2021 Greenhouse Gas Monitoring at TU Graz

and comparison with the 2017 and 2020 GHG balances

Final version

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STS Science, Technology and Society Unit

ISDS INSTITUTE OF INTERACTIVE SYSTEMS AND DATA SCIENCE

This 2021 report on greenhouse gas monitoring at TU Graz (final version, last updated on 10/12/2014) 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 using the 2021 version of the *ClimCalc* tool: ClimCalc_v3.2_EF2021 (Alliance for Sustainable Universities in Austria 2024).

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 2021 greenhouse gas monitoring at TU Graz, considering the categories *Energy, Mobility, Material use,* and *Canteen,* with data collected at the main and secondary locations of TU Graz.

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

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Data provided by:

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

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1. Method descriptions and system limits

As part of the “Climate-neutral TU Graz 2030” project, a decision was made that annual GHG monitoring should be carried out from 2021 onwards in addition to the triannual, 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:

GHG monitoring is performed at TU Graz to provide a quick annual overview of the development of GHG emissions at TU Graz in the categories of energy, mobility, material use, and canteen. The data that can be collected without investing a great deal of time and research effort are collected precisely. The remaining data are taken from the most recent complete GHG balance and adjusted if necessary; in this case, they were taken from the 2020 GHG balance.
The CO_2e emissions were calculated using the *ClimCalc* tool (Alliance for Sustainable Universities in Austria 2024). The emission factors used come from the Austrian Federal Environment Agency. The emission factors available as of June 2024 for the year 2021 were used (version "ClimCalc_v3.2_EF2021"), which is why this is the **final version** of the 2021 GHG monitoring.

The following subcategories were surveyed completely and accurately for 2021:

- Electricity
- PV on-site 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 in some cases adapted:

- Natural gas (heat)
- Fuels for research
- Staff commuting (adjusted based on the number of staff)
- Commuting students (adjusted based on the number of students)
- Business trips (adjusted based on the number of business trips in 2021; these could be accurately recorded annually from 2022 onwards using the CO_2 business trip tool)
- Own vehicle fleet
- Paper
- IT equipment

Not recorded:

- Buildings (new buildings/renovations, demolition)

This method of monitoring allows us to accurately record data in those subcategories with the highest emissions at TU Graz (electricity, district heating) on an annual basis and to obtain a relatively accurate approximation of the actual emissions in the emissions-intensive *Mobility* category.
Therefore, the category of *new buildings/renovations* was not included in this GHG monitoring, as there is still no generally accepted methodology for recording the "grey" GHG emissions from buildings (i.e. GHG emissions from the production of relevant building materials) in the emissions balance of organisations (such as universities). However, TU Graz will endeavour to include this category in the next 2022 GHG Monitoring.

System limit:

The TU Graz net floor area in 2021 (reference date 1 October 2021; GuT 2022) was as follows

Total net floor space	255,375 m^2
Net heated floor area	231,981 m^2

Table 1: Total net floor area and heated floor area at TU Graz in 2021

The numbers of TU Graz staff and students were taken from the 2021 Intellectual Capital Report (TU Graz 2022, p. 17). In addition, the number of staff at shareholdings was added to the number of general staff, with these data provided by the *Assistance to the Rector: Statistics and Data Protection* organisational unit. Shareholdings are included in GHG monitoring if they are very closely connected to TU Graz in terms of their finances, location, and/or personnel.

	According to the 2021 Intellectual Capital Report	Shareholdings 2021	Total
Staff			
Individuals (reporting date 31.12.2021)	3,914.0	992.0	**4,906.0**
Full-time equivalents (FTE) (annual average value 2021)	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 TU Graz staff and students in 2021

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

2. GHG Monitoring

2.1 Summary

In total, around **15,700 tonnes of CO_2e** were produced at TU Graz in **2021**. This means that the GHG emissions are at the same level as in **2020 with 15,700 tonnes of CO_2e**. Although there were fewer restrictions related to the coronavirus pandemic in 2021 and this led to changes in various categories, the emissions remained at roughly the same level.

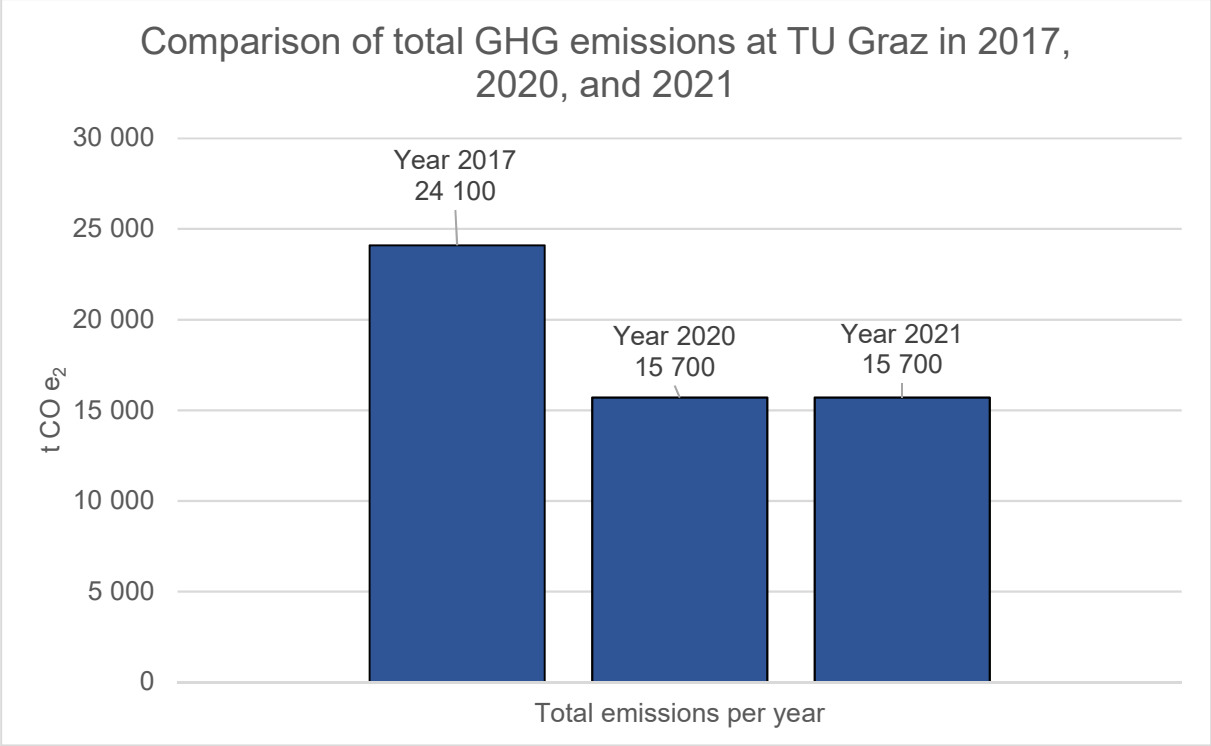

Figure 1: Comparison of total GHG emissions at TU Graz in 2017, 2020, and 2021

GHG emissions are divided into three different scope categories: Scope 1 emissions are emissions caused directly by an organisation, Scope 2 emissions are indirect, energy-related emissions (arising from the generation of purchased electricity, steam, and district heating and cooling), Scope 3 emissions are also indirect emissions (upstream and downstream; here, for example, caused primarily by mobility or material use).
The following graphs depict the emissions by scope category in 2017, 2020, and 2021. The distribution in the various scope categories has changed significantly in the period shown. While the share of Scope 3 emissions has dropped from 50% to 40% over the years, the share of Scope 2 emissions has increased by 8%. This increase is due to the fact that consumption in the *Energy* category increased as the restrictions related to the coronavirus pandemic eased and due to the higher number of heating degree days in 2021, but the emissions from mobility in 2021 are still low (in some subcategories even lower) than in

