VISION ON SUSTAINABILITY

REVIEW AND STRATEGY AS OF 2022

TU Delft

TU Delft GreenTU

Vision on Sustainability

Review and Strategy as of 2022

by

GreenTU Delft

Research Committee 2021-2022

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Preface

Nobody achieves anything great alone - a saying that is nearly always true, but applies especially to the challenge of sustainability. In order to make real, lasting impact we must work together, regardless of our backgrounds, histories, or differences. That is exactly what we did to put together this third version of GreenTU's annual sustainability report, the creation of which would have been impossible without the '21-'22 GreenTU research committee.

Building on the preceding work, GreenTU Delft's *Vision on Sustainability: A Review and Strategy 2020-'30* and *Vision on Sustainability: A review and strategy as of 2021*, the current report aims to draw a vision to achieve the sustainability targets set by TU Delft and GreenTU. Specifically, this report reflects on achievements made by GreenTU in the '21-'22 academic year, and provides a vision for the upcoming '22-'23 academic year. Like its predecessors, this report focuses mainly on the four pillars GreenTU targets, which are sustainability in education, research, operations and community/social engagement. For each of these pillars, an overview of its current state is provided before focusing specifically on GreenTU's contributions during the past academic year. Additional sections explain GreenTU's organisational structure and highlight our fantastic GreenTeams.

Although extensive, it should be noted that this report is limited by the knowledge in possession of the GreenTU community, which is not as complete as the knowledge held by TU Delft overall. This is one of the reasons why we decided to focus upon GreenTU's own contributions and suggestions to TU Delft's sustainability goals. This report is also limited by time constraints inherent to an academic year (time really does fly). Any questions or remarks regarding this report's content can be directed towards GreenTU@tudelft.nl.

Regardless of any shortcomings, this report is the direct product of the dedication of the '21-'22 GreenTU research committee, for whom I am so thankful. Pedro, thank you for your enthusiasm and design skills. Laura, for your team spirit and thorough writing. Gaurav, for your ambition and always thinking about ways to improve our work. Aniek, for your helpfulness and perseverance (despite broken limbs, dying laptops and endless lab days). And last but not least Quan, for bravely finishing this report and improving it for next year as the new GreenTU secretary! I'm so happy to pass my work onto you in full faith. Lastly, I would like to thank all other GreenTU committees, board members, and GreenTeams who have contributed to this report. Keep on reading to learn more about all the amazing things the GreenTU community has accomplished during the '21-'22 academic year!

Naomi Hubert, Secretary of the '21-'22 Board
GreenTU Delft
Delft, October 2022

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1 Introduction

1.1. About this report

This sustainability report was written by the 2021-2022 GreenTU Research Committee. The report is a continuation of the 2021 GreenTU sustainability report,[6] with a focus on the progress realised towards a more sustainable TU Delft during the 2021-2022 academic year.

1.2. Aim

The aim of this report is to give a holistic overview of the progress made to further improve sustainability at TU Delft during the 2021-2022 academic year. Herein, the focus lies mainly on GreenTU's role in stimulating a greener campus through lower waste production and smarter energy usage, in creating awareness and information for the individual impact on sustainability, and in hosting sustainability-centred events. Specifically, this report focuses on the accomplishments of GreenTU structured along its four core pillars: Education, Research, Operations, and Community & Social Engagement. In addition to accomplishments reached in the 2021-2022 academic year, future goals and aspirations of GreenTU in regard to these core pillars will be disclosed. With this report, the research committee hopes to inform TU Delft students, staff, partners, and any other interested readers on GreenTU's efforts and accomplishments in the 2021-2022 academic year.

1.3. Report structure

Prefaced by this introduction to the report and the introduction to GreenTU in Part I, the main body of this report is divided into four core chapters. Each chapter covers the progress regarding sustainability as related to one of the four pillars of GreenTU.

The first pillar covered is Education (see Part II), which discusses relevant additions and revisions to the different bachelor, masters, and minor programmes at TU Delft. These additions and revisions help create a more central focus on sustainability within courses or programmes, and provide practical applications of the educational material to sustainability-related topics. Within this pillar there is a specific focus on the Green Thread initiative.

The second pillar is Research (Part III), for which the number and growth of research groups focusing on sustainability as a core theme or application has been recorded. As these research groups are critical to TU Delft's prominent role at the forefront of sustainability research, a number of researchers have been interviewed to provide a personal insight into the crucial research being done at the university.

Thirdly, the Operations pillar covers all actions taken to work towards TU Delft's climate goals of being completely circular and climate-neutral by the year 2030 (see Part IV). These large operational projects often extend beyond GreenTU's scope on campus, but nonetheless this chapter describes the impressive developments in e.g. green energy production and storage, reducing the carbon footprint of buildings on campus and improving smart and sustainable waste management systems. Of course, GreenTU's own operational initiatives taken during the 2021-2022 academic year are discussed in detail as well.

Finally, all GreenTU events and outreach initiatives are thoroughly covered in the Community & Social Engagement pillar (see Part V). This chapter includes reflections on all of our educational and engaging events organised in the 2021-2022 academic year, such as the 'Roaring Green Twenties' Day of Sustainability, flower sowing and tree planting on campus, social media outreach initiatives, and the award ceremony of our GreenTU sustainability label for study associations. Furthermore, the accomplishments of the faculty GreenTeams are also discussed, as well as some of the other student groups focusing on sustainability. In addition, an overview is provided of the sustainability-related events organised by the larger TU Delft community during the 2021-2022 academic year, specifically those organized in light of this year's Lustrum celebration.

1.4. Method

Information regarding the content of various TU Delft bachelors, masters, and minor programmes was largely available on the TU Delft study guide and website. The learning goals and website description of each programme were specifically considered when determining the extent to which sustainability was likely to be a core concept in each programme.

Based on public information from TU Delft, various research groups were contacted via mail, where possible, to verify their group's correlation to sustainability research. Personal interviews were conducted by our committee members via Zoom.

The developments made in order to achieve a circular and sustainable TU Delft discussed in the Operations pillar are largely based on and credited to Andy van Dobbelsteen's most recent sustainability report. Andy is the sustainability coordinator at TU Delft, and is Professor of Climate Design & Sustainability. Information was also provided and verified by the GreenTU's operations coordinator.

Information about the green community and social engagement initiatives was collected partially from the different websites or social media platforms of the different communities involved. Parties responsible for events and initiatives were contacted where possible to verify. Communication with GreenTU's outreach coordinator and events coordinator was also maintained.

I

GreenTU

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About GreenTU

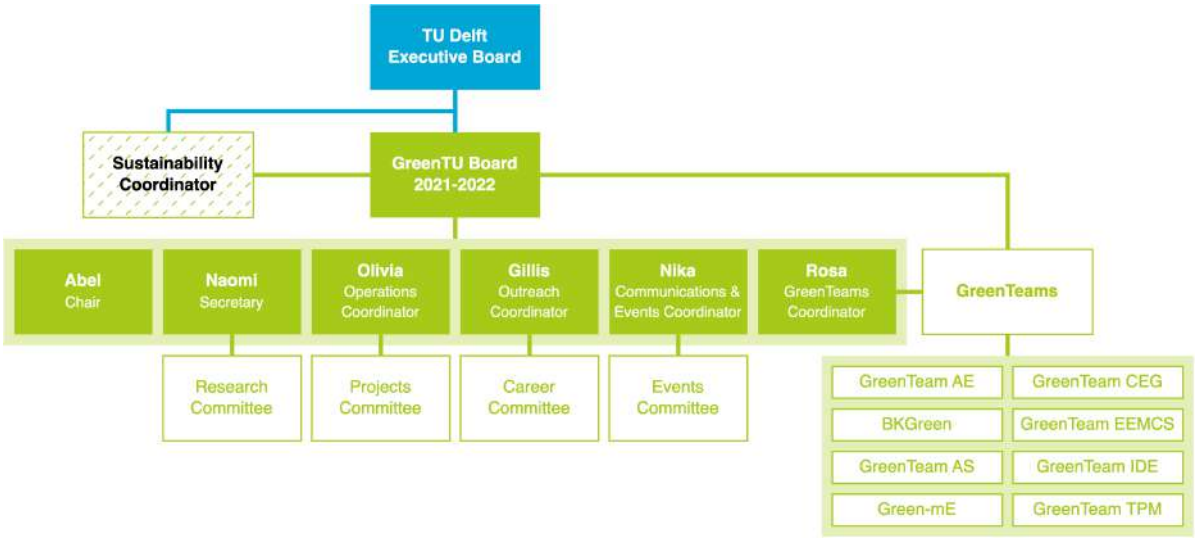
GreenTU is a student organisation which serves a central role in making TU Delft more sustainable. Since 2014, GreenTU has worked as a bridge between the students, TU Delft Corporate Office and faculty teaching staff. By stimulating the teaching of sustainable practices in education, bringing students to green research positions, initiating social workshops, and contributing to make TU Delft carbon-neutral by 2030, GreenTU hopes to lead its students and teachers to a greener future!

The GreenTU board oversees GreenTU's campus-wide efforts, consisting of six students working parttime for the duration of one academic year (after which new members are hired). The six GreenTU board members for the 2021-2022 academic year were Abel, serving as Chair, Naomi, the Secretary, Olivia, as Operations Coordinator, Rosa, as GreenTeams Coordinator, Gillis, as Outreach Coordinator, and Nika, the Events and Communications Coordinator. These board members oversaw the execution of all GreenTU events and initiatives, and coordinated with faculty GreenTeams. The GreenTU board was supported by the sustainability coordinator at TU Delft, Andy van den Dobbelsteen, who is also the board's connection to the university and all of its sustainability initiatives.

In order to achieve the wide variety of goals set for the academic school year, the GreenTU board employs a number of committees. These committees aid the board with the execution of different events or projects. The Projects Committee for example, was coordinated by Olivia, and implemented projects aimed at improving sustainability on campus (such as with food waste, mobility, energy, and buildings). The Communications and Events Committee led by Nika, organised exposure events such as the Green Xmas or Funghi night, and was also in charge of online promotions. The Career Committee, overseen by Gillis, bridged the gap between passionate students and green industries or initiatives. Finally, the Research Committee led by Naomi, was charged with the creation of this annual sustainability report.

Last but not least, faculty-specific GreenTeams are focused on applying GreenTU principles and improving sustainability at their own faculty. These GreenTeams run themselves, but are supported and coordinated by the GreenTeams Coordinator of the board.

The 2021-2022 board and committees of GreenTU.



The organisational structure of GreenTU.

3

GreenTeams

Besides the GreenTU board and committees, there are the **GreenTeams**: student teams hard at work on sustainable education, research, operations and events relevant to their own faculty. As of 2021-2022, with the inauguration of the EEMCS GreenTeam, there now is a GreenTeam at each of TU Delft's faculties.

On the following pages, all but one of the 2021-2022 GreenTeams will present their team members and work over the past year.[a] If you're a student with ideas for your own faculty - or perhaps an interest in joining a GreenTeam - be sure to get in touch with your faculty's team![b]

[a] It was not possible to get a writeup about BKGreen, the Architecture GreenTeam, on time.
[b] `https://www.tudelft.nl/greentu/greenteams`

3.1. GreenTeam TPM

In this section you will find a short summary of the things the GreenTeam TPM has been working on during the previous academic year.

3.1.1. Finished projects

Warm sweater day

On the 11th of February it was national 'Warm Sweater Day'. We as a team wanted our faculty to participate in this day. The idea was that the heating in the building was turned down by one degree and that people should put on a warm sweater. This was a success, since most people didn't even notice that the heating was turned down. To draw attention for the Warm Sweater Day, we organised a nice challenge. We had put a vase with coal and helium balloons at the opening of the faculty and people could guess the amount of carbon dioxide that would be emitted by the coal and the 'methane' in the balloons. Besides that it was a nice challenge it also drew attention for the fact that the heating was going to be turned down. We had two winners who both had the same answer (a student and a teacher) and they both received a nice sweater. We think the day and the challenge were a success and the heating can be turned down permanently.

The Green Initiative

On the 23th of March the GreenTeam organised The Green Initiative. The idea for this day started at the beginning of the year and together with the GreenTU board we made it a university-wide initiative.

Multiple GreenTeams from different faculties organised similar activities that day. At TPM six different parties contributed to the day: OdC, Curius, Energy Transition Lab, Delft Circularity Lab, FSC and Aukje Hassoldt and Andy van den Dobbelsteen. All the parties organised an activity themselves. Together with Linda Kamp the GreenTeam coordinated the day by making sure everyone had a timeslot and a room for their activity. Students and staff could register for 9 activities in total. Unfortunately not enough people registered for every activity, so three of them were cancelled. We think one of the reasons for this could be the minor event for Bachelor students that took place on the same day. When we set the date at the beginning of the year, it was not yet known that the minor event would also take place that day. We also think that a reason for the low number of registrations may be the large amount of activities that were organised. And next time we will give even more attention to the promotion of the day than we did this time, preferably in collaboration with Curius, because they have a bigger outreach. Despite this, we think that The Green Initiative was a success. We had some nice and positive feedback. Because of The Green Initiative discussions have been established. This has led to the thermostatic valves being turned to the lowest position in the faculty and posters everywhere explaining that you can only turn them on again if it is really necessary and you need to turn them back afterwards.

Sustainable educational case

In collaboration with Andrea Gammon we have developed a teaching case revolving around a simple game about waste management. Students play the game for 10 to 20 minutes, after which a discussion takes place about how the game reflects reality. The game attempts to capture the complex environment created by the simple fact that the payment for recycling usually happens before the recycling actually takes place.

The game was played in one of Andrea's classes, and found to be very successful. Andrea is currently working on integrating the teaching module into a global network of ethical teaching materials, ensuring that other teachers can also make use of the game.

Clothes swap

On the 10th of May the Greenteam organised a Clothes Swap. We wanted to create awareness about the impact of the clothing industry on our climate and we wanted to show students and staff that preloved clothes can be really nice. We also wanted to show that it can be fun to make someone else happy with your old clothes. Before we started organising the event we spread out a survey on Instagram and we noticed a lot of people were enthusiastic about a clothes swap. We started the promotion of the event a month before. We shared it on Instagram, LinkedIn, on the (coffee)screens in the faculty, in the newsletter and on posters in the faculty. This resulted in 30 sign-ups for the Clothes Swap. The Clothes Swap was hosted in the canteen in TPM. We also bought some drinks and snacks for the participants. So the event turned out to be a nice and cosy afternoon. There were a lot of participants and everyone took a lot of clothes with them to swap. It was a success and we had a lot of nice feedback about the event. After the event we brought all the leftover clothes to the clothes bank 'Buurvrouw' in Delft. They were happy with the clothes. Next time we can do the event a little bit later so that we can reach more people who couldn't participate now due to their working hours. Besides this, it really was a success.

3.1.2. Projects in progress

Sustainability Thesis Journal

We are currently working to publish a thesis journal in which we will showcase some of the most outstanding theses from TPM students writing on sustainability topics. We have already received many enthusiastic responses from both students and supervisors alike. This will be a great opportunity for

students to present their hard work, whilst simultaneously providing a channel for others to get to know more about the latest findings on sustainability.

Sustainable Kantine

We finished our survey among TPM students and staff and got 78 respondents. The results were a bit mixed: over 50% of the respondents would consider buying more organic and vegetarian products if they would be offered to a larger extent in the cafeteria of TPM and almost 50% of the respondents would consider buying more vegan products. However, the other 40-50% of the respondents would definitely not consider buying any of those products. For now, we are waiting for the results of an internal meeting where the vision of the faculty regarding the sustainability of the cafeteria was discussed. Once we know this vision, we want to assist the faculty in achieving their goals.

Cooking workshop

This workshop aims to teach students how to cook simple and healthy vegan food. Our food system has an enormous impact on our environment! We aim to show that cooking vegan doesn't have to be difficult or boring. We will prepare a three-course menu, which we will then eat together. Students and staff are both welcome!

Outreach/social media

The GreenTeam is still increasing their visibility in the faculty, not only with all our organised activities, but also on social media. Within a year time the GreenTeam doubled their amount of followers on Instagram[c] (from 268 to 538). At least once a week we post something on our account, for example a vegan recipe, a funny fact, pictures of our organised events, or we highlight nice activities from other organisations in the university. Since the third quarter of the '21-'22 year we also collaborated more with the communication department of the faculty, for example we had a 'story take-over' day on the Instagram page of TPM. Besides Instagram, we use LinkedIn to share some things now and then. The posts on LinkedIn are more formal than on Instagram. With Instagram we reach mostly students and with LinkedIn we reach mostly staff.

[c] https://www.instagram.com/greentpm_tudelft/

3.2. GreenTeam AS

The 2021-2022 GreenTeam of Applied Sciences reflects back on a successful year. At the start of the year, our focus was largely on education and considering how sustainability might be implemented in the material of various courses. We also researched Bachelor and Master thesis opportunities for students who wanted sustainability to play a role in their end projects. The results of our research could then be found at the various thesis markets that were held throughout the year by the study associations of Applied Sciences.

However, since the pandemic and the lockdowns had had a detrimental effect on student participation within the faculty, we really wanted to work on getting them involved with sustainability as well. We finally got the chance to do so as the lockdown started to be lifted, and gradually we started to shift our focus towards events that would get people excited and stimulate student interaction with sustainability.

During the year, the GreenTeam organised two lunch lectures which had free lunch and drinks, and a topically relevant sustainable lecture to go with it. The first was given by Supersola, a company that offers a range of plug-and-play solar panels for home use, and the second was given by Ruud van Ommen, who gave an introduction to TU Delft's e-Refinery. The lunch lectures were fun intermissions in the full days of university, especially due to the enthusiastic discussions that followed and stayed with us until days afterwards.

In May, we hosted a pub quiz and an alumni event. The pub quiz had around 20 participants in groups all trying to get the most points through answering questions which were centred around sustainability, geography and general knowledge. There was pizza, music,

free drinks, and the night ended with a tense tie breaker. Eventually the winners left with their sustainable prizes of TU Delft cutlery sets and bees wax sheets for zero-waste food storage. The alumni event gave students the opportunity to speak with alumni from the Applied Sciences faculty, who are now actively working and applying their knowledge to projects which further the transition to a circular economy and a more sustainable future. While the expected questions came up – such as why they chose their line of work, and how they came to be where they are – unexpected knowledge was gained as well, with advice on career paths, whether to do a PhD, and future expectations being a main theme of the night. It also gave the alumni the chance to talk amongst themselves and gain insights on what other sectors are working on sustainability. The night ended successfully, with most participants staying and chatting for over an hour past the official ending time.

Apart from student activities, the GreenTeam has also been working on more operational aspects of the faculty. The discussion was started regarding a cafeteria that offers more vegetarian and vegan food, maybe eventually becoming like the cafeteria offered at the Architecture building, if students and staff are enthusiastic. These talks are still occurring, but we have hopes that a pilot will soon start in the Southern Applied Sciences building 58. Additionally, a plan on how to improve the heating and isolation of building 22 has been in the works after various complaints from some students and staff. We have also contributed to discussions regarding the design of the new physics building, in which circularity and sustainability play big roles.

And so, as the academic year and our time as GreenTeam members end, we stay hopeful and full of curiosity to what great things the next GreenTeam of the Applied Sciences faculty will achieve. If you want to become a member of next year's team and want to contribute to our faculty, send us an email at Greenteam-AS@tudelft.nl.

3.3. GreenTeam AE

The GreenTeam AE at the faculty of Aerospace Engineering consists of four different portfolios, each with the goal to pursue a sustainable future for the Aerospace faculty. Within operations, this goal is about the building and workings of the faculty, within education about the curriculum, and within social engagement and awareness about the mindset and actions of our people. Here, we describe the work that the GreenTeam AE has accomplished this year.

3.3.1. Operations

The Operations portfolio aims at working to generate changes in how students and staff experience their daily university life on a more practical side. First, since last year a group called the Climate Action Task Force[d] was created and the GreenTeam AE had one member join this group. The objective of the group is to work on pitching sustainable ideas directly to the Management Team of the faculty, the Faculty Student Council and the ODC (the Personnel Committee). The two main projects for this academic year were to have the Mobility Pilot approved, and start the conversation on possible changes on the Faculty canteen.

The Mobility Pilot, aimed at promoting more sustainable ways of dealing with the staff business and academic travels, was ideated in late 2020 and was finally approved and became an official Faculty policy in March 2022. Since December 2021, a series of conversations between the Climate Action Task Force, the Faculty administrative bodies and CIRFOOD, were started. Those conversations were focused on obtaining a larger variety of affordable,

[d] https://www.tudelft.nl/lr/organisatie/climate-action-task-force

high-quality vegetarian and vegan options at the Faculty canteen. This Food pilot is still at the design stage, but the GreenTeam AE will continue to work on it during the next academic year.

3.3.2. BSc Education

The BSc education portfolio's main objective was to improve the sustainable education given within already existing BSc courses. At this moment, adding a new course solely on the topic of sustainable engineering in the curriculum was not considered feasible. For the introduction within the courses various professors were contacted to work with. This academic year consisted of working primarily with the two projects given in first year. For each of these projects a different approach was used to improve the sustainability education. Each of these is detailed below.

The first of the two project is a course called Exploring Aerospace Engineering, which runs in the first two periods of the first academic year. For this course, students are expected to use knowledge gained in the courses running parallel to create a concept for a drone design. The course considers environments both on Earth and in space. To get to the final design, the course consists of various modules intended to test the knowledge of the students in a multidisciplinary way. To create an on-going consideration into sustainable engineering, questions intended to stimulate sustainability and environmental concerns are posed various times throughout the reader in several of the modules. Therefore, the method chosen is more to focus on students discussing and considering various sustainable topics, included differences in impact in different environments on climate change concerns, resource depletion, end-of-life considerations, and so on. It is intended primarily to encourage from the beginning of the BSc education thought on the topics.

The second project is a course called Design and Construction. The course had already been adapted last year by the GreenTeam to include considerations into the sustainability of the design of the groups. The approach used this year was slightly different as the reader was updated. In this case the students are also questioned and graded on the considerations made toward sustainability in the reports. The GreenTeam was also working with an MSc student carrying out his thesis on the topic of implementing sustainability into education, for this certain student sets were contacted to discuss environmental and sustainable matters. These students set had various follow up discussions to see the differences over time.

