2021

# Carbon Footprint Report

Delft University of Technology

TU Delft

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# Executive Summary

Climate change manifests around the world: extreme weather patterns, frequent forest fires, and rising sea levels. There is an urgent call to reduce global greenhouse gas emissions to achieve a habitable future planet. TU Delft is dedicated to creating a sustainable society and has set bold targets. TU Delft has set a goal to be $CO_2$-neutral, climate-adaptive, and circular by 2030, with a focus on living quality and biodiversity.[1] Recognizing the challenges, from financial hurdles to changing behaviour, the path is not straightforward. Nevertheless, the institute believes that with collaborative efforts - from suppliers to faculties and students - significant change is achievable. Monitoring and reporting progress in sustainability performance are part of these efforts.

This report provides a detailed examination of TU Delft's carbon emissions for 2021. The university's total estimated carbon footprint stands at 108 thousand metric tonnes of $CO_2$. Of this, 18% originates from direct emissions like natural gas consumption, while the remaining 82% is attributed to indirect sources, including emissions across the supply chain and travel by employees and students. The report does not dictate policies but offers crucial data to shape the carbon reduction efforts. The methodology is grounded in the internationally recognized Greenhouse Gas Protocol, ensuring accuracy and consistency. This includes assessing emissions from both the direct operations and broader activities.

To tackle direct emissions, TU Delft should aim to reduce energy use and accelerate its transition to renewable energy sources, particularly solar, wind, and geothermal. At the same time, energy efficiency in buildings is desirable; for example, by adapting strategies to actual space utilization. Given the increasing heatwaves and periods of droughts, the strategies should also anticipate and mitigate increased energy demands for cooling.

Indirect emissions are the largest contributor to the total carbon footprint. Reduction requires a multifaceted approach. The university could strengthen the procurement and real estate policies with a clear focus on decarbonization. Supplier relationships need to be evaluated, prioritizing partnerships with those who are committed to sustainability. The same principle applies to materials procurement, emphasizing the importance of reducing, reusing and recycling.

Building and construction activities remain central to the carbon footprint. Given the environmental impact of new constructions, there is consideration to rethink the construction practices. While the building strategies have evolved, emphasizing the principles of reducing, reusing, and recycling materials remains crucial. Moreover, as construction methodologies change, the university should ensure that investments benefit the long-term.

Our 2021 data pinpointed increasing emissions in research equipment and consumables. Addressing this requires communication with all stakeholders about the environmental impact, while making sure that research is supported. Cross-departmental collaborations are essential, paving the way for a climate mitigation plan that is both robust and university-wide.

The effects of automation and telecommunications also require attention. Purchase decisions in this sector can be aligned with the broader sustainability objectives. Engaging in dialogue with suppliers, considering strategies for products at the end of their lifespan, and promoting various solutions, such as more network virtualization, will be essential steps forward.

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).

Travel and commuting, while affected by recent global events, offer valuable lessons. The reduction in business flights, while beneficial, may not be a permanent shift. Shaping and enforcing sustainable travel policies, encouraging virtual event participation, and enhancing on-campus transport accessibility can help structuralize the reduction of travel during the pandemic.

Lastly, while this year's reporting brought clarity to the carbon footprint, it is essential to gauge community engagement and awareness of the initiatives. Refining of monitoring methods, offering clearer insights into emission sources and impacts, and intensifying engagement efforts will ensure a cohesive approach to the sustainability goals.

# Contents

# Introduction

**Climate change is evident. People are witnessing more extreme weather cycles, rising sea levels, and accelerated biodiversity loss. The imperative is clear: to hold global warming to a limit of 1.5°C within this century, anthropogenic greenhouse gas (GHG) emissions must decrease to net-zero.**

Today, various organizations – from corporations to educational institutions – have acknowledged their role in this global crisis, initiating self-directed climate actions and policies. Universities, in particular, hold a distinctive position. They are not merely institutions of learning but stand as community leaders, researchers, and partners in sustainability endeavors. Their influence extends beyond campus borders, touching local, national, and global spheres.

TU Delft stands firm in its commitment to fostering a sustainable society, uniquely positioned to combat climate challenges. Yet, it recognizes the inherent challenges that follow this pursuit. Whether logistical, financial, or behavioural, these challenges underscore the magnitude of the collective undertaking in society. By shaping the thought leaders of tomorrow, spearheading cutting-edge innovation, and leading by example in sustainable transitions, the university believes it can catalyze meaningful change. In line with this, the university has anchored this vision in its sustainable campus goals: to be carbon neutral, climate-adaptive, and circular, contributing to the quality of life and biodiversity, by 2030.[1] This focus should encompass all aspects that affect the climate and the environment: from buildings and energy systems to waste management and mobility. Realizing this objective demands the shared efforts of every facet of the university ecosystem – the faculties, administration, corporate offices, staff, and, of course, the students.

