# GREENHOUSE GAS EMISSIONS OF UNIVERSITIES: CHANCES AND CHALLENGES ON THE WAY TO GREENHOUSE GAS NEUTRALITY

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Universities contribute to the goal of climate neutrality with their research, but also emit greenhouse gas (GHG) emissions by means of their operations. The aim of this paper is to assess the GHG emissions of a university as an institution, identify the main sources of emissions and analyse chances and challenges on the way to become a climate neutral university. The analysis is based on the GHG balance of Esslingen University developed according to the standards of the GHG protocol. While many academic institutions in Europe issue climate reports, they often do not or only partly include scope 3 emissions and therefore underestimate the emissions. With its broad accounting approach, this paper extends the knowledge about the emission sources of a university, but also shows the limitations of areas such as procurement, which lack data for an exact quantification of the emissions. Three main sources of emissions can be identified: commuting, procurement and buildings (electricity and heating). The main obstacles to implement the changes on part of the university are budget limitations, limited influence on the part of the university as well as staff shortages.

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## 1 Introduction

Science plays a crucial role for the mitigation of climate change and the achievement of climate neutrality. Political decisions are based on the findings of climate research and science can provide important impetus for political planning and for the development of new products in the economy (Federal Ministry of Education and Research). Civil society organisations such as Fridays for Future explicitly refer to scientific findings and call for the use of those findings as a basis for decision-making (Posmek and Bastian 2023, p. 1). Furthermore, a more application-focused research can develop solutions for challenges on the ground, e.g. in municipalities (Marquardt 2019, pp. 108-110). Through their teaching, universities enable students to make sustainable decisions and train them in skills they need to mitigate climate change (Zürn et al. 2023, p. 47). However, universities as an organisation also emit greenhouse gases (GHG) within the scope of their activities and thus contribute to climate change (ALLEA 2022, p. 11). This paper analyses the GHG balance of Esslingen University in order to identify measures reducing GHG emissions and areas which need further research.

## 2 Theoretical Background / Literature review

While more and more academic institutions are starting to measure their GHG emissions and publish them in climate reports, there is no standardized approach regarding the creation of a GHG balance, in particular there is a great variety concerning the inclusion of scope 3 emissions. Many climate reports do not or only partly include scope 3 emissions and therefore underestimate the emissions (ALLEA 2022, pp. 7, 11, 25). While there is a lot of research regarding universities' emissions, it focuses on non-European countries with different university systems (e.g. Bailey and LaPoint 2015 (USA), Vásquez et al. 2015 (Chile), Wang 2019 (Taiwan)) or analyses a specific part of the GHG emissions (e.g. DeWeese et al. 2022 (commuting), Sippel et al. 2018 (student lifestyle), Thurston and Eckelman 2011 (procurement)).

Hence, the aim of this paper is to extend the knowledge about the emission sources of a university within the European context with a particular focus on scope 3 emissions by analysing the greenhouse gas balance of Esslingen University of the year 2022.

Esslingen University is located in the south of Germany, in one of Europe's strongest economic regions. 6,300 students study in 31 Bachelor's and 14 Master's degree programs in technical, economic and social fields. 219 professors, 438 employees and 466 lecturers are teaching, researching and working at the university (figures from winter semester 2022/23). The university is certified under the European Eco Management and Audit Scheme (EMAS) since 2012. It has two locations in the city of Esslingen am Neckar and one location in the city of Göppingen with a total of 25 buildings on a net floor area of over 93,000 m² (figures from 2023).

## 3 Methodology

**Table 1: Emission sources included in the GHG balance and origin of data**

| | *Emission source* | *Origin of data* |
|---|---|---|
| Scope 1 | Vehicle fleet | Consumption according to fuel bill |
| | Air conditioning systems | Refilling quantity according to maintenance report |
| | Heating (generated on site) | Meter reading |
| Scope 2 | Purchased heating | Meter reading |
| | Purchased electricity | Meter reading |
| Scope 3 | Waste | Amount according to the university's waste report |
| | Procurement | Extrapolation based on a sample of invoices |
| | Business trips | Business travel expense reports |
| | Canteen | Produced main meals by operator |
| | Commuter traffic | Survey on mobility |
| | External events (not on site) | Estimates based on press releases / consultation with organisers |
| | Up- and downstream chains (Scope 1 & 2) | |
| | Water / waste water | Meter reading |

The GHG balance is compiled in accordance with the standards of the Greenhouse Gas Protocol (Smith et al. 2004) on the basis of the final energy-based polluter pays principle for all three university locations and includes the emission sources listed in table 1. The emission factors stem from widely used sources such as the German Environment Agency or the UK Department for Environment, Food and Rural Affairs and can be requested from the author. Emissions from electricity consumption were calculated on the basis of the general German electricity mix (location based method), although Esslingen University uses green electricity. This is intended to visualise the effects of electricity savings (Huckestein 2020, p. 37).

Looking at the different origins of data, it can be seen that some have a higher accuracy than others. Whilst meter readings, maintenance reports etc. provide a high certainty that the numbers are correct, there is a lower probability in the areas of mobility and procurement.

