2022

Carbon Footprint Report

Delft University of Technology

TU Delft

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Executive Summary

The current climate situation underscores the critical need for action. The year 2022 was marked by unprecedented extreme weather events, including severe storms and droughts, highlighting the risks of climate change. TU Delft is dedicated to fostering a sustainable society and acknowledges its responsibility in addressing this global challenge. The university's goal is to achieve a climate-neutral, adaptive, and circular campus by 2030.[1] Recognizing the complexity of this task, TU Delft is committed to making substantial progress through collective efforts. These efforts include monitoring, reporting, and adjusting sustainability indicators.

This report provides a comprehensive analysis of TU Delft's carbon footprint for 2022, building upon the 2021 report with updated findings. The university's estimated total carbon footprint is 103 thousand tons. Direct emissions, primarily from gas consumption, account for 13% of this total, while indirect emissions – encompassing supply chain activities, waste processing, air travel, and commuting by staff and students – contribute the remaining 87%. Although this report does not set specific policies, it serves as a crucial foundation for supporting carbon footprint reduction initiatives. The reporting methodology adheres with a few modifications to the Greenhouse Gas Protocol, ensuring accuracy and consistency.

In response to the energy shortage caused by the Russian invasion of Ukraine, TU Delft has drastically reduced its use of natural gas and has switched to more green, purchased electricity. The university also initiated an energy-saving project in 2022. This project focuses on various aspects, including lowering the indoor temperature in buildings to 19 degrees, changing opening hours, optimizing the use of facilities, and accelerating the implementation of automated systems for climate control and lighting. This has resulted in a reduction of direct emissions. To further reduce these emissions, the university can prioritize usage reduction, storing surpluses, and transitioning to renewable energy sources, such as solar, wind, and geothermal energy. The rollout of the Delft Geothermal Project can make a significant contribution to this effort. Moreover, energy efficiency in buildings remains desirable; for example, by aligning energy use with the actual use of spaces. Given the increasing frequency of heatwaves and drought periods, it is important to anticipate future energy needs for cooling.

Indirect emissions constitute the largest part of university's total carbon footprint, and addressing them requires a broad and coordinated strategy. The university can revise its procurement and real estate policies with a strengthened emphasis on sustainability. By critically evaluating supplier relationships, TU Delft can enter into collaborations with parties committed to sustainable practices. This approach could also be applied to the procurement of materials, focusing on reducing usage, encouraging reuse, and purchasing circular alternatives such as bio-based materials. This would not only contribute to lowering indirect emissions but could also serve as an exemplary role in the broader academic and business community.

Construction and building activities remain central to the carbon footprint. Given the share of this category in the footprint, it is desirable to support more sustainable construction practices. While construction strategies evolve over time, the focus on reducing, reusing, and recycling materials remains crucial. Furthermore, as construction methods change, the university could ensure that long-term investments account for sustainability needs.

Emissions related to research equipment and consumables remain approximately the same but are still important. To address this, communication with all stakeholders about the footprint is desirable. Collaborations between departments are essential; awareness and attention pave the way for an action plan that can contribute to a significant reduction in emissions.

1. Andy Van den Dobbelsteen and Deirdre Van Gameren, *Sustainable TU Delft - Vision, Ambition and Action Plan for a Climate University* (Delft University of Technology, 2022).

Indirect emissions from automation and telecommunications continue to increase. Purchasing decisions in this category can be aligned with broader sustainability goals. Engaging in dialogue with suppliers, considering strategies for end-of-life products, and promoting various partial solutions, such as more network virtualization, will be essential steps forward.

Travel and commuting are rising as society no longer has restrictions on transport and traffic post-pandemic. The previous reduction in business flights has been somewhat reversed. Therefore, shaping and enforcing sustainable travel policies, encouraging participation in virtual events, and improving transport accessibility on campus remain important for reducing these emissions.

Finally, this year's report supplements that of 2021 and provides more clarity on the carbon footprint over 2022. It is essential to gauge community engagement and awareness of new initiatives. Refining monitoring methods, providing clearer insights into emission sources and effects, and intensifying involvement will ensure an effective approach in achieving sustainability goals.

Contents

Introduction

Climate change remains an urgent reality. The year 2022 has underscored this with even more force, with more extreme weather conditions and ongoing drought. The need to limit global warming to a maximum of 1.5°C within this century is now clearer than ever. A reduction in human-caused greenhouse gas emissions (GHG) must be realized.

Today, many organizations - from businesses to educational institutions - have recognized their role in this global crisis and have initiated self-directed climate actions and policies. Universities, in particular, hold a distinct position. They are not only educational institutions but also serve as leaders, researchers, and partners in sustainability efforts. Their influence extends well beyond the confines of the campus, impacting local, national, and global spheres.

TU Delft stands firm in its commitment to promote a sustainable society, uniquely positioned to address climate challenges. Yet, it acknowledges the inherent challenges that come with this endeavor. Whether they are logistical, financial, or behavioral, these challenges underscore the magnitude of the collective undertaking in society. By shaping the thought leaders of tomorrow, fostering groundbreaking innovations, and leading sustainable transitions, the university believes it can catalyze meaningful change. In line with this, the university has embedded this vision in its sustainable campus goals: to be climate-neutral, climate-adaptive, and circular by 2030, contributing to the quality of life and biodiversity.[1] This focus must encompass all aspects that influence the climate and environment: from buildings and energy systems to waste management and mobility. Realizing this goal requires the joint efforts of every facet of the university ecosystem - faculties, administration, business offices, staff, and of course, the students.

This report complements the 2021 report. It aims to provide clarity on the carbon footprint of TU Delft for 2022. For every organization, and especially for large institutions like universities, understanding the carbon footprint is fundamental for effective climate action.