3.3.3. MSc Education

Regarding the MSc programme at Aerospace Engineering, the GreenTeam had two main objectives: to make it easier for students to choose a degree with a (partial) focus on sustainability, and to implement more sustainability in the MSc curriculum.

Before contacting lecturers to implement more sustainability-related topics in their courses, a survey was created for both BSc and MSc students. Questions for BSc students were focused on their satisfaction with the current curriculum and the way sustainability was included, and what criteria they would use to choose their MSc. For MSc students, the survey included questions related to their expectations of the programme and to what extent these were met.

Overall, the outcome showed that students would like to see more sustainability in their programme, both in the BSc and in the MSc. Over 80% of students wanted to have a dedicated course on this topic.

Furthermore, a course guide was created for students, which can be used to select a profile or electives based on the relevance of sustainability in the provided courses. However, it can also be used simply as a comparison between MSc programmes in general, as it contains a list of all mandatory and recommended elective courses. This includes an indication on the number of ECTS that can be achieved and the periods in which the courses are offered

Finally, the GreenTeam AE 2021/2022 has worked on multiple MSc courses to implement more sustainability in the curriculum. The first project was related to the course 'Manufacturing of Aerospace Structures and Materials', in which a lecture on sustainability was included. Next, the Green Thread Initiative was applied at the Aerospace Engineering faculty to bring more sustainability into the courses 'Ethics and Engineering for Aerospace Engineering' and 'Research Methodologies'. The course content related to sustainability was organised by applying the Engineering for One Planet framework.

3.3.4. Social Engagement & Awareness

The main objective of the social engagement & awareness portfolio is to organise events that promote a sustainable lifestyle in the personal and professional lives of everyone involved in the Aerospace faculty. In accordance with that objective, two lunch lectures, a sustainability drink, a network day, and a pubquiz were held. In addition to that, the sustainable activities in and around the faculty have been promoted through social media, which was started up a year ago and has reached over 200 people so far.

Through the first lunch lecture, sustainable materials in the aerospace field were discussed by Christian Rueckerts from Airbus. This event had been organised together with AE master societies Enlightness, AWEP, and STATO. Another lunch lecture was given later in the year by Food and Future, who brought amazing home-made food and spoke to the students about the impact of the food we eat on the individual carbon footprint, and on the environment.

As part of the objective, we also created a space for both students and staff to come and discuss sustainability in aerospace while enjoying some drinks at the aerospace bar 'de Atmosfeer'. This was not the only event where discussions regarding sustainability were held. At one of the VSV Leonardo da Vinci events, the GreenTeam collaborated and held a pubquiz together with the DeBaCo committee which was a huge success. The final event organised during this year was part of The Green Initiative, where WWF came by our faculty to talk about reducing our environmental footprint and participants could see many of the projects within the faculty that have a focus on sustainability while they were displayed at the lobby.

3.4. GreenTeam IDE

The GreenTeam of IDE has had their first year of activities after delivering the report on the current status of our faculty. The action points coming from our report had improvements proposed for all four pillars.

3.4.1. Operations

For the pillar operations, we focused on increasing the number of vegetarian options within the faculties canteen. Together with the FSC, we have accomplished that 75% of all available food is now vegetarian. Secondly, we have initiated a heating campaign that will remind the staff to turn off the heating in their offices. This heating campaign will be executed in winter of the ’22-’23 year, by our new team!

3.4.2. Education

On education, we have organised a lunch lecture together with Energy Club given by Peter Pot. This was initiated to teach students how to set up a company with a completely sustainable business model, and to inspire them. Next, to reach master's students we organised an IDE Academy. This is a course which provides full-day workshops that master students can sign up for. Our workshop was on showing students what TU Delft is currently doing on sustainability, with lectures from Erik Tempelman and Andy van den Dobbelsteen. In the afternoon, together with KOOS Service Design, we organised a case on creating circular waste streams within our faculty.

3.4.3. Community & Research

For communication, we helped our sustainability coordinator create infographics on the different researchers and topics on sustainability at IDE, our next step is to get these on the TU Delft IDE website. Lastly, an important focus for us was broadening our relations with students, committees (other GreenTeams, ID study association, FSC, Energy Club, etc.) and staff members. The Green Initiative day was used to get ourselves known by standing in the faculty hall and handing out 200+ vegan cookies.

3.5. GreenTeam 3mE / Green-mE

Green-mE is the GreenTeam active on the faculty of 3mE. The 4 team members this year were Sanne Middelkoop, Rathish Nagulagama, Leonoor Verbaan and Rosa Weinzierl. When Green-mE was founded, the first projects were taken up with regards to education. Also during the ’21-’22 year, education has been one of our foremost priorities, since we want to ensure that students at our faculty are educated and trained to be engineers that will contribute to the transition to a more sustainable society and play an active role in this movement.

3.5.1. The Green Initiative

On the 23rd of March 2022 at all faculties, a day around sustainability was organised. The idea for this day originated from the study associations of 3mE, and with the help of GreenTU, it was executed on all faculties. For 3mE specifically, together with the study associations, we organised a couple activities. We organised a Townhall meeting during which Deirdre van Gameren and Andy van den Dobbelsteen discussed the current developments at our campus regarding sustainability and afterwards, we talked about what we could do to improve our faculty in specific.

Furthermore we offered several researchers/teachers of 3mE that focus on sustainability within their research, the opportunity to display their interesting projects. It showed us, as well as fellow students, that sustainability has a valuable place in jobs or research we could encounter in the future.

We closed the day with presentations of all the groups that participated in our case study:

How do we make the faculty of 3mE self-sufficient in energy?

The students came up with creative solutions to maybe one of our greatest challenges we face as a university. They showcased a good balance between proven-technologies and innovation, giving us many takeaways at the end of the day.

3.5.2. Green Award

First year's Mechanical Engineering students always participate in a design competition for one of their biggest courses. The competition is multi-faceted and they can win several prizes in different categories. One of them is the Green Award, handed out by Green-mE. Each year the students need to design a different product, this time a 'wave energy accumulator'. For this, we drew up a few criteria for the students to keep in mind when designing a sustainable product and referred them to the Sustainable Mechanical Engineering Guide written by our predecessors. A few groups admitted their projects to us and we were able to select a clear winner. During the day of the Energy Challenge Event on the 9th of June, the competition took place and we handed out our prize.

3.5.3. The Green Thread

In line with the Green Thread Initiative, last year Green-mE provided a sustainable topic list for an oral presentation course taught at our faculty. This year we evaluated the list together with the teacher and with the help of student feedback and made improvements accordingly. Furthermore, with the help of our study associations, we were able to approach several other teachers to talk about the Green Thread. We were met with enthusiasm and have made a few connections, which the upcoming team can build on after the summer. Since 3mE is a faculty that accommodates many different study directions, we have laid the foundation for expanding our efforts to other programmes besides Mechanical Engineering.

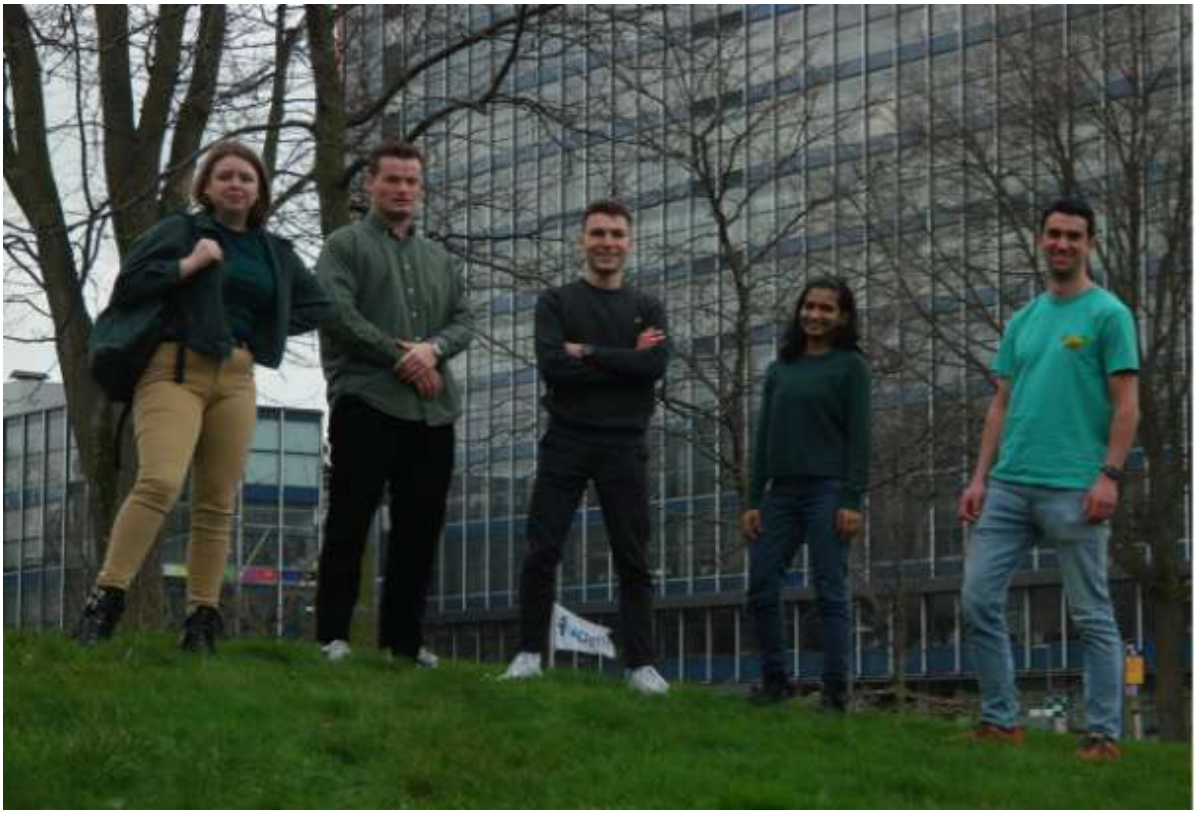
3.5.4. Girl's Day

Every year, 3mE hosts a Girl's Day to get young girls familiar with Mechanical Engineering. As Green-mE we were asked to organise a workshop that highlights the sustainable side of Mechanical Engineering. We did a little quiz beforehand and afterwards the girls had to make posters on certain sustainable research topics we provided them with. The day resulted in many beautiful posters on wind turbines, solar panels and beach cleaning robots.

3.5.5. Warmetruiendag

Next to education, awareness is something we find important and a great initiative to create awareness is the national, annual Warmetruiendag. Last year and this year, Green-mE also joined the day. Last year due to Covid we targeted students and staff at home, this year we had the opportunity to include the faculty itself. We turned down the heating by two degrees on the 11th of February '22 and held a contest to win a TU Delft sweater. We managed to include several other buildings such as Pulse, the Library and IDE and aim to do it campus-wide next year!

3.6. GreenTeam EEMCS



From left to right: Andreea Zei, Simon Hammecher, Tyren Koning, Priya Sarkar, Thomas Crul.

We are proud to announce that since December 2021, the EEMCS faculty also has an operational GreenTeam, consisting of five enthusiastic students. The focus of this year is to officially install the GreenTeam as a student body of the faculty. This includes creating awareness among students and staff, integrating into the faculty, setting up our first projects and paving the way for future GreenTeams of EEMCS.

Creating awareness in the faculty was done by participating in the Green Initiative on the 23rd of March. During the week, the team organised a potluck pub quiz in the /pub, provided a place for students to exchange gadgets, and launched the “bring your own cup” campaign together with GreenTU and Coffee-star. This week also provided an opportunity for us to talk to students and gain insight into which aspects of sustainability they consider important. Organising this event, for the first time within the faculty, proved to be a real challenge from which we learned a lot.

Next to creating awareness, we started with setting up our first projects related to the different pillars. Because we start all projects from scratch, this provides an opportunity to create a certain structure for setting up projects, on which one of our projects is focused. Having such a structure can help in setting up projects efficiently and would therefore also be relevant for the other GreenTeams, for example. A project on temperature management within the faculty is set up in relation to the operations pillar. Currently, the thermostat is

automatically reset to a temperature of 21 degrees Celsius every night. If someone has a permanent office and wants a lower temperature, this has to be done manually every morning. We are discussing with the faculty what can be done about this to prevent unnecessary heating. In regard to the community pillar, the focus was on organising events to spread awareness and becoming known to students. Besides the earlier mentioned Green Initiative, the team will participate in the Energy Club lustrum with their own stand, challenging others in a game of sustainable twister. The education pillar focused on how to incorporate the Green Thread into the curricula of the EEMCS courses. Every program provided by the faculty should incorporate some knowledge about sustainability. The first steps taken this year were having discussions about this topic with the study associations. One of the goals of the research pillar is to find out what the general view is of students and staff on sustainability. In order to get this insight, surveys will be used.

The team will continue to operate until the second quarter of the 2022-2023 educational year. In order to help the next team get started in the best possible way, we are already thinking about the proper set-up of transfer documents and the transition period.

II

Education

4

Introduction to education

As a university and educational institution, TU Delft's main goal is to supply the creation and transfer of knowledge. Over 26 000 students are associated with TU Delft yearly. TU Delft may hope to lead all of these individuals, in a wide range of backgrounds and fields, towards a path of sustainable development.

Education at TU Delft is largely conducted on a faculty basis. Bachelor (BSc) and master (MSc) material is largely decided by the faculty's directors of education in coordination with the bachelor and master programme directors. The content included in individual courses is determined for a significant proportion by individual lecturers.

In the following sections, we will first attempt to give an overview of the current status of sustainability within TU Delft's bachelor and master programmes. Then, GreenTU's efforts for sustainable education at TU Delft will be discussed. This includes the implementation of sustainability relevant courses in all existing programmes through the Green Thread initiative, which would provide students with the necessary "grammar" to consider sustainability employments in their fields. GreenTU feels students should also be provided with attractive and topical skills to explore sustainability further, and become specialized with sustainability in their continued studies. Education for sustainability is here understood as providing students with the methods, tools, and thinking processes required to solve (field-specific) sustainability problems.

4.1. What is education for sustainability?

Before going further into what GreenTU has done for education during the '21-'22 year, as well as what we hope to still accomplish for education in the future, it is important to first discuss what our understanding is of "education for sustainability". How sustainability is or should be incorporated into education may differ depending on who you ask. Thus, allow us to explain how we at GreenTU (currently) envision this matter. GreenTU's vision for sustainability in education involves that each student's education at TU Delft includes the following:

- **Basic grammar** concerning sustainability and social issues to the extent that these are

relevant to a student's discipline. For example, a basic understanding of a life-cycle approach or circularity;

- **Exploration opportunities** for students to discover how they can further integrate sustainability in their education if they wish to do so;
- **Expertise opportunities** for students wishing to integrate sustainability into their specialisation and thesis research (and possibly their future career).

These describe an imagined future in which sustainability is properly integrated into TU Delft's education. However, they don't say much about how to achieve this. To this end, and through the effort of the campus-wide education theme team led by Andy van den Dobbelsteen, the following three-point roadmap is being developed, which is adapted more closely to how education is currently structured at TU Delft:

- **Fundamentals of sustainability** falls under the basic grammar mentioned above, and includes the subjects which are relevant in some way to all (or most) programmes, which can be organised from a somewhat central position;
- **Discipline-specific sustainability** includes themes of sustainability which are only relevant to specific fields, to be integrated in the programmes related to that field through that programme's educational staff – this can be seen as specialised basic grammar;
- **Interdisciplinary sustainability knowledge** connects different fields on sustainability topics students can contribute to, such as through the JIP (joint interdisciplinary project: an internship substitute which is available to several master programmes) – this is coordinated between faculties, with people such as Hans Hellendoorn, Pro Vice Rector Magnificus Joint Education Affairs (what a title!).

5

Current state of sustainability in education

To know what to improve, it is imperative to first have an overview of the current (baseline) situation. For the matter of sustainability in education, GreenTU created such an overview for our second sustainability report (2020-2021). This second report thus precedes the current report. At that time, GreenTU created an overall inventory of the status of sustainability in education, as well as a more in-depth study per faculty. For the complete overview, please see last year's GreenTU sustainability report.[6] Overall results are summarised below:

- With the exception of BSc Architecture, Urbanism and Building Sciences, few of TU Delft's 16 bachelor programmes directly incorporate sustainability.
- Although every faculty offers at least one minor relevant to sustainability, only 10 out of 42 TU Delft minors do so explicitly.
- Although sustainability is mentioned in at least half of TU Delft's master programmes, only 5 out of 35 master programmes and 15 out of 49 master tracks do so explicitly.
- If Honour students want to work on a sustainability-related assignment, this depends on the agreements between student and supervisor. The same goes for thesis students.
- Although sustainability can be and often is a topic of a PhD at TU Delft, candidates have indicated that too few courses of their Doctoral Education deal with sustainability. In addition, sustainability is a topic in 2 of the 5 professional doctorates (PDeng), and in 3 of the 5 post-master programmes offered by TU Delft.
- With the exception of the faculty of Architecture and the Built Environment, there are not many MOOCs or ProfEd courses that fully integrate sustainability.

The overview in the previous GreenTU sustainability report was our first attempt to try and provide a structured, complete synopsis of the status of sustainability in education at TU Delft. Whilst extensive, it may thus not be perfect.

5.1. Sustainability education around TU Delft

During the 2021-2022 year, GreenTU has also assessed the state of sustainability in each individual study programme (BSc, MSc, and minors). In the following table, each programme is rated based on whether they have explicitly listed sustainability-related topics as part of their description/brochure on TU Delft's website and in their learning goals (information which can easily be found by anyone, and often the first source for prospective students). If yes, ✔ appears and if not ⊗. If unclear or unknown, for example if we could not find any explicit learning goals, ? is shown.

Architecture and the Built Environment

Education programme	Details
BSc Architecture, Urbanism and Building Sciences ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Field of study description includes "environmental engineering" in building technology. In the brochure, it is stated that "all aspects of technology are addressed... and climate design" (translated from Dutch). Director of Education states "...you can contribute to solutions for... climate change, health and sustainable urbanisation".
Minor Architecture Presentation - Visions Reviewed ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Cities, Migration & Socio-Spatial Inequality ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Although no explicit link to sustainability, minor focuses heavily on equality and justice, which are considered significant aspects of sustainable development.
Minor Spatial Computing in Architectural Design ✔ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Description states that "the new generation of architects will be expected to improve the quality and the performance of existing and new buildings in face of new environmental, social and econonmic challenges". Also "how can we improve the sustainability...in quantifiable ways".
Minor Sustainable Urbanism - the Green-Blue City ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states "Dutch cities have to deal with urgent environmental problems" and "climate change has become a visible problem in the urban environment". "Sustainable urban design" is main subject, with focus on "concrete sustainable design exercises" to adapt cities and pubic spaces to the climate crisis.
Minor Archineering ⊗ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Learning goals include "explore construction, climate design... and be able to experiment with these design aspects in your own design project".
Minor Heritage & Design ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit links to sustainability. Yet, the focus on preservation of historical cities in a modern setting could be considered to be important for social sustainability.
Minor Spaces of Display ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
MSc Architecture, Urbanism and Building Sciences - Architecture ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability-related topics not explicitly stated. Focus on sustainability is possible, but depends on the electives and graduation studio a student chooses.
MSc Architecture, Urbanism and Building Sciences - Building Technology ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states topics such as "the sustainable designer", focusing on "climate design", and "students learn how to contribute to smart buildings that are sustainable, comfortable and environmentally intelligent". Emphasis on "design of innovative and sustainable bulding components".

Education programme	Details
MSc Architecture, Urbanism and Building Sciences - Landscape Architecture ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states focus on "making space inspired by nature". Students "acquire knowledge of plants and vegetation types, soils, hydrology, ecology, sociology, history and theory of landscape architecture".
MSc Architecture, Urbanism and Building Sciences - Management in the Built Environment ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description.
MSc Architecture, Urbanism and Building Sciences - Urbanism ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states "learn to integrate social, cultural, economic and political perspectives with the natural and man-made conditions... shape and plan for more sustainable development". And "students respond to... global trends such as globalisation, climate change, demographic trends and the energy transition".
MSc Metropolitan Analysis, Design and Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states that this master's has "a focus on sustainable development". Students "learn to creative innovative solutions for the challenges that metropolitan regions are facing in securing environmental change, urban sustainability and the quality of life in cities". Issues addressed include "water and waste management" and "energy and food security".
MSc Geographical Information Management & Appl. ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Could be be sustainability-oriented, depending on the specific projects students choose to investigate (e.g. rooftop solar panels, spatial planning of nature).
MSc Geomatics ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states "increasing environmental and societal challenges... call for innovative ways to interact with, design and model our built surroundings".

Aerospace Engineering

Education programme	Details
BSc Aerospace Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The question "how do you make an aircraft more sustainable?" is stated as the opening sentence of the program description on the website. Similarly, the brochure opens with "how do you make an aircraft climate neutral? How do you design satellites that can monitor climate change?".
Minor Airport Development ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Description states "development and growth of any large airport is to a large extent determined by its ability to balance... environmental and social demands." Learning goals mention topics such as "demonstrate understanding of the system concepts that address the... environmental problems associated with the development of airports." and "judge the right balance between economic, environmental and social interests in sustainable airport development."
Minor Offshore Wind Energy ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Description states wind energy as one of the most promising renewable energy sources. Learning goals mention having knowledge of the production and transport of (sustainable) electricity, as well as placing wind energy, smart grids and energy markets in a social context.
MSc Aerospace Engineering - Aerodynamics and Wind Energy ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	Aerodynamics profile seems to make no explicit mention of sustainability. Although the Wind Energy profile of course focuses on a major renewable energy source, this is not explicitly mentioned.