This report seeks to offer clarity into TU Delft's carbon footprint for 2021. For any organization, and especially for large institutions like universities, understanding the carbon footprint is foundational for effective climate action. A comprehensive assessment of current emissions does not just shed light on past and present performance; it provides a roadmap for the future, informing decisions regarding feasible reduction strategies, potential consequences, and the financial implications. While the findings here do not prescribe policy recommendations for reducing $CO_2$ emissions, this report will undoubtedly help guide the efforts in systematically reducing and offsetting emissions.

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

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 $CO_2$ emissions from acquired products, such as food, business travel, waste, and employee commuting.
  - Downstream $CO_2$ emissions post-sale, including distributed but unsold products.

Scope 1 and scope 2 emissions are those that contribute 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.

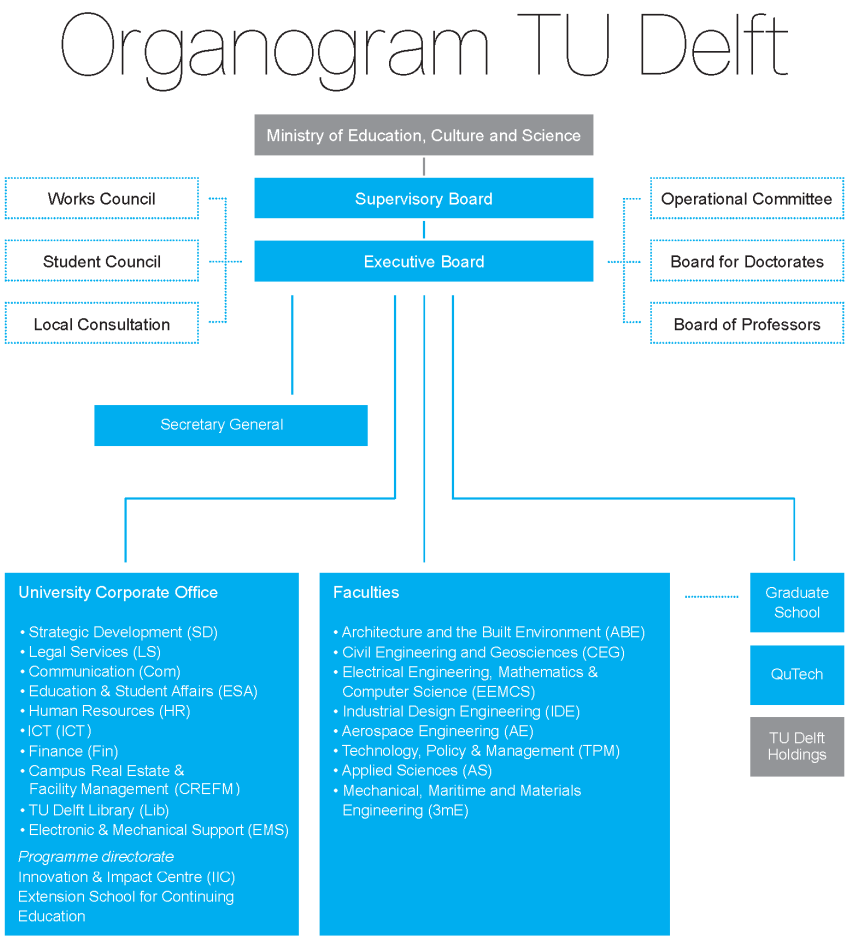


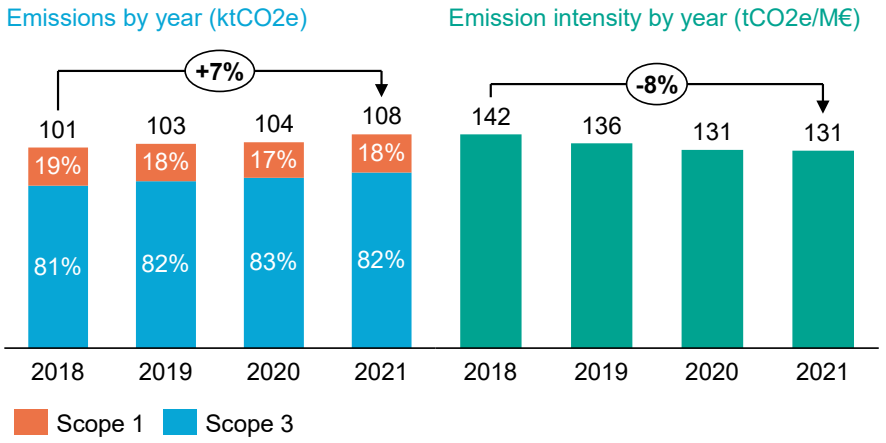

Figure 3.1: Organogram of the TU Delft

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 offers a comprehensive analysis of the university's carbon footprint, taking into account all three emission scopes and positioning these emissions within both incidental and structural university events and operations and across several years.**

In 2021, the university was responsible for 108 thousand metric tonnes of $CO_2$ emissions. Out of this, 19,300 tonnes resulted from direct emissions, primarily from natural gas usage for heating and electricity co-generation. Approximately 89 thousand originated from indirect sources, including construction work, building services, and the utilization of instruments and equipment within the university.