A comprehensive assessment of current emissions not only sheds light on past and present performance; it also offers a roadmap for the future and informs decisions about feasible reduction strategies, potential consequences, and financial implications. While the findings here do not dictate policy for reducing greenhouse gas emissions, this report will undoubtedly assist efforts to systematically reduce emissions.

The report is structured as follows: Chapter 3 outlines the approach, scope, and boundaries of the studied organization. Chapter 4 specifies the CO_2 estimates for each category of activities. The final chapter (5) provides recommendations based on the analysis of this year's carbon footprint.

1. Dobbelsteen and Gameren, *Sustainable TU Delft - Vision, Ambition and Action Plan for a Climate University*.

Methodology

This chapter specifies the methodology and organizational boundaries underlying the quantitative information and calculations of the environmental footprint of the university.

The approach to defining the scope and collecting information for the carbon footprint is guided by the GHG Protocol (Greenhouse Gas Protocol). The GHG Protocol is an internationally recognized set of standards for measuring, managing, and reporting greenhouse gas emissions. It stipulates how organizations can create transparent and consistent greenhouse gas inventories, aiding them in understanding and reducing their environmental impact.

Scope Definition

The disclosed carbon emissions are categorized into three scopes defined by the GHG Protocol. These ensure a reference standard for disclosure and mitigate double counting. What emissions from activities fall under each scope is dependent on the consolidation approach used to set the organizational boundary.

- Scope 1: Emissions from installations owned or controlled by the university, including gas boilers, combined heat and power installations, ovens, and vehicles.
- Scope 2: Emissions arising from generation and purchase of electricity, heat, cooling, and steam generation.
- Scope 3: Emissions originating from sources not owned or managed by the university, subdivided into:
  - Upstream emissions from acquired products, such as food, business travel, waste, and employee commuting.
  - Downstream emissions post-sale, including distributed but unsold products.

Scope 1 and scope 2 emissions are considered within the organizational boundary of the university. Scope 3 emissions, generally larger in magnitude than scope 1 and 2, relate to emissions originating from activities outside the university's organizational boundary.

Calculation and Emission Factors

The university's carbon footprint is presented as estimated values measured in carbon dioxide equivalents (CO_2e). These figures are derived using primary data collected from data owners across different staff departments and organizational divisions, along with emission factors sourced from scientifically verified and reliable authorities.

The emission estimates are calculated based upon physical activity data (e.g., kilometers traveled, kilograms of waste) and financial activity data (e.g., spent on goods and services). This information is disaggregated and multiplied to corresponding emission factors relating the data to carbon dioxide equivalents.

Assumptions and Limitations

In the process of quantifying the university's carbon footprint, several assumptions and limitations must be acknowledged. Some emission factors used in calculations are derived from generalized data, and while they are based on scientifically verified sources, they might not fully represent the unique characteristics of the university's specific activities or geography.

Furthermore, the scope 3 emissions encompass a broad range of indirect sources, and quantifying these accurately is challenging due to incomplete information, truncation, or reliance on estimations. Limitations in data collection, such as potential inconsistencies or gaps in reporting across different departments, could also introduce uncertainties.

Finally, great effort has been made to adhere to recognized standards like the Greenhouse Gas Protocol. For issues not addressed in this standard, assumptions are made that seem fitting for the operations and impact of the institute. Above all, some degree of approximation is unavoidable, which could influence the precision of the overall footprint assessment. These assumptions and limitations are integral to understanding the report and should be considered when interpreting the results and drawing conclusions from the data.

Temporal Boundaries

The university's carbon emissions are reported on a yearly basis, covering the calendar year. This means that the emissions for the year 2020 will be reported in 2021 at the earliest. The information used to calculate the emissions is based on the latest available information for the year in question. This information includes primary data from the university, information from its suppliers and stakeholders, and calculation methodologies.

Updates and Revisions

The university's carbon footprint calculations are based on an evolving set of data, reflecting current scientific understanding, organizational structures, and real-world circumstances. To maintain the accuracy and integrity of this reporting, this process is inherently prone to updates and revisions.

The calculations rely on specific hypotheses about the world, such as the carbon intensity of various energy sources and emissions associated with different activities. New scientific insights or changes within the university may lead to modifications in these hypotheses. For example, if emerging research reveals that the carbon intensity of electricity generation is lower than previously assumed, the carbon footprint related to the university's electricity consumption would correspondingly be revised downward.

Similarly, the state of the organization itself may change in ways that necessitate updates to the carbon footprint calculations. Organizational shifts and availability of more granular primary data will lead to recalibration of the reporting to ensure accurate representation.

In doing so, this report aims to provide a comprehensive and up-to-date view of the university's carbon footprint. Moreover, it includes insights and recommendations for enhancing the accuracy, reliability, and transparency of future carbon footprint assessments.

This reflective approach ensures that the carbon accounting remains aligned with the best available science and accurately represents the university's ongoing commitment to environmental stewardship.

Materiality Assessment

The environmental footprint information is collected and disclosed to the extent necessary for a thorough understanding of the effects of the university's activities on the environment. Information is therefore disclosed in the context of the development, performance, and position of the university in relation to its effects on the short-, medium-, and long-term impact on society. This approach prevents marginality, reduces unnecessary burdens on the collection of information, and most importantly, better serves the institution's internal and external stakeholders by highlighting relevant concerns.

Organizational Boundaries

TU Delft defines the organizational boundary to ensure comprehensive data collection and calculation. The organizational boundaries set for the current analysis remain consistent with those outlined in the previous footprint report. These consist of the university entities highlighted in blue in figure 3.1.