Business trips are analysed on the basis of the employees' travel expense reports. This means that student travel, for example for semesters abroad, is not taken into account. Business trips that are not accounted for by employees, for example due to a lack of travel expenses or excessive expenditure, are also not included in the overview. The data for commuter traffic is derived from a survey on mobility that took place at the end of 2022, in which 500 students and 284 employees took part.

In order to determine the emissions from procurement, invoices were checked. Only cost types with physical goods were taken into account. A random sample was taken based on the quantity of procurements and the GHG emissions were extrapolated. For this purpose, the purchased goods were categorised and the GHG emissions were calculated based on those categories and the sums spent. Hence, there were no GHG emissions for a specific product available. Furthermore, the emission factors used are designed for the US market. Therefore, the numbers regarding procurement represent only a first approach to the emissions of procurement.

## 4 Results

In total, Esslingen University emitted 10,831 t $CO_2e$ in 2022. This corresponds to 1.59 t $CO_2e$ per university member and 0.12 t $CO_2e$ per $m^2$ net floor area.

Figure 1 shows how the emissions are distributed among the three scopes. Scope 3 accounts for the largest share (approx. 70%), followed by Scope 2 (approx. 22%) and Scope 1 (approx. 8%).

Looking at the distribution of GHG emissions across the various emission sources (Fig. 2), three areas emerge that together account for almost 95% of Esslingen University's GHG emissions in both 2019 and 2022: Commuting, procurement and buildings (heat and electricity).

The GHG balance and further analyses will gradually be published on the website of Esslingen University[1].

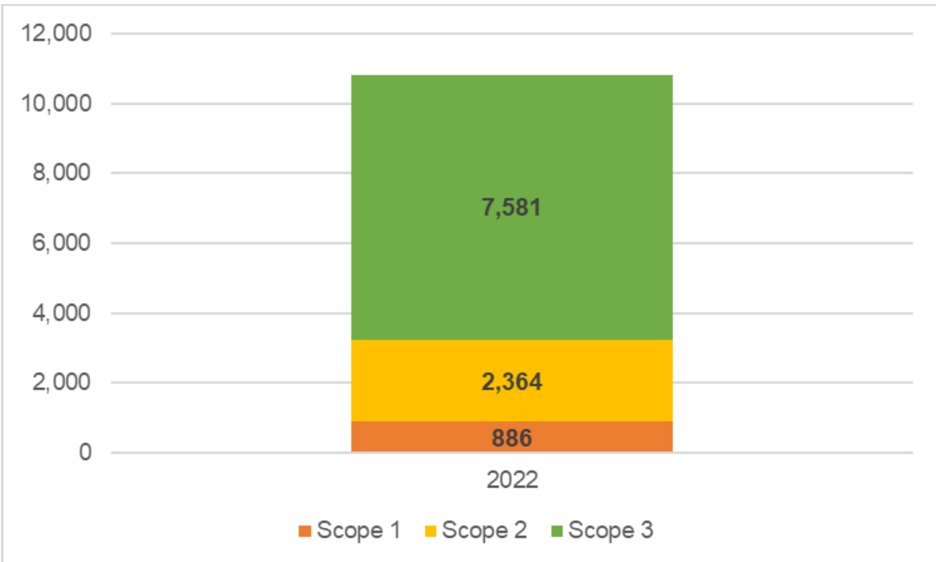


**Figure 1: Emissions by scope**

[1] https://www.hs-esslingen.de/hochschule/profil/nachhaltigkeit/klimaschutzmanagement/