An examination of emissions over the past four years indicates a 7% increase in total emissions. However, the distribution across scopes 1, 2, and 3 has remained consistent throughout. 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.

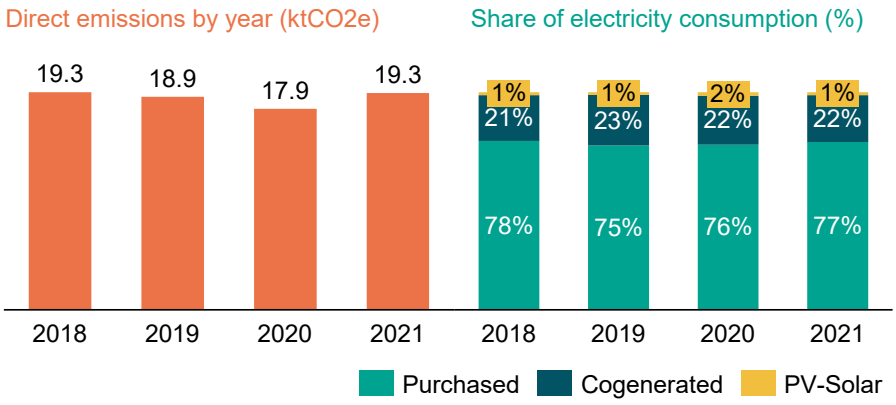
While the total emissions showed an upward trend, the emission intensity of the university, a measure that relates total emissions to the university's total revenue, is showing a downward trend. This reduction results from changes in operational practices, volume, and transition to activities that lead to decarbonisation. In addition, emissions per full-time equivalent (including students) have decreased from 3.4 in 2018 to 3.2 in 2021, expressed in tons of $CO_2$ per FTE.

## Scope 1 and 2 emissions

The Scope 1 emissions are the direct emissions from infrastructure either owned or controlled by the university. In 2021, this amounted to 19.3 thousand tonnes, making up 18% of total emissions, primarily due to natural gas consumption for heating and the cogeneration of electricity.

Between 2018 and 2021, the direct emissions stay relatively consistent, with no notable increases or decreases compared to the 2018 values. However, a spike of 8% in comparison to 2020 can be observed, attributable to reduced building operations during the pandemic.

Minor emission sources, such as university-owned vehicles, are not highlighted given their trivial contribution (less than 1%) to the overarching carbon footprint and the extensive administrative work required for their assessment.




Scope 2 emissions encompass those emerging from electricity, heat, cooling, and steam generation. TU Delft's electricity sources include renewable wind energy (Eneco Windfarm Luchterduinen), co-generated electricity via natural gas combustion, and solar panels on building roofs.

Energy usage is considered based on a full life-cycle analysis. 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 lifespan, leading to a net reduction in total carbon emissions.

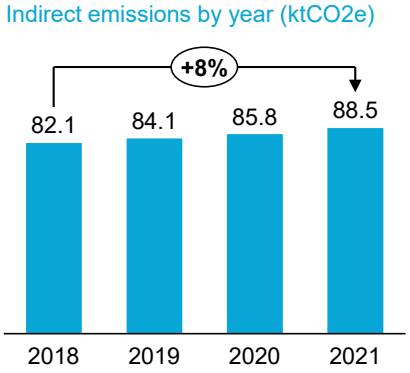
Gas-based co-generation of electricity, while optimizing natural gas usage, is not classified as a renewable source since it involves burning fossil fuel. In 2021, electricity derived from renewable sources constitutes 78% of the total.

## Indirect emissions

Delft University's commitment to environmental responsibility extends beyond its direct operations and boundaries. The categorization of these emissions has been set out based on previous reports and the aim to provide an accessible and actionable analysis. A significant part of its carbon footprint comes from indirect emissions originating from the entire supply chain in phases such as raw material extraction, material processing, manufacturing, operation, and end-of-life. These are categorized as Scope 3 emissions. The total Scope 3 carbon footprint is 88.5 thousand metric tonnes which accounts for 82% of the university's total carbon footprint in 2021.

The analysis of the university's indirect emissions are based upon industry, supply chain estimates in combination with product information and registration. For procured products and services of the university, only their supply chain emissions up to operation is considered. This means that the emissions from using such a product or service and its end-of-life are not included.

Over the years from the base year 2018, the emissions have increased. In 2021 the indirect carbon footprint is estimated to have increased 8% relative to 2018.