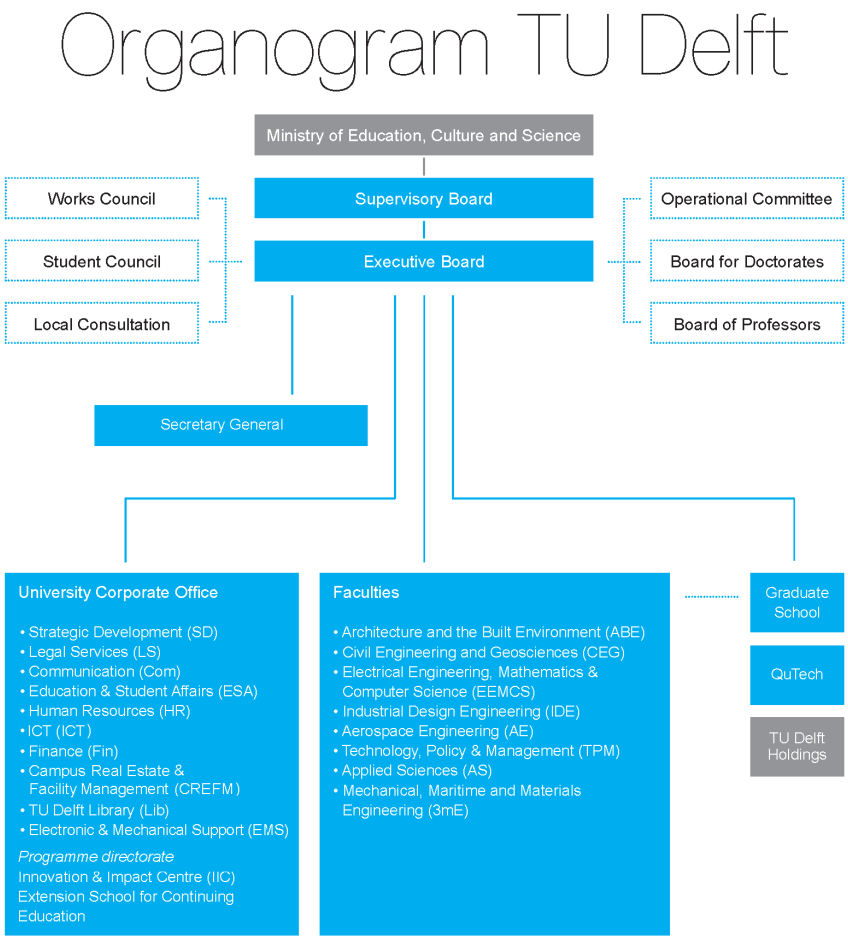


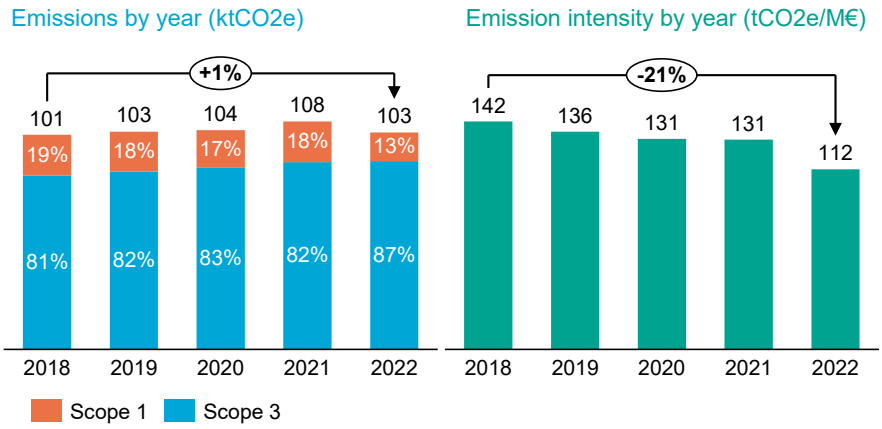
Figure 3.1: Organogram of the TU Delft

TU Delft Holdings, which includes subsidiaries like Delft Enterprises (DE) and TU Delft Services (TDS), is not included in the carbon footprint disclosure. DE functions as an investment company supporting startups based on TU Delft's knowledge, while TDS aids TU Delft in activities better suited for private entities. Together, they work towards the valorisation objectives of TU Delft, but their operations are currently outside the scope of this carbon footprint report.

Results

This chapter provides a comprehensive analysis of the university's carbon footprint, taking into account all three emission scopes and the position and operations of the university.

In 2022, the university was responsible for 103 thousand tons of CO_2 emissions. Of this, 13,600 tons came from direct emissions, primarily due to natural gas consumption for heating and electricity generation. About 89 thousand tons came from indirect sources, including construction work, building services, and the use of instruments and equipment within the university.

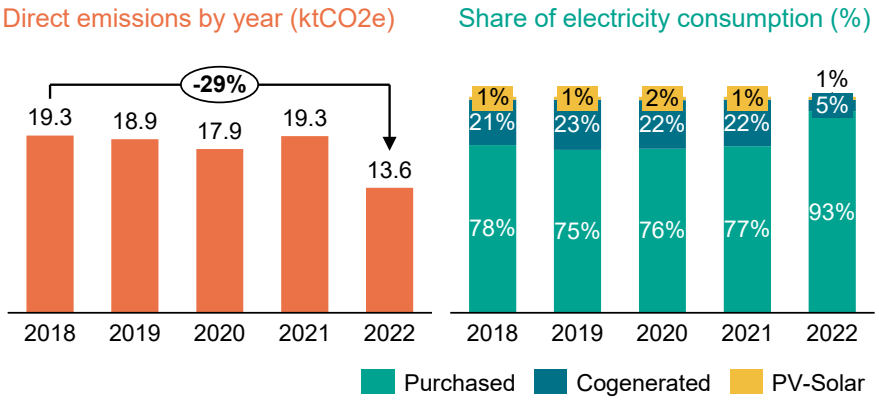


Total emissions have remained about the same, with an outlier in 2021. Compared to 2018, there was a 1 percent increase. Also during the less traveled corona years 2020 and 2021, an increase in absolute emissions occurred. That trend was broken in the year 2022. However, the university's emissions intensity, a measure that relates total emissions to the university's total revenue, shows a downward trend. In addition, emissions per full-time equivalent (including students) decreased from 3.4 in 2018, 3.2 in 2021, to 3.0 in 2022, expressed in tons of carbon dioxide subscript2 per FTE. This reduction is due to changes in operational practices, volume and transition to activities leading to sustainability. The 21% reduction shows that despite the growth of the university and therefore its revenues, a reduction in carbon intensity is possible.