Education programme	Details
MSc Aerospace Engineering - Aerospace Structures and Materials ✔ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Description mentions that "important issues such as sustainability, recyclability, and environmental aspects need to be accounted for in the lifecyle of aerospace materials and structures". The student profile also states that knowledge about the complete life cycle aspects (incl. recycling) will be expanded.
MSc Aerospace Engineering - Control and Operations ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Student profile description states that "the C&O student has a high affinity with sustainability". The Sustainable Air Transport profile has included environmental impact as a Key Performance Indicator that is to be understood, in one of the learning goals. Questions related to sustainability also mentioned in this profile description (What is the contirbution of aviation to greenhouse gasses in the atmosphere?).
MSc Aerospace Engineering - Flight Performance and Propulsion ✔ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Student profile description states that the "the ideal FPP student... wants to make an impact on future sustainable aviation". Depending on electives, students can deepen their knowledge on e.g. "aviation sustainability aspects", "environmental impact" and "alternative energy systems".
MSc Aerospace Engineering - Space Flight ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.
MSc European Wind Energy Master - Rotor Design (AE) ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	Although this track of course focuses on a major renewable energy source, the link to sustainability is not explicitly mentioned in the description or learning goals (mainly provides technical knowledge to work in R&D of wind turbine rotors). With the exception that for the profile of Structures and Composites, graduates give "special attention to the aspects relevant to wind turbines (e.g. fatigue and sustainable production)".
MSc European Wind Energy Master - Offshore Engineering (3mE) ✔ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	Description states that track "trains students to master the interpretation of environmental data for the design of structures to be used in offshore wind turbines" (a major renewable energy source). The focus however is on manufacturing, transport, installation, operations and maintenance. Whether e.g. the social aspect of sustainability is included or just the technical aspect, is unclear.
MSc European Wind Energy Master - Wind Farms & Atmospheric Physics ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	Like the other tracks of European Wind Energy, the focus is on technical aspects instead of explicitly on sustainability ("provides students with the scientific and technical knowledge to work in R&D as well as operation of wind power plants"). Although, of course wind energy is a major renewable energy source.
MSc European Wind Energy Master - Electric Power Systems (EEMCS) ✔ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	Description states that track "provides students with technical knowledge about components and systems necessary for the integration of renewable energy within the power system". Mainly technical, link to (other) aspects of sustainability is unknown.

EEMCS

Education programme	Details
BSc Electrical Engineering ? Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description lists sustainability-related technologies which could not have been designed without Electrical Engineering, such as solar panels, electric cars and a sustainable electricity grid. Brochure states that Electrical Engineers lay the foundation for innovations in the field of e.g. sustainable energy (translated from Dutch). One of the sub disciplines of the field of study is Energy Supply, which deals with "development of more efficient solar panels and quick chargers for electric cars" as well as "smart grids, which smartly connect renewable energy sources to electricity consumers".
BSc Applied Mathematics ? Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Description states that field of study focuses on "the optimisation of... climate models" amongst other topics. Thus, programme applies mathematical models to real-world situations, including topics of environmental science.
BSc Computer Science and Engineering ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description.
Minor Electrical Sustainable Energy Systems ✓ Sustainability explicit in description/brochure ✓ Sustainability explicit in learning goals	Description states that "electrical power systems worldwide are undergoing a major transformation as a consequence of the transition towards the widespread use of clean and sustainable energy". Minor prepares young engineers for this challenge. Learning goals (what you will learn) includes: "technologies, design, and analyses tools for greener, affordable, sustainable, and resilient energy systems".
Minor Computational Science and Engineering ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
Minor Computer Science ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
Minor Electronics for Robotics ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
Minor Engineering with AI ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
Minor Finance ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
Minor Physics for Electronics ? Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Field in the broader sense may contibute to sustainable development.
MSc Computer Science ✓ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	Field is significant to the energy transition and sustainable innovation, but the extent to which this is reflected in the curriculum depends on the student and their chosen track: electives and thesis topics on sustainability are possible but not pre-defined. E.g. description of data science & technology track states students can focus on "unlocking energy-relevant data.. to optimise our usage of energy". And "unlocking environment-relevant data... climate-adaptive buildings and cities, water management".
MSc Embedded Systems ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	Sustainability not explicitly mentioned in description or learning goals. Field is significant to the energy transition and sustainable innovation, but the extent to which this is reflected in the curriculum depends on the student.

Education programme	Details
MSc Computer Engineering ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Sustainability not explicitly mentioned in description or learning goals. Field is significant to the energy transition and sustainable innovation, but the extent to which this is reflected in the curriculum depends on the student.
MSc Electrical Engineering ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Field is significant to the energy transition and sustainable innovation, but the extent to which this is reflected in the curriculum depends on the student and their chosen track: electives and thesis topics on sustainability are possible but not pre-defined. E.g. description of Electrical Power Engineering track states "electrical power engineers are needed in order to design... sustainable materials and efficient conversion processes, as well as to integrate them into a smart and adaptable electricity infrastructure". Learning goals (what you will learn) of this track also state that "programme covers a wide range of issues... renewable energy, smart grids, environmentally friendly material technologies" etc.
MSc Applied Mathematics ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Field is closely linked to sustainability efforts, but pre-defined focus lies on technical and theoretical aspects.
MSc Sustainable Energy Technology ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Focus on many aspects of the energy transition and sustainable energy, which is clearly and extensively stated in description. Profiles are organised campus-wide and can focus on e.g. energy generation, storage, and economic and societal impact (all profiles are relevant to sustainability).

Civil Engineering and Geosciences

Education programme	Details
BSc Applied Earth Sciences ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability is explicitly mentioned in the description of the programme: "Its engineers know how to secure our future sustainable energy supply and are needed for obtaining the scarce resources for your phone, windmills and car-batteries"
BSc Civil Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Yes, Sustainability is mentioned in the description of this programme: "Civil engineers make the world a safe, liveable and accessible place with solutions that address climate and economic change."
Minor African Dynamics ⊗ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Sustainability is considered in the context of building an understanding of "integrated and sustainable development approaches in Africa". It is unclear whether this refers to purely economic and social sustainablitiy, or if the minor also shows relevance to climate change and sustainable energy and resources.
Minor Geo-Resources for the Future ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Yes, the first paragraph of the description introduces the trade off between fossil fuels and more sustainable technologies for the future: "Geo-resources are used everywhere in our daily life, it's not just the petrol that drives our cars and busses and the gas that warms our houses. Geo-resources are also needed to make sustainable energy sources. Rare earth metals are for instance used for solar cells, wind turbines, electric motors, and last but not least in our mobile phones."

Education programme	Details
Minor Climate Change, Adaption and Mitigation ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Climate change is the sole focus of this minor, the description stating "Climate change is arguably the most severe challenge that our planet is facing the 21st century. Human interference is perturbing the climate system through emissions of greenhouse gases, changes in aerosol concentrations and changes in land use. Climate science aims to estimate how the climate is changing in the near and more distant future and its impact on our living and build environment. Engineering solutions are required to cope with the evolving climate change impacts (adaption) and to prevent further emissions (mitigation). In addition, even more drastic solutions might be needed design to undo the already committed climate changes (climate engineering)."
Minor Environmental Engineering & Sustainable Design ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Yes. Sustainability and circularity are the sole focuses of this minor, the description of this minor states, "On the one hand this minor focuses on techniques and systems that prevent environmental impact, such as a plant for water or flue gas cleaning, recycling, or biomass processing. On the other hand it focuses on an integrated design that takes into account the future of available resources for water, energy and materials. Examples of sustainable design are reducing the use of raw materials, recovering materials from slurry or solid waste, recycling old building materials, or reusing old products or structures. Dominant concepts are circularity, renewable materials and renewable energy."
Minor Bend and Break ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	Although no explicit link, the minor focuses heavily on recycling, efficient material usage and planning towards a more circular future.
Minor Delta Expert, Water for Future ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	Although no explicit link, this minor does mention water resources management, which plays a key role in a sustainable future.
Minor Integrated Infastructure Design ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Transport, Infrastructuur en Logistiek ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Research Project Applied Earth Sciences ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Relevance to sustainability is dependant on decided topic of the research project (the opportunity for a topic highly relevant to sustainability is available)
Minor Project Management: from Nano to Mega ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
MSc Msc Civil Engingeering ✔ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	Climate change and resource depletion is mentioned in the course description: "Civil engineers have the knowledge to find sustainable solutions for actual problems such as climate change, sea-level rise, resource depletion, population growth and urbanisation, and ageing of infrastructure." but sustainability does not seem to be a core theme.
MSc Applied Earth Sciences ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals *Applied Earth Sciences programme is currently being restructured: from the 2022-2023 academic year, it will have different tracks, as well as the track Environmental Engineering becoming a separate programme*	Yes, sustainability is a recurring theme. In the course description the following is mentioned, "The earth is our home, shared with millions of other living species. In order to make it a safe and sustainable living environment, we need to monitor and understand how the earth and its climate are changing due to natural processes and human interactions, and we need to be able to responsibly extract energy and other resources."

Education programme	Details
MSc Applied Geophysics ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability is mentioned in the description, "To meet the growing demands of the world's expanding population for natural resources, escalating need for space for living, storage, transportation and other facilities, to resolve problems created by our use/misuse of land and the subsurface, to respond to the effects of climate change and dramatic population growth, to provide critical data for architects and civil engineers, and to forecast the effects/potential of natural disasters, it is necessary to acquire detailed spatio-temporal information of the structure, composition and condition of the outer skin of the Earth. Applied geophysicists provide this essential information through application of non-destructive geophysical methods." The programme has implications for sustainability, but does not directly educate the student on sustainability.
MSc Construction Management and Engineering ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals *Hosted together with Architecture and TPM.*	No explicit link to sustainability in description or learning goals.
MSc Geomantics ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
MSc Environmental Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Yes, sustainability is explicitly mentioned in the description of the programme: "The world is changing. Due to urbanisation most of the rapidly growing world population lives in or around cities. The need for water and other resources increases, while climate change asks for engineering solutions to keep cities liveable."
MSc Metropolitan Analysis, Design and Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Yes, the description states that "The master's Metropolitan Analysis, Design and Engineering (MSc MADE) is a master's with a focus on sustainable development. You learn to create innovative solutions for the challenges that metropolitan regions are facing in securing environmental change, urban sustainability and the quality of life in cities.
MSc Offshore & Dredging Engineering ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	While there is a track which focuses on offshore renewable energy, sustainability is not explicitly mentioned in the description nor the learning goals, and does not seem like a focus of this programme.
MSc Transport, Infastructure & Logistics ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals *Hosted together with 3ME and TPM.*	No explicit link to sustainability in description or learning goals.

Applied Sciences

Education programme	Details
BSc Applied Physics ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The description of this programme introduces the programme by posing the question: “Of hoe je met nanotechnologie veel betere zonnecellen kunt maken?” implying a consideration for sustainable implications and renewable initiatives. Sustainability is not explicitly mentioned.
BSc Life Science & Technology ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The description of this programme briefly mentions biodegradable plastic when it asks “Wat is de overeenkomst tussen penicilline, bier en biologisch afbreekbaar plastic?”. Sustainability is not explicitly stated
BSc Molecular Science & Technology ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	In the opening sentence for the description of this programme, a reference to solar pannels is made: “Chemie is overal om je heen: van je kleding, cosmetica en voeding tot je smartphone, geneesmiddelen en zonnecellen”. Later, it states a clean planet is one of the things chemists strive towards, and that they help work towards green or more efficient energy “Een schone en gezonde wereld: dat is waar chemici en chemisch technologen aan werken. Ze ontwikkelen bijvoorbeeld nieuwe technologieën op het gebied van energie, water en gezondheid”.
BSc Nanotechnology ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The description of this programme makes no explicit link to sustainability, and no sustainability-related topics are mentioned or refered to.
Minor Modern Physics ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.
Minor Quantum Science and Quantum Information ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.
MSc Applied Physics - Physics for Energy ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Yes, sustainability is mentioned “physics knowledge to address the challenge of sustainable energy production and storage. The development of new solar cell materials, magnetocalorics materials, batteries, hydrogen storage materials, etc. as well as the analysis and development of new innovative nuclear reactors and fuel cycles that excel regarding safety and sustainability are examples where of physics plays an important role in addressing the threat of climate change caused by greenhouse gas emissions”
MSc Applied Physics - Physics for Fluid Engineering ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Considers climate modeling, but sustainability is not mentioned in course description.
MSc Applied Physics - Physics for Health and Life ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.
MSc Applied Physics - Physics for Instrumentation ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.
MSc Applied Physics - Quantum Devices and Quantum Computing ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in learning goals or description.

Education programme	Details
MSc Chemical Engineering - Chemical Product Engineering ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Although there is No explicit link, solar cells are energy storage devices mentioned.
MSc Chemical Engineering - Process Engineering ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Yes, sustainability is mentioned and is a theme of this course "However, in a world in which resources are becoming scarce and where the environmental impacts of chemical and manufacturing processes are a matter of growing concern, process engineers are challenged to design processes that are elegant, efficient, environmentally responsible and sustainable."
MSc Life Science and Technology ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability is mentioned, in, among others: "Based on this understanding, students are taught how to design (or redesign) new, sustainable ways of making a wide range of products, including biofuels, pharmaceuticals and clean drinking water."

Note that AS students may also choose a joint minor, which can be focused on sustainability, e.g. minor Sustainable Chemistry & Biotechnology (offered by TU Delft and Leiden University). Joint minors are not included in this list - only TU Delft's "own" options.

Industrial Design Engineering

Education programme	Details
BSc Industrial Design Engineering ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	There are without a doubt applications of this programme that are very relevant to sustainability, but these are not explicitly stated in the description found about this programme.
Minor Designing Sustainability Transitions ✓ Sustainability explicit in description/brochure ✓ Sustainability explicit in learning goals	Yes, sustainability is mentioned, "Sustainability will be approached from both environmental and social perspectives."
Minor People in Transit ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability is not explicitly mentioned, although automotive technologies will be considered (and therefore a link to electric or sustainable transit can be made)
Minor Advanced Prototyping ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Connected Creativity ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Interactive Environments ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
MSc Design for Interaction ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link, but depending on electives or graduation project topic the programme can be highly variable.
MSc Integrated Product Design ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Sustainability is considered in product design, but not a core theme of the programme: The IPD Master's programme provides an integrated approach to the disciplines involved: advanced studies in innovative design theory and methods, aesthetics, ergonomics, engineering, and sustainability.
MSc Strategic Product Design ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.

Technology, Policy and Management

Education programme	Details
BSc Technische Bestuurskunde ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The opening sentence of the description for this programme introduces the engagement with sustainability: "Het opwekken van duurzame energie, de introductie van zelfrijdende auto's, het beschermen van je online privacy of het verantwoord ontwikkelen van artificial intelligence."
Minor Frugal Innovation for Sustainable Global Development ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	This minor considers how innovations may contribute to "sustainable global transformation processes that serve both people and planet". This minor is invested in UN SDGs, but not specifically on environmental sustainability.
Minor Responsible Innovation ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	While socioeconomic implications and ethics are considered, sustainablilty is not explicitly stated in the description for this minor
Minor Security, Safety&Justice ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	No explicit link to sustainability is made in the description of this programme.
Minor Companies and innovation ✗ Sustainability explicit in description/brochure ✗ Sustainability explicit in learning goals	Sustainability is not mentioned in the description of this minor. This minor considers ethics (but not necessarily environmental sustainability).
Minor International Entrepreneurship & Development ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	This minor considers socieoeconomic development and sustainability, but makes no explicit mention of environmental sustainability.
Minor MedTech-Based Entrepreneurship ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability is made in the description of this programme.
Minor Technology-Based Entrepreneurship ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability is made in the description of this programme.
MSc Complex Systems Engineering and Management - Energy ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The energy track has a focus on sustainability, the description specifies focus lies with "renewable energy, electricity and gas infrastructures and markets, and how possible interventions for their improvement can be designed".
MSc Complex Systems Engineering and Management - Information & Communication ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Information & Communication can have sustainable or green applications, but this is no explicit link to sustainability is made in the core of this track.
MSc Complex Systems Engineering and Management - Transport & Logistics ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability is made in the description of this programme.
MSc Engineering and Policy Analysis ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	The description of this minor stated that "climate change policy adaption is a topic commonly analysed through EPA lenses"
MSc Management of Technology ✗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability is made in the description of this programme.
MSc Industrial Ecology ✓ Sustainability explicit in description/brochure ✓ Sustainability explicit in learning goals	Website description states that Industrial Ecology is considered to be the "toolbox for sustainable development" and the "science of sustainability". Joint degree with Leiden University, whose website does not explicitly list learning goals but does mention "acquiring knowledge and skills needed for the analysis of sustainability problems".

Mechanical, Maritime and Materials Engineering

Education programme	Details
BSc Mechanical Engineering ✔ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Brochure states mechanical engineering focuses on "design, analysis, and realisation of mechanical systems which make our lives more sustainable...". Description states that field of study also includes knowledge on "lifespan, energy consumption, safety and recycling". Lastly, sustainability is included in social responsibility, which is a part of the third-year curriculum.
BSc Clinical Technology ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description or brochure.
BSc Marine Technology ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No exclicit link to sustainability in description or brochure. To the best of our knowledge however, sustainability is incorporated into some of the project courses.
Minor Engineering for Large-scale Energy Conversion and Storage (ELECS) ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Description states that the aim of the minor is "to equip bachelor engineering students with knowledge and skills concerning energy conversion and storage systems... based on renewable resources". Minor treats a major challenge of the energy transition, namely energy storage to bridge the gap between peak production and peak consumption. Learning goals (what you will learn) states "fundamentals of the most relevant intermittend renewable energy systems".
Minor Biomedical Engineering ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
Minor Robotics ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals.
MSc Materials Science & Engineering ✔ Sustainability explicit in description/brochure ✔ Sustainability explicit in learning goals	Description states that students of this programme consider materials "...from raw material processing through sustainable production and application of materials, to failure, durability and recycling". Also, programme "is concerned with the sustainable development of materials". Learning goals (what you will learn) also states that in the programme "you will study the design of new materials that perform better, last longer, enhance function, conserve resources and have a low environmental footprint". One of the circular economy master programmes of LDE Centre of Sustainability. Students can choose to focus on e.g. the use of material science for circularity, in the specialisation of Materials for Sustainable Development.
MSc Systems & Control ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Sustainability can be sought out by interested students but is not an integrated part of the curriculum.
MSc Technical Medicine - Imaging & Intervention ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Sustainability can be sought out by interested students but is not an integrated part of the curriculum.
MSc Technical Medicine - Sensing & Stimulation ✘ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Sustainability can be sought out by interested students but is not an integrated part of the curriculum.
MSc Robotics ✘ Sustainability explicit in description/brochure ✘ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. Sustainability can be sought out by interested students but is not an integrated part of the curriculum.

Education programme	Details
MSc Offshore & Dredging Engineering ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with CEG and TPM.*	No explicit link to sustainability in description or learning goals.
MSc Transport, Infrastructure and Logistics ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals *Hosted together with CEG and TPM.*	No explicit link to sustainability in description or learning goals. Field may be relevant to sustainability, and may be sought out by interested students depending on e.g. electives and specialisations.
MSc Biomedical Engineering - Neuromusculoskeletal Biomechanics ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals *Hosted together with AS and EEMCS.*	No explicit link to sustainability in description. Focus on sustainability may be possible but limited to electives, a JIP, or a sustainability-oriented internship.
MSc Biomedical Engineering - Medical Devices ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Focus on sustainability may be possible but limited to electives, a JIP, or a sustainability-oriented internship.
MSc Biomedical Engineering - Medical Physics ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description. Focus on sustainability may be possible but limited to electives, a JIP, or a sustainability-oriented internship.
MSc Marine Technology ⊗ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	No explicit link to sustainability in description or learning goals. The topic of sustainability may be studied if students choose to do so, e.g. in their specialisation.
MSc Mechanical Engineering - BioMedical Design ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description.
MSc Mechanical Engineering - Energy, Flow and Process Technology ✓ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	Brochure states students "acquire expertise in the fundamentals... needed to enable the upcoming energy transition". Some focus on sustainability, especially in the specialisations of Energy Technology and Process Technology.
MSc Mechanical Engineering - High-Tech Engineering ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description.
MSc Mechanical Engineering - Opto-Mechatronics ⊗ Sustainability explicit in description/brochure ? Sustainability explicit in learning goals	No explicit link to sustainability in description.
MSc Mechanical Engineering - Multi-Machine Engineering ✓ Sustainability explicit in description/brochure ⊗ Sustainability explicit in learning goals	Description states this track addresses challenges "to meet demands on efficiency, sustainability, and safety of complex processes".

6

GreenTU's own work on education: The Green Thread

6.1. About the Green Thread pilot

As could be seen in the previous chapter, not every programme at TU Delft makes an explicit link with sustainability yet. To be fair, our overview was based on the website description and/or brochure as well as the learning goals, as a way to evaluate programmes from the outside looking in (we did not have the means to carefully investigate the content of each programme from the inside). Thus, some programmes may very well make a link to sustainability that is less explicit. Nonetheless, we believe there is room for improvement in nearly every programme when it comes to education for sustainability. This is why we started the Green Thread project.

The Green Thread was developed by GreenTU in 2020 in order to enable and encourage the integration of sustainability, both as a core concept and as a link to existing course material, in different TU Delft curricula. The Green Thread aims to empower students and provide enthusiastic teachers with new opportunities by incorporating sustainability horizontally into existing curricula. This is accomplished by allowing GreenTeams from individual faculties to work with academic teaching staff to substitute or extend existing materials (such as case studies or project topics) with materials centred around sustainability. The GreenTeam is able to provide a TA (teaching assistant) who can support and aid a teacher in realising practical changes to the every-day curriculum.

After university-wide surveys showed a consistent recommendation for the integration of sustainability in curricula, GreenTeams employed a number of TAs in specific faculties. Each of these TAs first entered a research phase, in which course-specific research was conducted to find how best to incorporate sustainability in the existing programme. This research may consist of a literature study which provides an organised overview of material to be included in lectures, or can materialise through speaking to representatives from comparable degrees around the world and how their programmes incorporate sustainability. With assist of the TA, the teacher may then redesign lecture slides, project topics, or tangential worked examples to

introduce more sustainable education.

