
Carbon footprint calculation 2023

Background

Aalto University has set the path towards carbon neutrality. The university has the goal to be **carbon neutral** with regards to energy and to reduce its GHG emissions by 50% by 2030. To reach the goal, it is important to annually check the emissions development.

This calculation is for 2023 and it is in line with the calculations from previous years. This calculation presents the **total amount of emissions** but also a **comparison** to previous years.

The emission categories have stayed the same as in the 2022 calculation. Some emission factors have been acquired from more accurate sources than previously. All changes in emissions and the emission categories are explained in the report.

Emissions of procurements are calculated with a **spend-based method**, using average emission factors for different goods and services and their costs in the reporting year. Emissions calculated this way are in nature more general than emissions based on concrete units such as meals prepared, or electricity consumed. The procurement boundary includes furnishing and research infrastructure.

Calculation methods 1/4

GHG Protocol

- The calculation has been conducted according to the internationally widely used **GHG Protocol method**, covering scopes 1 - 3 of the standard.
- Emission categories in the report are divided into scopes 1-3. Furthermore, scope 3 emission categories have been divided into 15 subcategories.
- Calculation methods have been described in more detail in the latter parts of the report.
- Unless otherwise mentioned, the unit of emission is **tons of carbon dioxide equivalent (tCO₂e)**. Most emission factors are from Ecoinvent 3.8 (2021) or from Exiobase (2019). Emission factors are mainly regional to Finland, but some are European averages.

Calculation methods 2/4

Scope 1

- **Energy production**
 - Emission calculation is based on the amount of used fuels and fuel specific emission factors.
- **Refrigerants**
 - Emission calculation is based on added refrigerants in 2023 and refrigerant-specific emission factors determined according to their global-warming potential.
- **Fuel burning in owned and leased vehicles**
 - Emission calculation is based on fuel types, amounts of vehicles and their estimated usage in 2023.

Scope 2

- **Energy procurement (Market-based method)**
 - Emission calculation is based on the emission factors of consumed district heating and electricity.
 - Scope 2 is calculated as both market-based and location-based. In the market-based method, the type of purchased electricity and heating are considered. I.e., the emission factors of purchased carbon neutral products are used in the calculation. In the location-based method, average emission factors of used energy grids are used (e.g. the average emissions of Fingrid for electricity).
 - The use of market-based emissions has been recommended for Aalto University for this report.

Calculation methods 3/4

Scope 3

- **Indirect energy life cycle emissions**
 - Scope 3.3, average-data method.
 - Emissions calculation is based on the type of used electricity and an estimation of emissions for solar electricity and geothermal heat.
- **Water consumption**
 - Scope 3.5, average-data method.
 - Emissions calculation is based on the amount of used water and an emission factor for one cubic meter of water.
- **Waste**
 - Scope 3.5, supplier specific method and average-data method.
 - Emissions calculation is based on the amount of waste produced on campus and the emissions data from waste companies.

Scope 3

- **Commuting of staff and students**
 - Scope 3.7, distance-based method.
 - Emissions calculation is based on employee and student commuting distances, commuting methods, and time spent on campus. Input data has been obtained through surveys.
- **Travel**
 - Scope 3.6, supplier specific data and spend-based method.
 - Air travel emission amounts have been obtained from the data of travel agencies and are based on DEFRA's emission factors.
 - Other emissions from traveling have been calculated based on used euros in procurements. Emission factors are mainly from Exiobase 2019.