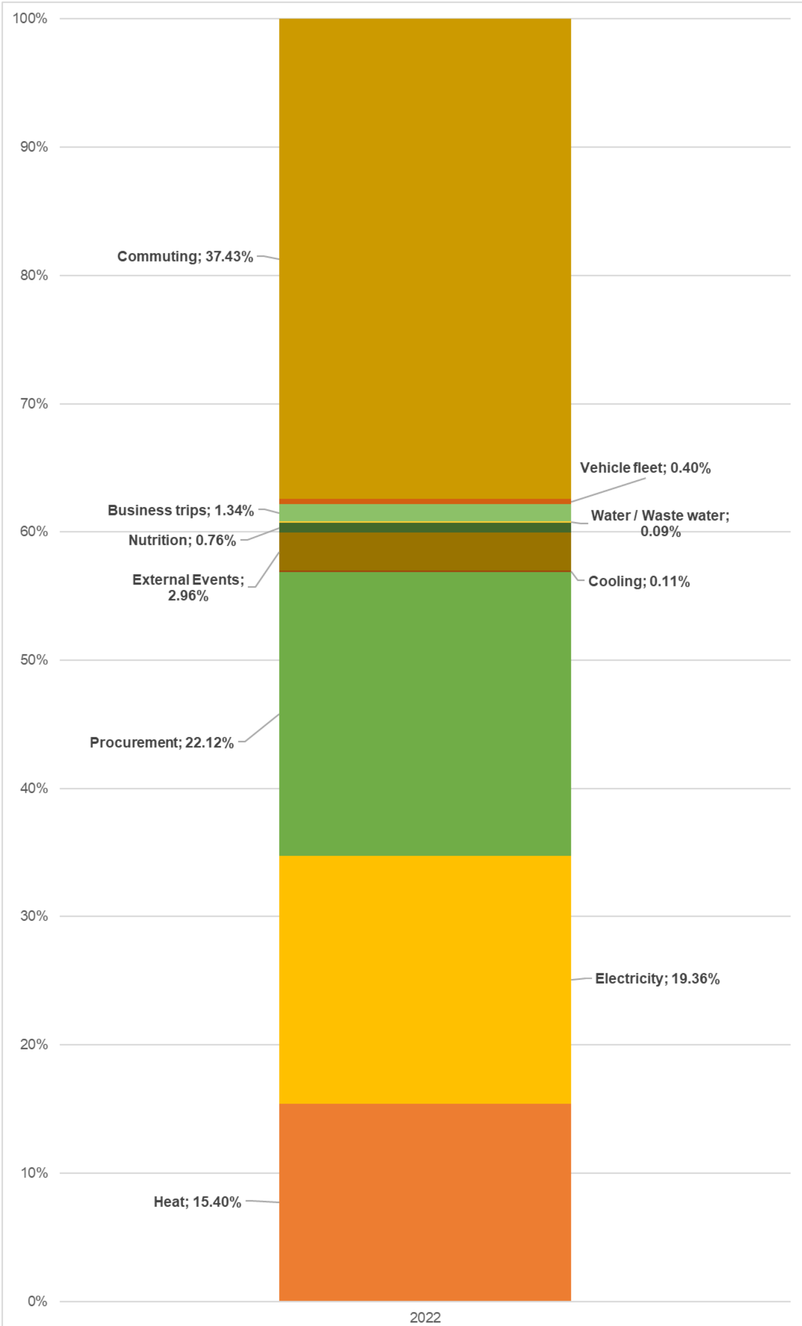


**Figure 2: Emissions by source**

## 5 Discussion

As commuting, procurement and buildings make out the major share of the Esslingen University's GHG balance, reducing emissions in those areas has a major effect and they should be the focus of the climate concept. However, it must also be noted that the results in the areas of commuting and procurement are only projections and the figures only represent an approximation of the actual situation and are subject to uncertainty. This is due to the fact that the figures for heat and electricity are based on meter readings, while the figures for commuting and procurement were estimated (see also the Methodology section) and may therefore be over- or underestimated. Nevertheless, they provide an initial approximation of the actual figures.

In terms of buildings, the measures to reduce GHG emissions are clear. Measures such as building refurbishment, automated building technology or efficient data centres can generate savings, whereby the GHG savings can be calculated with sufficient data. The main obstacles to implement these changes are budget limitations as well as shortage of staff in facility management or IT departments. In the case of the Esslingen University, there is also the specific situation that the buildings are owned by the state of Baden-Württemberg, not by the University itself, meaning that the latter cannot decide on the measures mentioned. Further measures regarding buildings include organisational changes such as the implementation of home office and desk sharing and information campaigns to change user behaviour.

In contrast, emission reductions in commuter traffic are only possible by changing user behaviour. The university can incentivise this through measures such as more bicycle parking spaces or charging facilities for electric vehicles, but whether this is accepted by university members is up to them. The fact that the university does not own the properties and therefore cannot make these decisions alone also comes into play here. Moreover, the university has little influence on important factors such as local public transport connections, their quality or the frequency of public transport services.

With regard to procurement, the data situation is difficult due to the large number of procurements from various departments at the university, particularly as no central database on procurements exists to date in the university administration.

There is also a lack of information on the carbon footprint of many products, meaning that emissions can only be estimated and products can hardly be assessed on the basis of their climate impact. In addition, there are also requirements from the state of Baden-Württemberg as well as budget constraints, meaning that the university's ability to exert influence is limited.

It is therefore advisable to look also at areas with lower emissions but greater scope for influence. The vehicle fleet and business trips are particularly worth mentioning here.

Looking at the ALLEA report (pp. 22-23), which compares the GHG emissions of 25 European universities, the emissions of Esslingen University of 1.59 t $CO_2$e per university member are above average. However, there is a vast variety as regards the emission sources which universities take into account. Many universities solely account scope 1 and scope 2 emissions. Others include only specific parts of scope 3 emissions such as business travel or commuting. Those universities that also account for scope 3 emissions have GHG emissions ranging from 1.04 $CO_2$e (Stockholm University) to 8.23 $CO_2$e (University College London) per university member. This huge range shows that it is necessary to develop a common mechanism for assessing the GHG emissions of universities.

## 6 Conclusions

Focusing on their operational GHG emissions represents a chance for universities to underpin the credibility of their teaching and research on sustainability.

Based on the GHG balance of Esslingen University, this paper has shown that the main emission sources of a university are commuting, procurement and buildings. Developing reduction measures in those areas can influence the GHG balance to a great amount. The main obstacles are budget limitations, limited influence on the part of the university as well as shortage of staff. Hence, also areas with lesser emissions should be looked at.

More research is needed regarding which emission sources should be part of the GHG balance and how emissions in areas such as procurement should be accounted for.

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