By targeting the curricula horizontally, the Green Thread enables all students regardless of discipline to diversify and extend their education of sustainability. It can also be completed seamlessly alongside each programme without needing to adapt or make room for additional courses in the already existing and dense bachelors or masters curricula. The Green Thread also requires little extra workload for teachers enthusiastic about its initiative, as TAs who conduct most of its realisation are found by the GreenTeams, although sustainable course content brainstorms can certainly be a combined effort amongst teachers and TAs.

The Green Thread was first piloted during the 2020-2021 academic year, at the faculty of AS and the CEG faculty (see below). The implementation of the pilot has been enthusiastically received in both the CEG and AS faculties. For example, the course, an “Introduction to Civil Engineering”, saw an additional 2-3 slides at the end of each lecture focusing solely on the sustainable applications of the weeks course material; while the Environmental Engineering master track was redesigned to include core sustainability to a greater extent. The timeline of already realised Green Thread initiatives in the CEG and AS faculties is shown further below. GreenTU is enthusiastic about continuing the success of this Green Thread initiative in the future. The implementation of the past Green Thread pilot is summarised next.

6.2. Findings from the Green Thread pilot evaluations

In order to further improve the Green Thread initiative it was important to evaluate its pilot together with the involved parties: the teachers and their TA’s.

To do so, both the teachers and the TA’s of the CEG faculty who were involved in the Green Thread pilot during the 2020-2021 academic year were interviewed by GreenTU during the 2021-2022 academic year. Discussing the experiences of these teachers and TA’s lead to the formulation of strengths and weaknesses of the Green Thread, summarised below. It was important to identify these strengths and weaknesses so the Green Thread could be improved going forwards. The next section details the current state of the project (ongoing achievements) whilst recommendations for its continuation during the 2022-2023 academic year (and beyond) are provided in the concluding chapter of this report.

Civil Engineering and Geosciences

Course	Description
Financial Engineering	Teacher Daan Schraven was helped to introduce practices of sustainable finance and the circular economy.
Introduction to Civil Engineering	Teacher Luuk Rietveld was helped to give students an introduction to sustainability in the first week, plus a workshop to assess the environmental impact of civil structures in Delft. In the remaining weeks, each lecture was dedicated to a specific aspect of civil engineering, also discussing the interaction between each aspect and sustainability.
Environmental Engineering	This application of the Green Thread involves the redesign of a programme, not a course. The Green Thread was useful to the redesign of the Environmental Engineering track, which was part of the MSc Applied Earth Sciences but will kick-off as a standalone master programme in the '22-'23 academic year.

Applied Sciences

Course	Description
Elektriciteit en Magnetisme	A GreenTeam member helped provide three exercises in a contemporary and sustainable context.
Introductory Practical	A GreenTeam member helped develop a new practical set-up with solar panels. In the course material, a brief introduction into the relevance of renewable energy and photovoltaics basics was included, as was a paragraph written by a former chief of the TU Delft Solar Boat Team's electronics department.
Computational Science	A GreenTeam member helped introduce an assignment about the plastic soup.
Design Engineering voor Fysici	A GreenTeam member helped find alternatives for some of the course material, which are equally as educational as the original material but more focused on sustainable design.
Lab course	The GreenTeam created a chapter on sustainability for the booklet.
Biofarmaceutische technieken en maatschappij	A GreenTeam member helped create a list of sustainable topics for this presentation course. Via a short list of topics and example theses, students could choose their own topic or get inspired.
Transport Phenomena	The GreenTeam created examples of sustainable exercises, which were used in the presentations for the course.

The Green Thread Timeline

2020-21

Survey research by GreenTeams

Showed consistent recommendation for horizontal integration of sustainability into curricula, by making it relevant to the disciplines students are instructed in.

Q1 2020-21

Lijst Beta and GreenTU develop the Green Thread initiative

Lijst Beta proposes the initiative, GreenTU is responsible for its execution.

Q2 2020-21

The Green Thread pilot at AS & CEG

At CEGT: Two courses + one program renewal (three TA's). At AS: six courses (GreenTeam members as TA's). The budget for the pilot came from GreenTU.

Q2 2020-21

Pilot evaluations & spreading the word

GreenTU evaluates CEG pilot, interviewing TA's, teachers & surveying students. GreenTU also works on spreading the word, through collaboration with the Teaching Academy, informing all GreenTeams & writing a summary doc.

Q3&4 2021-22

New participants at AE & Energy Challenge

GreenTeam is helping two teachers to find (one) TA. GreenTU helps where possible to make the Energy Challenge a success (uses similar principles as Green Thread).

STRENGTHS

Hit the ground running due to being directly linked to a teacher.

Inspiring to work with teachers who are interested in sustainability.

Met with enthusiasm by teachers who are eager to make changes & happy to have the extra help.

The Green Thread

CHALLENGES

No community to meet with other TAs doing similar work.

Most courses are already dense, which limits room for change.

No set format or place to document progress and findings.

6.3. Current state of the Green Thread

Following the pilot evaluations, GreenTU has worked hard over the 2021-2022 academic year to spread the Green Thread projects to other faculties (or expand it at the faculties that already joined the pilot). This has proven to require patience: locating teachers interested in joining the project takes time, as does talking to faculties to allocate funding (relying on GreenTU's budget indefinitely will not suffice).

To tackle the first matter especially, GreenTU made sure to discuss the Green Thread as loudly and frequently as possible to spread the news of its existence across campus. For instance, collaborating with the Teaching Academy proved fruitful, as the GreenTU board pitched the Green Thread during their Education Day in November 2021 and was featured in their newsletter thereafter. Another pitch was provided during the Climate Action Flagship kick-off in March 2022. Such opportunities to spread the word are always welcome. Other approaches taken by the GreenTeams have also worked well, especially reaching out to the study associations present at a GreenTeam's respective faculty. GreenTeams generally have a closer bond with their study associations than the campus-wide GreenTU board, and their close collaboration has helped spread the word about the Green Thread across faculty management (at 3mE especially).

Ultimately, the networking efforts by GreenTU (including its dedicated GreenTeams) has lead to an expansion of the Green Thread to other faculties (especially Aerospace Engineering and 3ME) during the 2021-2022 academic year. Many of these efforts are still ongoing, spanning into the new 2022-2023 academic year, and are summarised in the table below. As stated previously, recommendations on how to improve and continue the Green Thread in the long term are provided in the concluding chapter of this report.

Architecture and the Built Environment

Course	Description
-	The Green Thread has not yet been initiated at this faculty, since education related to sustainability offered here is relatively present when compared to other faculties.

Aerospace Engineering

Course	Description
Research methodology	Teacher Ines Balbin was helped to create a document outlining how to perform research in a sustainable way (both regarding being socially responsible and use of resources.
Ethics	Teacher Udo Pesch was helped to update assignments for tutorials with more recent study cases which also include topics related to sustainability (both social and environmental).

EEMCS

Course	Description
-	The Green Thread has not yet been initiated at this faculty.

Civil Engineering and Geosciences

Course	Description
Introduction to Civil Engineering	Teacher Luuk Rietveld is assumed to be continuing with the changes set out during the Green Thread pilot which weren't implemented due to COVID-19.

Applied Sciences

Course	Description
The Basics of Transport Phenomena	Initial idea for this MOOC was to introduce more tangible sustainability examples and exercises. However, currently on hold because the teacher fell ill.
Thermodynamica van levensprocessen	TA was found to help teacher Cees Haringa include more practical sustainability examples.
Biotechnologie en Maatschappij	Topic list for oral presentations was updated with new/-more popular sustainability topics on behalf of teacher Inge Schouten.

Industrial Design Engineering

Course	Description
IDE Academy	The GreenTeam taught one of the IDE Academies on the waste streams of the faculty and how to make it more circular.

Technology, Policy and Management

Course	Description
Environmental Ethics	The GreenTeam helped teacher Andrea Gammon to develop a game to play with the students.

Mechanical, Maritime and Materials Engineering

Course	Description
Oral presentations	Helped teacher Patrick van Delft to replace one of the presentation topics with sustainability. The GreenTeam provided the first list in 2020-2021 and gave an update to this list. Can be done every year.
Design competition	For the second time teacher Regine Vroom was helped to add an optional prize category to the competition for the most sustainable design, based on the criteria set up by the GreenTeam that suited this year's design. This can be done every year.
Mechanics of Materials	Contact was initiated with teacher Matthijs Langelaar and a brief brainstorm session was held on possible implementations the teacher was open to. Now on halt and needs to be resumed when there is time.
Robotics Minor Project	Contact was initiated with teacher Martin Klomp and a brief brainstorm session was held on possible implementations. Teacher was very interested in having TA's. Now on halt and needs to be resumed when there is time.

III

Research

7

Introduction to research

One of the main aims of TU Delft is, of course, research. At the university, research is spread across its eight faculties, all with their own departments, sections, research groups, and researchers. But truly dynamic and active research, which is crucial to achieve impactful and innovative initiatives and projects, goes further than this: the university also involves research institutes, student teams, and start-ups. It also looks beyond the lab: how can small-scale research be scaled up and implemented in real-life society?

TU Delft aims to use its research to meet societal needs in a sustainable way, especially in the face of increasing effects from climate change. In 2021, TU Delft launched the *Climate Action Programme*,[12] aiming to support research into climate science, and the related topics of mitigation, adaptation, and governance. As such, many of the research groups, initiatives, and projects that can be found around TU Delft are directly or indirectly involved with sustainability. In this section on *Research*, you will find an overview of some of these, as well as more information on the Climate Action programme.

7.1. Collaborations and partnerships

While TU Delft aims to be a leading climate university, this goal cannot be reached alone. TU Delft is a member of the International Universities Climate Alliance, a worldwide network of universities united in their commitment to critical climate research. It also works together with a large amount of educational, societal and industry parters via the TU Delft Energy Initiative, the TU Delft Climate Institute, the AMS Institute, the Green Village (see Chapter 11), and of course GreenTU.

Via the LDE Centre for Sustainability, TU Delft works together with Leiden University and Erasmus University Rotterdam on education and research on topics such as circular economy.[7] And via 4TU.Resilience Engineering, the four technical universities of the Netherlands collaborate on a variety of resilience-related topics. This includes DeSIRE, an extensive interdisciplinary research and capacity building programme.[1] Finally, TU Delft is part of the IDEA League, a strategic alliance between five European universities. Together, they are in the process of formulating ambitious joint targets for climate action.

7.2. Research trends

TU Delft's online research repository stores all published research from the university.[14] Over the last decade, sustainability topics have become increasingly relevant in TU Delft's research output. The following chart shows the evolution over time of some sustainability-related keywords in the research repository.

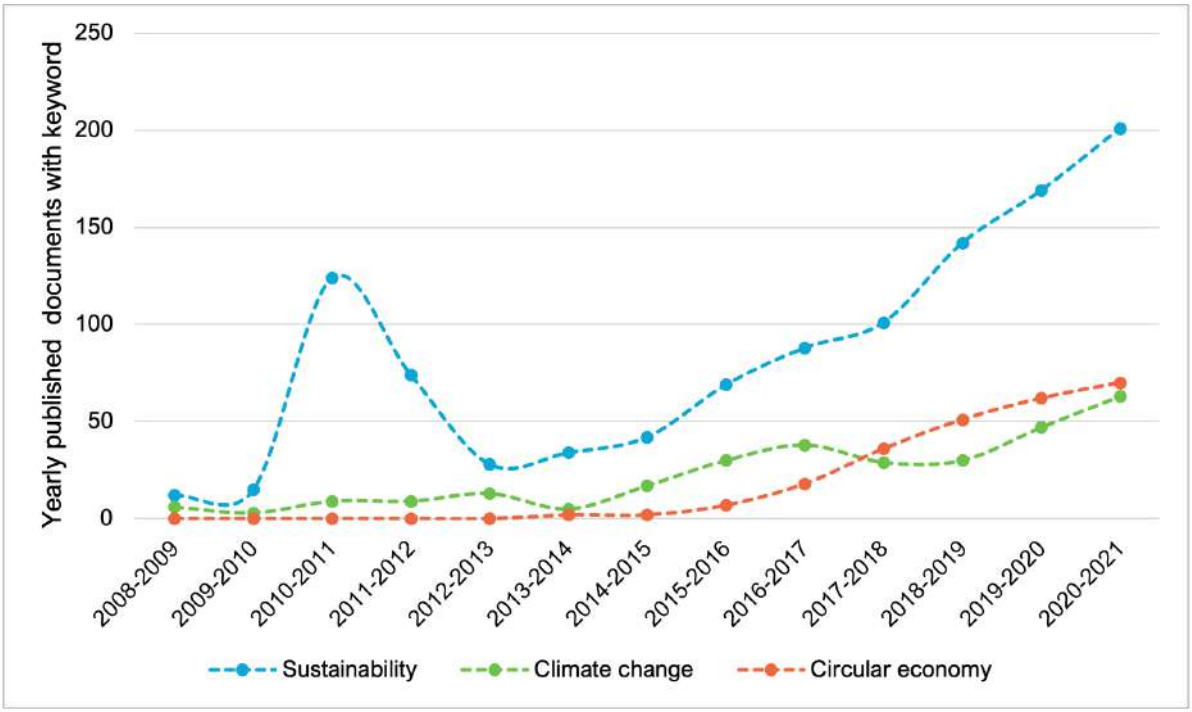


Figure 7.1: Trend of documents published in the TU Delft research repository using various sustainability-related keywords.

7.3. Want to know more?

In the rest of this section on *Research*, you will find interviews with inspirational researchers from various sustainability-related disciplines, an overview of all research groups related to sustainability, and an overview of TU Delft's new Climate Action Programme. GreenTU's recommendations for Research follow in the concluding chapter of this report. For more information on TU Delft's research with a focus on sustainability, you can also read last year's GreenTU *Vision on Sustainability: A Review and Strategy as of 2021*.[6]

8

Inspirational researchers

This year, we decided to interview some professors, postdoc researchers and PhD candidates who are working on the topic of sustainability. The primary motivation behind this interview series is to get to know the person behind the nametag “researcher”. We hope that we all can relate to the researchers more by getting to know the actual person. This will allow more and more students to get curious about sustainability and start their careers as researchers.

- **Dr. Andrea Ramírez Ramírez** of Engineering Systems and Services (TPM)
- **Dr. Niels van Oort** of Transport & Planning (CEG)
- **Dr. Gianluca Limodio** of Photovoltaic Materials and Devices (EEMCS)
- **Inger Bij de Vaate, MSc** of Geoscience & Remote Sensing (CEG)

First, we introduce each researcher and their primary research area. But then we shift towards more personal questions, like the impact doing their research in sustainability has had on their daily life, the physical and mental roadblocks they face, and what methods they implement to overcome those situations. We asked them to give one message to the next generation of researchers that will help them in their journey to become researchers.

As these interviews are all about getting to know the person behind the research, and we are on the topic of sustainability, we end the interview with a more fun question: *would you rather shower without hot water for half the week, or never shower longer than 3 minutes?*

We hope you will enjoy this interview series!

Dr. Andrea Ramírez Ramírez

Dr Andrea Ramirez Ramirez is a Professor of Low Carbon Systems and Technologies at Engineering Systems and Services and director of the Graduate School of TPM. She holds a bachelor's in chemical engineering (Colombia), a master's in Human Ecology (Belgium), and a PhD in the field of energy efficiency (the Netherlands). Her research focuses on evaluating novel low-carbon technologies and the design of methodologies and tools to assess their potential contribution to sustainable (energy and resource) systems.

Research and sustainability

"My research group works on industrial decarbonisation, where we develop methods to evaluate processes that use other sources of carbon, such as CO_2. Defossilisation in the industrial sector is not always possible because many of the products we have today use carbon and will keep using carbon in the future. Therefore, we need to find alternative sources of carbon. So our research mainly focuses on assessing technologies that produce products from CO_2, biomass, or waste. We are also part of the e-refinery institute of TU Delft which works on converting CO_2 into fuels and chemicals."

"Part of the work focus on assessing the impacts of scaling up technologies that are today at the lab scale. At a lab-scale, materials are produced in small amounts: for instance with equipment of 5 by 5 centimetres, production of 20 millilitres… We work with the companies to explore the potential impact of such a process at industrial level, where they would instead produce millions of litres of fuel. We call this ex-ante technology assessment. In this, we focus on the technical performance, the economic, the bottlenecks, and the life cycle assessment of such technology at the industrial level. In this way, we identify issues in the process and discuss them with stakeholders to make it commercially and sustainably viable."

Motivations

"At the university, we want to create a better world, do something for the world. In my field, this happens to be by designing better industrial processes, which I like to do. Moreover, cheaper is not always better; most of the time, we have to find environmentally-friendly solutions which are often not cheaper. This is a big challenge."

"From an academic point of view, I did my bachelor thesis on environmental impact assessment. So, I was always heading in the direction of sustainability. I see myself as a web thinker. I like to see the connection between things, which is a skill that helps me do my research."

Impact of research on personal life

"This is a struggle for many of us; we always struggle with the practical side of things. Nevertheless, when you start to research sustainability, you become more aware of your purchasing practices and traveling practices. I changed the windows of my house to isolate them better to reduce the energy consumption. Now, we are installing PV on the roof of the house. You do things one step at a time."

Roadblocks in research

"I think everybody faces roadblocks and setbacks in research. Research is about 70 percent failure and 30 percent success, as we wander into the unknown to find answers. I am very enthusiastic about my research, but I do not romanticize it. I consider delays and failure to be part of the game. The research will have its ups and downs; it will require patience, dedication, and continued improvement. Moreover, you do not get to do everything you want to do. Do not take the pressure of unachievable goals. If you do that, you are setting yourself up for failure.

Qualities in post-doc and PhD students

"I have a very international group; we have students from China, India, America, Netherlands, Mexico. We have a nearly equal ratio of males and females. However, the main characteristic of all the members is that they are team players. I look specifically for team players because you cannot do system analysis alone. Moreover, they all are web thinkers who like to think out of the box and think very systematically."

Message to future researchers

"Be enthusiastic but realistic about your work. Science is not an easy path, but it is fulfilling. Push yourself to your limits, but do not burn yourself during that process. There is a very fine line between those two, and you have to be very careful about that. You are not going to like all things about research, but there will be many things you will feel good about. So sometimes you have to do some things which you do not like. For example, someone who likes experiments but hates reading hundreds of research articles. However, they have to read to do the experiments and understand the field."

Would you rather shower cold for half the week, or never shower for longer than three minutes?

During my childhood, I lived in Bogotá which is at 2500 m over sea level. We did not have a water boiler, so we had to shower with very cold water. As a child, I hated it. So I would go with a hot shower in less than three minutes.

Dr. Niels van Oort

Niels van Oort works as an assistant professor of Public Transport at Delft University of Technology and is co-director of the Smart Public Transport Lab. He has been involved in public transport projects and research for over 15 years. His main fields of expertise are public transport planning and design, passenger behaviour, service reliability, and emerging models. Niels studied traffic and transport at Delft University of Technology and finished his Master in Public Transport in 2003 and his PhD in 2011. Until 2018, he combined his academic work with jobs in the industry.

Research and sustainability

"I am co-director of the Smart Public Transport Lab, where we research and teach public transport, including first/last mile solutions and shared mobility. I work at the Department of Transport and Planning of the Faculty of Civil Engineering, and our group is divided into multiple labs. Each lab is dedicated to a specific transport type or theme. We work for instance closely with the data and the cycling labs. An important part of my research is to analyse passenger behaviour while choosing a mode of transport. Which helps us optimize supply and demand in the transport sector, facilitating and stimulating a shift to sustainable mobility."

"We are also working on new transport phenomena, such as the e-bike, and the e-scooter, and their interaction with public transport. We try to find the optimal setting for this kind of transport to increase the share of sustainable transport in the whole transport sector. Our main goal is to design the optimal transport system for a livable, sustainable, accessible city."

Motivations

"I've wanted to work on public transport my whole life. As a young boy, I was obsessed with trains. I already had the drive to improve public transport, mainly driven by the sustainability perspective of the transport system. During my teenage years, I was a bit of a radical anti-car usage person. Public transport is the only way to reach sustainability in the transport sector, was my opinion. That was the primary motivation for me to start working on public transport to make it more beneficial and convenient for the people to use it. That way, the transport sector public will become sustainable, safe and inclusive."

Impact of research on personal life

"In my view, I was always following sustainability practices before becoming a researcher. However, I learn a lot by teaching and interacting with my students. I think your generation [students] is much more aware of sustainability, and I am constantly learning new ways to incorporate sustainability into my life. For example, the concept of shared mobility, I discuss a lot with my students. So to say, teaching has more impact on my sustainability practices than my own research."

Roadblocks in research

"Apart from academic skills, I really focus on what kind of impact a person wants to make in society. During PhD and post-doc interviews, a candidate must be aware of what kind of impact he or she wants to make and how. Some people want to do PhD as a stepping stone to the next job; I am afraid that is not the correct answer."

Qualities in post-doc and PhD students

"Another thing I look for is the ability to listen to other people and teamwork capability. If you want to make an impact on society, you must listen to what society wants. Apart from that, everybody has their strength and weakness. By working in a group, you can support each other."

Message to future researchers

"Simple and sweet message from my side: Follow Your Dreams. To make it more tangible, try to make your own profession, and do not assume something is impossible unless you try it. From my personal experience, when I was working at HTM I thought I could not do a part-time PhD in my field, but once I started asking questions and discussing this with my employer and the university, things started to align. In the end, I managed and sort of created my dream job. So go for it, follow your passion and dreams!"

Would you rather shower cold for half the week, or never shower for longer than three minutes?

I have a double answer here. When I was young, I was really into hiking, camping in the cold, etc. So at that point, I would have chosen the cold shower. But now that I am 43, and I would go for the hot shower option, but no longer than three minutes. On a serious note, I think we all together could save a lot of energy by following either of these options.

Dr. Gianluca Limodio

Gianluca Limodio is a postdoc in the PVMD (Photovoltaic Materials and Devices) group at Delft university of technology. He completed his bachelor's and master's degree from Università Degli Studi di Napoli Federico II in electrical engineering. He got his PhD in solar cell design from the Delft University of Technology in 2019. He is currently working on the design and fabrication of thin-film solar.