Calculation methods 4/4

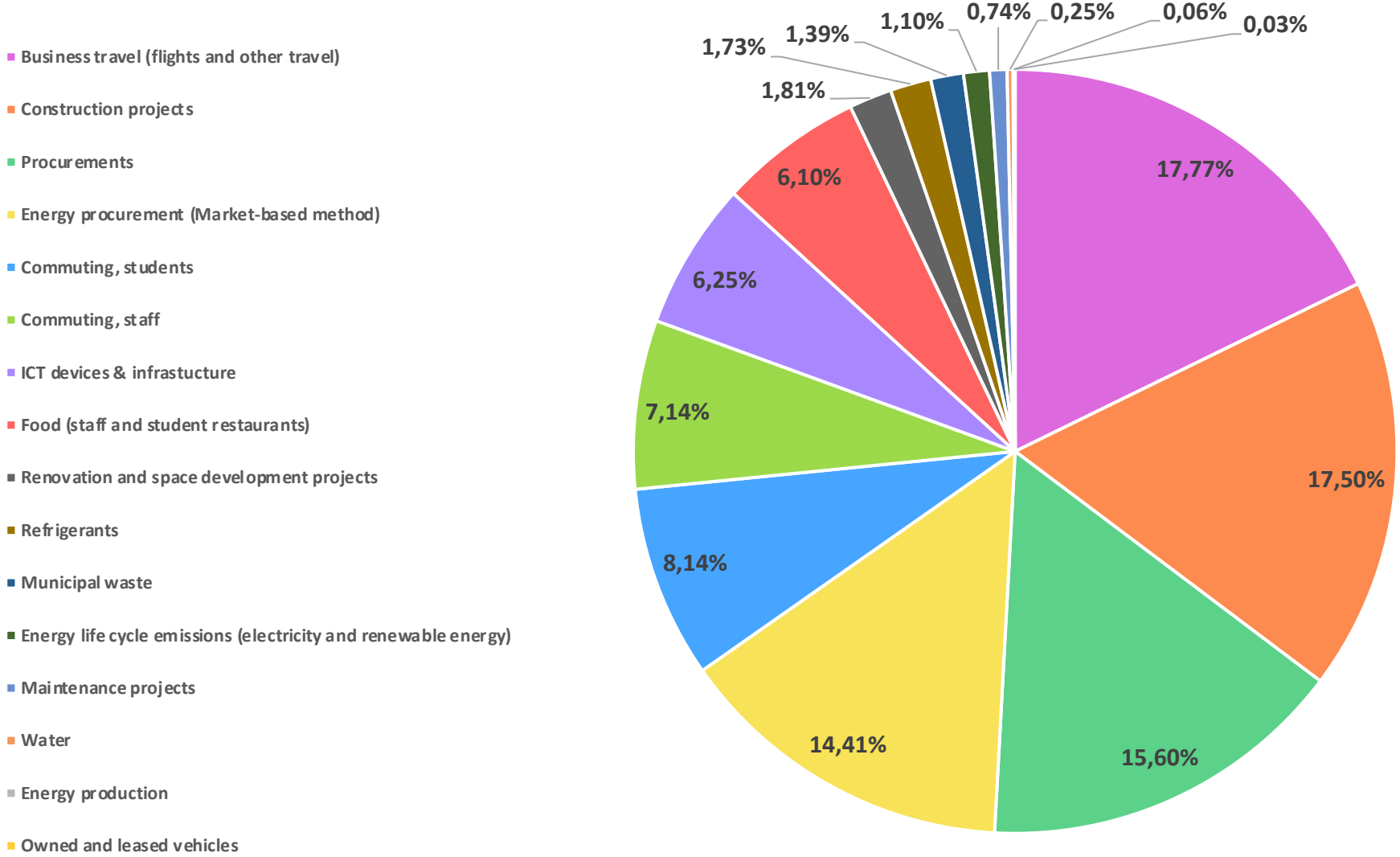
Scope 3

- **Procurements and ICT**
 - Scope 3.1 and 3.2, supplier-specific method and spend-based method
 - ICT emissions are based on the number of devices in use and device-specific emission factors. Calculations are more accurate, since they mainly use supplier data and average university lifetimes.
 - For other procurements, such as furniture and infrastructure, the emissions were determined using the spend-based method. Emission factors are mainly from Exiobase 2019.
- **Construction projects**
 - Scope 3.1
 - Emissions calculation is based on the spend-based method.
- **Food**
 - Scope 3.1
 - Emissions calculation is based on the average-data method. Calculation is based on the amount and type of meals sold in campus restaurants.

Total emission distribution 2023

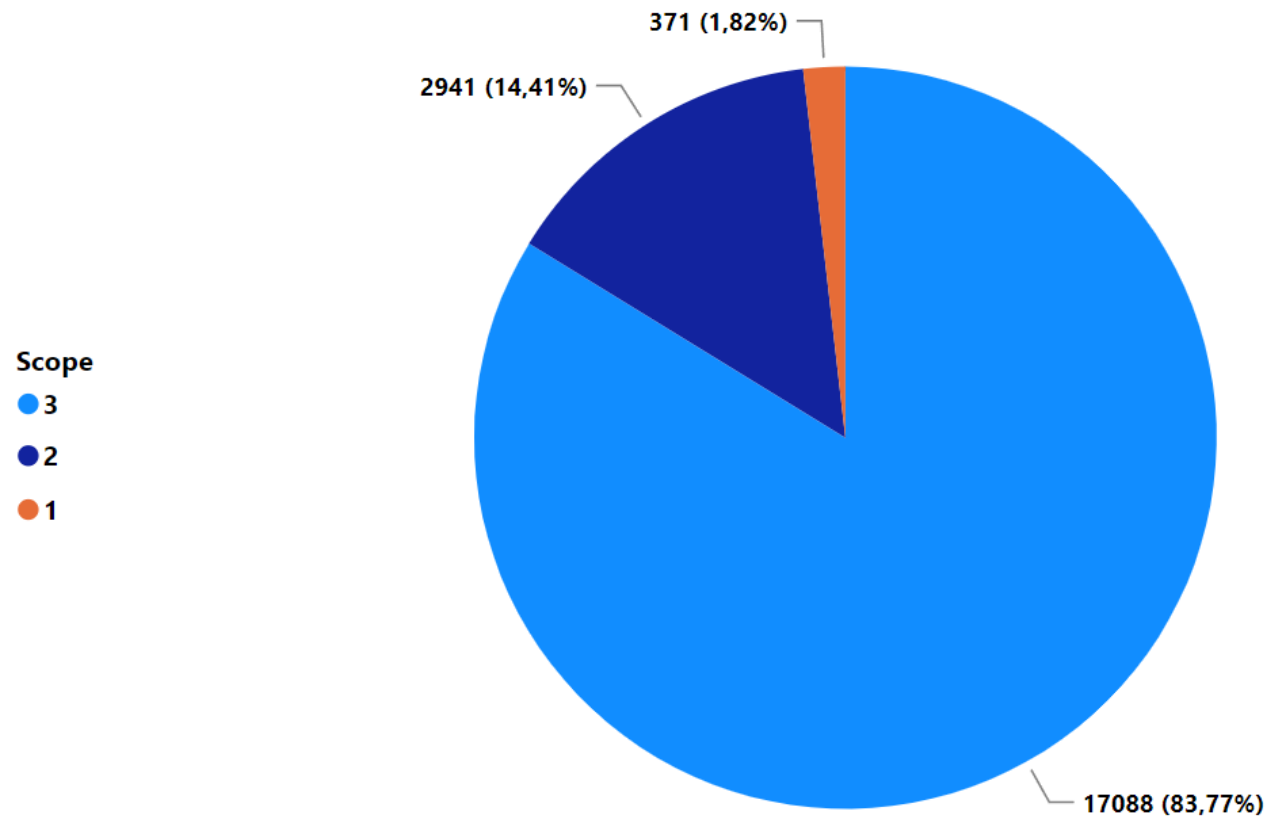
Emission type	Emissions (tCO2)	Percentage	Scope
Business travel (flights and other travel)	3 624	17,77 %	3
Construction projects	3 570	17,50 %	3
Procurements	3 182	15,60 %	3
Energy procurement (Market-based method)	2 941	14,41 %	2
Commuting, students	1 660	8,14 %	3
Commuting, staff	1 456	7,14 %	3
ICT devices & infrastucture	1 274	6,25 %	3
Food (staff and student restaurants)	1 245	6,10 %	3
Renovation and space development projects	370	1,81 %	3
Refrigerants	353	1,73 %	1
Municipal waste	283	1,39 %	3
Energy life cycle emissions (electricity and renewable energy)	223	1,10 %	3
Maintenance projects	150	0,74 %	3
Water	51	0,25 %	3
Energy production	12	0,06 %	1
Owned and leased vehicles	6	0,03 %	1
Total	20400	100,00 %	