2020. Scope 1 emissions increased from 2% to 4% from 2017 to 2020 and then remained the same.

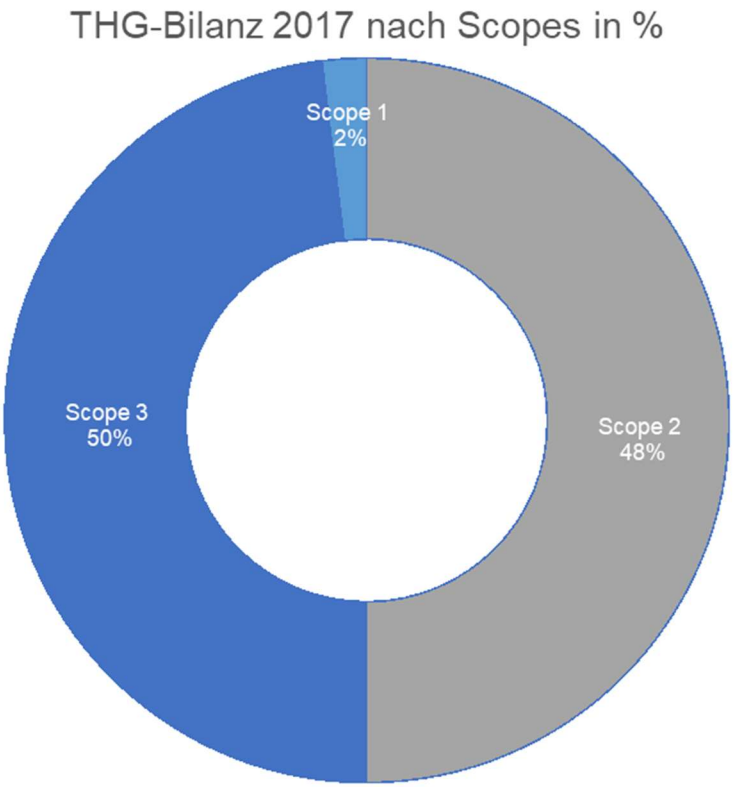

Figure 2: 2017 GHG balance by scope category in %

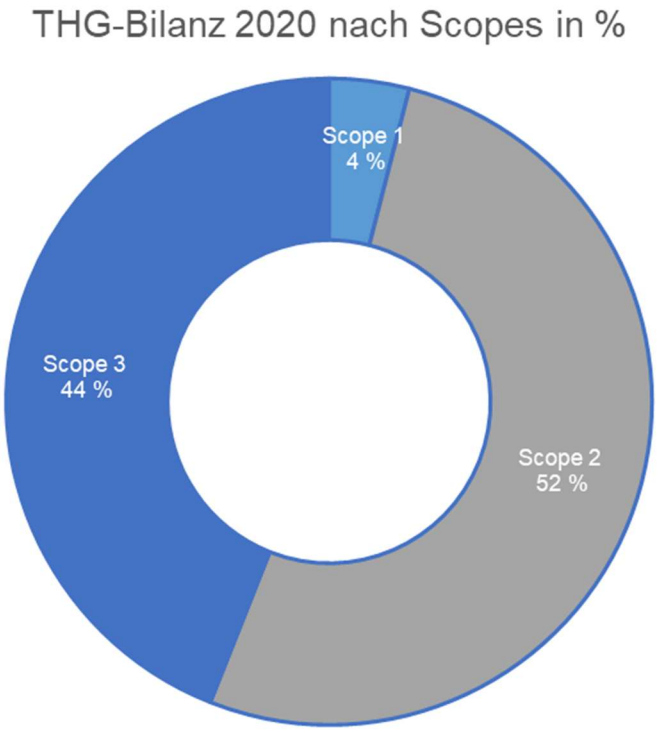

Figure 3: 2020 GHG balance by scope category in %

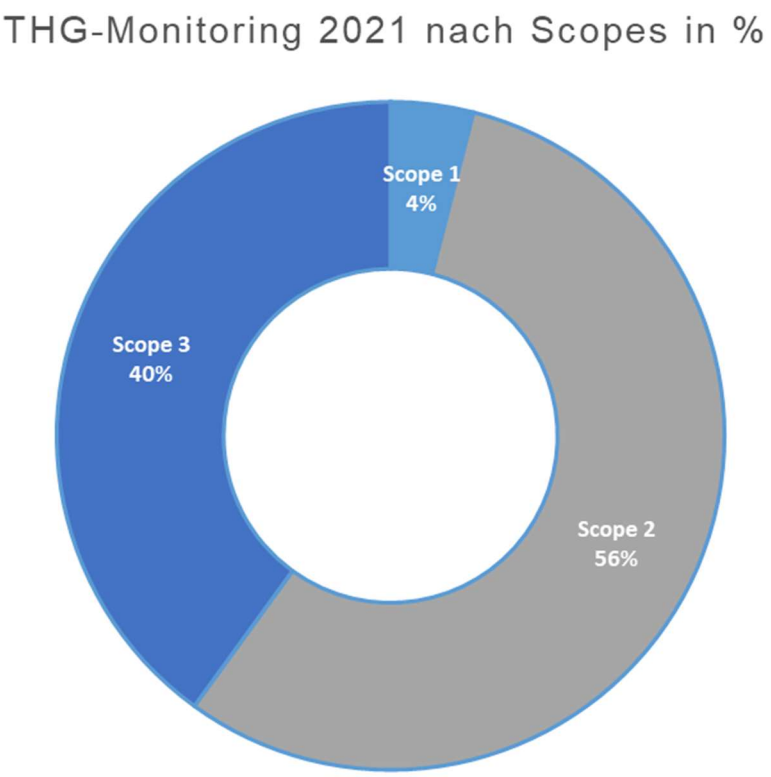

Figure 4: 2021 GHG monitoring by scope category in %

The largest share of emissions is seen in the *Energy* category (12,147 tonnes of CO_2e), followed by the *Mobility* (2,765 tonnes of CO_2e), *Material use* (587 tonnes of CO_2e), and finally the *Canteen* (186 tonnes of CO_2e) categories.