Research and sustainability

“I am a postdoctoral researcher at the photovoltaic a material and device (PVMD) group at the Faculty of Electrical Engineering, Mathematics & Computer Science. Currently, we are working on a project with the code name Flamingo PV. Flamingo PV stands for 'Flexible, lightweight advanced material for a new generation of photovoltaic technology'. We are working with HyET solar, where we are developing a flexible thin-film solar module that can be placed where traditional models cannot be placed. By doing this, we can get solar electricity anywhere in the world where sunlight is available.”

“The best thing about our solar panels is they are like a sticker which you can place on any surface, and they will start producing power. Our panels are not intended for normal rooftops, but for building integration with structures like silos where the surface is too curved to place normal solar panels. As these panels are stickers, there is a huge weight reduction compared to traditional solar panels. For the same power output, the weight of our solar panels is one-tenth that of traditional solar panels.”

Motivations

"Societal impact drives me to do my research. In some fields, it is very hard is transfer what you do at the university to society. What I like about my research is that the company is directly adapting it. If I do good and create something, it will not just stay in the university, but it will enter society and be used by somebody in the near future. Moreover, let me tell you this thing is not trivial. It is very hard to transport the things develop at the university level to the company or societal level—also, we are living in a world where energy transition has become the primary focus. By doing research in the energy transition field, you can make an impact on society. That drives and pushes me to work more in the field."

Impact of research on personal life

"I recently bought a house and I installed solar panels on it. It is pretty basic. If you are working on solar modules and haven't installed solar panels on your rooftop, that is self-contradicting, right?. Apart from that, when you do research about energy, you became more aware of your energy consumption and try to reduce it."

TU Delft support

"From the perspective of finance, after your project gets approval, you don't have to think about the money involved in research. When you have to go to a conference to present your work or purchase some material for your research, the university takes care of that. I really like the system of writing proposals for grants in advance and getting these approved in advance."

Roadblocks in research

"On an average day, I am happy about my work. When things are going well, I am extra happy. However, on some specific days when things are not going according to plan, not getting the results that I want, I feel unhappy. Nevertheless, satisfaction is one of the important things for me. When I learn something new and master it, I feel happy and satisfied. So I hit some roadblocks in my research. I try to understand and learn new things to remove that roadblock. Of course, results are important, but it is more important to know the process to replicate it and get better results in other topics. That is the most satisfactory thing for me."

Message to future researchers

"If you want to do solar-specific research, learn semiconductor physics. Joking apart - if you want to be a researcher, you have to be really motivated and passionate about the topic. The time will come when things will not go as planned. At that time, your passion and motivation for the subject will help you to stay on the path."

Would you rather shower cold for half the week, or never shower for longer than three minutes?

I choose the second option, I would shower for only three minutes with hot water. It is all about energy saving by using less energy. You should have a very quick shower, but very effective.

MSc Inger Bij de Vaate

Inger Bij de Vaate is a PhD researcher at TU Delft. Her research is part of the FAST4NL project that revolves around quantifying the impact of Arctic sea ice decline on tides and surges in the Arctic on a global scale, and the consequences for the Netherlands. Before starting her PhD, she studied Future Planet Studies (major in Earth Sciences) at the University of Amsterdam and followed the master's program in Marine Sciences at Utrecht University. During her master's, she did an internship at the Institute of Marine Research in Bergen, Norway.

Research and sustainability

“I started my PhD in Delft three-and-a-half years ago, and I am currently working in the Department of Geoscience and Remote Sensing. My PhD is part of a small research group, FAST4NL, that works on predicting arctic tides and surges for the Netherlands. My research does not directly relate to sustainability, but it is closely related to climate change. Changes in Arctic sea ice are a direct consequence of climate change and as a result, tides and surges in the Arctic Ocean will change. Those changes will have an impact on the climate of the Netherlands.”

Motivations

“I was interested in ocean and seas from an early age, but there is one particular reason. My grandfather lived in Zeeland, and I heard from him about the 'watersnoodramp' (North Sea flood of 1953). From those conversations with him, I got intrigued by the fact that the sea can be this violent and catastrophic. That is one of the reasons why I chose a master's in the field of Marine Science and am now continuing with a PhD in the same field.”

Impact of research on personal life

"Well, my personal research does not directly impact my life, as the Arctic is far away from where I live. But yes, working in a research field related to climate change does affect my personal life. I am more aware of global warming and climate change, which motivates me to make different decisions in my daily life that are good for the environment and planet Earth."

Roadblocks in research

"Research is like venturing into the unknown, it has its pitfalls, and the COVID-19 situation didn't make it better. But the most important thing in that condition is to talk to other people. People who went through the same situation or are currently going through this situation. Most importantly, talk to your supervisor. When you discuss your situation with others, you will notice that your condition is not as bad as you imagined."

"Apart from that, I would suggest non-work-related activities, following your hobbies or passion in your personal life. I love to practice outdoor sports like boulder-climbing, obstacle running, camping, and hiking. These things keep you in the correct mindset, and you can work better in your professional life."

Message to future researchers

"My one message to people would be to do research in the field that they love. One shouldn't choose their field of research based on career prospects. If you don't like the field, don't work in it. Because when a tough time comes, and it will come during your research, if you love your research field, you will not quit and push through it."

Would you rather shower cold for half the week, or never shower for longer than three minutes?

First, I thought I don't like cold showers; however, I love outdoor sports like running and obstacle courses. After those sports, I have to take a long shower, and could not shower in less than three minutes every day. So I will go with the cold water shower option.

9

Sustainability research around TU Delft

Around all faculties of Delft University of Technology, researchers have made sustainability and climate part of their research topics. In this section, an overview is given of all research groups performing research into sustainability at TU Delft. Also listed is if the research groups tend to have BSc and MSc theses and PhD positions available ✔ or not ⊗, or if this varies/is unknown ?.

We would like to thank all mentioned research groups for providing the necessary information, as well as to give the following disclaimers:

- Each faculty and department has a different internal organisation, and because of this, in some cases the listed groups correspond to formal research groups, while for others, they may be individual researchers' labs, department research themes, or other such teams or groups.
- Due to the above, some faculties may have a longer list of research groups included. The length of the lists does not reflect on the importance given to sustainability at each of TU Delft's faculties, which all work on this topic.
- Despite our best efforts, some information may be incomplete or incorrect - for full and up-to-date information, contact the research groups!
- If you have some changes to propose for future reports, do not hesitate to contact us at research-greentu@tudelft.nl!

Architecture and the Built Environment

Research group	Sustainability-related research topics
Architectural Design Crossovers BSc ? MSc ✓ PhD ?	Multifaceted challenges faced by urban areas, including sustainability
Architectural Engineering + Technology BSc ? MSc ✓ PhD ?	Sustainable and circular built environment; climate adaptation, resilience, and mitigation
Glass and Transparency BSc ? MSc ? PhD ✓	Sustainable glass structures: recycling and re-use of glass components
Architectural Façades and Products BSc ✗ MSc ✓ PhD ✓	Sustainable solutions in façade construction: energy savings, climate performance, and circularity
Management in the Built Environment BSc ✓ MSc ✓ PhD ✓	Working towards a sustainable built environment where the interests of the end user and other stakeholders are key. MBE focuses on solutions for the development and management of buildings, portfolios and urban areas and the education to the next generation of managers in the built environment.
Environmental Technology and Design BSc ✗ MSc ? PhD ?	Sustainable urban development, urban metabolism, urban resilience, environmental technology, urban climate, biophilic design

Aerospace Engineering

Research group	Sustainability-related research topics
Aircraft Noise & Climate Effects BSc ✗ MSc ✓ PhD ✓	Modelling and measurement of aircraft noise, acoustic imaging, modelling of the contribution of aircraft emissions to global warming and local air quality, atmospheric physics
Air Transport Operations BSc ✗ MSc ✓ PhD ✓	Studying how new technological developments, such as electric taxiing and electric/hybrid aircraft, can contribute to greener aviation. Optimising ground, in-flight and maintenance operations to reduce the overuse of resources.
Wind Energy BSc ? MSc ✓ PhD ✓	Wind energy systems, wind energy technology, wind energy science, floating wind, airborne wind energy, aeroacoustics, wind power in the built environment

EEMCS

Research group	Sustainability-related research topics
DC Systems, Energy Conversion & Storage BSc ? MSc ? PhD ?	DC systems and (micro) grids for integration of Renewable Energy Sources and Energy Storage: applications such as smart (green) cities; electric mobility; utilization, reliability and controllability of DC grids
Intelligent Electrical Power Grids BSc ? MSc ? PhD ?	Research covers the generation, transmission and distribution of electrical energy, and a characteristic is the system-oriented approach
Photovoltaic Materials & Devices BSc ? MSc ✓ PhD ✗	Builds up expertise in the design and fabrication technology of solar cells and other devices based on thin semiconductor films.

Civil Engineering and Geosciences

Research group	Sustainability-related research topics
Biobased Structures and Materials BSc ✔ MSc ✔ PhD ✔	Performance and ageing of biobased composites and materials; wood and bamboo - material properties, connections and service life; performance of structures using trees and vegetation.
Railway Engineering BSc ✔ MSc ✔ PhD ✔	Railway is the backbone of sustainable mobility. The section of Railway Engineering deals with the physical assets of the railway system, including track, embankment, rolling stock and catenary, as well as the interfaces and dynamic interactions between them.
Resources & Recycling BSc ? MSc ? PhD ?	Circularity in the built environment, circularity & sustainable development, recycling technologies
Geo-Engineering BSc ✔ MSc ✔ PhD ✔	Development of technology and knowledge for societal issues, including construction resilience, increasing the lifetime of existing soil structures, and sustainable use of the sub-surface. Shallow-surface geothermal energy and foundations for wind turbines.
Reservoir Engineering BSc ✔ MSc ? PhD ?	Developing innovative technologies to simulate and study the behaviour of fluids in the subsurface, including, but not limited to geothermal energy, sequestration of hydrogen, sequestration of CO_2 and other greenhouse gases. Studying the impact of subsurface activities on the environment, such as subsidence (and associated flooding risks), induced seismicity and CO_2 emission
Ramon Hanssen BSc ✔ MSc ✔ PhD ✔	Sea level and climate change
Roland Klees BSc ? MSc ? PhD ?	Sea level, ice and climate change; mass redistribution and climate change
Pieternel Levelt BSc ? MSc ? PhD ?	Earth's atmospheric chemical composition in the context of climate change, air quality and the ozone layer
Herman Russchenberg BSc ✔ MSc ✔ PhD ✔	Climate change: the role of clouds, rainfall and aerosols in the climate system
Susan Steele-Dunne BSc ✔ MSc ✔ PhD ✔	Microwave remote sensing of vegetation to understand its role in the water, carbon and energy cycles.
Bas van de Wiel BSc ? MSc ✔ PhD ✔	Atmospheric physics, relevant for e.g. sustainable agriculture, climate research, wind energy predictions, and air pollution modelling.
Louise Nuijens BSc ✔ MSc ✔ PhD ✔	How do clouds, in particular convective clouds, impact our weather and climate?
Stef Lhermitte BSc ✔ MSc ✔ PhD ✔	Developing innovative remote sensing methods for quantifying the effect of climate (change) on snow/ice, vegetation dynamics, etc. and determine their (climate) feedbacks
Marc Schleiss BSc ? MSc ? PhD ✘	Precipitation prediction, extreme rain and flooding, sensitivity to climate change
Sukanta Basu BSc ✔ MSc ✔ PhD ✔	Wind resources, wind turbines

Research group	Sustainability-related research topics
Stephan de Roode BSc ⊗ MSc ? PhD ?	Short-term weather predictions of wind and solar energy for sustainable energy applications. In this NWO funded project (Renewable Energy Forecasts from Observations and high-Resolution Modeling (REFORM)) we use field observations for data assimilation purposes, in particular to improve on the initial state conditions of the atmosphere. The weather predictions are performed at a very high spatial resolution and may include obstacles like buildings. The project is sponsored by Greenchoice and the TU Delft spinoff company Whiffle.
Miren Vizcaino BSc ? MSc ? PhD ?	Climate modelling, interaction between ice sheets and climate
Pepijn Veefkind BSc ? MSc ? PhD ✓	Remote sensing techniques for atmospheric composition observations, and the global trends in aerosols and trace gases, in relation to climate change and air quality
Wouter van der Wal BSc ⊗ MSc ✓ PhD ✓	Postglacial rebound and the interaction with ice sheet dynamics and sea level change
Bert Wouters BSc ✓ MSc ✓ PhD ✓	Remote sensing of the climate, mainly using satellite gravimetry and altimetry
William Ball BSc ? MSc ? PhD ?	Air quality and air pollution within a climate change context, using satellite observations and chemistry climate models, particularly atmospheric trace constituents relevant to public health and the environment and climate
Franziska Glassmeier BSc ✓ MSc ✓ PhD ?	The role of clouds in climate projections.
Hydraulic Structures and Flood Risk BSc ? MSc ? PhD ✓	Hydraulic engineering systems, such as flood defences, storm surge barriers, tunnels and locks. Flood risk management, eco-design, and life cycle aspects in hydraulic engineering.
Coastal Engineering BSc ? MSc ? PhD ✓	Implementation of the Building with Nature concepts, viz. using natural processes to achieve more sustainable coastal systems
Rivers, Ports, Waterways and Dredging Engineering BSc ? MSc ? PhD ✓	Response of the river system to change; measures that help serve the various river functions: flood safety, navigation, freshwater supply, ecosystem services, and recreation
Materials & Environment BSc ✓ MSc ✓ PhD ✓	Development of sustainable cementitious materials based on biological (by) products
hEAT Lab BSc ⊗ MSc ✓ PhD ✓	Development innovative and sustainable solutions to challenges involving electric and automated transport systems
Smart Public Transport Lab BSc ✓ MSc ✓ PhD ✓	Planning and operations of multi-modal public transport systems, including shared mobility and first/last mile solutions, to contribute to accessible, sustainable and liveable cities and regions. Both focus on the demand side (e.g. shift to sustainable modes for urban and long-distance travel (passenger behaviour)) and supply (e.g. life-cycle impacts and emissions of transport systems and services).
Freight & Logistics Lab BSc ⊗ MSc ✓ PhD ?	Roadmap towards zero emission logistics; Resilience, environmental and social sustainability of freight transport.
Active Mode Lab BSc ✓ MSc ✓ PhD ✓	Develop theories, behavioural models and methods to assess, manage and optimize active mode infrastructures

Research group	Sustainability-related research topics
Sustainable Urban Multimodal Mobility Lab BSc ? MSc ✓ PhD ?	Development of sustainable, inclusive and accessible urban regions using a digital twin approach to design adaptive infrastructures and mobility services
Water Management BSc ✓ MSc ✓ PhD ✓	Urban water systems; observation & modelling of water resources; water quality, treatment & reclamation; monitoring & control of water processes

Applied Sciences

Research group	Sustainability-related research topics
Catalysis Engineering BSc ✓ MSc ✓ PhD ✓	Conversion of CO_2 to valuable chemicals, environmental catalysis, production of hydrogen, solar and synthetic fuel production, (reactive) gas separation
Materials for Energy Conversion and Storage BSc ✓ MSc ✓ PhD ✓	Development of new materials and methods for sustainable energy applications
Opto-electronic Materials BSc ✓ MSc ✓ PhD ✓	Investigating the nature and dynamics of excitons and charge carriers in materials with potential applications in e.g. solar cells
Transport Phenomena BSc ✓ MSc ✓ PhD ✓	Wind, Urban Heat Island, Vegetation, Pollution, Atmospheric Chemistry and Crowd Behaviour in the Built Environment (Kenjeres), Green & Circular Process Design (De Haan), Multiphase Transport Phenomena and Membrane Technology for Renewable Energy (Vermaas, Portela)
Environmental Biotechnology BSc ? MSc ? PhD ?	Bioprocesses for waste treatment, waste-to-product processes, biobased materials in a circular economy
Bioprocess Engineering BSc ? MSc ? PhD ?	Developing novel concepts for compact, clean and efficient biotechnological manufacturing processes
Biotechnology and Society BSc ✓ MSc ✓ PhD ✓	Design of strategies to communicate and implement sustainable and responsible innovation in the context of a circular, biobased economy
ImPhys / Optics BSc ✓ MSc ✓ PhD ✓	Development of novel, more efficient lighting; photothermal effect; development of high-tech optical devices (with applications including energy and environment); photothermal CO_2 conversion.
Reactor Physics and Nuclear Materials BSc ✓ MSc ✓ PhD ✓	RPNM is the only academic group in the Netherlands for research and education in nuclear fission energy. Research topics include reactor physics, radiation transport, thermal hydraulics, nuclear materials chemistry, and physics transport processes.
Fundamental Aspects of Materials and Energy BSc ✓ MSc ✓ PhD ✓	Sustainable hydrogen, PV materials, waste heat recovery, efficient greenhouse gas free heat pumps
Luminescence Materials BSc ✓ MSc ✓ PhD ?	Thin luminescence films to be applied as solar conversion layers for photo-voltaic applications in the built environment
Storage of Electrochemical Energy BSc ✓ MSc ✓ PhD ✓	Developing safe and high performance energy storage in batteries, necessary at all scales (mobile electronic equipment, electrical vehicles, and daily storage of renewables and grid stability)

Technology, Policy and Management

Research group	Sustainability-related research topics
Information and Communication Technology BSc ✔ MSc ✔ PhD ✔	Sustainability of edge AI architectures, AI systems in the context of electricity networks, (blockchain-based) information architectures to achieve circularity.
Energy and Industry BSc ✔ MSc ✔ PhD ✔	Smart grids, supporting technology and emerging institutions for the transition towards sustainable energy systems
Social Complexity of Climate Change Lab BSc ✘ MSc ? PhD ?	Understanding behavioral change in face of climate change, the cumulative impacts of these individual choices, and social mechanisms of transformative change/regime shifts/ tipping points in social systems. Focus on climate change adaptation, i.e. cities adapting to climate-induced hazards like floods and sea level rise in delta cities.
Delta Futures Lab BSc ? MSc ? PhD ✘	Works on spatial design, engineering and governance of deltas.
Energy Transition Lab BSc ✘ MSc ✔ PhD ✔	Approaches, methods and tools for fostering an effective, fair, legitimate energy transition

Industrial Design Engineering

Research group	Sustainability-related research topics
Design for Sustainability BSc ? MSc ✔ PhD ✔	Design for sustainability, circular product design. Circular products for the global south
Strategies for (Sustainable) Innovation BSc ? MSc ? PhD ?	Enabling designers to design sustainable innovations that will be adopted by organisations and consumers and thereby contribute to a Circular Economy

The Faculty of Industrial Design Engineering (IDE) has over 50 researchers - ranging from PhD candidates to full-professors - who devote time to sustainability topics. As the structure of each department at IDE varies, there are few research groups that are organized around specific topics. Researchers conducting sustainability design research tend to be dispersed amongst various thematic sections with rotating chairs. Thus upon first glance, it may seem as though sustainability research is limited to two sections: Design for Sustainabity and Strategies for (sustainable) Innovation. For IDE, it may be better to identify major topical areas that researchers focus on, rather than trying to identify official research groups. Some prominent sustainability topics investigated at IDE include (but are not limited to): circular product design, sustainable behavior, human centered design of energy efficient technology, sustainable futures, bio-materials, and sustainable health.

Mechanical, Maritime and Materials Engineering

Research group	Sustainability-related research topics
Reliable Large Floating Systems BSc ? MSc ? PhD ?	Creation of floating islands for purposes such as solar panels, floating offshore wind turbines, and floating habitation
Sustainable Drive & Energy Systems BSc ✓ MSc ✓ PhD ✓	Electrification, chemical energy storage, and renewable energy generation in the maritime sector
Interfaces BSc ✗ MSc ? PhD ?	Interface properties using X-ray analysis, including for energy applications such a solar and hydrogen
Metals Production, Refining and Recycling BSc ? MSc ? PhD ✓	”Closing the metals cycle”, providing a sustainable supply of raw material with minimum environmental impact
Energy Technology BSc ? MSc ✓ PhD ✓	Design and modeling of thermal energy conversion systems, with a focus on renewable energy
Gas Turbines BSc ? MSc ✓ PhD ✓	High-efficiency gas turbines, alternative fuels & hydrogen combustion
Large-Scale Energy Storage BSc ✓ MSc ✓ PhD ✓	Long-term, large-scale storage of power for the implementation of solar and wind energy: electrocatalytic conversion, hydrogen, coupling of biomass/waste

10

Climate Action Programme

In 2019, TU Delft published a vision paper detailing in what way it planned to contribute to climate action.[13] In 2021, it launched the **Climate Action Programme**,[12] building on this vision and presenting concrete steps for involving sustainability in research and education, as well as improving the sustainability of the campus itself.

In the beginning of 2021, TU Delft appointed Prof. Andy van den Dobbelsteen as its first sustainability coordinator. Among other tasks, he is developing a sustainability vision and programme for the TU Delft campus. TU Delft also closely involves students by collaborating with GreenTU and the faculty GreenTeams.

The research component of the Climate Action programme is based on four themes:

Climate Science

Climate Change Mitigation

Climate Change Adaptation

Climate Governance

TU Delft will research climate solutions in seven “flagship research programmes” based around these topics.

10.1. CO_2 road map and accounting

TU Delft can only reduce its CO_2 emissions by first calculating and meticulously monitoring its CO_2 footprint, and drafting ambitious plans to bring these down. In 2019, Andy van den Dobbelsteen and Tess Blom published a **CO_2 road map**,[2] and TU Delft’s own CO2 footprint is reported on annually.

In 2020, the university’s CO_2 footprint shrunk by 41%.[9] However, this is partially because of the change in working patterns due to the COVID-19 pandemic, shifting emissions to private households which are not included in the reporting methodology. The conclusion is that current efforts are not enough, and more actions need to be taken in order to reach TU Delft’s

sustainability ambitions. Of course, work is in progress on this, and can be read about in more detail Part IV: Operations.

10.2. TU Delft sustainability website

Finally, TU Delft has released a new sustainability website.[a] This website is meant to be a hub for all things sustainability-related at TU Delft, containing information on the carbon footprint of the university, news, stories, reports, and links to other relevant pages. We would like to refer to this for up-to-date information on recent and upcoming events and actions related to sustainability at TU Delft. Be sure to check it out regularly!

