipment, if necessary, it is suggested to procure devices that can be repaired more effectively. For example, TU Graz could offer the *Fairphone* as a business 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, as well as pays attention to social aspects. The use of the *Fairphone* as a work mobile phone at TU Graz would have a strong symbolic impact, underlining its commitment to more sustainability, in addition to extending the useful lifetime of such devices.
   A discussion on this matter is being carried out with the TU Graz Purchasing Service.

6. **Emissions from building maintenance**
   In order to more precisely calculate the emissions from the special category of *Buildings,* a student thesis could be assigned, for example, which addresses the topic of area B (maintenance) at TU Graz in detail. This would allow a more precise

assessment of the emissions from this category to be made, and specifically those related to TU Graz emissions.
For this reason, the OU Buildings and Technical Support has commissioned a project to examine the material costs incurred and associated emissions from maintenance activities by referring to the example of the New Technology Campus and the reference year of 2020. The project was completed in mid-July 2022. The results indicate that the emissions associated with maintaining the buildings on the Neue Technik Campus were very low in 2020.

7. **Involvement of students and HTU student representatives**
   In order to achieve the goal of climate neutrality by 2030, students could also be more heavily involved, for example, through the HTU. It is recommended to provide the HTU with support in expanding its sustainability projects, such as the cargo bike rental or the urban gardening project, and to promote the implementation of new ideas by students.
   Contact between representatives of the HTU GIN unit (Unit for Society, Innovation and Sustainability) and the managers of the Climate Neutral TU Graz 2030 project has been established and maintained. Current projects and activities include: cargo bike rental, urban gardening, repair café, advertising the purchase of TU Graz bicycles to students, Car-free Fridays. A particular focus should be placed on the "Repair Café" project in the future, and this offer should be expanded if necessary. In addition, a competition to collect ideas is being considered.

8. **GHG monitoring**
   In order to evaluate the success of the measures, it is suggested that GHG monitoring (quick balance) be carried out annually at TU Graz. The categories for which data can be collected quickly as they are partly automated (e.g. energy, business trips, refrigerants) could be reproduced exactly, and the remaining data can be extracted from the last complete balance. This would provide an even more detailed picture of how GHG emissions are changing over time at TU Graz. This measure will be implemented for the first time in 2021 in consultation with the *Buildings and Technological Support* organisational unit.
   This proposal will be implemented for the first time in conjunction with this report. The next GHG monitoring is planned for 2022 and is expected to be prepared in spring 2023.

9. **Financial resources**
   Another aspect that is currently not considered 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, albeit indirectly, reduce GHG emissions.
   A discussion on this topic with those responsible is being planned.

10. **Sustainable procurement**
    In addition, TU Graz could take further measures to improve sustainable procurement. For this purpose, a strategy for the procurement of sustainable goods, such as office materials, could be developed in cooperation with the main TU Graz Purchasing Service, or the strategy used by the *Allianz Nachhaltiger Universitäten in*

Österreich [*Alliance of Sustainable Universities in Austria*] could be declared as binding.
A discussion on this topic with the TU Graz Purchasing Service is being planned.

5. List of figures and tables

6. Bibliography

Allianz Nachhaltige Universitäten in Österreich 2022. „Arbeitsgruppe ‚Klimaneutrale Universitäten & Hochschulen'". Website of the Allianz Nachhaltige Universitäten in Österreich [Alliance of Sustainable Universities in Austria]. Available online: https://nachhaltigeuniversitaeten.at/arbeitsgruppen/co2-neutrale-universitaeten/ Accessed on: 28.6.22

Forstner, Jürgen 2021. „Vergleich der Mobilität zwischen der TU Graz und österreichischen Städten". Master's thesis submitted to the TU Graz Institute für Highway Engineering and Transport Planning.

GuT 2022. „Verbrauchsdaten 2022". Excel datasheet received from the OU Buildings and Technical Support

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 Accessed on: 28.6.22

Stadt Graz 2019. „Mobilitätsverhalten der Grazer Wohnbevölkerung 2018". Department of Traffic Planning, City of Graz

TU Graz 2022. „Wissensbilanz 2021". Approved by the TU Graz Senate in April 2022