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Introduction

The final report of our project on the energy consumption calculator for students aims to provide an overview of the project's objectives, methodology, and findings. Our project aimed to educate students about energy consumption of lectures and encourage them to adopt more sustainable practices. Our contribution to the project involved adding sustainability guidelines, energy consumption benchmark, and a new website design.

Our contributions aimed to enhance the calculator's effectiveness in educating students about energy consumption and promoting sustainable practices. The new website design made it easier for students to access and use the calculator, while the sustainability guidelines and energy consumption benchmark provided students with actionable steps to reduce their energy consumption. The Commercial Miscellaneous Electric Loads report (Commercial Miscellaneous Electric Loads: Energy Consumption Characterization and Savings Potential in 2008 by Building Type, 2010) provided insights into energy consumption characterization and savings potential in different building types, which helped us develop sustainability guidelines that encourage students to adopt more energy-efficient practices. Through this report, we hope to contribute to the ongoing efforts to reduce the energy consumption of lectures and promote sustainability.

Problem statement

The energy consumption calculator project, that started in project group electUM, part of Class 2021 of the TUM: Junge Akademie, has an existing calculator, but it has several problems that need to be addressed. These problems include:

- It is hard to understand what to do with the result, making it difficult for students to take actionable steps to reduce their energy consumption.
- The calculator exists only for some departments, limiting its reach and effectiveness.
- No one knows about it, which means that it is not being used to its full potential.

Methodology

The main type of analysis that was used to come up with solutions for the stated challenges was benchmark analysis. Benchmark analysis is a process of comparing the performance, practices, or characteristics of a system, process, product, or organization with established standards, industry best practices, or similar entities. In our case we depicted 4 areas, where this type of analysis was done. Namely:

- Energy consumption all over the world (among students and other people)
- Sustainability practices
- Website designs
- Promoting strategies

It involves measuring and evaluating various parameters and metrics to identify areas of improvement, set goals, and make informed decisions.

For energy consumption benchmark, several representative countries were chosen - countries from EuroTeQ collider partner universities and countries with the most and the least energy consumption all over the world.

For sustainability practices regarding lowering students and professors' energy consumption, several existing lists were chosen to depict relative ones.

For website design as well as for promoting strategies – websites and social media accounts that promote sustainability were compared to each other to point out the most important parts of their design and social marketing strategies that must be implemented in the solution.

Final product

Comparison of user energy consumption with others

Energy consumption per capita is an essential indicator of a country's energy use and sustainability index (Alexei Y, 2020). In this chapter, to allow website users to understand the implications better once the results are known, we will use a methodologically based approach to analyze energy consumption per capita in several European countries and the US and provide data for the countries concerned. In addition, we will discuss why some countries and regions have a comparatively high level of energy consumption.

Energy consumption varies depending on several factors, such as energy policy, lifestyle, climate, population size, economic development, and the availability of resources (Robert B, 2022). But the most direct influences are industrialization, the convenience of transportation, the residential area, and the policy of energy-intensive industries. Countries with high energy consumption are mainly those with a high energy consumption per capita, such as the United States, Canada, Australia, Iceland, Norway, ... (Wikipedia, List of countries by energy consumption per capita) (IEA, 2021). Their high consumption includes population size, energy-intensive industries, and climate. Low-consuming countries are those that consume relatively little energy per capita, such as France, Japan, and the UK (Wikipedia, List of countries by energy consumption per capita) (IEA, 2021). Excellent implementation of energy efficiency schemes and using renewable energy and nuclear power are among their strategies for efficient energy use.