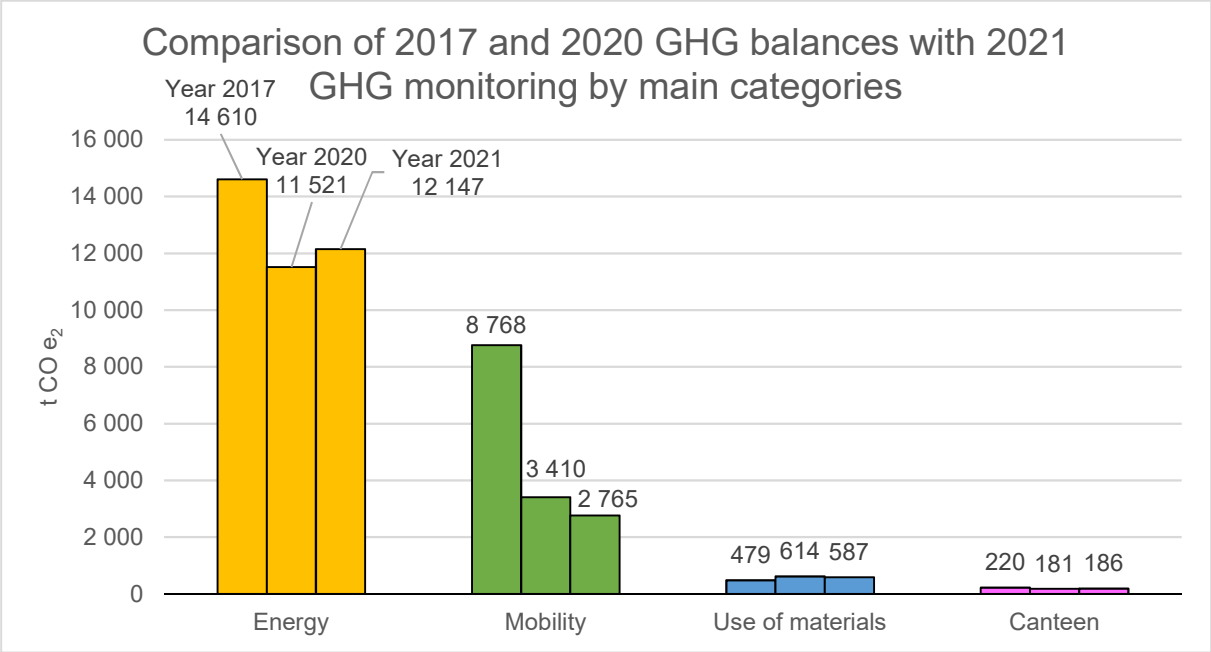

Figure 5: Comparison of 2017 and 2020 GHG balances with 2021 GHG monitoring by main categories

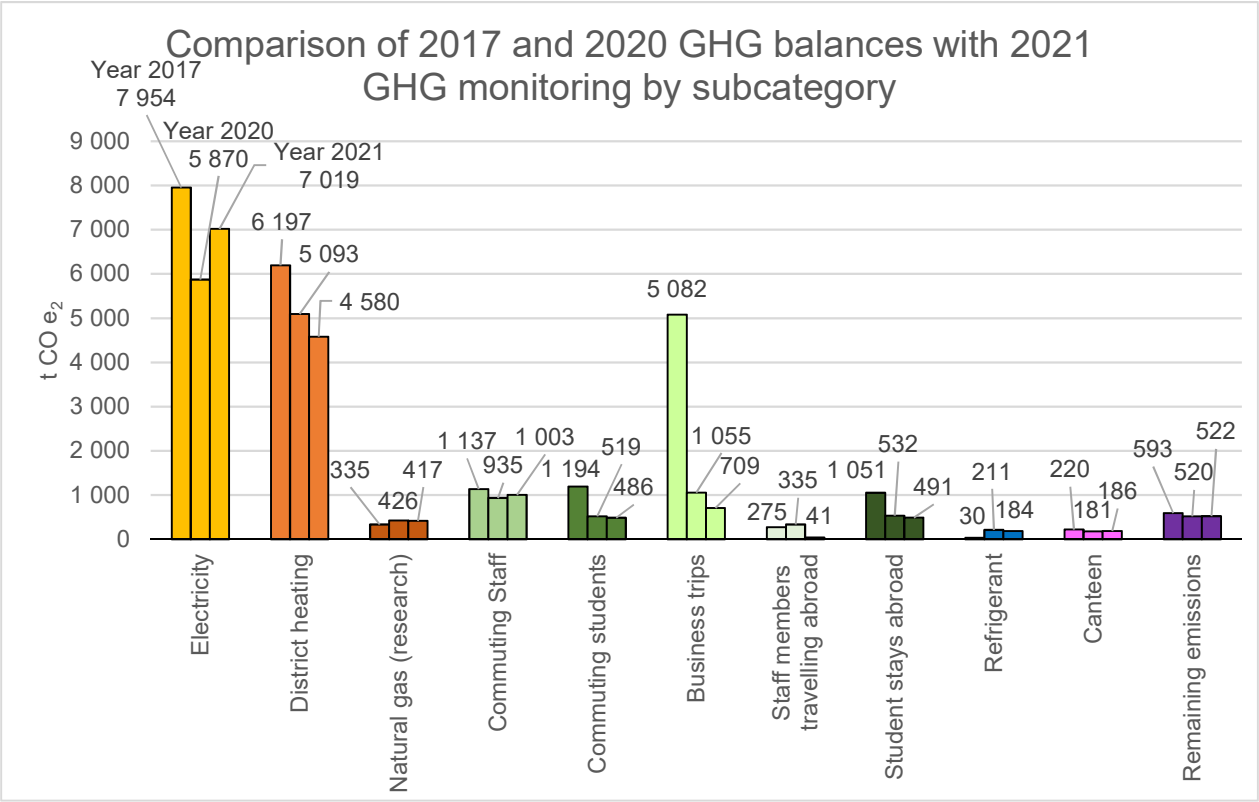

Figure 6: Comparison of 2017 and 2020 GHG balances with 2021 GHG monitoring by subcategory

2.2 Energy

GHG emissions for the *Energy* category are calculated for the *electricity, district heating, natural gas (heat),* and *natural gas (research)* subcategories by recording consumption data (kWh or MWh), which are then multiplied by the corresponding emission factor. The following graph shows an overview of consumption in these subcategories in 2017, 2020, and 2021. The *electricity* subcategory was divided into *electricity consumption (excl. HP*, where HP stands for heat pumps), *electricity consumption from PV (photovoltaics),* and *HP electricity consumption*. The presentation of consumption data is important insofar as it shows whether TU Graz (regardless of its emissions) is achieving reductions in consumption or increased efficiency in the areas of electricity and heat. From page 11 onwards, this energy consumption is also presented in a tabular form. When interpreting the numbers, please note that TU Graz has been growing continuously since 2017, it has also grown in terms of staff and m^2 of net floor space, and factors such as restrictions related to the coronavirus pandemic and the number of heating degree days influence consumption.