The distribution across scopes 1, 2, and 3 shifted in 2022. This was caused by a significant decrease in natural gas consumption in the combined heat and power (CHP) plant due to the purchase of green electricity. Scope 2 emissions remain negligible as the university purchases its electricity from the certified green energy source. Additionally, the cogenerated electricity from natural gas consumption is accounted for under Scope 1.

Scope 1 and 2 Emissions

Scope 1 emissions are the direct emissions from infrastructure owned or managed by the university. In 2022, these amounted to 13,600 tons, constituting 13% of the total emissions, mainly due to natural natural gas consumption for heating and combined electricity generation.



The direct emissions of 2022 have significantly decreased (29%) compared to 2018. This is a result of the decision to reduce natural natural gas consumption as much as possible in response to the energy scarcity caused by the Russian invasion of Ukraine. In 2022, the university initiated an energy-saving project. This project focuses on various aspects, including lowering the indoor temperature in buildings to 19 degrees, changing opening hours, optimizing the use of facilities, and the accelerated implementation of automated systems for climate control and lighting. Other sources of emissions, such as university vehicles, are not highlighted due to their marginal contribution (less than 1%) to the total carbon footprint and the extensive administrative work required for their assessment.

Scope 2 emissions arise from the generation of electricity, heat, cooling, and steam. TU Delft's electricity sources include renewable wind energy (Eneco Windpark Luchterduinen), combined electricity generation through gas combustion, and solar panels on building roofs. Therefore, the increase in the proportion of purchased electricity is higher in relation to the reduced natural gas consumption.

Energy consumption is considered on a full life-cycle basis. Although the production and eventual dismantling of (renewable) infrastructure such as wind turbines and solar panels generate emissions, these are relatively small compared to the total energy they produce during their operational life, leading to a net reduction of the total carbon emissions.

Gas-fired electricity generation, while optimizing natural gas consumption, is not classified as a renewable source because it involves the combustion of fossil fuels. In 2022, electricity from renewable sources accounted for about 95% of the total.

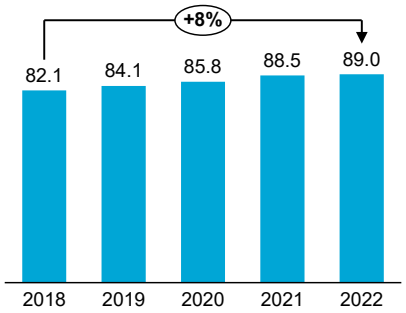
Indirect Emissions

TU Delft's commitment to sustainability extends beyond its direct activities and boundaries. A significant part of its carbon footprint comes from indirect emissions arising from the supply chain: raw material extraction, material processing, production, and end-of-life. These are categorized as Scope 3 emissions. The total Scope 3 carbon footprint is 89 thousand tons, which is 87% of the university's total carbon footprint in 2022.

The analysis of the university's indirect emissions is based on industry and supply chain estimates combined with product information and registration. The categorization of these emissions is set out based on previous reports and the accessibility of the analysis. For the products and services purchased by the university, only supply chain emissions up to use are considered. This means that emissions from the use of products or services and the end of life are not included.

Over the years since the baseline year of 2018, emissions have increased. In 2022, it is estimated that the indirect carbon footprint has increased by 8% compared to 2018.

Indirect emissions by year (ktCO2e)

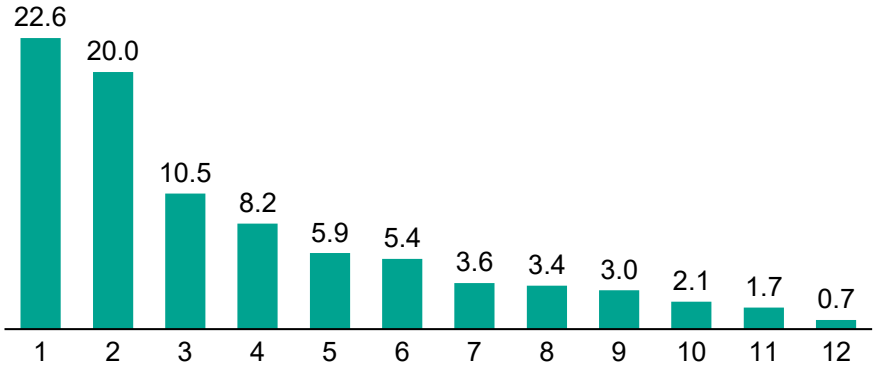


Accounts for

87%

of the total carbon footprint

Indirect emissions of 2022 by category (ktCO2e)

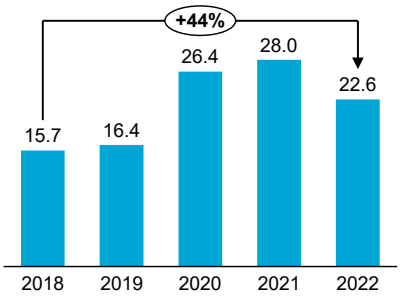


1. Buildings and building-related installations and services
2. Service-specific
3. Automation and telecommunications
4. Person-related matters
5. Work as secondment and temporary staff
6. Office and business management resources
7. Student commuting
8. Employee commuting
9. Service, advice, and research
10. Business flights
11. Activities for third party operations
12. Waste operations

1 Buildings and Building-related Installations and Services

The emissions associated with buildings and their related installations and services concern the footprint of property management at the university. This category encompasses a wide range of activities. It takes into account the carbon footprint of new construction, extensive renovations, maintenance of electrical and water systems, and fire safety measures. In addition, the footprint of essential services such as cleaning, food and catering, utility management, and landscaping is considered.