Total emission distribution 2023



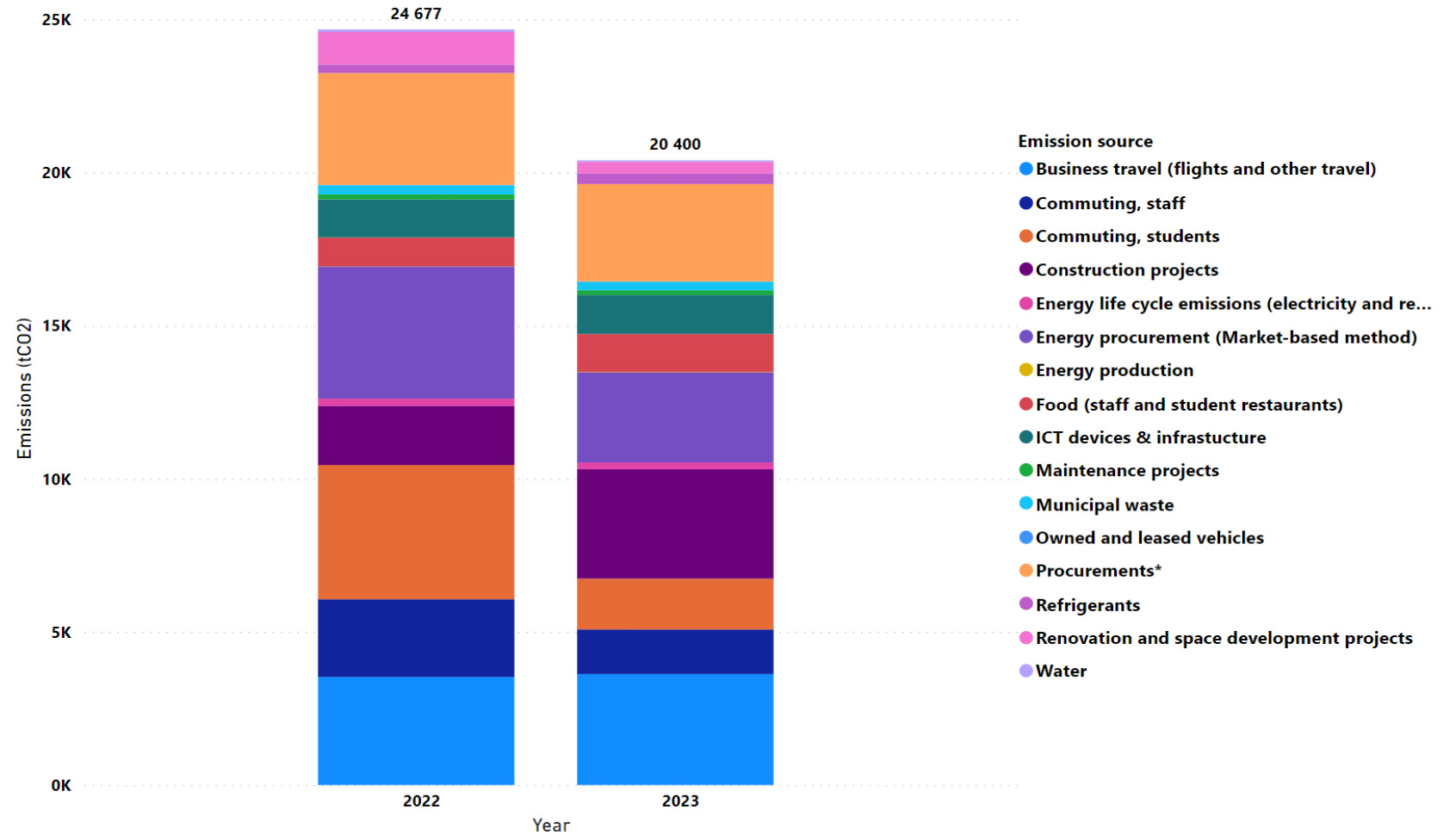
Distribution of emissions by scope 2023

Emissions (tCO2) by scope



Annual emissions comparison

*Procurements are based on spend-based emission factors. Procurement emissions factors have been inflation-adjusted in 2022 and 2023.



Significant emission changes 2022 - 2023

Procurement emissions

Emissions of procurements were calculated using emission factors mainly from **Exiobase 2019**. Since the emission factors are based on spend-based data, the effect of inflation has been removed from the procurement values from 2022 and 2023. The procurement boundary includes furnishing and research infrastructure.

Energy procurement emissions (market-based)

The average Finnish emission factor decreased from 2022 to 2023 resulting in smaller electricity emissions. Similarly, in tenant properties and in owned Helsinki properties, emission factors of district heating decreased as district heating companies moved towards their own carbon neutrality goals. (Espoo properties have used emission free district heating since 2022.)

Commuting of employees and students

In previous years, commuting of employees and students has been calculated using a general emission factor for all public transport (in addition to biking, walking, and using own vehicles for commuting.). In 2023, based on Aalto University's survey on mode of transportation, the emission factor was derived. In Finland, trains and metros do not have a large emission impact. Buses have the biggest impact on emissions and their use is quite small compared to rail travel to the Aalto campus. The emissions of commuting have decreased significantly in 2023 as the emission factors have become more accurate.

Significant emission changes 2022 - 2023

Water emissions

A more accurate and recent emission factor of tap and waste-water was used in the calculation for water emissions in 2023. The previous emission factor was from Bionova database.

Construction, maintenance, and renovation projects

The emissions of different property related projects were calculated using a spend-based method. Their emissions vary greatly between years as the amount of especially construction projects done each reporting year varies.