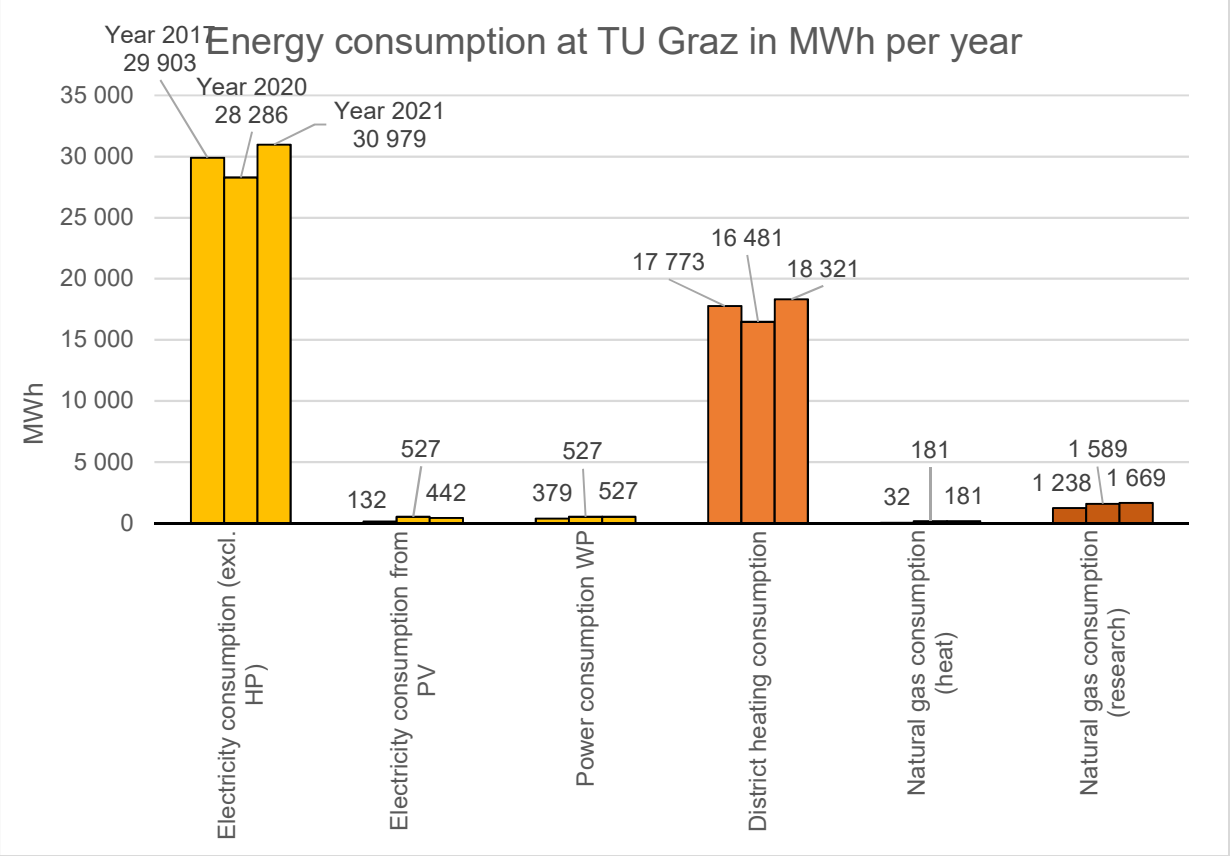

Figure 7: Energy consumption at TU Graz in MWh per year

A total of 12,147 tonnes of CO_2e were produced in the *Energy* category in 2021.
The three most emission-intensive electricity subcategories (consisting of electricity consumption without UZ-46 certification and electricity consumption from our own PV systems), district heating, and natural gas (research)) were analysed in detail for the 2021 GHG monitoring. The consumption data for natural gas (heating) and fuels (research) were taken from the most recent complete GHG balance sheet (2020).

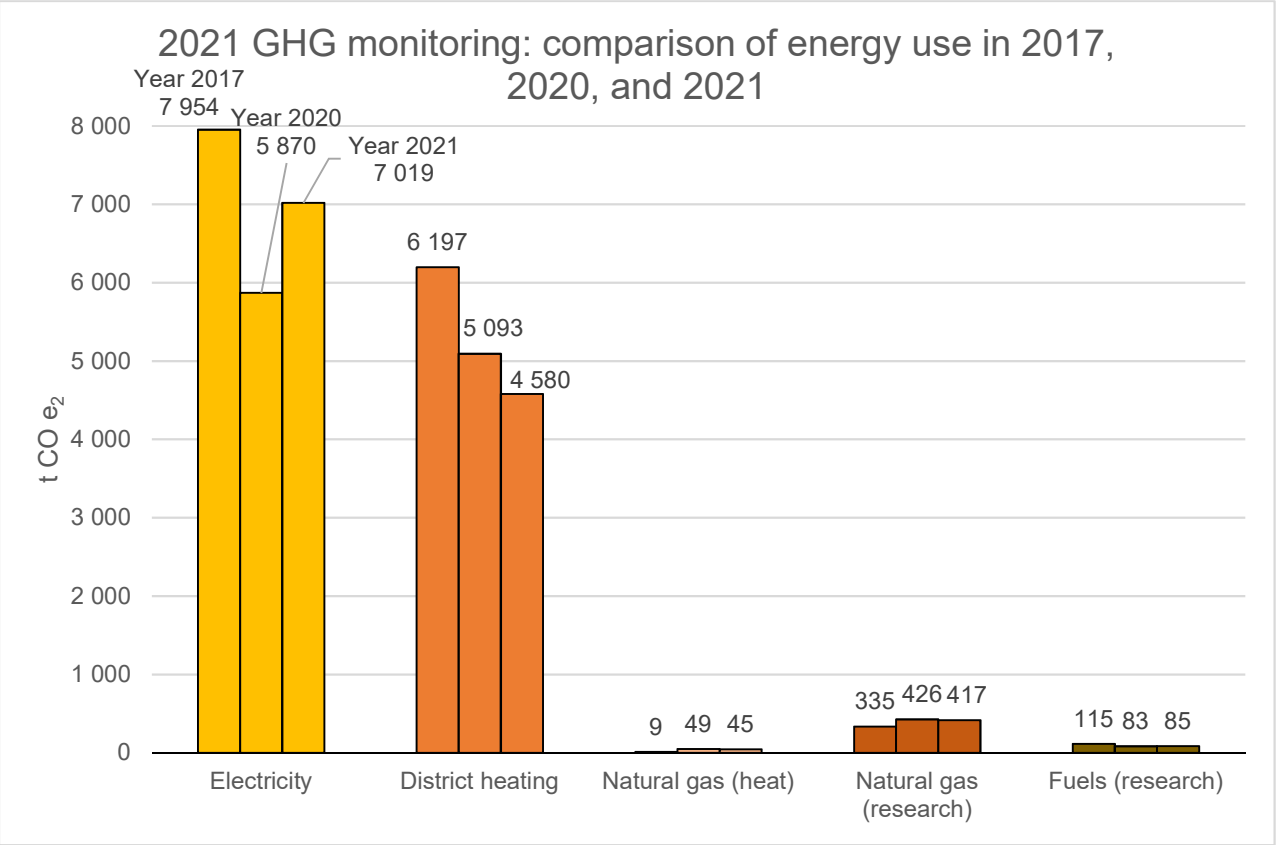

Figure 8: 2021 GHG monitoring – Comparison of energy use in 2017, 2020, and 2021

The following table shows how consumption, the emission factor (EF), and emissions from electricity without UZ 46 certification and PV electricity have changed from 2017 to 2020 and 2021. The consumption and emissions from heat pumps are also shown. This value is the same for 2021 and 2020, as no exact values were available for 2020; therefore, the data from 2021 were used as an approximation when the 2020 GHG balance was prepared.
The observed increased electricity consumption is due to the fact that TU Graz was busier in 2021 than in 2020, and the number of staff increased. The yield from the PV systems was slightly lower in 2021 than in 2020, as no new systems were added in this period, and the yield was lower due to the weather. The PV system achieved the highest monthly yield in 2021 in June with 79,498 kWh. 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 tonnes CO_2e
2021 Electricity without UZ 46 certification	30,979,438 with 527,150 used by heat pumps	0.2260	7,001 with 119 from heat pumps
2021 PV	441,582	0.0400	18
Total	31,421,020		**7,019**

2020 Electricity without UZ 46 certification	28,813,347 with 527,150 used by heat pumps	0.203	5,849 with 107 from heat pumps
2020 PV	526,924	0.0400	21
Total	29,340,271		**5,870**
2017 Electricity without UZ 46 certification	30,882,000 with 379,000 used by heat pumps	0.2573	7,946 with 100 from heat pumps
2017 PV	132,000	0.0600	8
Total	30,414,000		**7,954**
Increase/decrease in % electricity (from 2020 to 2021)	Plus 7%	Plus 11%	Plus 20%
Increase/decrease in % PV (from 2020 to 2021)	Minus 16%	Same EF used	Minus 16%
Total			**Plus 20%**

Table 3: Comparison of electricity data for 2017, 2020, and 2021

The consumption of district heating increased by 12% in 2021 compared to 2020, while emissions dropped by around 10%. The increase in consumption is mainly due to the higher number of heating degree days in 2021, which amounted to 3,948.8 in 2021 as compared to 3,627.3 in 2020 and 3,852.6 in 2017 (GuT 2022). The increased consumption in 2021 compared to 2017 is due to the number of heating degree days, but also to the growth of TU Graz. The lower emissions are solely due to the lower emission factor.