Category emissions by year (ktCO2e)



Accounts for

22%

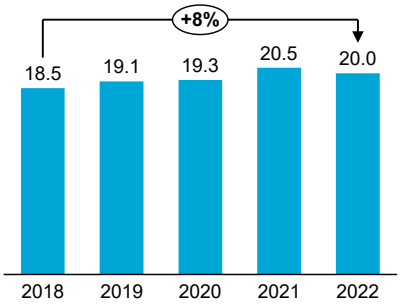
of the total carbon footprint

This category is the main source of emissions for the university. A significant portion of the emissions arises from construction and maintenance activities of university buildings. Several projects from 2021 were continued, which significantly influenced the carbon footprint. One of them was the construction of the 'Echo' educational building. Which in several years has brought about 17 kilotons of CO_2 emissions. All projects combined resulted in a 44% increase in the carbon footprint compared to 2018. Fewer emission-intensive project actions took place.

2 Service-specific

The service-specific category are extensive and include a range of specialized services and products essential to the operation of the university. It includes the footprint of acquiring, leasing, and maintaining instruments and equipment, as well as metalworking, plastics, and laboratory materials. In addition, (electro)technical consumables are included, which are necessary for the university's technical infrastructure.

Category emissions by year (ktCO2e)



Accounts for

19%

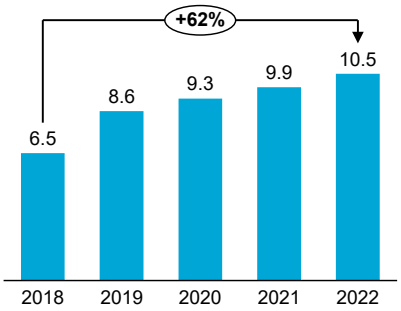
of the total carbon footprint

This category emerges as the second-largest contributor to indirect emissions. Since 2018, there has been an upward trend towards 2022. The emissions of that year have increased by 8% compared to 2022. This increase is primarily attributed to the purchase of laboratory chemicals and essential equipment, indicating the growing needs and expansions of research within the university.

3 Automation and Telecommunications

The category of automation and telecommunications relates to emissions from the university's digital operations. The category includes the carbon footprint of purchasing, renting, and maintaining hardware such as computers, printers, and network equipment. Also included are the acquisition and maintenance of software, infrastructure, and the use of telecommunications, both mobile and fixed.

Category emissions by year (ktCO2e)



Accounts for

10%

of the total carbon footprint

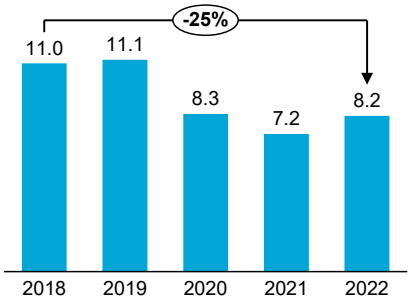
Recent data indicate an increase of emissions related to automation and telecommunications within the university. A significant portion of this increase can be attributed to investments in computer hardware and improvements to the network infrastructure at TU Delft. This includes emissions from, for example, the investment in purchasing the new supercomputer 'Delft Blue', which is housed in the Delft High Performance Computing Centre. As a result of such upgrades and expansions in the digital infrastructure, emissions in 2022 have increased by 62% compared to the levels recorded in 2018.

4 Person-related matters

Person-related emissions relate to the emissions directly associated with activities of individual employees. This category includes the impact of employee training and coaching, occupational clothing and care, and emissions from work-related events and activities. Also included are emissions associated with organizational dynamics, ranging from specific recruitment efforts to initiatives that promote employee welfare, such as insurance provisions and gifts.

Since the pandemic and accompanying restrictions have been lifted, there is a small increase in emissions related to study, coaching, training, and education for staff to be expected. The number of conferences, symposia, and related events is on the rise again. These events, in turn, are accompanied by additional activities, resulting in an increase in emissions associated with travel, accommodation, hospitality, and the clothing industry for both formal and occupational clothing.

Category emissions by year (ktCO2e)



Accounts for

8%

of the total carbon footprint

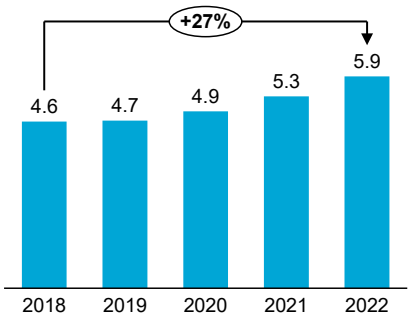
In 2022, it is observed that emissions are increasing but not to the level before the pandemic, with a total reduction of 25% compared to 2018. The question remains whether the pre-pandemic level will be reached over the course of years. This category itself is responsible for 8% of the total emissions.

5 Work as Secondment and Temporary Staff

In this section, the footprints associated with hiring specialized labor on a temporary or project basis are analyzed. This concerns emissions that arise when engaging professionals from various fields, including engineering, law, and finance. The impact resulting from the recruitment of temporary academic staff, ranging from professors and lecturers to supervisors of sports and cultural activities, is also evaluated.

This evaluation takes into account the way these professionals work, whether they operate through agencies or as independents. Investigating the specific footprint associated with their integration into the organization, the transport, and the resources needed for their functioning is essential to get a comprehensive picture of the total footprint.