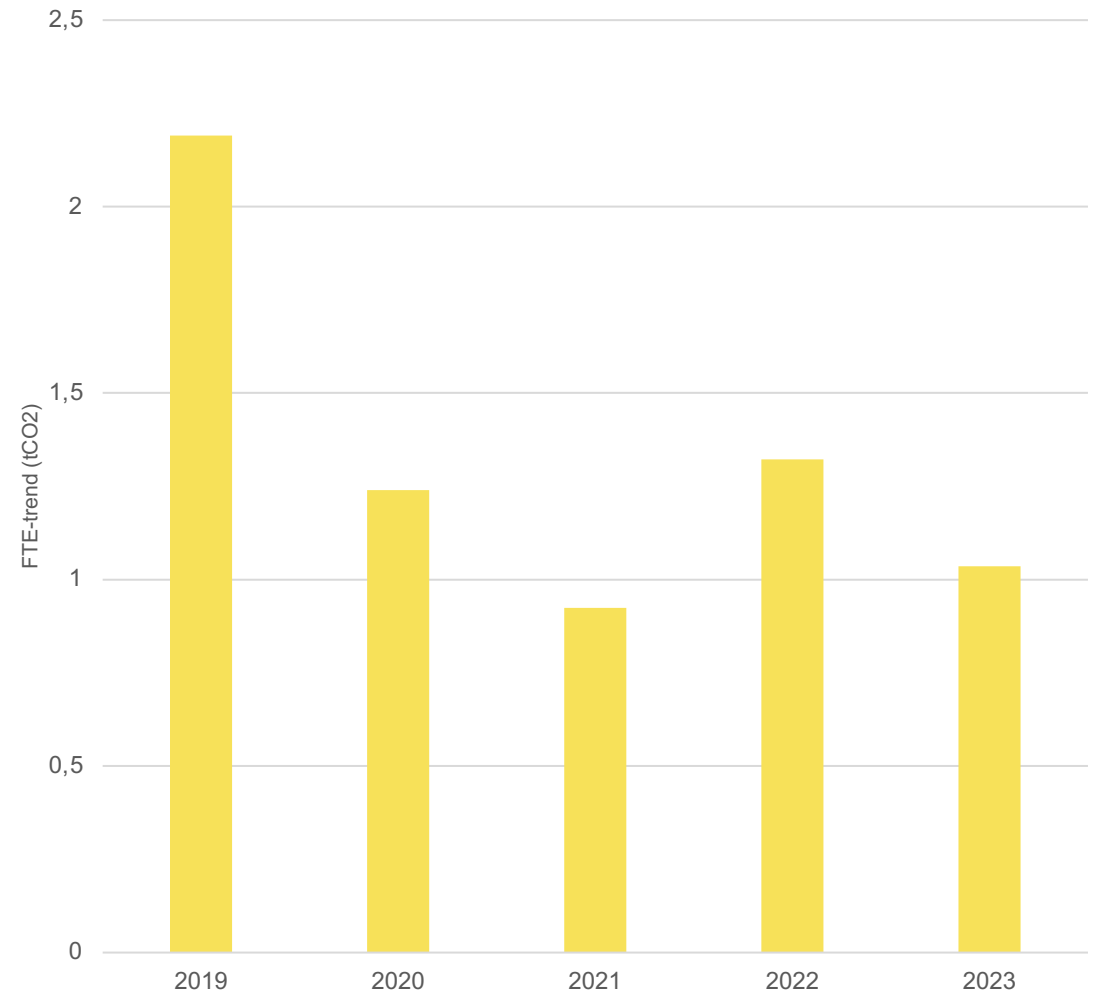
Annual emissions comparison

Emissions comparison between years is challenging due to **many changes**. Especially the covid pandemic (2019&2020) affected utility rates of properties as well as traveling. The emissions of new construction also varies between different years. In addition, indirect life cycle emissions of electricity and more comprehensive calculation of procurement emissions have been added to the carbon footprint.

Specific emissions per FTE* number are:

2023: 1,04 tCO ₂ /FTE	(2023 FTE = 19681)
2022: 1,32 tCO ₂ /FTE	(2022 FTE = 18672)
2021: 0,92 tCO ₂ /FTE	(2021 FTE = 17009)
2020: 1,24 tCO ₂ /FTE	(2020 FTE = 16035)
2019: 2,19 tCO ₂ /FTE	(2019 FTE = 15380)

*FTE = Full-time equivalent degree students and personnel



Scope 1

Energy production

- Metsähovintie 114 (Kirkkonummi) produces a part of its own heat energy using fossil energy (light fuel oil). In 2023, the amount of produced energy was **48,2 MWh** (2022: 24,8 MWh, 2021: 99,3 MWh, 2020: 113,6 MWh and 2019: 188,7 MWh).
- In 2023 emissions of produced energy were 2023 12,2 tCO₂e (2022: 6,3 tCO₂e, 2021: 25,9 tCO₂e, 2020: 29,7 tCO₂e and 2019: 49,3 tCO₂e).
- Other produced energy (geothermal heat and PV) is carbon neutral.

Refrigerants

- In 2022 the use of refrigerants were in total **111,7 kg**:
 - R 404A 48,5 kg
 - R 407C 48 kg
 - R 410A 7,5 kg
 - R 134a 40,5 kg
 - R 452a 2 kg.
- Emissions of refrigerants in 2023 were 353 tCO₂e (2022: 274 tCO₂e, 2021: 178,9 (tCO₂e, 2020: 102,5 tCO₂e and 2019: 112.5 tCO₂e).

Scope 1

Vehicles

- In 2023 there were in total 21 vehicles. 5 were gasoline vehicles, 13 diesel powered vehicles and 3 electric vehicles. The average mileage of cars was estimated to be around 4,000 km per year. In addition to this, there were one tractor (diesel) and 2 trucks (electricity).
- Total emissions from vehicles in 2023 were 5,9 tCO₂e (2022: 9,0 tCO₂e, 2021: 13,8 tCO₂e, 2020: 14,3 tCO₂e and 2019: 20,7 tCO₂e).

Scope 2

GHGP Scope 2 includes two different calculation methods; market-based and location-based. Presented below are scope 2 emissions calculated in both ways.

Market-based method*	Emissions (tCO₂)
Electricity, owned property	2012
Electricity, rented property	328
Heat, owned property	475
Heat, rented property	126

Location-based method**	Emissions (tCO₂)
Electricity, owned property	2012
Electricity, rented property	475
Heat, owned property	3836
Heat, rented property	324

District heating emissions are not equivalent tons, but tons of carbon dioxide. Emission factors are the best available ones in Finland. However, they do not include all GHG emissions required in the GHG protocol, only carbon dioxide emissions.

* Market-based calculation considers the quality of the purchased energy product. In this calculation this means mainly Ecoheat-product from Fortum in owned properties in Espoo and renewable energy in some rental properties. The goal of the calculation is to consider sustainability choices in addition to the consumption amounts.

** In the location-based method the emission factors are the average factors for the energy grid in Finland. The goal is to describe the location-based emissions without market influence. The emission factor for heat varies according to the district heating company and for electricity it is 63 kgCO₂/MWh.

Scope 2

Energy consumption and emission factors

Following trends are presented in the next two pages:

- Emissions from energy consumption 2020-2023
- Electricity consumption 2020-2023
- Heat (weather corrected) consumption 2020-2023.