Comparison of 2021 with 2020 and 2017: District heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes CO_2e
2021	18,321,200	0.2500	**4,580**
2020	16,416,560	0.3079	**5,055**
2017	17,773,000	0.3487	**6,197**
Increase/decrease in % (from 2020 to 2021)	Plus 12%	Minus 20%	Minus 10%

Table 4: Comparison of district heating data for 2017, 2020, and 2021

The consumption of natural gas for research increased by 4% in 2021 compared to 2020, as more natural gas was used for experiments. The data for natural gas used for heat consumption were taken from the 2020 GHG balance. Overall, the resulting emissions were 8% higher than those in 2020.

Comparison of 2021 with 2020 and 2017: Natural gas			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2021	1,850,579 Research use: 1,669.287 Heat use: 181.292	0.2500	**463** Research use: 417 Heat use: 45
2020	1,770,350 Research use: 1,589,292 Heat use: 181,292	0.2410	**427** Research use: 383 Heat use: 44
2017	1,269,946 Research use: 1,238.221 Heat use: 31.779	0.2703	**343** Research use: 335 Heat use: 9
Increase/decrease in % (from 2020 to 2021)	Plus 4%	Plus 4%	Plus 8%

Table 5: Comparison of natural gas data for 2017, 2020, and 2021

2.3 Mobility

Total emissions in the *Mobility* category amount to 2,765 tonnes of CO_2e in 2021
In this category, the subcategories of *staff stays abroad* and *student stays abroad* were fully surveyed for the 2021 GHG monitoring.
The 2019 transport survey (Forstner 2021) was used for the subcategories of *staff commuting* and *student commuting* and adjusted based on the number of staff and students and the restrictions related to the coronavirus pandemic (lockdown, distance learning, working from home). For this purpose, it was assumed that staff commuted 60% less often 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 in 2019 to 4,906 in 2021, so the emissions were increased proportionally. Regarding students, the assumption was made that they commuted 80% less during the 2.5 months of lockdown and 60% less during the remaining time (9.5 months) as compared to 2019 due to distance learning. The number of students in 2021 was 16,082, and the emissions from the 2019 traffic survey were adjusted proportionally. The next transport survey at TU Graz was conducted in 2023.
Around 250 fewer business trips were made in 2021 than in 2020. The business trip emissions from the 2020 GHG balance were adjusted proportionally for 2021. The data on the TU Graz (own) vehicle fleet were taken from the 2020 GHG balance.

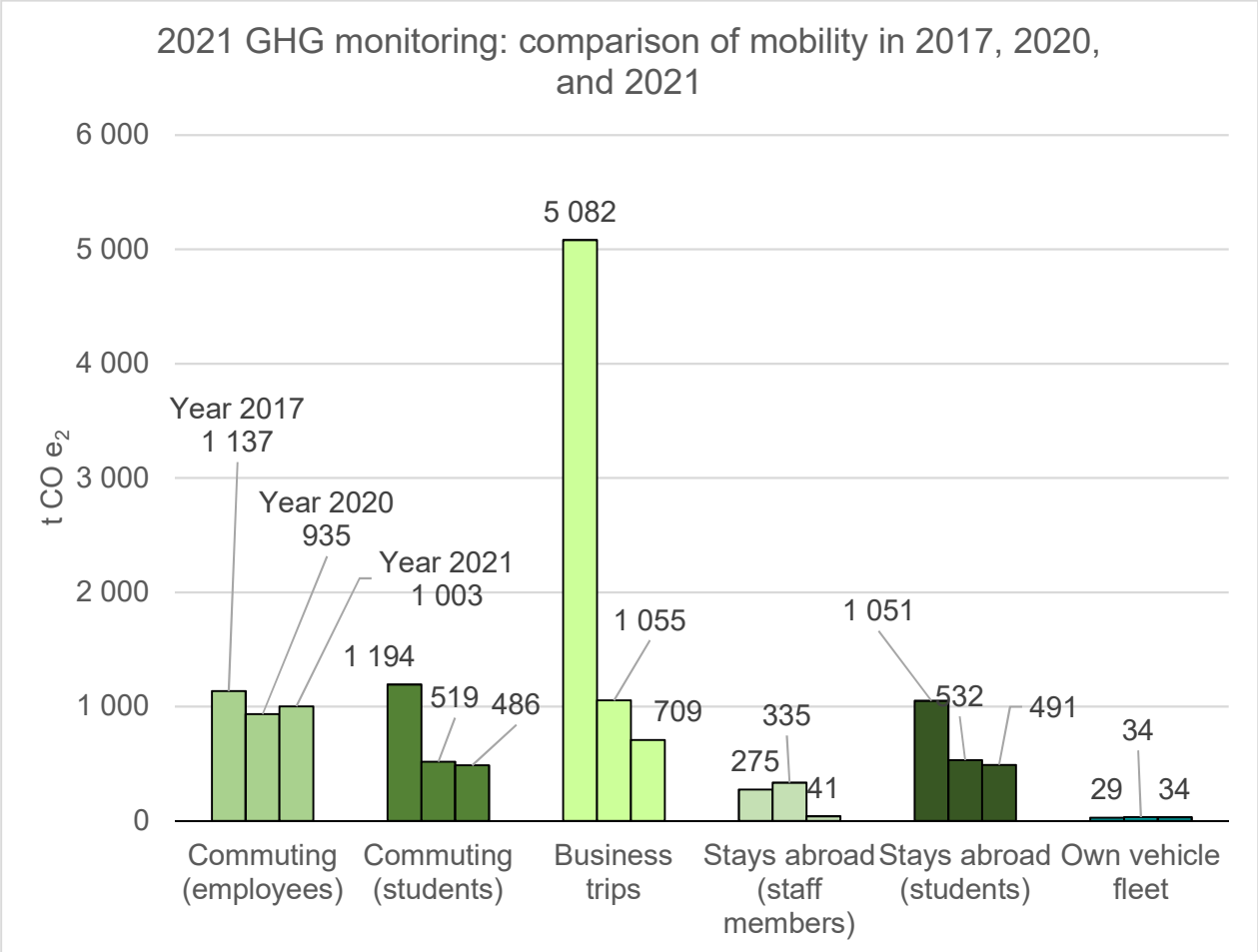

Figure 9: 2021 GHG monitoring – Comparison of mobility in 2017, 2020, and 2021

As stays abroad (staff and students) are the subcategories surveyed precisely in 2021, the following tables show the passenger kilometres, emission factors, and emissions in 2021 as compared to 2020 and 2017. Please note here that the modes of transport were not surveyed until 2020, but the allocation is based on estimates (up to 750 km, the use of long-distance bus transport was assumed and from 750 km, the use of a flight was assumed). It was only from 2021 onwards that data on the modes of transport were collected by integrating an appropriate question on a questionnaire sent out after the stay abroad. This is why more precise data are now available for 2021. These data show that long-distance buses are rarely used, while cars and trains are definitely used. Medium- and long-haul flights are used to reach more distant destinations (> 750 km), which have by far the greatest impact on emissions in this subcategory.

Comparison of 2021 with 2020 and 2017: Staff stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2021			
Car	6,960	0.2190	2
Railway	3,056	0.0130	(0.04) = 0
Long-distance bus	0	0.0510	0
Short-haul flight	7,540	1.4500	11
Medium-/long-haul flight	63,780	0.4530	29
Total	81,336		**41**
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%	Plus 4%	Minus 100%
Short-haul flight	Minus 60%	Plus 50%	Minus 40%
Long-haul flight	Minus 87%	Plus 15%	Minus 85%
Total			**Minus 81%**

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

Comparison of 2021 with 2020 and 2017: Student stays abroad			
	Passenger kilometres (pkm)	Emission factor in kg CO_2e/km	Emissions in tonnes CO_2e
2021			
Car	53,674	0.2190	12
Railway	35,400	0.0130	(0.46) = 0
Long-distance bus	3,740	0.0510	(0.19) = 0
Short-haul flight	36,080	1.4500	52
Medium-/long-haul flight	940,370	0.4530	426
Total	1,069,264		**486**
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%	Plus 4%	Minus 88%
Short-haul flight	Plus 22%	Plus 50%	Plus 79%
Medium-/long-haul flight	Plus 21%	Plus 15%	Plus 39%
Total			**Plus 44%**

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

2.4 Material use

In the *Material use* category, the refrigerants were precisely recorded for the 2021 GHG monitoring; the data for paper and IT equipment were taken from the 2020 GHG balance. The total emissions in this category amount to 587 tonnes of CO2e.