Category emissions by year (ktCO2e)



Accounts for

6%

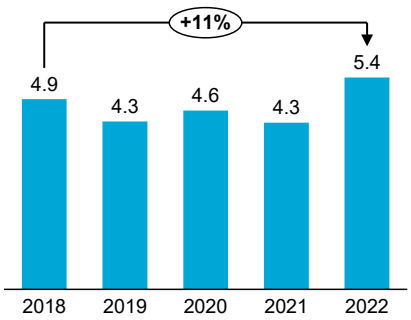
of the total carbon footprint

An analysis of the emission trends associated with secondment and temporary staffing shows that the increase continues between 2018 and 2022. It is evident that the demand for labor has increased within the university, which is reflected in the appointment of temporary employees. This category is responsible for about 6% of the total emissions.

6 Office and Business Management Resources

Office and business management resources capture the carbon footprint of maintaining and running a typical (research) workplace. This includes the footprint of office supplies, from paper to computer accessories. Emissions from office and laboratory furniture, including their production and maintenance, are included. The category accounts for the carbon footprint of printed materials, from marketing materials to professional publications. Emissions related to business insurance, advertising, and logistics, such as internal relocations, are also included.

Category emissions by year (ktCO2e)



Accounts for

5%

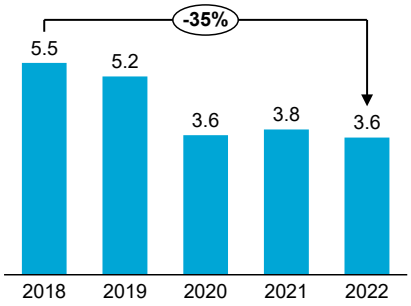
of the total carbon footprint

Analyzing the emission trends over the years reveals a relatively stable pattern, albeit with some notable fluctuations. The year 2022, on the other hand, shows a significant increase (11%). This deviation seems to be attributable to renovations, as well as to the furnishing of newly built buildings or recently established departments. Such initiatives naturally lead to a temporary increase in emissions, given the resources and activities involved. This category accounts for about 5% of the total.

7 Student Commuting

The carbon footprint related to student commuting has been calculated using data from the ESA overview (Education and Student Affairs). The method used is the same as that from the 2021 report. The ESA overview shows the total number of students and their respective postal codes. Using these postal codes, the average travel distance for students has been determined. Previous research[1] shows that only 2.3% of students choose to come to campus by car. Based on this, estimates have been made about preferred modes of transport: approximately 54% of students travel by bike or on foot, 2.3% by car, 30% by train, and 13.7% by other forms of public transport, such as buses, trams, and subways. Another important factor included in the calculations is the increase in home education due to the pandemic. In 2020, it was estimated that students studied at home 2 days per workweek, which decreased to 1 day per workweek after the pandemic.

Category emissions by year (ktCO2e)



Accounts for

3%

of the total carbon footprint

Comparing the emission data with that of 2018 shows a decrease of 35%. This decrease can largely be attributed to the reduction of travel movements due to better online facilities and, additionally, to the decrease in the number of students compared to 2021. This category is estimated at 3% of the total emissions.

8 Employee Commuting

In this section, the emissions resulting from the daily journeys that employees of TU Delft make to reach the campus are described. The modes of transport these employees rely on are also discussed in the report on campus mobility and accessibility.[2] As concluded from the research, the distribution of transport modes is as follows: 44% cycle, 32% drive by car, 14% take the train, 3% use bus/tram/metro, 2% carpool, 2% walk, and the remaining 2% is divided between motor scooters and e-bikes.

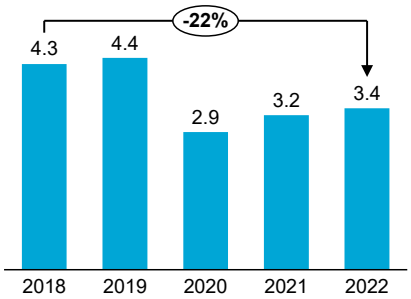
To derive the emissions from commuting, an HR summary was consulted. The same method as in 2021 was used here. Based on research from the CPB[3] and RIVM,[4] an estimate of working from home before the pandemic was established at 11%. This figure rose to 40% in 2020, with 35% thereafter. For categorization purposes, the university is aligned with the government sector rather than education. This reclassification more accurately reflects the nature of its activities, as opposed to a broader 'education' category that also includes primary and secondary education.

1. Serena van der Klugt et al., *Visie Mobiliteit en Bereikbaarheid* (2018).
2. Klugt et al.
3. Egbert Jongen, Paul Verstraten, and Christian Zimpelmann, *Thuiswerken vóór, tijdens en ná de coronacrisis* (January 2021).
4. Rijksinstituut voor Volksgezondheid en Milieu, *Thuiswerken tijdens de coronapandemie* (Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu, February 2023).

An annual estimate suggests that each employee makes two trips, to and from the university, for each workday. Taking into account a standard workweek and deducting holidays and vacations, this amounts to 442 trips per year per FTE. After correction for working from home, this number drops to 287 trips per FTE per year.

Distance also plays a role in the preference for modes of transport. Two main groups emerge based on proximity: (i) employees who live within a radius of 6 kilometers from the campus and (ii) those who live further away but within a 90-minute car ride. Addresses that indicate extremely distant or international locations were assumed not to serve as daily starting points for commuting and were excluded. For the nearby group, an average distance of 3.57 kilometers is calculated, while the latter group averages 26.11 kilometers. For those living nearby, the main means of transport are assumed to be on foot or by bicycle. People who live further away are likely to rely on cars, carpooling, trains, or public transport.