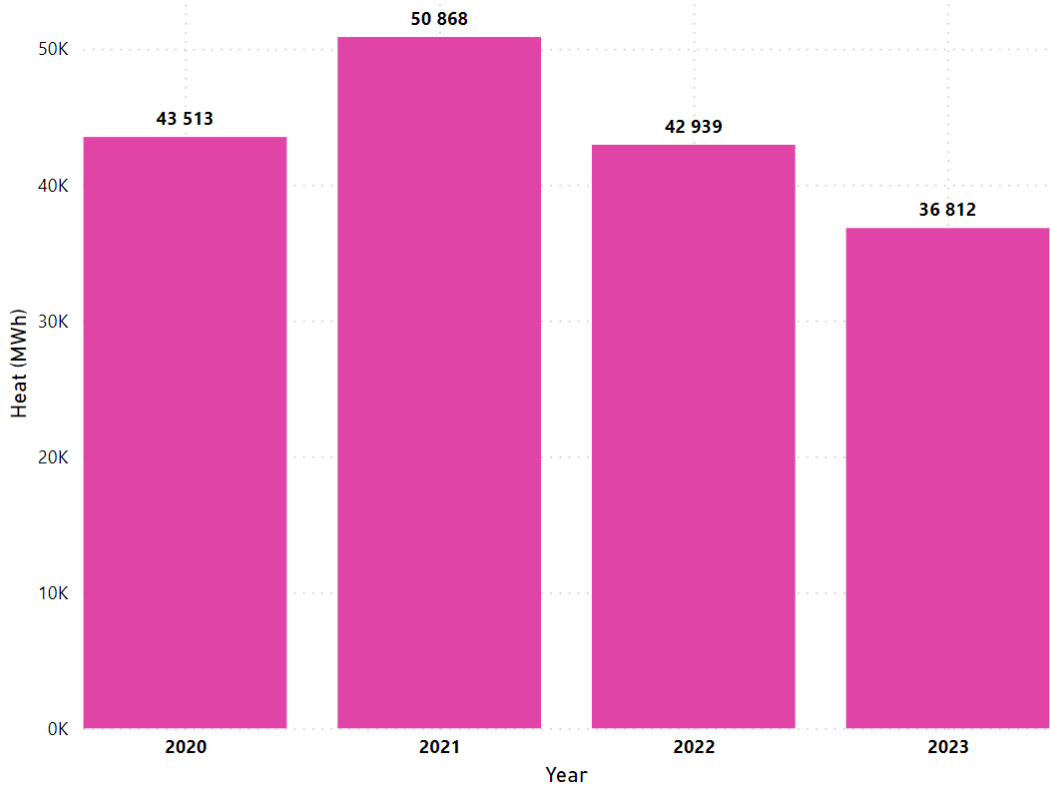
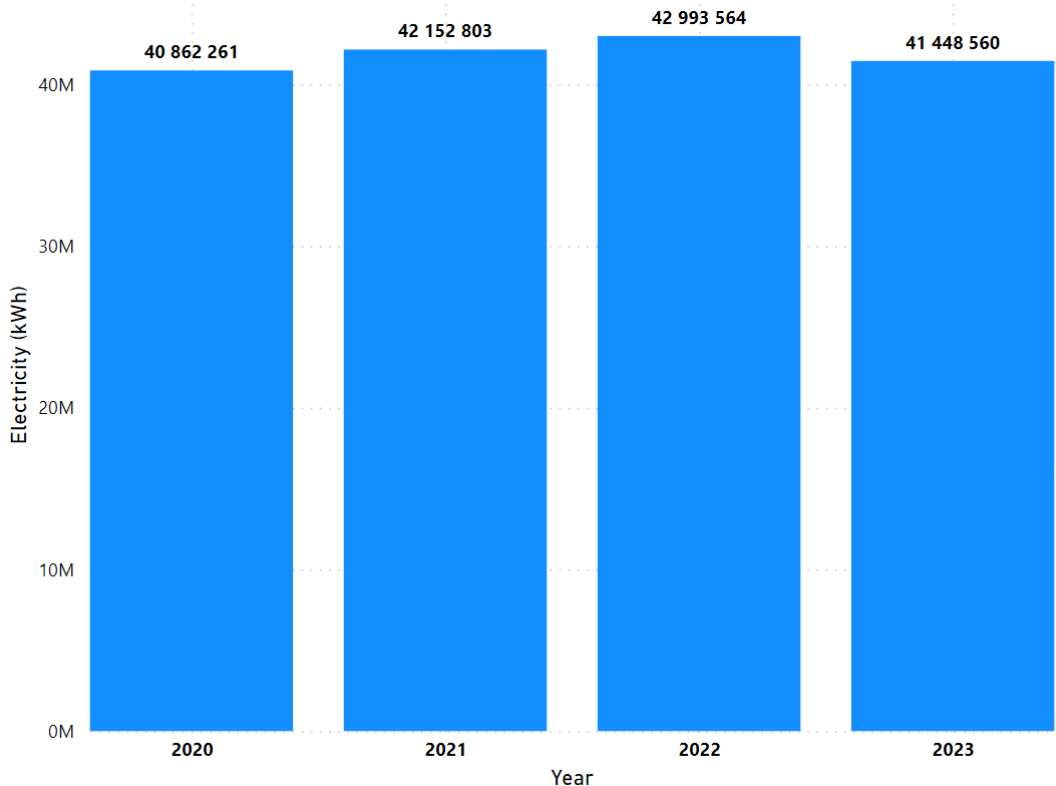
Energy consumption in 2019-2023:

- Electricity consumption 2023: 41 448 560 kWh (2022: 42 993 546 kWh, 2021: 42 152 802,7 kWh, 2020: 40 862 260,6 kWh and 2019: 43 195 133,9 kWh)
- Heat consumption 2023: 36 812,4 MWh (2022: 42 938,5 MWh, 2021: 50 867,5 MWh, 2020: 43 512,8 MWh and 2019: 45 258,3 MWh)

Aalto University started to purchase Fortum's Ecoheat-product in Espoo properties in 2022, which decreased heat emissions significantly. Aalto University also stopped purchasing emission free electricity in 2022, which in turn increased electricity emissions.

Scope 2

Energy consumption between years



Electricity

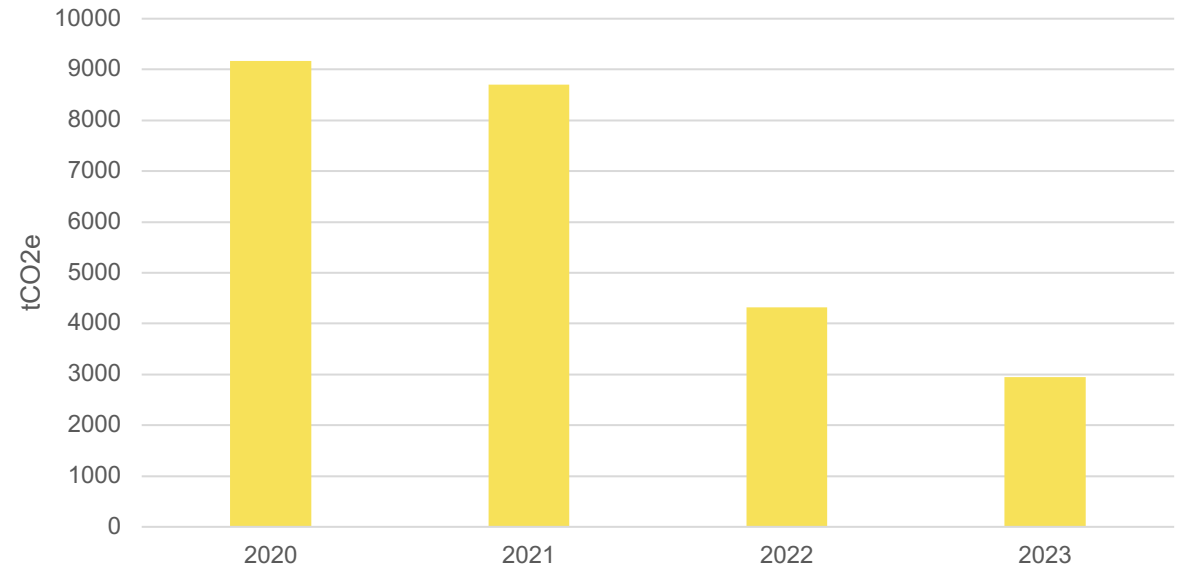
Heat



Emissions from energy consumption 2020 - 2023

In recent years energy companies have switched to calculate Combined Heat & Power plant emissions by sharing the total amount between electricity and heat generation (Finnish: hyödynjakomenetelmä), resulting in lower emission totals for district heating. This increases the comparability of district heating emissions. All emission factors of district heating are gathered from kpaastolaskuri.fi maintained by Paikallisvoima. Emission factors are calculated similarly for all Finnish district heating companies based on production distribution.