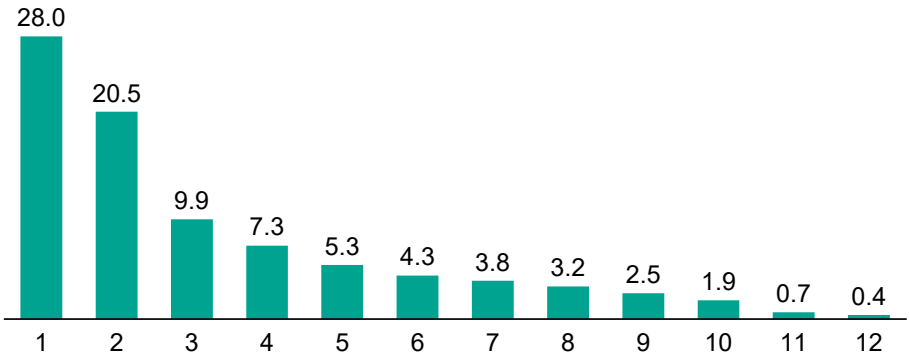



Accounts for

**82%**

of the total carbon footprint

Indirect emissions of 2021 by category (ktCO2e)

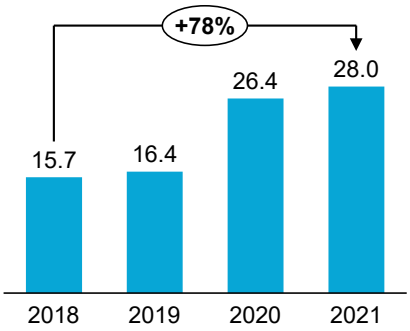



1. Buildings and building-related installations and services
2. Service-specific
3. Automation and telecommunications
4. Person-related matters
5. Work as secondment and temporary staffing
6. Office & business management resources
7. Student commuting
8. Employee commuting
9. Service, advice and research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

## 1 Buildings and building-related installations and services

The emissions associated with buildings and their related installations and services offer a look into the environmental impacts of property management at the university. This category encompasses a wide array of activities. It factors in the carbon footprint of new constructions, comprehensive renovations, the upkeep of electrical and water systems, and fire safety measures. Moreover, the environmental impact of essential services like cleaning, food and catering, utility management, and landscaping is also taken into account.

Category emissions by year (ktCO2e)




Accounts for

**26%**

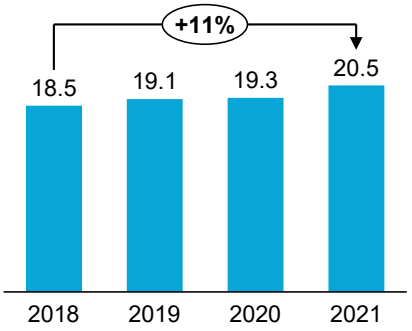
of the total carbon footprint

This category is the predominant source of emissions for the university. A significant portion of the emissions arises from construction and maintenance activities of university buildings. Notably, in 2021, there were several significant construction projects which greatly influenced the carbon footprint. Among them was the construction of the 'Echo' educational building, with its emissions being recorded both in 2020 and 2021. Additionally, the construction of a new parking facility at Rotterdamseweg and the extensive redesign of the Stevin area further increased the university's emissions. Together, the impact of these major projects, along with other undertakings during the year, resulted in a 78% increase in the carbon footprint compared to the baseline figures from 2018.

### 2 Service-specific

The service-specific category is expansive, covering an array of specialized services and products integral to the university's operations. It includes the environmental implications of procuring, leasing, and maintaining instruments and equipment, containing metalwork, plastics, and laboratory materials. In addition, (electro)technical consumables, which form the backbone of the required technical infrastructure for a multitude of tasks, also are included here.

Category emissions by year (ktCO2e)




Accounts for

19%

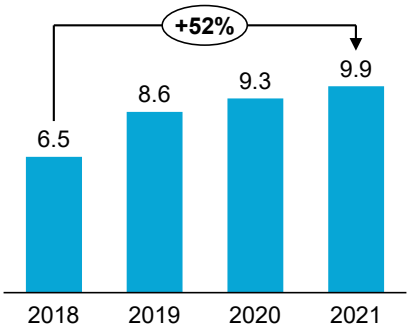
of the total carbon footprint

This category emerges as the second most significant contributor for the indirect emissions. Observing the trends from 2018 onward, there is a slight upward trajectory towards 2021. The emissions for that year are 11% more pronounced than those recorded in 2018. This increase in 2021 is primarily ascribed to increased purchase of laboratory chemicals and vital equipment, signifying the growing needs and expanding research endeavors of the university.

### 3 Automation and telecommunications

Automation and telecommunications category relates to emissions from the university's digital operations. It includes the carbon footprint of purchasing, renting, and maintaining hardware like computers, printers, and network equipment. Software purchase and upkeep, telecommunications infrastructure and usage, both mobile and fixed are also included. Additionally, the creation and maintenance of websites contribute to the environmental impact.

Category emissions by year (ktCO2e)




Accounts for

9%

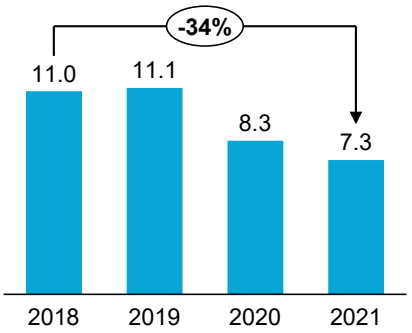
of the total carbon footprint

Recent data indicates a marked increase in emissions related to automation and telecommunications within the university. A substantial portion of this rise can be traced back to investments in computer hardware and enhancements to the network infrastructure at TU Delft. A noteworthy example of such an investment is the acquisition of the new supercomputer, 'Delft Blue', housed at the Delft High Performance Computing Centre. As a result of such upgrades and expansions in digital infrastructure, emissions in 2021 increased by 52% when compared to the levels recorded in 2018.