Category emissions by year (ktCO2e)



Accounts for

3%

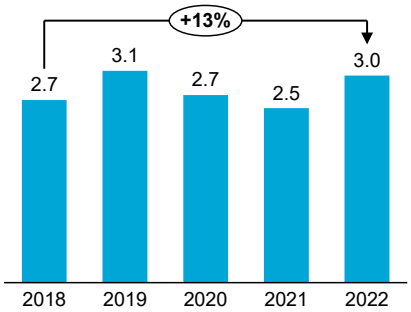
of the total carbon footprint

The 2022 figures indicate an increase in staff and the continuation of multi-day remote working.

9 Service, Advice, and Research

The service, advice, and research category encompasses the emissions from various professional services. These include ICT consultations, legal actions such as notarial activities, financial activities such as accounting, marketing and communication campaigns, and organizational consulting. It also includes specialized services such as soil research, asbestos removal, translation, and safety standards in various sectors.

Category emissions by year (ktCO2e)



Accounts for

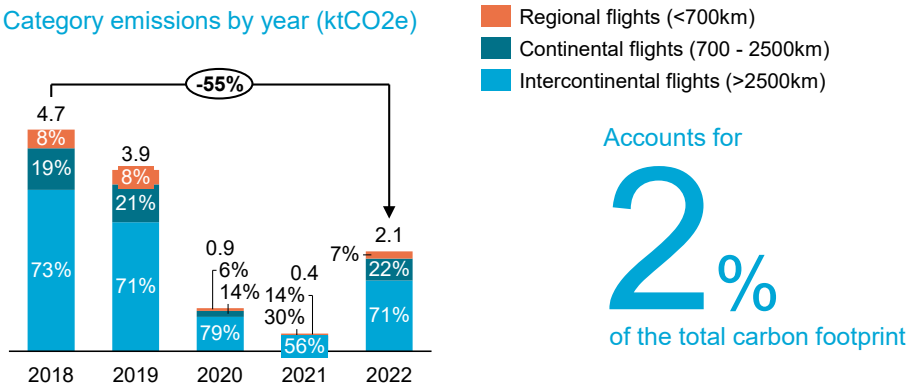
3%

of the total carbon footprint

Despite the wide range of activities under this category, the total contribution of service, advice, and research to the university's total carbon footprint remains modest. The non-CO_2-intensive nature of these activities ensures that the associated emissions remain relatively low. Over the years, this carbon footprint has remained fairly consistent. In 2022, there is a slight increase, making this category responsible for 3% of the emissions.

10 Business Flights

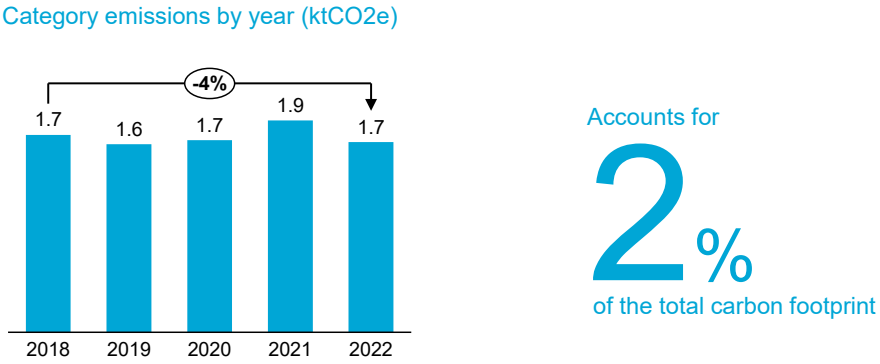
Data on business flights are sourced from the university's travel agency reports.[5] These flights meet the needs to attend conferences and support academic research and operations for staff members. International student travel (field trips, exchanges, projects) is not recorded and thus not included. In 2022, a cumulative total of 14.8 million passenger-km was reported, with an associated carbon footprint of 2137 tCO_2e. This figure is divided into short-haul flights (< 700 km), medium-haul flights (700-2500 km), and long-haul flights, contributing 7%, 22%, and 71% to the total, respectively. For each segment, an emission factor is applied based on the class flown: economy, economy-plus, business, or first class. This distinction is necessary because higher travel classes offer more space per passenger, resulting in fewer passengers being accommodated in the same space as in economy class. Therefore, the emission share per passenger increases when the emissions of a flight are divided over fewer passengers.



Flight emissions for 2020 and 2021 show a significant drop compared to 2018 and 2019. This is attributed to the pandemic. A reversal is seen in 2022, with a 55% reduction in flight emissions compared to the base year 2018. The proportions also resemble those of 2018 and 2019. The recorded business flights are responsible for 2% of the total emissions of 2022.

11 Activities for third party operations

The campus accommodates buildings operated by third parties. These buildings use resources such as gas, water, heat, and electricity. Although the university is responsible for procuring or producing these utilities, the emissions generated by these third parties fall outside the university's organizational boundary. The primary sources of emissions are from electricity consumption, gas use for both heating and power, and the upstream processing of water. This category accounts for 2% of the emissions.

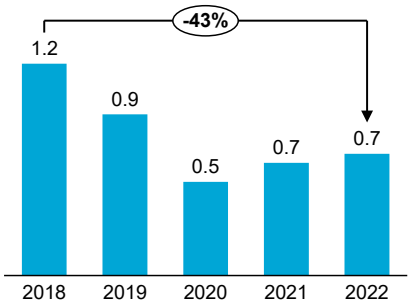


5. It should be nuanced here that it is possible that some flights may not be included in these reports if they were paid for or arranged in a different manner.

12 Waste operations

Waste management at the Delft University of Technology is divided into 21 different streams, each treated in a way that suits its classification. The campus outsources its waste collection and processing to the waste management service Renewi. To map the greenhouse gas emissions associated with waste processing, the university relies on an annual report detailing the weight (in kg) of waste for each of these streams. Waste calculations are consolidated into four primary categories: waste recycled as a resource, waste recycled for the production of green energy, waste recycled for the production of grey energy, and the processing of residual waste.