- Decreased emissions in 2022 are mainly due to a switch to the Ecoheat-product in Espoo properties. Total emissions decreased more in 2023 due to a decline in the emissions of the Finnish electricity production average. (A more accurate emission factor was used.)



Scope 3

Indirect life cycle emissions of energy

As a part of the value chain thinking, scope 3 emissions can include indirect life cycle emissions of energy. Since 2022 the life cycle emissions of electricity from the grid have also been calculated. The emission factor for electricity is 3,92 gCO₂e/kWh (Pohjalainen 2018).

For solar energy, the emission factor is 0,0747 kgCO₂e/kWh (Ecoinvent 3.8) and for geothermal heat 0,0252 kgCO₂e/MJ (Ecoinvent 3.8)

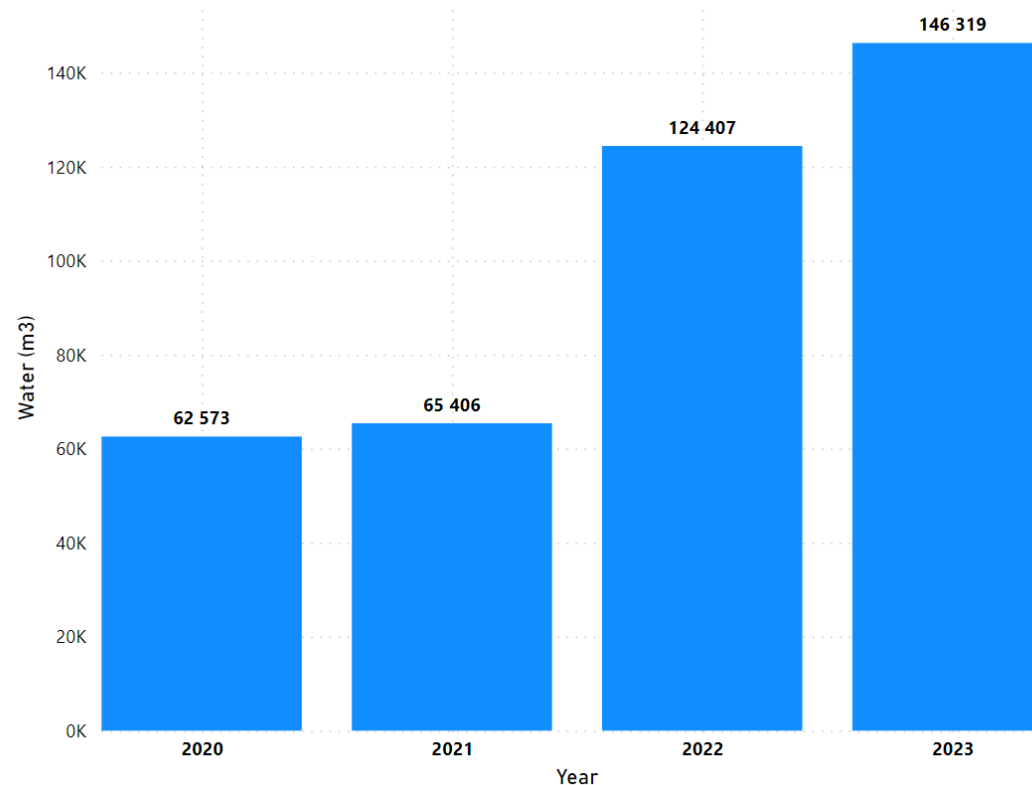
Indirect life cycle emissions for purchased electricity, solar energy and geothermal heat in 2023 were 223 tCO₂e (2022: 249,7 tCO₂e, 2021: 1037,0 tCO₂e, 2020: 1005,2 tCO₂e ja 2019: 1062,6 tCO₂e).

Scope 3

Water

Water emissions have been calculated using emission factors for tap water and wastewater (Ecoinvent 3.8). Emission factors have decreased in 2023 and are 0,0003 kgCO₂e/kg for tap water and 0,48 kgCO₂e/m³. The amounts of tap water and wastewater have been considered to be the same. Emissions factors of water changed in 2023, previously emission factor from Bionova database was used (0,69 kgCO₂e/m³). Emissions decreased due to a more accurate and recent emission factor.

Water consumption in 2023 was 146 319 m³ in Aalto owned properties (2022: 124 407 m³, 2021: 65 406 m³, 2020: 62 573 m³ and 2019: 119 951 m³). Total emissions from water consumption in 2022 was about 95,9 tCO₂e (2021: 44,8 tCO₂e, 2020: 43,2 tCO₂e and 2019: 82,8 tCO₂e).



Scope 3

Waste

Waste operators Urbraser and L&T have provided supplier specific waste data.

Forsman, HSY, and Recser provided the amounts of different waste categories (biowaste, municipal solid waste, batteries, waste wood, and metal). Their emissions have been calculated based on average emission factors (Ecoinvent 3.8).

Emissions from waste in 2023 were 282,9 tCO₂e (2022: 304,6 tCO₂e, 2021: 359,4 tCO₂e, 2020 84,1 tCO₂e and 2019: 442,5 tCO₂e)

Scope 3

Commuting

Emissions from commuting in 2023 were:

- Staff 1 456 tCO₂e (2022: 2 536 tCO₂e, 2021: 599,5 tCO₂e, 2020: 686,1 tCO₂e and 2019: 2003 tCO₂e)
- Students 1 660 tCO₂e (2022: 4 383 tCO₂e, 2021: 808,6 tCO₂e, 2020: 584,6 tCO₂e and 2019: 2762 tCO₂e)

The emission factor used for vehicles was 0,1782 kgCO₂e/km (DEFRA) and for the public transportation 0,01836 kgCO₂e/km (derived from SYKE Kulkuri calculation for commuting based on the use of different methods of public transport). Since rail travel is a popular mode of transportation among students and staff, the emission factor has decreased. The emissions of student commuting have decreased especially as they mainly use public transportation.