## 4 Person-related matters

Person-related matters focus on emissions tied to employee-specific activities. This relates to the impact of employee education and coaching, occupational attire and care, and emissions from work-related events and activities. Emissions associated with organizational dynamics are also considered, which span from select recruitment efforts to initiatives aimed at promoting employee welfare, such as insurance provisions and gifts. In 2018 and 2019, before the pandemic, significantly more emissions related to study, coaching, training and education for staff occurred. The number of conferences, symposia, and related events decreased. These events necessitated additional activities, leading to an increase in emissions associated with travel, accommodation, and the hospitality sector, as well as the clothing industry for formal wear and occupational attire.

Category emissions by year (ktCO2e)




Accounts for

7%

of the total carbon footprint

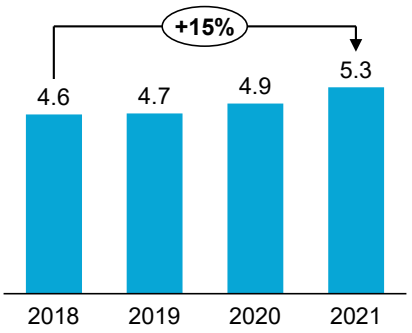
The year 2020, marking the height of the COVID-19 pandemic, witnessed a unique trend. Emissions related to traditional learning methods and in-person events diminished due to widespread restrictions. However, an increase in emissions linked to occupational health and safety occurred, with the procurement of emergency response materials and other consumables in ensuring the safety and well-being of the university community.

As the pandemic evolved, the changes implemented in 2020 had a cascading effect on 2021. While some activities started to normalize, the overall emphasis on digital learning, virtual meetings, and reduced travel resulted in a significant decline in emissions compared to the peak pandemic year, making 2021's carbon footprint notably lower. Therefore, the emissions here concern an incidental decrease with the question whether it becomes structural.

## 5 Work as secondment and temporary staffing

This section examines the environmental footprint of hiring specialized personnel on an interim or project-based arrangement. It includes the emissions resulting from integrating professionals into diverse roles, be it in technical, medical, legal, or financial domains. In addition to this, the category also registers the environmental toll of engaging temporary academic staff members. This group can range from professors and lecturers to instructors overseeing sports or cultural activities. The modality of these professionals' employment, whether they are affiliated with agencies or operate independently, are taken into account.

Category emissions by year (ktCO2e)




Accounts for

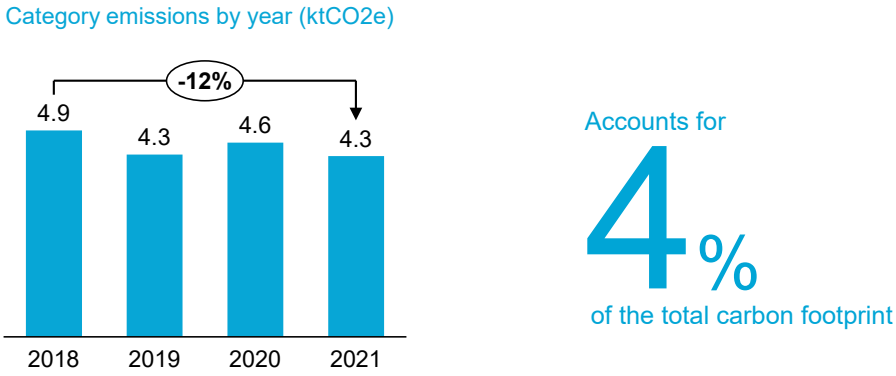
5%

of the total carbon footprint

An analysis of the emission trends linked to secondment and temporary staffing reveals a consistent increase from 2018 through to 2021. Interestingly, this escalation does not seem to originate from any singular event or distinct cause across all employment domains. Rather, the data suggests that this increase can be attributed to the organic expansion of the university's staffing needs and a heightened demand for specialized labor.

### 6 Office and business management resources

Office and business management resources capture the carbon footprint of maintaining and running a typical (research) working environment. This covers the environmental impact of office supplies, from paper to computer accessories. Emissions from office and laboratory furnishings, their production, and maintenance are included. Artistic elements, like decorations and artworks, also contribute. The category considers the carbon footprint of printed materials, from marketing assets to professional publications. Emissions tied to business insurances, advertising, and logistics, such as internal relocations, are also included.




When analyzing the emission trends over the years, a relatively stable pattern emerges, albeit with some noticeable fluctuations. For instance, the years 2019 and 2021 experienced are more pronounced. These deviations can largely be attributed to periodic renovations, as well as the furnishing of newly constructed buildings or recently established departments. Such initiatives naturally lead to a temporary increase in emissions, given the resources and activities involved.