[a] https://www.tudelft.nl/en/sustainability

11

Living lab

Putting research into practice in a real-life environment is a very important step, especially when this research is into sustainability. TU Delft has the ideal location for this: the **Green Village**, a 11 800 m^2 open-air field lab for sustainable innovation. At the Green Village, sustainable innovations from the university and beyond are really built and put into place. Specifically, the following three themes are worked on:

Sustainable building and renovation

Future energy system

Climate-adaptive city

The Green Village is unique in being exempt from standard construction regulations and having access to knowledge and contributions from TU Delft and its partners, yet offering a space with actual street infrastructure (including electricity, water, gas, and even hydrogen!) and inhabited houses. The projects at the Green Village are supported by the European Regional Development Fund, the Province of South-Holland, and the municipality of Delft.

The Green Village also offers an accessible learning environment open to all stakeholders. The Learning Community aims to intrinsically connect the processes of working, experimenting, learning, and inspiring, which pushes innovation forward. In this community, workshops, masterclasses, training, and guided tours are offered. By connecting actors in a network of shared knowledge, the Green Village ensures that any citizen or professional interested enough to join can contribute with their previous experiences, but also benefit from the expertise of others.

New innovations

Over time, many new innovations are added to the Green Village. Some highlights from the past year are listed on page 77.

A special mention should be made of the 24/7 Energy Lab.[10] This bold and disruptive project develops a local CO_2-free energy system for the built environment that apply concepts like autonomous and decentralized generation and diversity in energetic sources. By using solar and wind energy, generated energy is stored in batteries as well as hydrogen. The idea behind is to make technologies scalable to a neighbourhood and, soon enough, to a whole district.

Starting a new innovation

The TU Delft Green Village offers a space for public and private entities, researchers, and even student teams to test their innovation in a field lab setting. More information on this and other topics is available online.

Want to know more about the Green Village?

Want to know more about the Green Village or the innovations that can be found there? Check out the website and social media of the Green Village.[11]

Aerial photo of the Green Village.[10]

NoNo House
Sustainable building and renovation
A test location for sustainable construction, built with the reduction of nitrogen compound emissions in mind. It is built with various circular components, and its materials will absorb nitrogen over their life cycle. It also houses restroom and kitchen facilities for the Co-Creation Centre.

Borg (previously Summerheat)
Sustainable building and renovation
A prefabricated subterranean heat storage system for residential buildings. This system, tested in a replica of a typical Dutch building from the 70s, would be able to store heat from sustainable energy sources so it can be used at a later point.

H2@Home
Future energy system
Another replica 70s building has been adapted to fully use hydrogen (from the Green Village's subterranean hydrogen network) for cooking and heating, fully replacing natural gas. The performance, safety, etc. of this system will all be tested in this realistic scenario.

TILER
Future energy system
Based on a TU Delft patent, this special tile can automatically charge electric bicycles parked on it. By using electromagnetic induction between the tile and a special bike kickstand, TILER can deliver up to 500 W of power, without any need for cables or battery replacements.

Kroostegels
Climate-adaptive city
Fast-growing duckweed in Dutch canals currently gets removed and incinerated - but the *Kroostegel* ("duckweed tile") offers a way to give this material a new use. These biodegradable tiles allow water to permeate through and help reduce urban heat while increasing biodiversity.

Park Positive
Climate-adaptive city
Climate-friendly parking spots under research by Rain(a)way. They consist of a special underground and tiling with large open spaces, letting water filter through. Topics under investigation include infiltration speed and water storage capacity within the parking spaces.

12

GreenTU's own work on research

GreenTU's main involvement is with students and operational and educational staff, while its influence in research is limited. Even so, we are proud to collaborate in projects such as the TU Delft Climate Action Programme and to research and write this *Vision on Sustainability* report - and the GreenTeams (see Chapter 3) of individual faculties also have some interesting research-related activities.

Here are two highlighted projects.

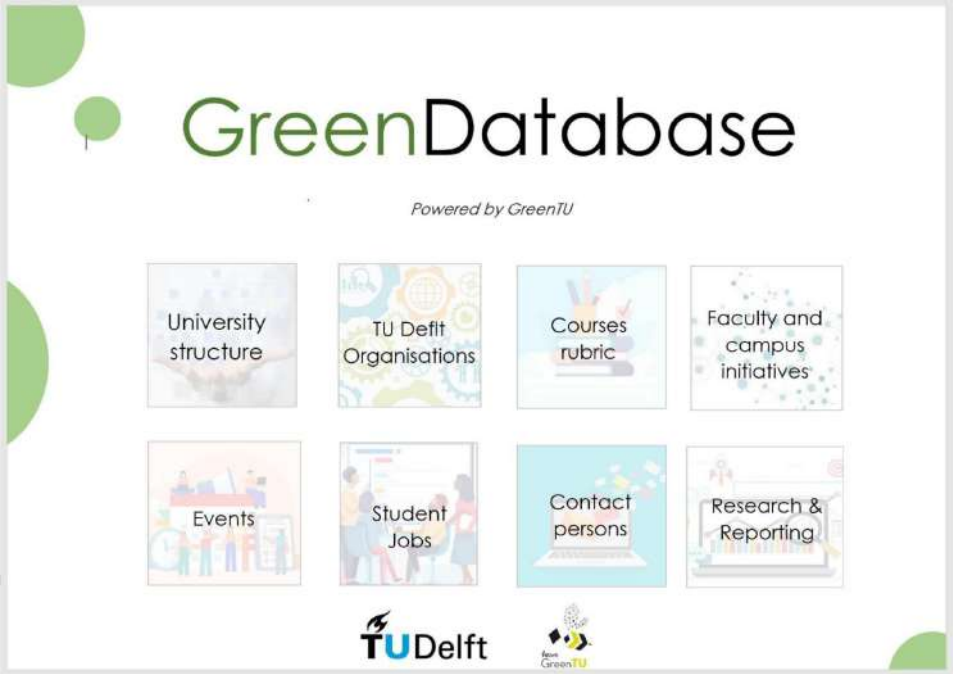
12.1. GreenDatabase

At the moment, many researchers and groups at the university are working on sustainability, but there is not yet a very clear and thorough overview of all information related to sustainability on campus. This makes it difficult, for example, for students to learn more about sustainability courses, for sustainability researchers to find each other and collaborate across faculties, or for everyone to find faculties' contact persons regarding sustainability.

To bring about a change in this regard, GreenTU is currently in the preliminary stage of planning out and obtaining funding for the **GreenDatabase**. This online platform will offer a very straightforward and clear way for students, researchers, employees, and other parties to find information about the following sustainability-related topics:

1. University structure
2. TU Delft organisations
3. Courses rubric
4. Faculty and campus initiatives
5. Events
6. Student jobs
7. Contact persons
8. Research & reporting

This extensive collection of information will be freely accessible, based on work by TU Delft, GreenTU (such as the list of research groups in Chapter 9), and ORAS, among others. Keeping it up-to-date will become part of the regular GreenTU portfolio, so that it always contains current information.



Sketch of a possible layout for the GreenDatabase.

12.2. Green thesis journal (GreenTeam TPM)

At the end of last academic year, the GreenTeam at the Faculty of Technology, Policy and Management set out to create a **thesis journal**,[4] which would feature summaries of theses related to sustainability or the energy transition. This would allow graduates to showcase their hard work, and help aspiring thesis candidates to get inspiration for their own research.

This academic year, the first edition was completed, and can be read online.[a] GreenTeam TPM is also gearing up for a second edition in the future!

[a] https://drive.google.com/file/d/1eFc2f2IS9azXDZA_x_OxVxQwswWfFxZn/view

IV

Operations

13

Introduction to operations

TU Delft has ambitious plans for its campus. By 2030, TU Delft needs to be circular, carbon-neutral, climate adaptive, while contributing to the quality of life on campus. Achieving these goals will require a considerable change in many parts of university life and organization, including its operations and the buildings of the campus itself, which currently are the largest source of CO_2 on campus. To facilitate this transition, the larger topic of operations has been divided up into seven core themes:

- **EcoCampus** aims to create a greener and more water-resilient campus with increased biodiversity and improved climate resilience and adaptivity.
- **Energy** focuses on implementing a sustainable energy system at TU Delft, including renewable and thermal sources and energy storage.
- **Buildings** concerns reducing the carbon footprint of both old and new real estate on campus and incorporating circularity in the buildings.
- **Mobility**'s goal is to design and implement policy for sustainable mobility by students and employees.
- **Food & Beverage** intends to decrease the environmental footprint of catering on campus through sustainable food policy.
- **Procurement & Waste** dedicated to circular resource management by smart and sustainable procurement and the avoidance/sustainable management of waste.
- **ICT, AI & Data Management** studies how to reduce the carbon impact of TU Delft's ICT and how to harness its potential for increasing energy efficiency for a smart campus.

Each core theme has their own desired future, challenges, and projects and plans. Dobbelsteen and Gameren [3] have written an extensive report on sustainability at TU Delft, *Sustainable TU Delft: Vision, Ambition and Action Plan for a Climate University*, including a detailed section on Operations on campus. This chapter is largely based on the research by DDobbelsteen and Gameren [3], supplemented with additional sources when necessary. Of the seven core themes of operations mentioned above, this chapter will summarize the current

situation of five in more detail: *Energy*, *Mobility*, *Food & Beverage*, *Procurement & Waste*, and *Buildings*. Core themes *EcoCampus* and *ICT, AI & Data Management* are discussed in lesser detail, since these did not fall under GreenTU's own sustainability core themes for operations during the '21-'22 academic year.[5] However, this might change in future versions of this report, based on GreenTU focal topics. Each core theme is discussed by its current carbon footprint, the ambitions and policies for that theme, and a short list of the projects planned by TU Delft. The penultimate section includes an overview of all the projects by GreenTU's Project Committee focusing on sustainable operations on campus. The last section outlines GreenTU's vision for the future of operations at TU Delft.

14

Current operational performance of TU Delft

14.1. Energy

This section will cover one part of the energy assessment of the TU Delft campus: the energy supply. In Section 14.5 on *Buildings*, the energy use at the Campus will be further discussed. The data used in this section represents the situation in 2018.

The amount of energy supplied by source can be seen in in Table 14.1.

Energy for heating and cooling

For heating the campus, TU Delft relies on three systems: the heat network of the Campus North and Campus Centre, which are supplied by a co-generation natural gas plant using normal gas boilers and combined heat and power (CHP) boilers. Second, 32 buildings on particularly the south part of the Campus are heated using heat from thermal energy storage systems. Lastly, some buildings are heated by local gas boilers. The majority of the energy used for heating, thus, comes from natural gas.[3] Energy generated for cooling mostly feeds into air-conditioning units and other cooling units of buildings. According to Dobbelsteen and Gameren [3], it is not exactly known how much energy is required for cooling TU Delft. They stress the importance of finding sustainable methods for cooling instead of mechanical cooling in the years to come.

Electricity supply

Electricity supplied to TU Delft mainly relies on imported Dutch wind energy. A smaller portion is produced by a CHP plant, and an even smaller fraction originates from PV panels. Dobbelsteen and Gameren [3] predict that the power grid will become increasingly challenged due to an increasing demand for electricity, from transportation, data centers, and air-conditioning. Switching to even more sustainable generation of electricity is crucial, yet large-scale application of PV can put extra stress on the energy system, due to the changeable productions of renewable energy.

Table 14.1: Characteristics of the energy supply of TU Delft in 2018.

	Energy delivered to TU Delft	Energy source
E-netwerk	67 907 MWh	Primarily wind energy[a]
Warmtenet	43 317 MWh	Gas combustion
Boilers	16 056 MWh	

Carbon footprint of TU Delft's electricity supply

The carbon footprint of the natural gas purchased by TU Delft is 20 743 tonnes of CO_2-eq[9] and this is the main source of carbon of the energy used by TU Delft. Important in this estimation is that it assumes that the carbon impact of the renewable energy is 0 tonnes of CO_2-eq.[3]

TU Delft's ambitions

The ambition of TU Delft is to create a local energy system in which energy used at the university facilities will be generated on campus. To a large extent, electricity will be created by PV systems on campus. Additionally, part of the electricity will come from hydrogen and synthetic methane generated using the excess power of PV in summer. The rest of the electricity will be bought from Dutch wind farms. The approach to achieve this and carbon neutrality in 2030 as outlined by Dobbelsteen and Gameren [3] can be summarized into seven points:

1. Create sustainable heat using geothermal heating, which can reduce the CO_2 emission for heating with at least 60%.
2. Create the necessary infrastructure for using geothermal energy and sustainable energy, through renovation, expansion of the heating system, and seasonal storage of heat and storage for renewable energy.
3. Implement a system to exchange heat and cold and a smart electricity grid on campus.
4. Install passive and nature-based cooling measures.
5. Increase TU Delft's PV network and possibly install wind turbine on South Campus.
6. Increase the use of green fuels on campus.
7. Continue research in the ESP Lab, the Electrical Sustainable Power Laboratory, to facilitate this energy transition.

Projects, pilots and actions related to energy

Dobbelsteen and Gameren [3] have included an extensive list of projects, pilots, and actions to achieve a sustainable energy system at TU Delft in the near future. These can be roughly divided in five categories, which logically follow from the seven points above:

1. Achieving a more sustainable heat system at TU Delft
2. Exploring sustainable cooling solutions for TU Delft

[a] In total, 82 576 MWh electricity is delivered to the E-network of TU Delft, of which approximately 80% is used by TU Delft and the other 20% is sold to external parties. 78% of this electricity is generated by wind turbines, 29% at a gas-powered thermoelectric power plant, and 1% is coming from PV.

3. Creating a sustainable electricity supply, including CO_2 capture and storage
4. Establishing Living Labs for experimentation and research to support the TU Delft energy transition
5. Decreasing energy use from data centers

14.2. Mobility

The following session further discusses mobility, specifically the three types of travel, described by Dobbelsteen and Gameren [3]. They include commuter travel of staff and students, business travel (national and international), and international student travel. This section also elaborates on the mobility road map proposed by CRE.

Mobility at present

Regarding different modes of transportation, domestic flights are the ones that emit the most greenhouse gases (GHG) per passenger per kilometre. Fossil fuels cars are also at the top of the list, but with the growing popularity of electric vehicles, they are expected to drop some positions and be equivalent to a coach in emissions. Plus, the national train system is operated by wind power energy, and thus it is carbon-neutral. Therefore, train transportation should be promoted as the most suitable mode of mobility at TU Delft in order to reduce carbon emissions.

Commuter travel

Dobbelsteen and Gameren [3] also shows that, in 2019, most of the staff from university commute by bicycle (44%), followed by personal car (32%) and train (14%). One reason for such numbers is the fact that almost 40% of employees live in Delft and have to travel less than 6 km a day. However, CO_2-eq emissions were estimated at 3118 tons in the same year, with 90% of these emissions coming from personal fossil fuels cars.

For students, the numbers vary a little. First, 54% of students live in Delft, with the main modes of transportation being bicycles, walking, and public transport. Cars represent only 2.3% of commutes among students. The emissions associated with student transport are about 2800 tons of CO_2-eq. Although this value may seem similar to the one related to employees, it is crucial to clarify that TU Delft has almost five times more students than staff members, which brings attention to some hotspots for change.

International business travel

Concerning business travel, the discrepancy between modes of transportation becomes even bigger. In 2019, employees of TU Delft travelled more than 29 million km by plan and only 300 thousand km by taxi or public transport. These are the distances of 733 and 7.7 times around the globe, respectively.

Emissions are also a concern in this difference. While air travel emitted 4839 tons of CO_2-eq, taxi and public transport travel were responsible for only 18 tons of CO_2-eq.[3] This shocking data further support the argument of better choices for travel modes as an essential step toward carbon mitigation on campus.

Student travel

Although no accurate data exist to account for international student travels, some improvements have been made in the field. As a first step, it is necessary to create a proper inventory of such travels, and also to encourage a sustainable fund for travelling that comprehends both mode of transportation and distance, like the one offered by Utrecht University.[15]

Projects and pilots

Commuter travel

Some projects and pilots for commuter travel are under discussion nowadays.

Labour conditions This project aims to encourage employees to use bikes and public transports, and also to make new employees aware of common sustainability goals that are pursued by the university.

Biking For biking, many projects can be done, ranging from promoting e-bikes for people that live farther than 30 km from campus, to bike-sharing, which has a free version pilot running in 2022. Another strategy is to offer purchase discounts on bike shops, which can also include free maintenance and loan bikes during repairs.

Public transport Many initiatives are made to promote public transportation among employees from TU Delft. By understanding the needs of potential groups, like ease of using public transport, comfort, and financial matters, many incentives are drawn. One example is the use of NS business cards and NS discount cards, that provide substantial motivation for employees to use public transportation.

Cars Regarding the use of cars, carpooling and ride-sharing is the major focus of the Sustainability Office, as well as promoting the use of electric cars when no other means of transportation (train, e-bikes, carpooling, etc.) are available.

Other arrangements Another suggestion would be promoting more home office activities, which was proven as possible during the coronavirus pandemic. Information is also a crucial point, and transparency on emissions should be promoted and ready-to-access by citizens through a mobile app. This could improve conscious choices related to mobility.

Facilities on campus Among facilities to be improved on campus, Dobbelsteen and Gameren [3] highlights improvements on teleworking and e-learning, better travel infrastructure for bikes, pedestrians and buses, enhancements on availability of facilities for e-bikes, and charging points for electric cars. Additionally, CRE is currently working on a mobility plan for better accessibility of the south of campus, which is closer to Delft Campus station.

Business travel

Hybrid events Offering a hybrid option for conferences can save time, money and have a tremendous positive impact on emissions related to business travel. Still, some studies have to be carried out in order to elaborate on the pros and cons of such solutions.

From air to green travel The travel agency should first indicate the most sustainable means of transportation before proposing air travels. Guidelines should be drawn in order to prioritise green travel.

National flights Dobbelsteen and Gameren [3] is very incisive about prohibiting national flights and between the Netherlands and Belgium. Some faculties, like the Faculty of Civil Engineering & Geosciences and the Faculty of Aerospace Engineering, are already using trains as default for business travel, which shows their compliance with TU Delft sustainable goals.

Travel protocols Travel options should be compared based on time and cost from door to door. Also, the travel map must be considered, once it shows the destinations in Europe that can be reached by train and the ones that air travel is accepted.

Student travel

Students usually travel for three main reasons: (i) for a course, (ii) for holidays with a student association, and (iii) for an exchange program or internship. For each category, many suggestions are given in Dobbelsteen and Gameren [3], like financial support as a promotion of green means of transport. Similarly, GreenTU and the student exchange office were developing the Green Travel Student Grant as a way to encourage international travel by bus and train. Yet, Erasmus+ came up with a project with similar objectives, which made GreenTU reevaluate the grant.

14.3. Food

This next section encompasses the sustainable traits in the food system of catering at TU Delft. This topic was considered as the second-largest contributor to CO_2-eq emissions in 2018, which is understandable considering that students and employees consume 50% of daily intakes on campus.[2] Therefore, this next section underlines the current situation by discerning contributions by product and availability of sustainable alternatives, as well as evaluating the distribution between diet types among students.

Carbon impact of food

According to Poore and Nemecek [8], one single kilogram of beef emits more than 99 kg of CO_2-eq, followed by lamb and mutton meat, with 39.72 kg of CO_2-eq per kilogram of food. These values are, respectively, 2200% and 890% higher than rice emissions, the first plan-based presented in the list. Thus, a radical protein transition is crucial in fighting climate change, leaving animal-based to a more plant-based one.

According to,[3] the majority of emissions associated with diets comes from a group of students that has meat as their main source of protein, also known as meat lovers. Their diet-related emissions surpass the line of 2000 kg of CO_2-eq, in contrast to the second position, average consumers, that approach the 1500 kg of CO_2-eq border with less meat consumption. The list is followed by pescatarians and vegetarians, both below the line of 1000 kg of CO_2-eq. Then, vegans close the dietary categories, slightly above the line of 500 kg CO_2-eq.

Environmental performance of TU Delft

Dobbelsteen and Gameren [3] elaborates on the carbon footprint of the food system on campus, which was estimated at 13 800 tonnes of CO_2-eq in 2019. This result is in consonance with national daily emissions associated with diets, representing on average 5.0 kg CO_2-eq. Thus, this is a clear starting point to understand the current situation at TU Delft, as well as draw solutions and propose interventions in hotspots related to the food system.

Policies for sustainable food and beverage

Some policies are suggested and revised in Dobbelsteen and Gameren [3], aiming to leverage a more sustainable diet for TU Delft community. One of the main ideas is to push vegan and vegetarian options on menus by making them cheaper through a meat-related fee, potentially based on carbon emissions price. Moreover, the importance of informing consumers about the environmental footprint and origin of the product is highlighted as a crucial strategy to raise awareness and to promote conscious consumption on campus. A great focus is given on implementing principles of sustainability throughout the whole food supply chain by, for instance, sourcing local products, with clear preference for sustainable organic food. Other topics under discussion are related to seasonal/nonseasonal products, to prioritising animal friendly options, and to implement sustainable plates and cutlery by phasing out single use materials on cafeterias and restaurants. Finally, sustainability in the food system has to consider waste that differs from the food itself, packaging, and tableware. Therefore, research should be done in the next years to uncover how to prevent packaging of food without spoilage, while also understanding the intertwined relation between food supply and the demand, with a central target of minimising food waste on campus.

Projects

Some projects and pilots related to sustainable food are listed in Dobbelsteen and Gameren [3]. A brief overview of those follows.

Restaurant Most projects aim to enhance vegetarian and vegan food consumption on campus, by either making them more available or by pricing meat. Some other ideas include packaging and discounts for those who adopt sustainable practices.

Catering for events The main concept behind this one is making food served during events vegan/vegetarian by default and preventing overuse of bottled water.

Vending machines Here, an urgency for alternative packaging is very clear. Also, Dobbelsteen and Gameren [3] discusses the necessity of having smaller machines or fewer machines per building, hence preventing expired food to be thrown away.