Category emissions by year (ktCO2e)



Accounts for

1%

of the total carbon footprint

The emissions from this source do not significantly contribute to the university's total carbon footprint. There has been a 43% reduction in emissions since 2018. The reduction in 2020 and 2021 can be attributed to the inactivity of the campus during the pandemic and the associated restrictions. In 2022, this has remained roughly the same as in 2021.

Recommendations

Understanding the carbon footprint is crucial for implementing effective strategies. Calculations of the carbon footprint can aid in guiding and validating reduction initiatives. The overarching goal is to achieve the 2030 objectives in emissions, circularity, and adaptation. The analysis largely aligns with that of 2021. This chapter presents the priorities and recommendations arising from this year's analysis.

The 2022 results provide a clearer picture, as incidental emissions from travel restrictions have had less impact. Nevertheless, the results point to a similar conclusion. Emissions from direct operations, primarily from gas consumption, amounted to 13,600 tons of CO_2e. This includes all emissions directly controlled and represents 13% of the university's total emissions. To address this, the university could prioritize moving to demand reduction, utilizing, exchanging and storing residual streams, and using renewable energy sources, such as solar, wind and geothermal. The energy-saving and geothermal project is therefore a good step. Finally, the university can investigate future energy consumption patterns, with particular attention to increasing heatwaves and drought periods, which may also require energy moderation for cooling.

Indirect emissions form a significant part and account for 87% of the total emissions. The main contributors are building-related activities (22%), service-specific (19%), and automation and telecommunication (10%). To reduce these, the university might choose to adopt a procurement and real estate policy that emphasizes sustainability. It can also collaborate with suppliers who prioritize sustainability and adhere to principles of reduction, reuse, and recyclability in the procurement of materials.

A large portion of the university's carbon footprint comes from buildings and associated services. A major cause of this footprint is the construction of new buildings that support research and teaching on campus. Although the energy efficiency of these buildings has improved due to national regulations and the university's own initiatives, there is still a need to make building materials more sustainable. The scale of construction, techniques used and materials selected - with an emphasis on reducing, reusing, and recycling and biobased construction - are crucial factors. The university's building ambition should encompass the full life cycle, noting that evolving building practices can have broader implications and potentially drive positive or negative changes over the life of the building.

The service-specific category mainly includes research instruments and other essential equipment used for academic purposes. The increase in emissions in 2022 is attributable to increased purchases of laboratory chemicals and essential equipment. Engaging internal teams, particularly staff and researchers, to communicate the environmental impacts of these tools is a desirable step. Other recommendations include prioritizing suppliers who adhere to sustainable practices, seeking grants or funding that promote environmentally friendly research methods, and collaborating across various departments and faculties to formulate a robust climate mitigation plan, with specific procurement needs and a well-defined trajectory towards the university's climate goals.

Automation and telecommunications belong to the third largest emission category for the university. The rising trend in emissions and acquisition of these products and services underscores the need for alignment with the university's objectives. Hence, discussing the impact of research instruments and equipment with internal departments is desirable. Furthermore, establishing relationships with suppliers and prioritizing those with sustainable practices can offer a clearer path towards the university's climate goals for these product types. Considerations for end-of-life, recyclability, and reuse are crucial. Other considerations, such as increasing network virtualization, could enhance hardware usage and reduce the need for physical infrastructure.

The reduction in business flights from the university seen in 2020 and 2021 has partly reverted in 2022. Implementing stricter policy measures and communicating the importance of these policies are critical for mitigation. Strategies such as foregoing certain events, replacing travel with virtual participation, and switching to land-based public transportation are recommended. Furthermore, it is important to make arrangements with the university's travel agency and encourage behavior. Therefore, it is essential to engage in open discussions and foster a culture of sustainable action, while people continue to commit to these initiatives.

The commute of employees and students has not returned to pre-pandemic levels, which is a positive outcome. However, the assumptions made to create these estimates are crucial. Therefore, it is recommended to conduct periodic (e.g., annual) surveys on the mobility of students and staff. At the same time, structural changes and accessibility to the campus, such as parking space, charging stations, public transport accessibility, and financial incentives to reduce emissions, can be considered in the long term.

This year's report, especially the indirect emissions, like the 2021 report, is based on a new monitoring and estimation approach for calculating the total impact of the carbon footprint. Particularly, emissions from the supply chain, which provide insights and help prioritize initiatives and sustainability strategies, are important. Nevertheless, this report focuses on CO_2 monitoring but does not measure the extent to which people are engaged in or aware of the university's initiatives. This engagement is important to ensure that behavior helps in CO_2 reduction. The recommendation is therefore to better align existing initiatives with monitoring. Another suggestion is to further refine and develop the estimates, so that the sources of emissions, their impact, and the potential for reduction become clearer.

Bibliography

Dobbelsteen, Andy Van den, and Deirdre Van Gameren. *Sustainable TU Delft - Vision, Ambition and Action Plan for a Climate University*. Delft University of Technology, 2022.

Herth, Annika, and Kornelis Blok. “Quantifying universities’ direct and indirect carbon emissions – the case of Delft University of Technology.” *International Journal of Sustainability in Higher Education* 24 (9 2022): 21–52.

Jongen, Egbert, Paul Verstraten, and Christian Zimpelmann. *Thuiswerken vóór, tijdens en ná de coronacrisis*. January 2021.

Klugt, Serena van der, Ingeborg Oostlander, Petri Ykema, Eline Lakerveld, Dennis Walta, Marc Numann, and Cathelijn Dijk. *Visie Mobiliteit en Bereikbaarheid*. 2018.

Rijksinstituut voor Volksgezondheid en Milieu. *Thuiswerken tijdens de coronapandemie*. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu, February 2023.