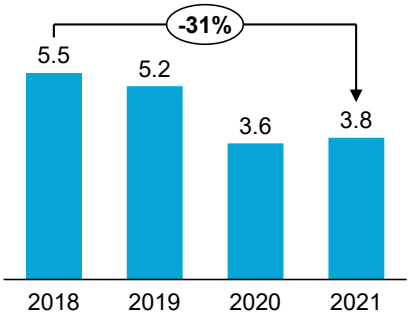
### 7 Student commute

The carbon footprint related to students' commuting has been calculated using data from the Education and Student Affairs overview. This overview shows the total number of students and their respective postal codes. Using these postal codes, the average commuting distance for students was determined. Previous research[1] indicates that only 2.3% of students choose to travel to campus by car. Based on this research, 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 metros. Distance assumptions were made in the calculations; after all, people living nearby will likely cycle or walk. 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.

Comparing the emissions data to that of 2018 reveals a downward trajectory. This decrease can largely be attributed to pandemic-induced travel restrictions and the consequential changes in student behavior. Nonetheless, the university has experienced a growth in its student population, suggesting that, all things being equal, a modest climb in emissions in the forthcoming years may arise.

1. Serena van der Klugt et al., *Visie Mobiliteit en Bereikbaarheid* (2018).

Category emissions by year (ktCO2e)




Accounts for

4%

of the total carbon footprint

## 8 Employee commuting

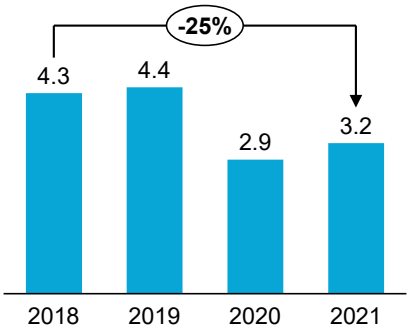
This section details the emissions resulting from the daily journeys made by TU Delft employees to reach the campus. The transport modes these employees rely on are also addressed in the campus mobility and accessibility report.[2] As concluded from the survey, the split of commuting methods is as follows: 44% cycle, 32% drive cars, 14% take the train, 3 use bus/tram/metro, 2% carpool, 2% walk, with the remaining 2% split between motor scooters and e-bikes.

To derive the emissions from commuting, an HR summary was consulted. A distinct shift from previous reports is the introduction of assumptions regarding the number of days employees worked remotely. Drawing on research from CPB[3] and RIVM,[4] a pre-pandemic work-from-home estimate has been set at 11%. This figure rose to 40% in 2020, with projections of 35% from 2021 onward. For categorization purposes, the university is aligned with the government sector rather than education. This reclassification more aptly mirrors the nature of its activities, as opposed to a broader 'education' category that encompasses primary and secondary levels.

An annual estimate proposes that each employee makes two trips, to and from the university, for each working day. Factoring in a standard workweek and deducting holidays and vacation leaves, this translates to 442 trips annually. Adjusting for remote work, this figure drops to 287 trips per FTE per year.

Distance also factors into transportation mode preferences. Two main groups emerge based on proximity: (i) employees living within a 6-kilometer radius of the campus, and (ii) those residing further but within a 90-minute car journey. Addresses suggesting extremely distant or international locations were assumed not to be daily commuting starting points and were excluded. For the proximate group, an average distance is calculated at 3.79 kilometers, while the latter group averages at 25.98 kilometers. For those living nearby, the primary commuting methods are assumed to be walking or cycling. People living further away likely rely on cars, carpooling, trains, or public transit.

Category emissions by year (ktCO2e)




Accounts for

3%

of the total carbon footprint

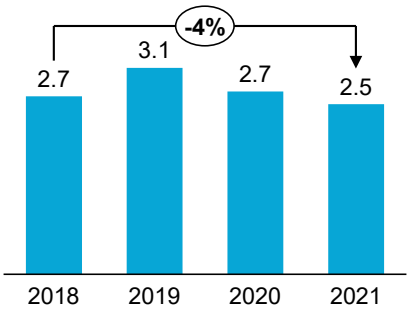
2. Klugt et al., *Visie Mobiliteit en Bereikbaarheid*.
3. Egbert Jongen, Paul Verstraten, and Christian Zimpelmann, *Thuiswerken vóór, tijdens en ná de coronacrisis* (January 2021).
4. Rijksinstituut voor Volksgezondheid en Milieu, *Thuiswerken tijdens de coronapandemie* (Bilthoven: Rijksinstituut voor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

The emissions data for 2021 is shaped predominantly by the increase in remote working and travel curbs set in place due to the pandemic.

### 9 Service, advice, and research

The service, advice, and research category captures the environmental impact of diverse professional services. This includes ICT consultations, legal actions like notarial activities, financial activities such as accounting, marketing and communication campaigns, and organizational advice. It also encompasses specialized services like soil research, asbestos removal, translation, and safety standards in various sectors.