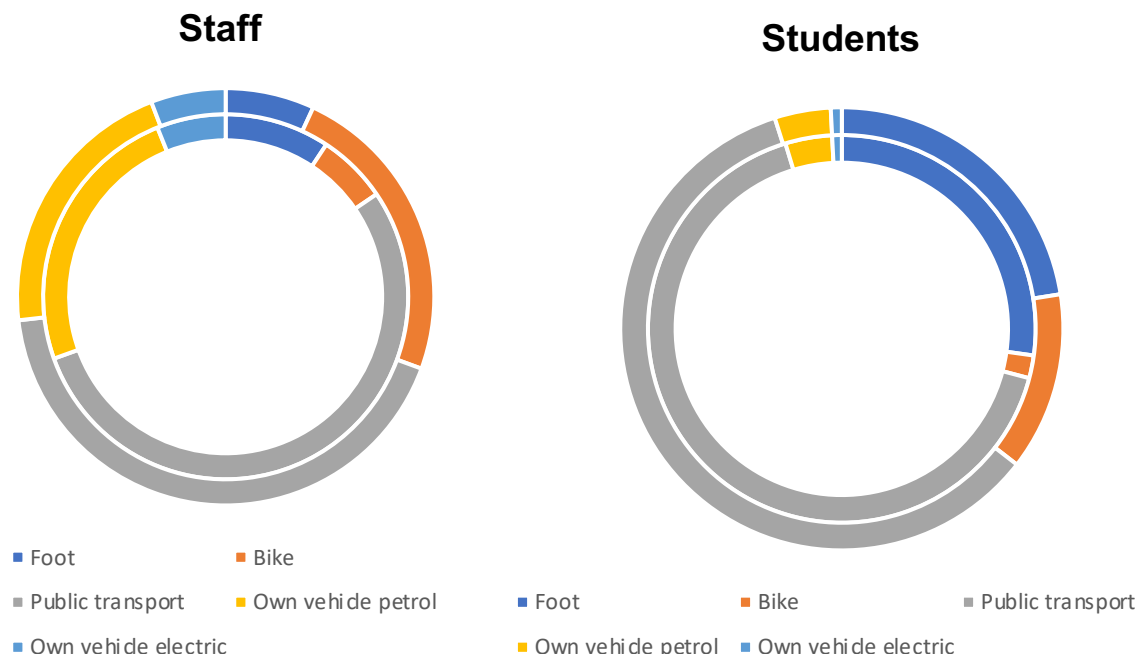
In 2023, Aalto University's staff and students answered a questionnaire about the means of transportation for commuting. The survey was divided into winter and other months.

When calculating emissions, the total amount of students and staff was evaluated by using the FTE-value.

- Students 2023: 15 203 (2022: 14 313, 2021: 12 611, 2020: 11 910 ja 2019: 11 205)
- Staff 2023: 4 478 (2022: 4 360, 2021: 4 398, 2020: 4 125 ja 2019: 4 125)

In 2023 there were 245 workdays used for calculation.

Means of commuting



Scope 3

Commuting

To evaluate the average daily commuting distance for both staff and students, information about the postal codes of the staff was used (no identifiable information). Due to the large number of postal codes, commuting trips were divided into the following groups according to the distance from the postal code area to Aalto University.

- 5 km
- 10 km
- 25 km
- 50 km
- >50 km.

Based on distances and Aalto University's survey on time spent on campus and transport methods, commuting emissions were calculated.

NOTE: The above values are rough estimates based on previous surveys and residence information. It is very important to understand that the figures are best available estimates, not exact results.

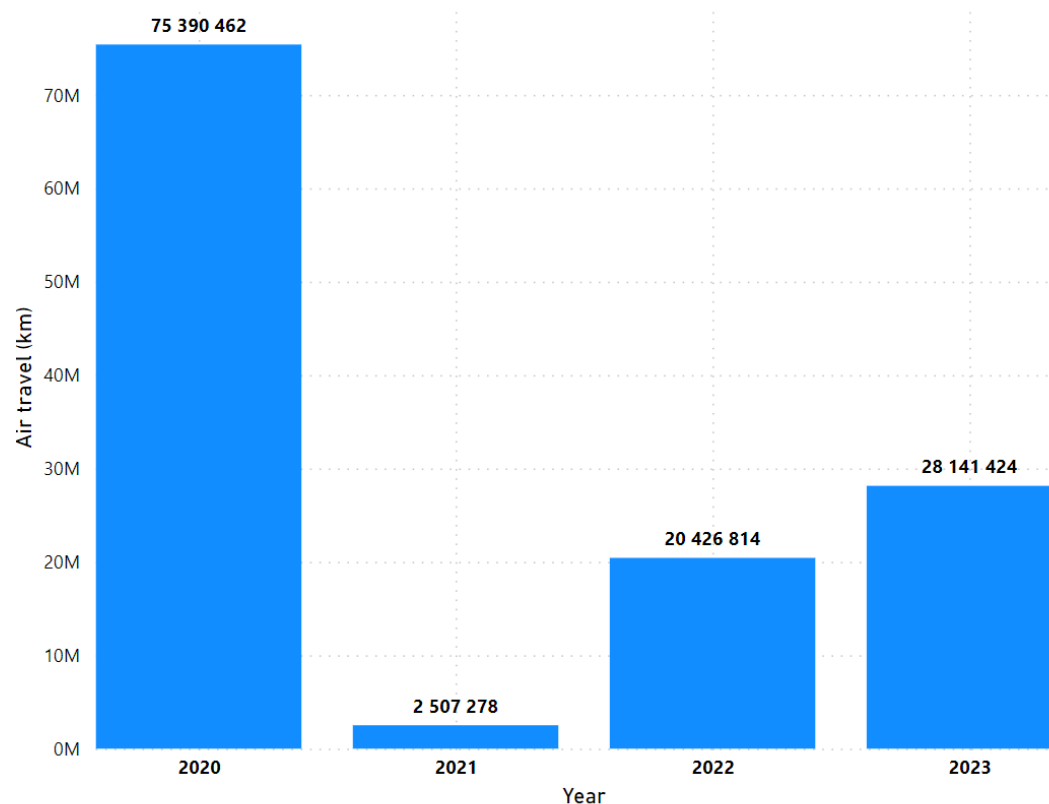
Scope 3

Air travel

The total amount of travel in kilometers in 2023 was 28 141 424km (2022: 20 426 814, 2021: 2 507 278 km, 2020: 7 530 462 km and 2019: 40 816 039).

The calculated total amount of emissions of the trips in 2022 was 2252,5 tCO₂e (2022: 2462,6 tCO₂e, 2021: 360,1 tCO₂e, 2020: 1931,7 tCO₂e and 2019: 6393,3 tCO₂e)

Air travel emissions were obtained directly from the travel agencies. The travel agencies have used DEFRA's emissions factors in the calculation.



Scope 3

Procurements

Procurements of Aalto University cover the following categories; research devices/infra and furnishing.