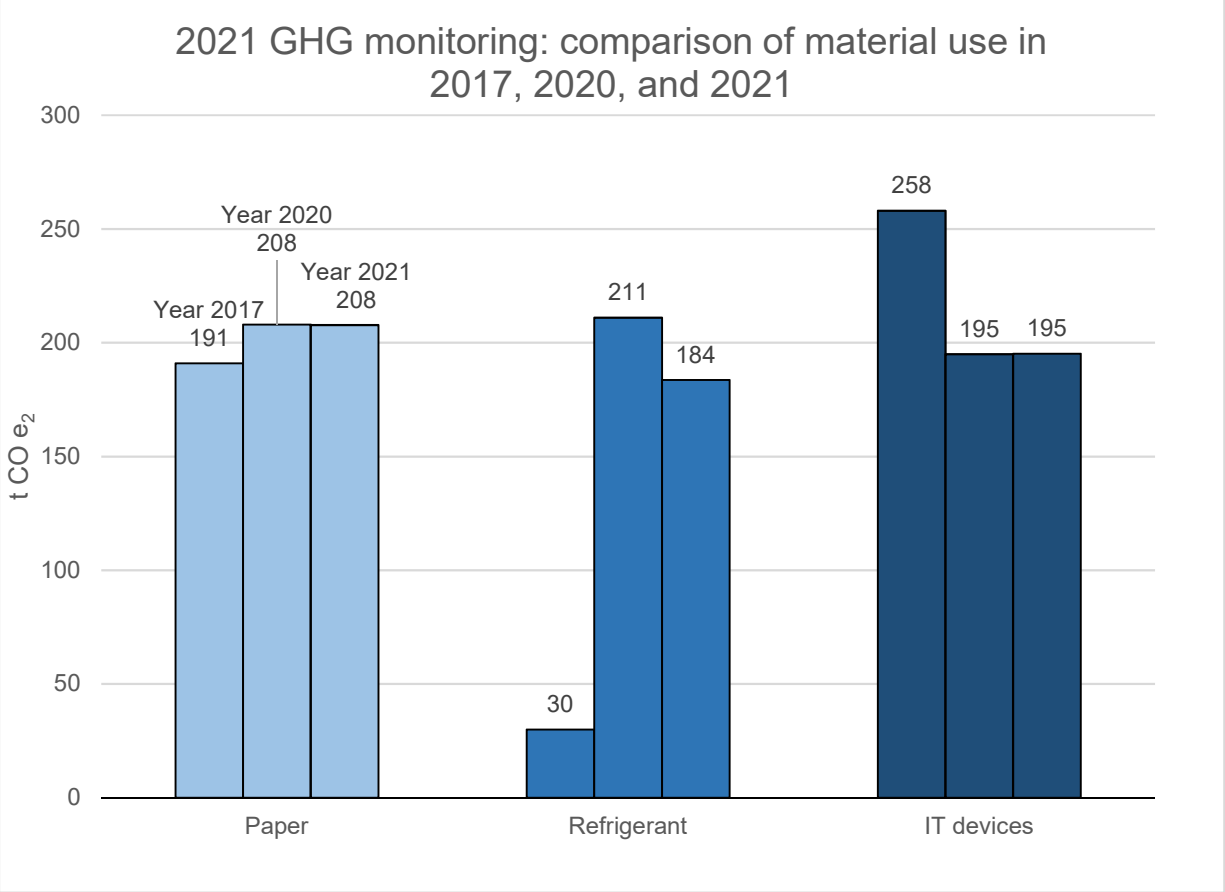

Figure 10: 2021 GHG monitoring – Comparison of material use in 2017, 2020, and 2021

As seen in 2020, refrigerant emissions are still very high in 2021, which was due to a defect in a system that allowed refrigerants to escape. However, the system has now been dismantled.

Comparison of 2021 with 2020 and 2017: Refrigerants			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in tonnes CO_2e
2021			
R410A	3	1,938.50	6
R407c	108.5	1,639.21	178
Total	111.5		**184**
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%	Minus 7%	Minus 83%
R407c	Plus 47%	Minus 8%	Plus 36%
			Minus 12%

Table 8: Refrigerant use – Comparison of 2017, 2020, and 2021

2.5 Canteen

Data for the *Canteen* category and all subcategories were fully recorded for the 2021 GHG monitoring. Total emissions increased slightly in 2021 compared to 2020, namely from 181 tonnes of CO_2e in 2020 to 186 tonnes of CO_2e in 2021.
Emissions from electricity consumption remained almost the same in 2021 compared to 2020. Those emissions from district heating also increased only slightly (which, in turn, is related to the increased number of heating degree days with a lower emission factor), while emissions from food consumption also increased only marginally. The comparatively very low district heating emissions seen in 2017 are due to the renovation work performed in the winter months of 2017.

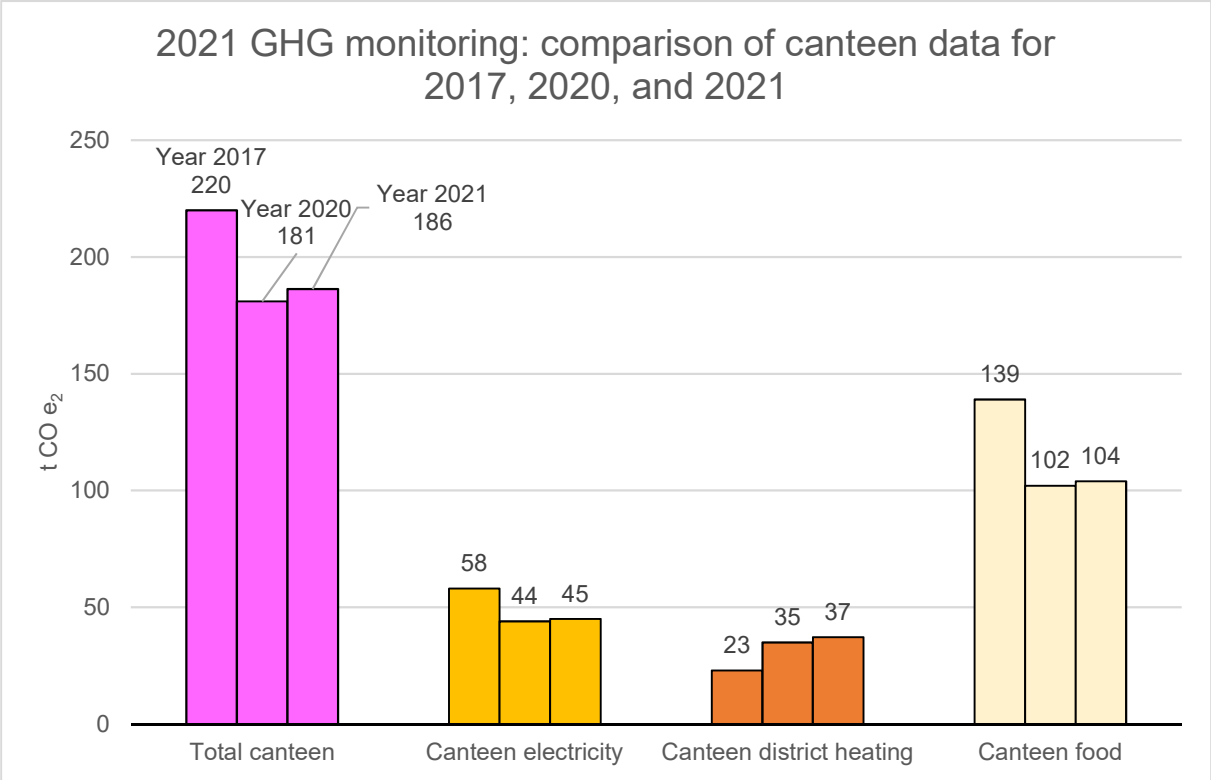

Figure 11: 2021 GHG monitoring – Comparison of canteen data for 2017, 2020, and 2021