Category emissions by year (ktCO2e)




Accounts for

2%

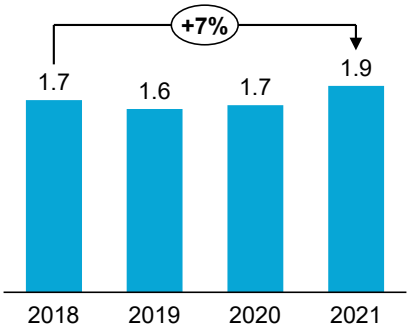
of the total carbon footprint

Despite the broad range of activities covered under this category, the overall contribution of service, advice, and research to the university's total carbon footprint remains modest. The inherently non-carbon-intensive nature of these tasks makes their associated emissions remain relatively low. Over the years, this carbon footprint has remained fairly consistent, with neither significant drops nor rises with 2019 as an exception, having a slight spike due to increased activities in this domain.

### 10 Emissions from activities to third parties

The campus accommodates buildings operated by third parties. These structures consume resources like gas, water, heat, and electricity. While the university is responsible for procuring or producing these utilities, the emissions generated by these third-party entities fall outside the university's organizational boundaries. The primary sources of emissions are from electricity consumption, natural gas usage for both heat and power, and the upstream processing of water.

Category emissions by year (ktCO2e)



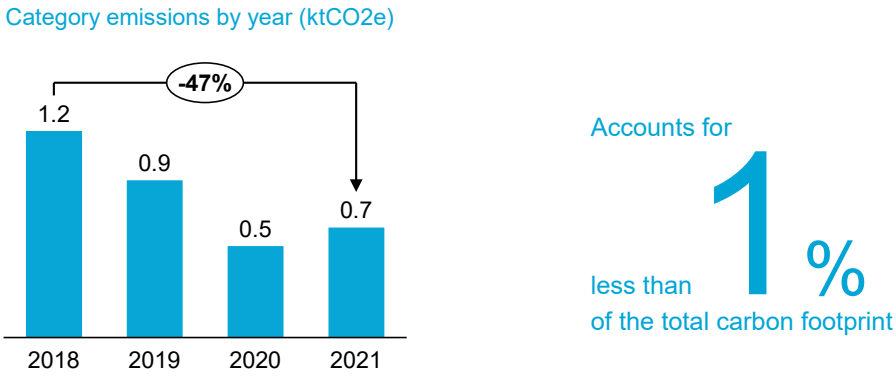

Accounts for

2%

of the total carbon footprint

### 11 Waste Generated in Operations

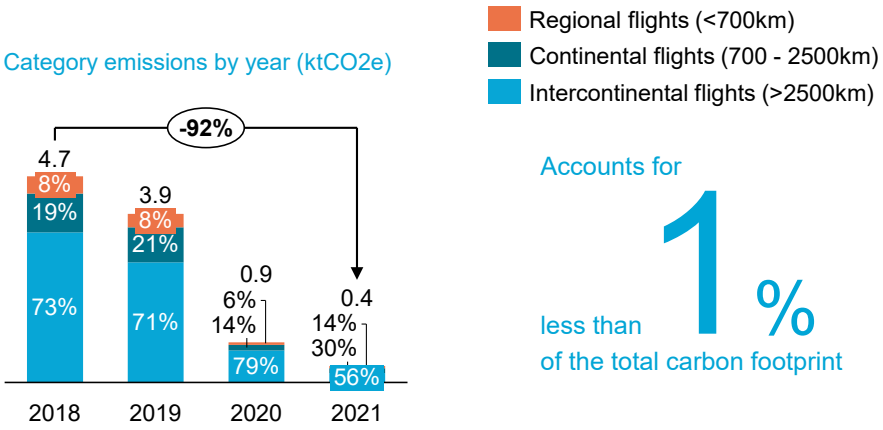
Waste management at Delft University of Technology is segmented into 21 distinct streams, with each being treated in a manner suited to its classification. The campus outsources its waste collection and processing to the waste management service Renewi. To calculate the $CO_2e$ estimates associated with 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 green energy production, waste recycled for gray energy production, and processing of residual waste.




The emissions from this source are not a major contributor to the total carbon university footprint. There has been a 47% drop in emissions since 2018. But, the reductions in 2020 and 2021 might be attributed to the campus' inactivity during the pandemic and accompanying restrictions.

### 12 Business Flights

Data on business flights are derived from the university's travel agency reports.[5] These flights cater to the needs of attending conferences and support academic research and operations for staff members. International student travels (excursions, exchanges, projects) are not recorded and therefore not included. In 2021, a cumulative total of 2.6 million passenger-kilometers was reported with an associated carbon footprint of 383 $tCO_2e$. This figure is divided into short-haul flights (< 700 km), medium-haul flights (700-2500 km), and long-haul flights, contributing 14%, 30%, and 56% to the total, respectively. For each segment, an emission factor is applied based on the flown class: 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 economy class. Therefore, when the emissions of a flight are distributed over fewer passengers, the emission share for each passenger increases.




Flight emissions for 2020 and 2021 show a significant decrease when compared against 2018 and 2019. In comparison to the base year of 2018, there was a 92% reduction in flight emissions in 2021. This decline can be largely attributed to the travel restrictions imposed due to the pandemic. Therefore, this decrease is incidental, and the figure might not reliably predict trends for the next years.