Food trucks Companies should only be selected when committing to the University's sustainability aims and targets. The availability of vegan/vegetarians mentioned above is applicable once again.

Food and Eating Design Lab Professors and research staff should be stimulated by the university to conduct research on sustainable food and beverage to be applied on campus.

14.4. Procurement and waste

Every day, thousands of people go around the TU Delft campus. With so many activities happening on a daily basis, an enormous amount of waste is generated. This next section discusses how waste management is currently carried out on campus, shedding a light on strategies in this area. Additionally, GreenTU provided feedback and input on the procurement of the food and beverage tenders that aim to be finished by summer 2023. Further information on procurement can be found in Dobbelsteen and Gameren [3].

Waste production on campus

Following Dobbelsteen and Gameren [3]'s insights, TU Delft generated about 2800 tonnes of waste in 2018, from which the great majority is residual waste (47%). This represents more than 90 kg per person that ends up in incineration in Rozenburg. Carbon emissions related to waste on campus crosses the line of 3000 tonnes per year, with the biggest contributions coming from green waste (pruning waste, maintenance of landscaping). Still, waste separation is a challenge on campus, with few buildings like X and Aula doing it efficiently.[3]

Preventing waste generation in the first place is imperative. Therefore, TU Delft should focus on the first three steps of the R-ladder (refusing, reducing and reusing residual flow). Meanwhile, transparency and conscious decisions about purchased materials should be tackled continuously, which gives a better understanding on sustainable sourced products as a strategy for preventing negative externalities. This decision-making process may benefit extensively from carbon pricing, as this system offers a fair comparison between product options.

Projects and pilots

Currently, some projects and pilots are under discussion at TU Delft. A clear and special focus is given to reducing the amount of consumables and disposable products as reducing waste production. Also, much needs to be done about the waste composition, highlighting opportunities for repair, refurbishments, remanufacturing, repurposing and recycling. Avoiding packaging is another hot topic in these discussions, alongside with promoting the use of durable goods, namely multiple-use cutlery and cups. As mentioned before, waste separation is another focal point for promoting an assertive management of each flow; informational campaigns are required and the adoption of multipurpose containers prevails as a potential solution. Moreover, other strategies include using algae for waste treatment with compost as a final product. With all those ideas in practice, TU Delft can rethink the way waste is perceived by extracting the maximum value out of it, as well as guaranteeing the proper treatment and disposal of material used on campus.

A special highlight should be given to a partnership project between GreenTU and GOM, the company responsible for cleaning on campus. In order to involve the student community, they are elaborating three business cases with themes like reducing the use of plastic trash bags, reducing the use of tap water for cleaning windows, diminishing stray litter around campus and decreasing residual waste.

14.5. Buildings

This section will discuss the sustainability of the real estate of TU Delft, with a large focus on energy use and its associated carbon footprint. Material use will also be shortly discussed.

TU Delft aims to be carbon-neutral in 2030. For buildings, this has led to the formulation of two goals by Campus and Real Estate (CRE):

1. Energy demand should be limited: the energy consumption per m^2 in 2030 should be halved compared to 2018 for both heat and electricity.
2. Sustainable energy from renewable sources should be used, following the aims outlined in the Energy section.

To follow and manage the carbon savings, CRE formulated key performance indicators (KPIs) that highlight subgoals for elements of the buildings. For example, there is a KPI for efficient use of heat, but also for life-cycle emissions and new construction. The KPIs for efficient use of heat and electricity, $100\,kWh/m^2$, will be used to discuss the energy use of buildings in the rest of this section.

Energy use of buildings at present

Most real-estate at TU Delft currently does not meet the KPI target of $100\,kWh/m^2$ energy use. According to Dobbelsteen and Gameren [3], only six of the 33 buildings of TU Delft met the goal in 2018. Following the assessments made by these authors, it can be concluded that the most energy-intensive buildings in 2018 on campus were the Reactor Institute, the CHP plant, TNW (Applied Sciences), the Botanic Garden, and the Aerospace Structures and Materials Laboratory. All these buildings used more $350\,kWh/m^2$ surface in 2018. Noticeable in the assessment by Dobbelsteen and Gameren [3] is the energy use of the Fellowship, which houses the Hive of GreenTU. The Fellowship had an energy use of little under $200\,kWh/m^2$ in 2018 and, thus, it does not meet the KPI and goal of CRE.

Carbon footprint of buildings

By estimation, buildings are responsible for the greatest share of CO_2 emissions of TU Delft, as the primary energy user on campus. Serious action is needed to reduce energy demand. Additionally, there is no overview available showing the sustainability of the materials used in real-estate at TU Delft. So far, such an inventory has been made of only one building, EEMCS. In order to create a sustainable material exchange that follows the best possible circular strategy, such inventories must be made of other buildings as well, and circularity should become a focal point in any real-estate design and development on campus.

Projects, pilots and actions

Dobbelsteen and Gameren [3] have created a thorough overview of all projects, pilots and future actions at TU Delft related to sustainable buildings. Sustainable real-estate is not one of the core pillars of GreenTU, so these projects will only be summarized shortly below. For further information, we refer to Dobbelsteen and Gameren [3].

- The so-called “quick wins” for present-day annoyances, which includes fixing small misfits that cost much energy. These mostly relate to changes in behaviour.
- End-of-use/disposal projects, which concern those buildings that are no longer useful for TU Delft at this point of time, but for which a sustainable end-of-life purpose must be found.
- Mid-life-renovation projects focused on improving the energy consumption of several faculties on Campus, with a special focus on heat production, and which are in average technical condition. All buildings will need to be renovated in the near future.
- “Small adjustments” projects which concern buildings that are close to being sustainable and only need small interventions to meet all the KPIs.

There are also some new construction projects in the works at TU Delft. The aim of these projects is to develop the necessary new real-estate, but do that in such a way that the buildings become energy positive through smart, passive, bioclimatic design. External projects, relating to real-estate that accommodates companies and knowledge institutes separate of TU Delft. This real-estate must also meet sustainability ambitions.

CRE’s Campus Strategy

The Campus and Real Estate office (CRE) has its own plans and strategies for improving the sustainability on campus. CRE’s plans focus both mobility and infrastructure on campus, as well as the maintenance, renovation, and construction of real estate. Several plans are in the works at CRE and in the future, more information about their aims can be found at their website[b] and the TU Delft sustainability website[c].

14.6. Other focus areas concerning operations

Two other areas concerning operations were included in Dobbelsteen and Gameren [3]: Eco-campus and ICT, AI & Data Management. These do not fall under the core operations themes of GreenTU this academic year[5] and will, therefore, not be covered extensively in this report. A short summary of both focus areas and their most important aims can be read below. For information, we refer to the original report of Dobbelsteen and Gameren [3].

Eco-campus: the sustainable campus of the future

In the future, the TU Delft campus should be a natural, biodiverse, circular, self-sufficient, climate positive campus where nature and people co-exist. The topic eco-campus in Dobbelsteen and Gameren [3] primarily includes biodiversity and water-management goals, although an eco-campus would also encompass sustainable building and energy elements. With its position in a polder system and relative height compared to NAP, parts of the campus are prone to flooding in the future and campus pavement increases the urban heat island. Moreover, given the size of the campus, the majority of the campus is quite low in biodiversity. The

[b] https://www.tudelftcampus.nl/nl/campus-development/
[c] https://www.tudelft.nl/sustainability/themes/construction-renovation

Botanic Garden largely increases the overall biodiversity and is a crucial stepping stone in connecting the greenery of the city and the campus, but in general single species dominance is common on campus.

In the climate-changed future, the campus must be able to buffer and store larger quantities of water. Investments must, therefore, be made to establish a sustainable water system on campus. Additionally, biodiversity can be increased by researching possibilities of adding greenery to every project on campus to increase the biodiversity and species-richness on campus. In the end, a green-blue network should be created on campus that on one side improves biodiversity and acts as natural carbon storage, and on the other side improves sustainable water management.

ICT, AI & Data Management

ICT, AI & Data Management (ICTAID) is a large part of the life of every student, professor, and employee of TU Delft. Currently, the exact energy usage and associated carbon emissions by the ICT and AI of TU Delft is an under-researched topic. This should be explored in the future. It is known, however, that the data centers and labs on campus use enormous amounts of energy per m^2, e.g. the data centers in EEMCS use over 3000 kWh/m^2. Back-up generators that run on diesel should also be replaced with those that are driven by environmentally friendly fuels. ICT and AI are already being used for increasing the efficiency of energy use on campus, and the implementation of ICT and AI for this purpose should be increased in the future. In general, TU Delft must reduce negative impacts of ICTAID by increasing its energy-efficiency and reducing the energy demand, including the energy costs. Additionally, TU Delft should increase the usefulness of its ICTAID resources. To achieve this, investments must be made in measuring tools for energy efficiency and sufficient storage to run the algorithms of ICTAID.

15

GreenTU's own work on operations

In the 2021-2022 academic year, GreenTU started several projects to improve the operational sustainability at TU Delft. GreenTU has worked extensively with TU Delft employees (such as Facility Management and Campus Real Estate) on improving operational policies internally on a structural level, as well as projects that encourage more sustainable behaviour of the university's users and promoting environmental awareness. The following section will dive deeper into those projects.

15.1. Mobility

Student Mobility Grant

The Student Mobility Grant started last year as a pilot at the Faculty of Architecture and the Built Environment, and aims to provide a financial incentive for students going on exchange through Europe to travel by train, instead of by airplane. This project is currently on hold after being approved last year. A similar grant is being offered by the European Union, and it is now being researched if and how this can be made accessible for TU Delft students.

15.2. Food

Plant-based coffee machines

In March 2022, the first dairy-free coffee machines were installed at campus. The machines served 100% dairy-, lactose-, and gluten-free coffee. This project was mostly spearheaded by ORAS, the largest party of the TU Delft student council, with some additional help of GreenTU. In the first two weeks of April 2022, GreenTU also launched a survey to further investigate the coffee-drinking behaviour on campus to gain more insights on how to make this more sustainable.

No Meat Week

From 7 to 13 March, GreenTU collaborated with CIRFOOD and other campus caterers to organise the annual No Meat Week. All food served in the canteens of CIRFOOD was veggie

or vegan that week. The other campus caterers were also encouraged to take part, and a majority of them also served new veggie options during that week.

15.3. Waste

Stickers for waste separation and reduction

GreenTU started two projects with sticker campaigns. The first sticker campaign focused on **stickers for garbage cans**. TU Delft has special garbage cans for waste separation in many buildings, but not every student knows how to effectively use them. The stickers, which contain information about which products go in which bin, will raise awareness for waste separation and provide students with information to better separate their waste. In that way, contamination of the waste streams is prevented. During the other sticker campaign, **stickers for coffee machines** were designed to decrease the use of single-use coffee cups on campus. Many coffee machines on campus allow students/employees to bring their own cup. However, this is not used to its full potential, because it is not always clear how to use your own cup on the machine. The stickers on the machines show a small infographic about how to correctly use your own cup in the machine, in the hopes to stimulate students/employees to bring their own cup.

Reusable cup system

In March 2022, GreenTU together with Coffee-star organised a Bring Your Own Cup campaign at all locations, to promote users bringing their own mug instead of using a disposable cup. Free samples of brownies were given away in return. The campaign was highly successful as all 3000 brownies were given away, and more awareness was spread on the possibility and ease of bringing personal mugs. In line with this sentiment, GreenTU proposed a project this year that aims to set up a reusable cup system at the Coffee-star locations on campus. The central idea is that customers will have to pay a deposit of €1,- for every cup that they take at the Coffee-star locations. For this deposit, they will receive a reusable cup from e.g. the brand BillieCup from which they enjoy their drink. If the cup is returned, the deposit is also returned. In this way, students/employees are encouraged to also return the cup or use it during their next visit to Coffee-star. This system that GreenTU is proposing is similar to systems that are already in place at multiple Belgian universities, as well as TU Eindhoven. GreenTU is collaborating on this project with Coffee-star, CIRFOOD, and the Facility Management of TU Delft and aims to have the system in place soon.

Business cases

The business cases were set-up in collaboration with the cleaning company of the campus, GOM, and the Events committee. Initially planned for April 21, 2022, the *Business Case Day* would present students with 3 cases related to improving the sustainability of cleaning on campus for which they would come up with innovative solutions and approaches. The results of the Business Case Day would hopefully inspire GOM. The three cases each had a different topic:

- Decreasing the use of trash bags
- Decreasing water use during cleaning
- Reducing stray litter around the campus

Due to a lack of interest, the Business Case Day was postponed indefinitely.

15.4. Eco-campus

Improving the operational sustainability of the TU Delft Botanic Garden

As part of the widespread renovations and revitalisation of the TU Delft Botanic Garden, GreenTU has provided recommendations to improve the operational sustainability of the Gardens. GreenTU has done the following to improve the sustainability of the Botanic Garden:

- Provided advice on sustainable waste management of the gardening waste and increasing recycling in the Botanic Garden. Following the advice of GreenTU, waste seperation bins are to be installed in the Gardens.
- Functioned as a mediator between the director of the Gardens and PV experts and PV companies to have solar panels installed at the Gardens. The Botanic Garden are one of the main energy users on campus.
- Negotiating with the new Coffee-star location that is going to be opened at the Gardens about only using returnable and/or reusable cups.

Wildflower sowing and tree planting on Campus

On March 11th 2022, GreenTU organized a flower sowing afternoon together with CRE. During this afternoon, wildflower seeds were planted along the length of the Mekelpark. This is one of the only patches of green at central campus, but is largely covered with grass. By planting the wildflowers, which are planned to flower in the summer of 2022, the biodiversity of this area is increased. Together with CRE, GreenTU has pinpointed other patches of green at Campus (towards Bouwkunde City and Campus) at which seeds will be planted by CRE's Green Maintenance team to help increase the biodiversity at those spots. On March 16th 2022, GreenTU celebrated 'Nationale Boomfeestdag' by hosting two tree planting moments. In collaboration with GAM and the Botanic Garden, new trees were planted near the Botanic Garden and near Stedin on Campus South.

ENERGY

Current state:

The energy comes primarily from wind power, with minor contributions of on-site PV.

The heat is obtained from gas combustion, and it is one of the main sources of GHG on campus.

Ambition:

The ambition is to create a smart and local energy system, giving access to green fuels on campus. In this system, heat comes from geothermal energy, while electricity is generated through PV and wind power.

MOBILITY

Current state:

Bikes are the main mode of transportation to/from campus. While students mainly travel by public transport, the staff uses more cars. This results in the largest GHG emissions on campus.

Ambition:

The ambition is to reduce staff mobility emissions by promoting alternative modes of travel.

FOOD

Current state:

Food is the second-largest contributor to emissions on campus, primarily coming from meat consumption.

Ambition:

The ambition includes pushing for more vegan and vegetarian options, raising awareness, and local food sourcing.

PROCUREMENT & WASTE • BUILDINGS

Current state:

Nowadays, waste separation is still a challenge: waste is not separated efficiently and not in all buildings.

Ambition:

The ambition is to prevent waste generation through refusing, reducing, and reusing residual flows and expanding the waste separation pilots.

WANT TO KNOW MORE?

If you are interested to learn all the initiatives and projects for sustainable operations at TU Delft, check the report by Dobbelsteen & Gameren (2022).

Current state:

The energy use of the TU Delft real estate is the largest contributor to TU Delft's GHG emissions.

Ambition:

The aim is to improve energy efficiency through maintenance, renovation, and construction of new real estate.

V

Community

16

Introduction to community

Community & Social Engagement is the fourth and last pillar on which GreenTU works to achieve sustainability. To reach TU Delft's sustainability goals, the wider community of TU Delft, including staff, students and (student) organisations, need to give the necessary support, making engagement an essential feature of achieving sustainability. Additionally, many sustainability plans on campus, both those of TU Delft and those of GreenTU, require active participation of the campus community, which is impossible to attain without social engagement and awareness. Lastly, social engagement is vital to make sure that all values of the campus community are represented to create a fair *and* sustainable future.

The Events and Career Committees of GreenTU play the largest part in social engagement for sustainability by GreenTU. Throughout the academic year, the two committees have organised a variety of events, which will be covered below. Next to that, with GreenTU's Sustainability Label, the board is also trying to boost the sustainability of Delft's student associations. Across Delft, there are many other groups with similar sustainability goals as GreenTU and this chapter will also highlight some of their most important achievements of last academic year.

17

The GreenTU Sustainability Label

GreenTU launched the GreenTU Sustainability Label several years ago, with the help of the Green Office of the University of Groningen. The label is used to highlight (student) organisations in Delft that take good action for becoming more sustainable, while also encouraging other parties to take more action. Student initiatives and organisations play an important role in the social life on campus and have the potential to have large influences on the sustainability of the campus community. The Sustainability Label is awarded by the GreenTU board after the organization sends in the Sustainability Label checklists. With this checklist, the organisation can provide evidence of their sustainability efforts and based on this, GreenTU can choose to award them the Sustainability Label in recognition of their efforts. Categorised as bronze, silver, and gold, the Sustainability Label logo can be put up on the website and/or social media of the associations for everyone to see. Associations can also send in an updated checklist in the following academic year if they think that their sustainability has improved, in which case they can obtain a better ranking. All organisations and associations located in Delft focusing on students of TU Delft can apply for the Sustainability Label. The Sustainability Label is managed by GreenTU's Outreach Coordinator.

17.1. Achievements in 2021-2022

In the 2021-2022 academic year, GreenTU continued to expand the Sustainability Label. This year, the prime focus for expanding the Sustainability Label lay on the TU Delft study associations. This goal was largely achieved: in total ten organisations/associations have now applied for the Sustainability Label, of which the far majority are study associations. Some student sport associations also have also applied and received a label. Moreover, some of the study-associations that already received the Label in previous years have applied for an updated Label this year to highlight sustainability improvements made since then.

In 2021-2022, the Sustainability Label has continued to grow. There are still study associations and other student organisations that have not applied for the Label, so the hope is the Label will continue to expand and more student organisations will take the time to fill in the checklist and be awarded the label.

The Green TU Sustainability Label awards.

18

GreenTU's own work on community

18.1. Outreach & communication

18.1.1. New TU Delft Sustainability Website

GreenTU is a notable player for sustainability on campus and works together with the Sustainability Coordinators on multiple fronts. Because of this, GreenTU is also prominently featured on the new TU Delft sustainability website that was released this year.[a] This feature provides GreenTU with another opportunity to reach the wider community on campus.

18.1.2. Instagram campaigns

As one of its main outlets, the GreenTU Instagram page (@greentu.delft) plays a key role in reaching its community. Throughout the academic year, the page also featured three recurring Instagram campaigns:

- On **Vacancy Friday**, a post would give attention to an interesting vacancy of a company working in sustainability. These could be regular job openings, but also internships, student positions, or participants in sustainability-related competitions and events.
- As the name says, the **Monday Initiatives** highlight sustainability initiatives. Ranging in topics, these posts included, among other things, sustainability campaigns, sustainable restaurants around Delft, or interesting green startups.
- The **Getting Greener** campaign shared easy ways to live a little more sustainable with GreenTU's following, such as ecofriendly ways of giftwrapping for the Holidays, but also easy tips on how clean your student room using more sustainable products. For the municipal elections of March 2022, #GettingGreener headlines 'What do Delft Municipal Parties say about Sustainability?', where GreenTU collected standpoints of each party in Delft about sustainability.

[a] https://www.tudelft.nl/en/sustainability

Example of a Instagram Monday Initiatives post.

Example of a Instagram Vacancy Friday post.

Example of Instagram Getting Greener post.

18.2. Events in 2021-2022

Besides Instagram campaigns, @greentu.delft is also the main outlet where GreenTU events are announced. During the 2021-2022 academic year, GreenTU's committees were busy with organizing several events. The majority of the events are organised by the Communication & Events Committee. All career-related events were spearheaded by the Career Committee. The events set up by the Projects Committee to improve the operational sustainability specifically have been described in Part IV: Operations and will thus only be mentioned shortly here.

Day of Sustainability 'The Roaring Green Twenties?' - October 5th 2021

The annual day of sustainability was one of the first events of this academic year organised by the 2021-2022 board. This year's theme 'The Roaring Green Twenties?' focused on the changes needed in the next 10 years to bring balance to climate again. Throughout the day, interesting guest speakers. companies, and (student) organisations considered this through the lenses of the needed financial system, the most effective technology, the necessary preparedness and the most beneficial policies. The day-long programme included lectures and workshops.

Lunch Lecture 'Contributing to the World's Most Sustainable University' - October 13th 2021

This interactive lunch lecture with TU Delft's Sustainability Coordinators, Andy van den Dobbelsteen and Deidre van Gameren, invited students to think about how to make their university more sustainable by considering sustainable travel, the energy transition, waste management and social engagement.

Dreaming of a Green X-Mas - December 18th 2021

In collaboration with X TU Delft, a green Christmas event was organised. The event included a clothing and gift swap to show students how to prepare for the upcoming Holidays in a sustainable way. Workshops were given on how to upcycle old, everyday products into the best holiday gifts.

Low Waste January (Instagram Post series) - January 2022

During the month of January, GreenTU's Instagram featured a series of posts which gave students and staff tips on how to live low-waste. The series included posts about reducing cooking waste, low waste grocery shopping, low waste cleaning, energy saving hacks, and what to put into your low-waste university backpack (this last one, in celebration of the return of on-campus education). During **Low Waste January**, followers could also participate in a giveaway of a low-waste living kit, including sustainable wraps for food, toothpaste tabs, a shampoo bar, and a body bar provided by the Delft store VOORLOPIG.

Appearance on 'What's your X?' from X TU Delft - January 13th 2022

Operations Coordinator Olivia was a guest on X TU Delft's podcast 'What's your X?' to talk about the TU Delft Energy Transition and other sustainability topics alongside one of TU Delft's Sustainability Coordinators Andy van den Dobbelsteen.

Lunch Lecture 'Decarbonizing energy systems through smart microgrids' - February 9th 2022

The Career Committee invited Oesha Thakoerdin to give a lecture on using smart microgrids for energy system decarbonization. With her experiences across geographies and sectors, such as energy, water, sanitation and waste, ms. Thakoerdin gave a fascinating talk about changing energy systems.