Comparison of 2021 with 2020 and 2017: Canteen electricity			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2021	199,342	0.2260	**45**
2020	202,984	0.2190	**44**
2017	225,000	0.2573	**58**
Increase/decrease in % (2020 to 2021)	Minus 2%	Plus 3%	Plus 2%

Table 9: Comparison of canteen electricity data for 2017, 2020, and 2021

Comparison of 2021 with 2020 and 2017: Canteen district heating			
	Consumption in kWh	Emission factor in kg CO_2e/kWh	Emissions in tonnes of CO_2e
2021	149,000	0.2500	**37**
2020	112,471	0.3079	**35**
2017	66,000	0.3487	**23**
Increase/decrease in % (2020 to 2021)	Plus 32%	Minus 19%	Plus 6%

Table 10: Comparison of canteen district heating data for 2017, 2020, and 2021

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

Comparison of 2021 with 2020 and 2017: Canteen food			
	Consumption in kg	Emission factor in kg CO_2e/kg	Emissions in tonnes of CO_2e
2021			
Beef	2,088	13.5000	28
Pork	3,585	5.0000	18
Poultry	4,838	3.5000	17
Fish	2,340	6.5000	15
Fats and oils	4,280	6.0000	26
Total	17,131		**104**
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%	Plus 2%	Plus 17%
Pork	Plus 102%	Minus 10%	Plus 80%
Poultry	Minus 51%	Plus 10%	Minus 45%
Fish	Plus 12%	Same EF used	Plus 7%
Fats and oils	Plus 8%	Plus 4%	Plus 13%
Total			**Plus 2%**

Table 11: Comparison of canteen food data for 2017, 2020, and 2021

2.6 New buildings/renovations

There were no significant new buildings or renovations in 2021.

3. Key figures

The key figures were rounded to one or two decimal places or to one decimal place. The following table shows a comparison of the key figures for 2017, 2020, and 2021
New additions in this report (compared to the 2020 GHG balance) are the key figures: "5. TU Graz electricity consumption (excl. heat pumps + charging stations, incl. PV + canteen) per m^2 net floor area total", "6.a TU Graz district heating consumption per m^2 net floor area heated with district heating, adjusted for heating degree days (mean value 2011–2019), 15/23 °C" and for the mobility key figures: "1a. For comparison: Modal split for commuting to work in the city of Graz in 2013/14, local and inbound commuters, main modes of transport (Forstner 2021, p. 65, Österreich unterwegs 2013/14)", "2. Modal split for TU Graz staff commuting in 2019, local commuters, main modes of transport (Forstner 2021, p. 69)" and "2a. For comparison: Modal split for work commuters in the city of Graz in 2013/14, local commuters, main modes of transport (Forstner 2021, p. 69, Österreich unterwegs 2013/14)".

Key figures		
1. TU Graz electricity consumption (excl. heat pumps + charging stations, incl. PV + canteen) per staff member (per individual)		
2021	**6,306**	kWh per individual
2020	**6,050**	kWh per individual
2017	**8,240**	kWh per individual
2. TU Graz electricity consumption (excl. heat pumps + charging stations, incl. PV + canteen) per staff member (FTE)		
2021	**9,224**	kWh per FTE
2020	**9,076**	kWh per FTE
2017	**12,130**	kWh per FTE
3. TU Graz electricity consumption generated by PV, per staff member (FTE)		
2021	**132**	kWh per FTE
2020	**165**	kWh per FTE
2017	**52**	kWh per FTE
4. TU Graz emissions from electricity (excl. heat pumps, incl. PV + canteen) per staff member (FTE)		
2021	**2,071**	kg CO_2e per FTE
2020	**1,806**	kg CO_2e per FTE
2017	**3,120**	kg CO_2e per FTE

5. TU Graz electricity consumption (excl. heat pumps + charging stations, incl. PV + canteen) per m^2 total net floor area		
2021	**121**	kWh per m^2
2020	**116**	kWh per m^2
2017	**127**	kWh per m^2
6. TU Graz heat consumption (incl. heat pumps) per m^2 net floor area heated		
2021	**85**	kWh per m^2
2020	**75**	kWh per m^2
2017	**91**	kWh per m^2
6.a TU Graz district heating consumption 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. TU Graz emissions from heat per m^2 net floor area heated		
2021	**21**	kg CO_2e per m^2
2020	**23**	kg CO_2e per m^2
2017	**21**	kg CO_2e per m^2
8. TU Graz emissions per student		
2021	**975**	kg CO_2e per individual

[1] The calculation of the heating degree day-adjusted key figures for district heating at TU Graz in the years 2013-2021 was carried out as follows: If the average daily temperature was below 15 °C, heating was set to 23 °C at TU Graz. Depending on how much the average daily temperature was below 15 °C, a higher or lower heating degree day figure was entered for that day. An average value per year was calculated from these figures, using the summed values for the years 2011-2019. Using this mean value and the following calculation, "Number of heating degree day for the year divided by the mean value, multiplied by the current district heating consumption in kWh", the district heating consumption of the current year can be adjusted based on the number of 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.

2020	**1,065**	kg CO_2e per individual
2017	**1,630**	kg CO_2e per individual
9. emissions TU Graz per employee (head)		
2021	**3,197**	kg CO_2e per individual
2020	**3,285**	kg CO_2e per individual
2017	**7,390**	kg CO_2e per individual
10. emissions TU Graz per employee (FTE)		
2021	**4,676**	kg CO_2e per FTE
2020	**4,928**	kg CO_2e per FTE
2017	**10,880**	kg CO_2e per FTE
11. emissions TU Graz per m^2 total net floor area		
2021	**61**	kg CO_2e per m^2
2020	**62**	kg CO_2e per m^2
2017	**114**	kg CO_2e per m^2
12. emissions TU Graz per m^2 net floor area heated		
2021	**68**	kg CO_2e per m^2
2020	**68**	kg CO_2e per m^2
2017	**126**	kg CO_2e per m^2

Table 12: Key figures for energy and total emissions

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

On foot	**7**	%
Bicycle	**15**	%
Motorised individual vehicle (MIV)	**56**	%
Public transport (ÖPNV)	**22**	%
2. Modal split for TU Graz staff commuting in 2019, local commuters, main modes of transport (Forstner 2021, p. 69)		
On foot	**17**	%
Bicycle	**59**	%
Motorised individual vehicle (MIV)	**9**	%
Public transport (ÖPNV)	**14**	%
2a. For comparison: Modal split for work commuters in the city of Graz in 2018, local commuters, main modes of transport (City of Graz 2019)		
On foot	**10**	%
Bicycle	**21**	%
Motorised individual vehicle (MIV)	**49**	%
Public transport (ÖPNV)	**20**	%
3. Modal split for TU Graz student commuters in 2019, local and inbound commuters, main modes of transport (Forstner 2021, p. 66)		
On foot	**19**	%
Bicycle	**52**	%
Motorised individual vehicle (MIV)	**7**	%
Public transport (ÖPNV)	**22**	%