Emissions from furnishing were 595 tCO₂e in 2023 (2022: 629 tCO₂e, 2021: 350 tCO₂e, 2020: 294 tCO₂e, and 2019: 380 tCO₂e). The emission factor used was 0,4096 kgCO₂e/€ (Exiobase 2019).

Emissions of research devices and infra purchases were based on depreciation in 2023. Furnishing emissions were calculated based on the expenses in 2023.

The emission factor for infra purchases was 0,47 gCO₂e /€. The same factor has been used in the previous years. Infra emissions were 2587 tCO₂e (2022: 6713 tCO₂e , 2021: 3060 tCO₂e, 2020: 2713 tCO₂e and 2019: 2825 tCO₂e)

The emission factor is from NTNU calculations on their research infrastructure.

Scope 3

ICT devices & infrastructure

Calculation of ICT device and infrastructure emissions is based on the number of devices in use and device related emissions data from device manufacturers. This improves the accuracy of emission calculations considerably.

Emissions of ICT devices & infrastructure for 2023 were 1274 tCO₂e. (2022: 1241 tCO₂e, 2021: 1034 tCO₂e, 2020: 1163,7 tCO₂e, and 2019: 669,3 tCO₂e).

Scope 3

Construction, renovation, and maintenance

Aalto University conducts several new constructions, renovations, and maintenance projects annually. Emissions from said projects are included in Scope 3 calculations (e.g., emissions from material usage). Emission factors for projects were determined by Granlund Oy by comparing projects in similar property portfolios. The units of emission factors are kgCO₂/(invested euro to project). Investments and emission factors are listed in the table below.

Type	Investment (€)	Emission factor (kgCO ₂ /€)	Emissions (tCO ₂)
Construction projects	36800000	0,097	3569,6
Renovation and space development projects	6600000	0,056	369,6
Maintenance projects	3000000	0,05	150
Sum	46400000		4089,2

Scope 3

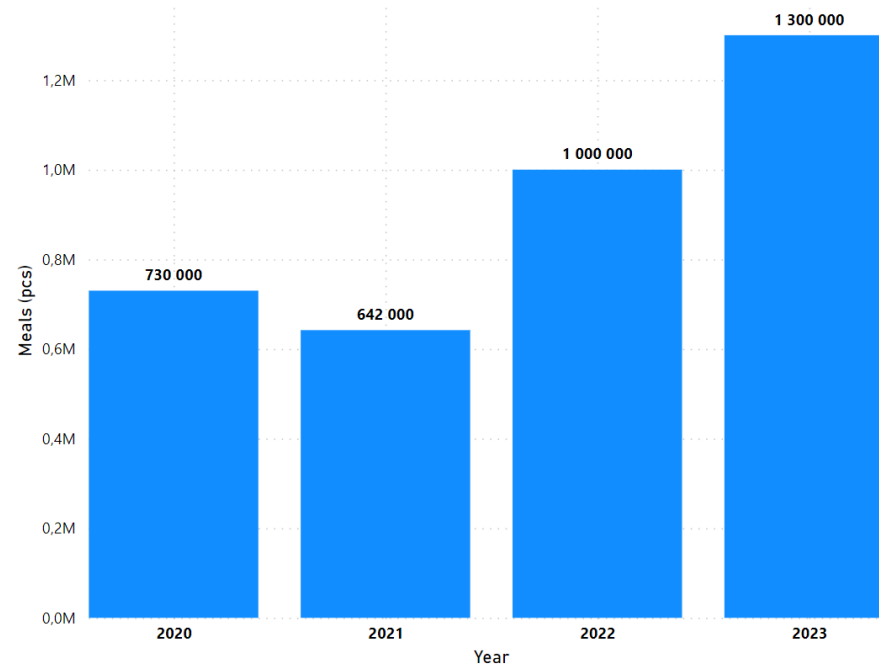
Food

Food emissions were calculated based on the number of meals sold in Otaniemi restaurants during 2023. All personnel and student restaurants were included in the emissions calculation. Based on the data collected, the restaurants sold 1,3 million meals. (2022: 1 000 000 meals, 2021: 642 000 meals, 2020: approximately 730 000 meals, and 2019: 1,3 million meals). Approximately 19 % were vegetarian meals and 9 % vegan meals (total of vegetarian and vegan meals. 2022: 32 %; 2021: 39%, 2020: 22% and 2019: 17%).

The emissions of meals sold were 1 245 tCO₂e. (2022: 945 tCO₂e, 2021: 545,0 tCO₂e, 2020: 657,3 tCO₂e, and 2019: 1277,6 tCO₂e)

NOTE: The error margin for a specific meal is quite large, since the size and proportions of meals vary greatly. In previous years, emissions were calculated by using emission factors from University of Turku. In the 2022 and 2023 calculation, emission factors used were from Compass Group Finland, which represents a significant amount of all meals sold in the Otaniemi campus:

- Meal, other 1,07 kgCO₂/pcs
- Meal, vegetarian 0,6 kgCO₂e/pcs
- Meal, vegan 0,46 kgCO₂e/pcs



Summary

- The GHG emissions of Aalto University decreased from 2022 to 2023 because of more accurate emissions calculation methods and Aalto actions to decrease emissions (as described in Aalto carbon roadmap 2023-2030). A couple of significant changes in the carbon calculation were the decreased emission factors of purchased energy and the more accurate calculation of commuting emissions.
 - In previous years, commuting of employees and students have been calculated using a general emission factor for all public transport. (In addition to biking, walking, and using own vehicles for commuting.). In 2023, based on the Aalto University's survey on the mode of transportation of personnel and student commuting, the emission factor was derived. In Finland, trains and metros, which are the most popular means of transportation to the Aalto campus, do not have a significant impact on emissions. The emissions of commuting have decreased significantly in 2023 as the emission factor has become more accurate.
 - The average Finnish electricity grid emission factor decreased from 2022 to 2023 resulting in smaller electricity emissions. Similarly, in tenant properties and in the owned Helsinki property, emission factors of district heating decreased as district heating companies moved towards their own carbon neutrality goals. (Espoo properties have used emission free district heating since 2022.)
- When comparing the GHG emissions from previous years, the effect of Covid-pandemic needs to be considered. The pandemic lowered the utilization rates of buildings and because of this it is difficult to compare carbon footprints especially between 2020-2021. For example, flying decreased significantly during the pandemic and is still on a lower level than before.
- GHG emission calculation is developing, especially in scope 3. In the future, more and more goods and services purchased by Aalto University can be added to the calculations. The base year of emissions can be calculated again using the updated calculation methods and thus, different years can be compared to each other. The emissions are less accurate when they are based on spend-based methods. In the future, the scope 3 category can be expanded and also evaluated using other calculation methods than the spend-based method, providing more accurate emission data.

Calculation conducted by Granlund Oy in collaboration with Aalto University



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