Cycling Route for X TU Delft's Health Week- February 21th until February 27th 2022

GreenTU Delft also participated in X TU Delft's Health Week by designing a cycling tour: the Green eXpedition! Starting from X and going towards Rotterdam, the scenic routes rewarded the cyclists with art, lovely views and excellent opportunities for bird watching. As the ultimate reward, the first 25 cyclists who completed the tour received a free warm beverage.

Fungi Lecture - March 7th 2022

IDE PhD candidate Wassabi Ng talked about designing with mycelium-based (aka fungi) and living materials.

Flower Sowing on campus - March 10th 2022

An event organized by the Projects Committee to improve campus biodiversity. For details, please see Chapter 15.

National Tree Planting Day - March 16th 2022

Tree planting around campus to celebrate National Tree Planting. For details, please see the Chapter 15.

No Meat Week - Week of March 7th 2022

For details, please see the Chapter 15.

Green Initiative Day - March 23th 2022

On March 23, Green Initiative Day was organized, on which the different GreenTeams of the faculty organise a sustainable initiative to promote sustainability at their respective faculties. Below, there is a short overview of the activities that each GreenTeam organised, which have also been discussed in Chapter 3. The day ended with closing drinks for all GreenTeams at the TU Delft Aula.

During this entire week, Green TU and Coffee-star collaborated to organise their own Green Initiative: if students/employees bring their own cup/thermos/mug during that week to any Coffee-star on campus, they will receive a free snack. Below are examples of the activities organized by several of the GreenTeams.

- For their Green Initiative Day, **GreenTeam TPM** organised an afternoon filled with interesting presentations focused on sustainability. Among others, Alliander gave a workshop, Rijkswaterstaat gave a lunch lecture and TU Delft's Sustainability researchers had an interactive meeting with students.

- **GreenTeam 3ME** also set up an afternoon filled with interesting activities, alongside partners such as Froude, Leeghwater, and Variscopic. They started the afternoon with a town hall meeting during which staff and students could share their ideas and opinions about sustainability. Following that, students could also look around a research market to learn more about 3mE's sustainability related research. Their last event was a case presentation, where students and staff could present solutions to several interesting cases.
- **GreenTeam AE** organised three activities at the Faculty of Aerospace Engineering as part of their 'Sustaviation' Green Initiative: an information market with DreamTeams and companies, a TechSwap to exchange or recycle old electronics. The last event was a workshop with the WWF to learn about environmental footprints.
- **GreenTeam CEG** organised an afternoon filled with presentations and activities centred around sustainability. Presentations were given by some front-running sustainability companies/start-ups. The day ended with an information market.
- For their Green Initiative, the **GreenTeam EEMCS** organised a Potluck and Games lunch for students and staff, including a sustainability-themed pub quiz.

Climate Action Flagship Kick-Off - March 25th 2022

During the Climate Action Flagship Kick-Off, GreenTU's secretary and Education Coordinator Naomi gave a pitch about the Green Thread, GreenTU's main project to integrate sustainability into TU Delft education, in the hopes of spreading the word to teachers about adjusting education for TU Delft's future engineers.

Textile Workshop - May 3th 2022

Participants in this workshop learned everything there is to know about clothing fabrics, their properties and their impacts. After having spent the afternoon learning about this, all participants also went home with a little fabric present.

Green Career Day - May 16th 2022

The Career Committee organized the Green Career Day. During this afternoon, filled with inspiring sustainable companies, students are shown how to take a step into a green future. The programme consists of a market where you can chat with all companies present, followed by workshops and lectures of the guest.

Award Ceremony GreenTU Sustainability Label - June 9th 2022

During the Energy Challenge Event on June 9th, the GreenTU Sustainability labels were awarded. Over the year, study- and student associations have submitted their efforts, which have been reviewed by the Board.

Workshop at the Harvest - June 30th 2022

In collaboration with on-campus restaurant The Harvest, a workshop was organised in which students learn all about what it takes to have a business/restaurant based on organic products and a sustainable network.

Activities during the Owee - August 22th & August 25th 2022

During the Owee, the general introduction week in Delft, GreenTU organized three activities to introduce the new cohort of students to the organization:

- On **Monday August 22th**, GreenTU had a stand at the Info Market at the Brabantse Turfmarkt alongside many of the other associations in Delft. Here, new and current students could learn about the committees and events of GreenTU, and how the organisation strives to make an impact.
- On **Thursday August 25th**, a secondhand clothes and book market was held where participants could drop off items to donate or shop the other items for free.
- As the second activity on **August 25th**, visitors of the book market could take part in a bin race to win fun, sustainable prices. Visitors had to deposit (clean) pieces of garbage into the right “bin” to score points.

19

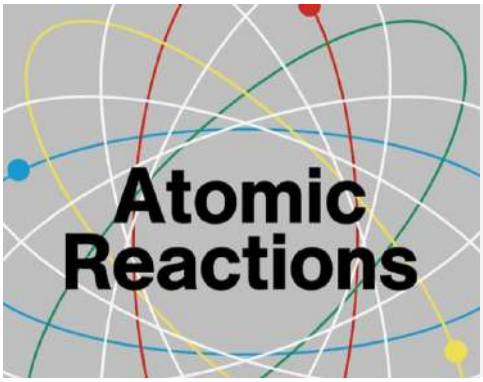
Lustrum

Starting from 14 January 2022, TU Delft celebrated its 180th Dies Natalis, its 180th birthday. This years' Lustrum was all about the Energy Transition, an important topic in these times of climate change and a topic that TU Delft is very much involved in. TU Delft aims to accelerate the energy transition through a wide-array of research projects at many of its faculties, collaborations, supporting new initiatives and labs, but most importantly by training the engineers of the future! During the 180 days of the Lustrum, the complex topic and challenge of the energy transition was discussed from many angles. But the goal always remained clear: constructing a clean, affordable, safe and reliable energy system.

19.1. Highlighted activities

The Lustrum celebration included many events, of which seven are highlighted below. These events all engage the community of TU Delft, as well at those outside the university, in differing ways in the celebration of the Lustrum.

Jeugduniversiteit
February 27, March 6, April 3, May 2022
In collaboration with MuseumJeugdUniversiteit, four TU Delft scientists gave lectures on interesting topics for children from 8 to 12 years old. These were nanoparticles (Prof.dr.ir. Ruud van Ommen), climate psychology (Dr. Gerdien de Vries), CO_2 and fuels (Prof.dr.ir. Paulien Herder), and smartphone charging with sustainable energy (Ir. Marieke Kootte).



Nuclear Art Festival 'Atomic Reactions'
Online & at the TU Delft Library
The Nuclear Art Festival centred around how information and knowledge about nuclear energy has been manipulated, distorted and misinterpreted over the past decades and how this has influenced the framing of nuclear energy in art, the political debate, and in the media. Consisting of an arts exhibition and a programme of lectures, workshops, and arts events at the TU Delft Library, this event aimed to untie the messy debate around nuclear energy.

Online courses
As part of the Lustrum, four new online courses were launched: Designing Climate Neutral Buildings & Transport, and three courses about Digitalization, Technology, Decision-making related to Intelligent & Integrated Energy Systems. The courses are open to everyone and freely available via TU Delft's Online Learning Platform.

Lectures
Online & at TU Delft Campus
Over the 180 days of the Lustrum several special lectures were organized. All topics were related to the energy transition in some way, ranging from wind energy and psychology, to nuclear fuel, to leaders in the energy transition.

Energy Snacks
Online and Mekelpark
A series of inspirational researchers give us a tiny snack of energy transition-related knowledge. These are revealed to us as the lustrum progresses, both online and on large posters along Mekelpark, the central part of the TU Delft campus.

All Energy Day 2022
May 24 in The Hague
This year's edition of the All Energy Day included a keynote speaker, workshops, company booths, and a pitch competition - all in the theme of sustainable energy, and based around technology, policy, entrepreneurship, and design.

Outdoor Cinema Event
June 2 at the TU Delft Library Greenroof
A outdoor showing of the documentary 'Into Eternity' about the safety of nuclear storage. The movie was introduced by PhD researcher Nynke van Uffelen, whose research views energy justice from a philosophical perspective. The event was organized by ORAS Delft and the TU Library, with entertaiment provided by LDE Sustainability Students.

Want to know more about the Lustrum?

Want to know more about TU Delft's Lustrum and the other events and activities celebrated? Check out the website![a]

[a] https://www.tudelft.nl/lustrum

20

Student groups working on sustainability around TU Delft

Several student groups associated with TU Delft work on different aspects of sustainability and the energy transition. Throughout the year, they mainly work on projects that integrate the technical aspect of the energy transition with social aspects. In this section, we want to celebrate the efforts and tell the stories of some of these groups (not associated to GreenTU directly).

Does your student group also want to be featured in next year's edition of this report? Be sure to get in touch with GreenTU.

20.1. LDE Centre for Sustainability Students

Centre for Sustainability
STUDENTS
Leiden•Delft•Erasmus

We are Centre for Sustainability Students, the student extension of the LDE research centre! Our mission is to incite awareness and enthusiasm around sustainability and to promote the educational opportunities of the Centre among students of LDE (Leiden, Delft and Erasmus) universities. By actively organising fun and relevant events around sustainability and the circular economy, we strive to strengthen ties between students, professionals and associations in the sustainability field. Our events focus on the different themes present at the three universities; past events range from panel discussions and lunch lectures to bike repair workshops and consultancy challenges. The LDE Centre itself offers thesis assignments within its sustainability labs and minor study programmes. Follow us on our social media or sign up to our mailing list to stay up to date with our events and initiatives!

Some of our 2021/22 event highlights:

- Bike repair workshop
- Climate communication workshop
- Clothes swap and repair workshop
- “Food for Thought” sustainable entrepreneurship lunch
- Dutch sustainable food supply chain panel discussion
- 3x academic lunch lectures
- ...and much more!

What does the Centre for Sustainability offer students?

- **Interdisciplinary thesis labs**
  With a team of students, work on a sustainability challenge set by an external organisation - like a team consultancy project for your thesis! Work on your individual thesis and follow a half year lab programme at the same time. Thesis labs to be announced in September 2022 for the upcoming year with possible themes including circular aviation and circular building materials.
- **Master/minor courses**
  The Centre runs a variety of master and minor programmes at all three universities around the topic of sustainability and circular economy. See their website[a] for a full list of all programmes.

[a] https://www.centre-for-sustainability.nl/

20.2. Energy for Refugees

Refugee camps utilise large quantities of diesel to run their camps on electricity. In 2017 a group of students at TU Delft, realised that we, as students, have the technical skills necessary to design, develop, organise and execute projects that provide renewable energy in refugee camps to aid the refugees while at the same time help the environment. This is how Energy for Refugees was founded. We are a Dutch NGO composed by ten master students with very different cultures and backgrounds but brought together by the same passion: helping others.

Our mission is to use sustainable technologies to give refugees access to electricity and reduce the running costs, making a real impact on refugee camps. We want to improve people's lives in the camps, contribute to solving the energy problem which will allow sustainable development. We aim to reduce the dependency on public parties and make the camps more autonomous while engaging the camp residents for setting up this system and later maintaining it by themselves. Each year we develop a plan of action, wherein we identify refugee camps that would need our help. After getting in touch with local NGOs to understand the

needs of the refugee camp, we start designing our system while simultaneously calculating costs and logistics of executing the project, which is then followed by a fundraising campaign to help fund the project. We believe in the utmost transparency in the usage of the funds we receive. This entire process usually takes a few months, after which we execute our projects in the summer following that academic year.

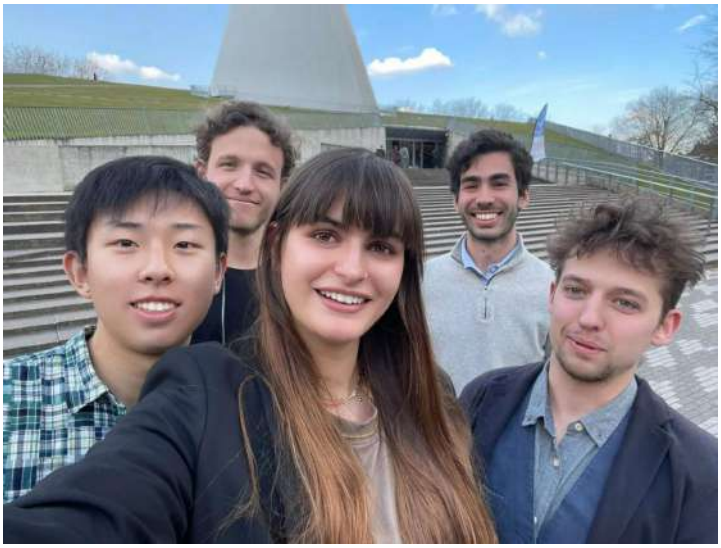
Energy for Refugees in 2021-2022

The 2020-2021 team successfully installed a 2.5 kWp solar system in Guadalajara, Mexico. Due to covid pandemic restrictions, they were not able to travel to the site and had to arrange everything from Europe. It was challenging but very rewarding and it marked the beginning of a very nice collaboration with the NGO FM4 Paso Libre. This year, we plan on expanding this system and changing some of their appliances so that they will run on electricity. This will significantly reduce their costs since they currently rely mostly on natural gas. Moreover, it will decrease their CO_2 emissions and it should be eligible for government's funding.

The main project for the current team is in Greece. We are collaborating with Habibi.Works, an intercultural maker space and platform for education, empowerment and encounters for refugees and Greek locals. They support people to create solution themselves. Since the ultimate goal is to help refugees, who knows what they need better than themselves? This is the idea on which Habibi.Works was founded, back in 2016, by a small German NGO, Soup and Socks. It consists of 11 different working areas in which people create, learn, teach and meet. These also include a kitchen, a wood and metal workshop and a media lab, which require quite a considerable amount of energy. In the beginning of September 2022 our team will go there for almost three weeks to install a 3.5 kWp solar system and enough storage capacity to satisfy their daily needs. We are really looking forward to this experience and to be prepared we were trained on how to install PVs, which was extremely interesting, useful and done for free by BDA, to which we are really grateful.

Apart from this, we also try to spread awareness within TU Delft campus on the seriousness of the refugee crisis. We recently organized an event in collaboration with the Red Cross to collect donations with the goal of restoring family links. It was our first event this year and we were really surprised and delighted by the success that it had. We are planning on organising more similar activities and at the end of September we will start recruiting the next team. If you are interested in what we do, follow us on our social media to always be updated or send us an email to board@energyforrefugees.com. We are always happy to receive feedback or interesting collaboration proposals!

20.3. IESA Shift



Shift is the Student Association for Industrial Ecology Students from the joint program between Leiden University and TU Delft. Corona has damaged the relations students used to have, but the online life has finished already and we are doing everything in our power for IE students to get to know each other, mixing people from different cities and throughout the years.

Besides social events, the association has a wide range of committees that work independently towards a same goal: improve IE student experience. Some examples would be some of the organised events like *IE student meets IE researcher*, where PhD candidates present students their research and answer all kind of questions about their investigation or about the experience of pursuing a PhD. We also put together private companies with students with our *career day*, where students could discover new companies and new fields, and could work hand by hand in the workshops organised by the companies.

On the other hand, one of our committees is focused on scientific outreach with the project **'Not Another Green Podcast'**,[b] where students interview professionals of the sustainability sector in private companies, universities or NGOs as well as fellow students that have already taken their first steps outside university. They talk about a wide range of topics, going from COP26 to climate psychology or greenwashing. If you are interested in IE or in sustainability-related topics, we encourage you to listen to it because it is really worth it! You will find us on Spotify 😁!

Finally, we also have future projects to do our bit to support sustainability projects. We are working on the details for donating money for every new member to an CO_2 offsetting NGO that develops projects with greater impact than the project itself. For example, protecting land around the project or spreading the benefits of the project itself.

[b] https://open.spotify.com/show/5271gbQEq0kvFhxnOwHqwE

VI

Conclusion

21

Conclusion

21.1. Summary of achievements listed in this report

Overall, this report has aimed to showcase all of the work GreenTU has done or contributed to over the 2021-2022 academic year to further improve sustainability in education, research, operations, and community at TU Delft. In terms of education, we are so glad to have extended the Green Thread project to the faculties of Aerospace Engineering and 3mE during the past academic year, whilst its pilot principles continue to be used to increase the focus on sustainability at the Civil Engineering and Geosciences faculty. For this pillar especially close collaboration with the GreenTeams has proved fruitful, and we are so thankful to them.

We are also really proud of our operational projects, such as discussing green travel during the study abroad week, helping the botanic garden switch to ceramic coffee cups and improve waste separation, and sowing wildflowers on campus. We also contributed during the week without meat, organised a bring-your-own-cup to Coffee-star campaign, evaluated the use of disposable coffee cups and lunch containers, and contributed to the catering service tender. Lastly, we created an infographic on how you can use your own cup at TU Delft's coffee machines, as well as posters to improve waste separation at a number of faculties.

With regard to community and social engagement, we have aimed to create a constant and consistent presence of GreenTU on campus, for example by posting on our socials regularly and by organising plenty of events for students on campus. Some highlights include the Day of Sustainability and our career event. We are also glad that 7 out of 12 (bachelor study) associations joined in the competition for our Sustainability Label. It should absolutely be mentioned that many of the events listed in this report would not have been possible without the efforts of our GreenTeams. Moreover, many of the other student groups and organisations listed in this report have organised their own fantastic events, further strengthening the sustainable community on campus.

Although a lot has been accomplished, there is always more to be done. That is a fact inherent to working on sustainability, and especially for a part-time student board such as ours, who will continue to dream big despite the time constraints of our studies. Therefore, in this final chapter we would like to offer some suggestions to the next (2022-2023) GreenTU board

who will be continuing the hard work (or the one after that, or after that). These suggestions are based on our (2021-2022 board) own experiences, and following up on them is of course not mandatory (hence the word suggestions!). One of GreenTU's main strengths is the fresh input from every new board member, new GreenTeam member, and new committee member. And from the rest of the TU Delft community! Should you have any suggestions, recommendations, or thoughts to share about GreenTU's performance and future, please reach out to us via GreenTU@tudelft.nl.

21.2. Suggestions for the Education pillar

Although we believe in the potential of the Green Thread to transform education at TU Delft in a low-key yet effective way, there is plenty of room to improve the project. We feel there is especially a great need to further streamline, structure and professionalise the project if its impact is to be expanded all across campus. For example, a crash course on the Green Thread could be created for (new) GreenTeam members in charge of education, so all GreenTeams are up to date on the project's content and approach. We would also suggest monthly meetings between these education members from the GreenTeams and GreenTU board members in charge of education, to catch up and set to do's.

Continuing upon the above, we see a lot of value in the creation of a community for past/current/future Green Thread participants. Currently, there is no central place for teachers, teaching assistants, GreenTeam members and GreenTU board members to connect. Such a place would be useful to exchange experiences, ask questions, share progress and streamline documentation regarding the Green Thread. This central community could simply be hosted via Microsoft Teams, or any other way the new board sees fit. Close collaboration with the Teaching Academy is also recommended, to explore what we can offer each other.

21.3. Suggestions for the Research pillar

We would recommend a yearly update of our GreenTU sustainability report, to make it easy to showcase to students and stakeholders what GreenTU continues to accomplish in term of sustainability improvements at TU Delft. However, there are also new ideas to explore in terms of the research pillar.

For example, the creation of the educational overview as well as the research group overview for the current report (which was the first of its kind) has sparked the idea for a novel research project: the creation of a database (as has been discussed in Chapter 12 already). Through such a database, of which the exact format and content is still open for suggestions, all sustainability-related information regarding TU Delft could be gathered and organised in a central manner. In our opinion this would greatly benefit the communication between all the different parties and people working on sustainability at TU Delft. Such a central database should be interactive and easily adaptable. Ultimately, such a database could benefit the creation of a shared sustainability report if desired, instead of separate reports created by us at GreenTU, Andy van den Dobbelsteen, etc.

21.4. Suggestions for the Operations pillar

To further improve sustainable operations at TU Delft we'd firstly really love to see the disposable coffee cups and cutlery disappear. Instead, initiatives like Billie Cup could be interesting to take on. We also believe students need to be further encouraged to travel more sustainably, especially when going abroad for their studies. An initiative like a student green travel grant could really help in this regard. These ideas aren't entirely new at TU Delft but have not been accomplished yet. On the other hand, there is always room for fresh, new ideas as well.

Regardless of how we at GreenTU wish to improve operations, it is imperative for us to work even more closely together with other parties to make sure our projects align. We recommend to continue close collaborations with TU Delft employees, the Student Council, all GreenTeams, and with Deirdre van Gameren and Andy van den Dobbelsteen. This is especially important to prevent double work from being done, create consistency among faculties and projects, and to form a more unified front when discussing daily operations with other stakeholders at TU Delft.

21.5. Suggestions for the Community pillar

To further strengthen TU Delft's sustainable community, and to include those outside of the "green bubble" as well, a number of steps could be taken. Firstly, the scope of our Sustainability Label could be expanded to the Sports and Culture associations active on or around campus. We have noticed that there is a lot of interest in our Label from the SCVR (Sport en Cultuur Verenigingen Raad).

Secondly, and continuing upon the first point, we would like to re-approach umbrella organisations such as VeRa (Verenigingsraad), SVR (Studie Verenigingen Raad) and (as aforementioned) the SCVR. We believe this will make it much, much easier to reach out to all study- and student associations and include them in our activities. Study- and student associations make up an important share of the social community at TU Delft, thus together they can make a huge impact regarding sustainability at our university. Ultimately, we would like for at least all (bachelor) study associations to compete for our Sustainability Label. We believe this is certainly possible, especially when utilising the umbrella organisations!

Thirdly, when creating or expanding any kind of community it will become clear that communication is key. We would emphasise that good, clear communication (amongst board members, to GreenTeams, to committees, to students) takes time but will always pay off in the end. A suggestion here would be to build upon our attempt to give a "behind the scenes" look at what GreenTU does via our socials.

VII

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