4. Modal split for those commuting to educational institutions in the city of Graz in 2013/14, local and inbound commuters, main modes of transport (Forstner 2021, p. 66, Österreich unterwegs 2013/14)		
On foot	**11**	%
Bicycle	**19**	%
Motorised individual vehicle (MIV)	**22**	%
Public transport (ÖPNV)	**48**	%
5. Modal split for business trips by total kilometres in 2018 (Forstner 2021, p. 41)		
Motorised individual vehicle (MIV)	**5**	%
Public transport (ÖPNV)	**16**	%
Air transport	**79**	%

6. Flight emissions of staff (stays abroad and business trips) per staff member (individual)		
2021	**175**	kg CO_2e per individual
2020	**341**	kg CO_2e per individual
2017	**1,554**	kg CO_2e per individual
7. Parking spaces per staff member (individual)		
2021	**0.13**	Parking spaces per individual
2020	**0.13**	Parking spaces per individual
2017	**0.17**	Parking spaces per individual
8. Parking spaces per staff member (FTE)		
2021	**0.18**	Parking spaces per FTE
2020	**0.21**	Parking spaces per FTE
2017	**0.25**	Parking spaces per FTE

Table 13: Key figures for mobility and mobility-related emissions

4. Recommendations: Measures and projects

(as of: December 2022)

1. Car monitoring – Commuting

As part of the development of the GHG monitoring, the project has been defined to record the emissions caused by staff commuting by car on a monthly aggregated basis using the anonymised entry data of those authorised to park. This process of collecting anonymised data per month is currently under development. From the 2022 GHG monitoring onwards, it will probably be possible to record and report car emissions caused by commuting in this way.

2. Erasmus+ Green

As the 2021 GHG monitoring shows, emissions caused by student stays abroad increased from 2020 to 2021. The EU Erasmus+ Green programme offers students a subsidy of € 50 if they choose climate-friendly modes of transport when travelling to and from a stay abroad (bus, train, carpooling). TU Graz could match this contribution for a total of € 100 to offer a greater incentive for students to use more climate-friendly modes of transport.

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

1. **Green hydrogen instead of natural gas for research**
   Natural gas for research should be replaced by green methane or green hydrogen. At TU Graz, natural gas for research is mainly used at the Institute of Thermal Engineering and the LEC (Large Engines Competence Center). Of course, the needs of the clients of the respective research projects would have to be considered.
   The opportunities for this conversion may be higher, since the construction of an electrolyser on the TU Graz campus is currently under discussion.

2. **Demand the expansion of Park&Ride/Bike&Ride options and promote the use of e-bikes and folding bikes**
   Commuters who commute to Graz every day from outside the city often travel longer distances by car; thus, TU Graz could take further measures to promote the use of alternative transport. Promoting the Styrian climate ticket together with demanding the further expansion of Park&Ride and Bike&Ride options at railway stations near the commuters' homes, as well as promoting the use of e-bikes, could achieve the desired effects here. Promoting the purchase of folding bikes could also be considered. In any case, commuting routes should be analysed for staff who have access to the TU Graz car parks to encourage more use of public transport.
   The recommendation to subsidise 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 each).

3. **Amendment to the Business Travel Directive to reduce the attractiveness of using a private car**
   The most common destination for staff travelling by car on business trips in 2020 was Vienna (see Appendix 4). As the majority of these journeys could also be made by public transport, the business travel policy could be adapted, e.g. so that cars can be

used to transport heavy goods or if no reasonable public transport connection is available, but otherwise public transport should be used. Another way to reduce car travel would be to establish a rule that business trips should always be carried out using rented cars or company cars (e-cars from *Family of Power*). TU Graz could also encourage the use of a taxi from the train station near a business trip destination to travel the last few kilometres if this destination is difficult or impossible to reach by public transport.
TU Graz's business travel policy was amended in March 2021 to indicate that rail travel should be preferred over air and car travel for trips within Europe. In addition, the newly created page "My climate-friendly business trip" on the TU Graz intranet (TU4U) points out that a taxi can be used (and reimbursed) for the last few kilometres of a business trip if the destination cannot be reached by public transport or can only be reached with difficulty.

4. **Subsidies for stays abroad**
   When travelling abroad, climate-friendly rail travel within Europe could be promoted for both staff and students, e.g. by subsidising day and night train tickets or Interrail tickets. The subsidies for staff could be modelled on the subsidies for business trips.
   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 entered into force in 2023.

5. **Fairphone**
   Another proposal relates to IT equipment. The roadmap for the Climate Neutral TU Graz 2030 project already states that the minimum utilisation period for IT equipment should be increased to 6 years (TU Graz 2020). To extend the useful lifetime, if necessary, equipment could be procured that can be repaired more easily. For example, TU Graz could offer the *Fairphone* as a company mobile phone. The *Fairphone* advertises the fact that defective parts can be replaced quickly and easily, which significantly extends the useful lifetime of a device. The *Fairphone* company also pays attention to fair and sustainable procurement of the materials used, as well as to social aspects of production. The manufacturer is planning a presentation on the *Fairphone*'s emissions (Fairphone 2020). The use of the *Fairphone* as a work mobile phone at TU Graz would have a strongly symbolic effect, illustrating a commitment to greater sustainability, and offer benefits due to the extended service life.
   A meeting with the TU Graz Purchasing Service is being planned.

6. **Emissions from building maintenance**
   For a more precise calculation of emissions from the *Buildings* category, for example, a student dissertation could be assigned to examine TU Graz area B (maintenance) in more detail. This would allow the emissions from this category to be more precisely assessed, and specifically those related to TU Graz.
   To this end, a project was commissioned by the Buildings and Technical Support OU to analyse the material costs incurred and the associated emissions from maintenance activities using the example of the Neue Technik Campus and the reference year 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 the HTU student union**
   To achieve the goal of climate neutrality by 2030, students could also be more closely involved, e.g. via the HTU. The HTU could be supported in further expanding its sustainable projects, such as the cargo bike hiring scheme or the urban gardening project, and in promoting the application of new ideas from students.
   Contact between the representatives of the HTU GIN department (Department for Society, Innovation, and Sustainability) and the management of the Climate Neutral TU Graz 2030 project was established and has continued. Current projects and activities include the cargo bike hiring, urban gardening, repair café, advertising for the purchase of TU Graz bicycles by students, and Car-free Friday. The "Repair Café" project in particular will continue to receive attention in the future and will be expanded if necessary. An innovation competition is also being considered.

8. **GHG monitoring**
   To review the success of the measures, a rapid assessment ("monitoring") should be performed annually at TU Graz. Results for categories in which the data can be collected quickly through processes that are partially automated (e.g. data for energy, business trips, refrigerants) could be accurately produced, while the remaining data could be taken from the last complete balance. This would provide an even clearer picture of the development of GHG emissions at TU Graz. This measure was implemented for the first time in 2021 in consultation with of the *Buildings and Technical Support* organisational unit.
   This proposal is being implemented for the first time with this report. The next GHG monitoring is planned for 2022 and is expected to be prepared in the spring 2023.

9. **Financial resources**
   Another area that is not currently included in TU Graz's GHG balance is the possibility of investing financial resources sustainably. In this way, TU Graz could also promote ecological and ethical progress through its financial investments and – at least indirectly – reduce GHG emissions.
   A discussion on this matter is being planned with those responsible.

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

5. List of figures and tables

6. Bibliography

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