5. It should be noted that some flights might not be included in these reports if they were paid for or arranged in a different manner.

# Recommendations

**Understanding the carbon footprint is crucial for implementing effective strategies. The quantitative analysis of the carbon footprint guides and validates initiatives designed to reduce the university's carbon footprint. The overarching objective is to meet the 2030 goals of carbon neutrality, circularity, and adaptability. This chapter presents the priorities and recommendations derived from this year's analysis.**

The data from 2021 highlight challenges in identifying clear paths to the $CO_2$ reduction goals, largely due to the unpredictable impact of pandemic-related restrictions, changed employee behavior, and long-term investments (buildings and machinery). Emissions from direct operations, mainly from natural gas consumption, amounted to 19,300 metric tons of $CO_2e$. This includes all emissions directly controlled by the university and represents 19% of the university's total emissions. To address this, the university could prioritize reducing usage, storing surpluses, and transitioning to renewable energy sources, such as solar, wind, and geothermal energy. Given the stable trends in natural gas consumption over the years, the university could also reduce total energy consumption in buildings by exploring flexible energy usage strategies, that is, adjusting usage based on space utilization. Finally, the university can examine future energy usage patterns, with particular attention to increasing heatwaves and drought periods, which may also require energy use moderation for cooling.

Indirect emissions constitute a significant portion and account for 82% of the total emissions. The primary contributors are building-related activities (26%), specific services (19%), and automation and telecommunications (9%). To reduce these, the university can opt to adopt a procurement and real estate policy that emphasizes sustainability. It can also collaborate with suppliers in purchasing materials who prioritize sustainability and adopt principles of reduction, reuse, and recyclability.

A major portion of the university's carbon footprint stems from buildings and their related services. A significant driver of this footprint is the construction of new buildings that support research and education on campus. Although the carbon efficiency of these buildings has improved due to national regulations and the university's own initiatives, sourcing and producing building materials remain a challenge to decarbonize. The scale of construction, the techniques employed, and the materials selected—with an emphasis on reducing, reusing, and recycling—are crucial factors. The university's ambition in building should encompass the full lifespan, noting that evolving construction practices might have broader implications, potentially driving positive or negative change throughout the construction's lifetime.

Service-specific goods and services category primarily involves research instruments and other essential equipment utilized for academic purposes. The increase in emissions in 2021 can be traced back to increased purchases of laboratory chemicals and vital equipment. Engaging with internal teams, especially staff and researchers, to communicate the carbon implications of these tools is a necessary step. Other recommendations include prioritizing suppliers who uphold sustainable practices, seeking grants or funding that encourage environmental positive research methodologies, and collaborating across various departments and faculties to shape a robust climate mitigation plan, detailing specific purchasing needs, and setting a well-defined trajectory towards the university's climate targets.

Automation and telecommunications rank as the third highest contributors at the university. The rising trend in emissions and acquisition of these products and services needs to align with the university's objectives. It is essential to discuss the impact of research instruments and equipment with internal departments. Additionally, engaging with suppliers and prioritizing those with sustainable practices can provide a clearer pathway towards the university's climate objectives for these product types. Considerations for end-of-life, recyclability, and repurposing are crucial. However, other considerations such as increased adoption of network virtualization can enhance hardware utilization and reduce the need for physical infrastructure.

The significant decrease in university business flights is a positive trend. However, it is uncertain if this trend is structural, as the 2020 and 2021 emissions correlate with imposed travel restrictions. Implementing stricter policies and communicating the importance of these policies are crucial for mitigation. Strategies such as abstaining from certain events, substituting travel with virtual participation, and mode-shifting to ground-based public transport are recommended. Moreover, it is vital to establish agreements with the university travel agency and incentivize behavior. For the former, this entails monitoring and contractual agreements. For the latter, it is essential to engage in open discussions and foster a culture of sustainable action, while ensuring people remain committed to these initiatives.

The employee and student commuting has undergone a notable shift in emissions due to the travel restrictions and periods of lockdown. These incidental events make monitoring, prediction, and structural change harder to estimate. Therefore, it is recommended to perform periodic (e.g., yearly) sample questionnaires on student and staff mobility. At the same time, structural changes and accessibility to the campus such as parking space, charging stations, public transport accessibility, and financial incentives to decrease carbon intensity should be taken into account for long-term adjustment.

This year's reporting, especially the indirect emissions, is based on a novel monitoring and estimation approach for calculating the total carbon footprint impact. Particularly important are the supply chain emissions, which provide insights and aid in prioritizing initiatives and decarbonization strategies. This report relies on this quantitative monitoring but does not gauge the extent to which people are engaged with or aware of the university's carbon initiatives. This engagement is crucial for ensuring a harmonious progression of behavior alongside carbon reduction. The recommendation, therefore, is to better align existing initiatives with the monitoring. Another suggestion is to further refine and develop the estimates, making clearer the emission sources, their impact, and the potential for reduction.

# 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.