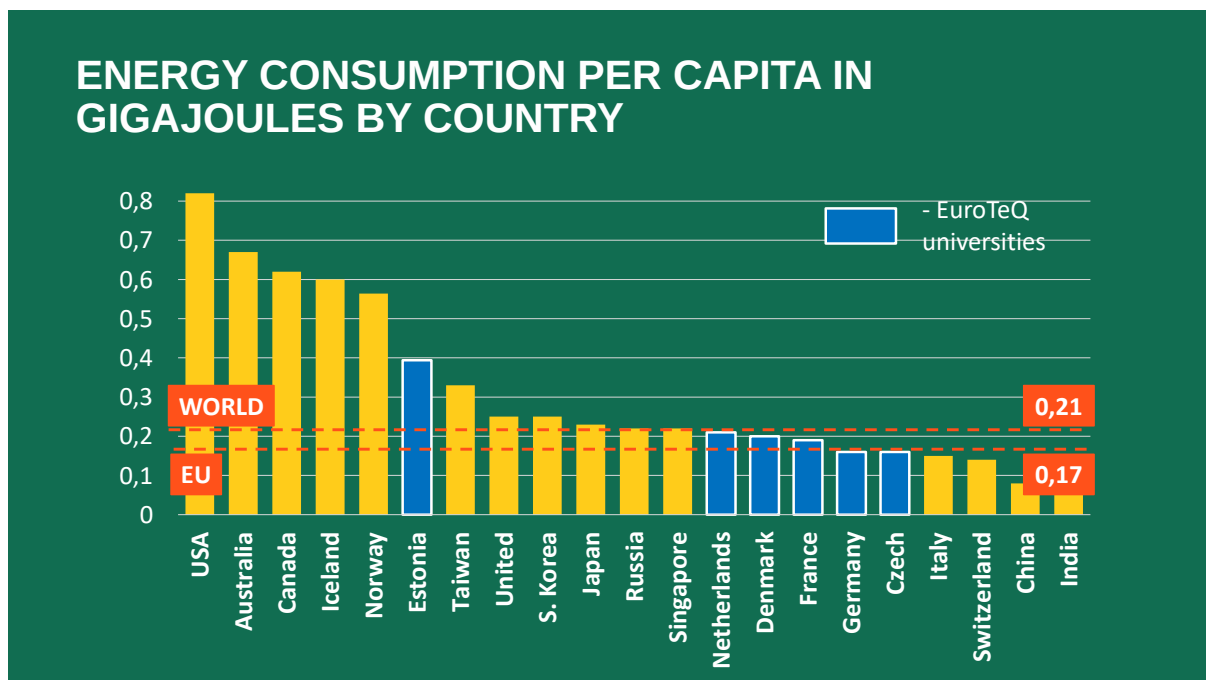


Figure 1 Results of energy consumption benchmark analysis

On average, energy consumption per person per day in Europe is relatively low compared to other world regions. However, it is worth noting that the Scandinavian countries, such as Sweden, Norway, and Iceland, tend to consume more energy on average, mainly due to the weather contingency. The higher latitudes and extreme cold weather mean that domestic energy needs are much higher than in warmer-weathered southern European countries such as Italy, Spain, and so on.

Guidelines adapted for specific user

This chapter provides guidelines for improving energy consumption in higher education institutions. Higher education institutions have a significant role to play in promoting sustainability and reducing carbon emissions. By implementing practical solutions to reduce the energy consumption, universities and colleges can contribute to a greener future while inspiring their students and the wider community. This chapter explores strategies for improving energy use in both on-site and online delivery environments by highlighting the importance of responsible energy consumption and sustainable practices.

To begin with, optimizing energy consumption within lecture halls is crucial for reducing environmental impact. By replacing traditional bulbs with energy-efficient LED lights, universities can achieve significant energy savings. Also, motion sensors or timers can be installed to ensure lights are only active when needed, minimizing unnecessary energy wastage. Similarly, choosing energy-efficient microphones, cameras, and amplifiers helps reduce power consumption without compromising audiovisual quality. Identifying and replacing older, inefficient electrical devices with energy-saving alternatives further contribute to energy conservation efforts. Encouraging faculty and students to turn off unused devices not only reduces unnecessary energy consumption, but also fosters a culture of responsible energy use. Addressing transportation needs is another key aspect of improving energy usage. Promoting sustainable transportation options, such as carpooling, using public transportation, or walking and cycling for short distances, significantly reduces energy consumption. Universities can also consider organizing lectures closer to student accommodations to reduce long-distance commuting and lower fuel consumption. Moreover, the establishment of shared bicycle stations on campus encourages students and faculty to choose greener modes of transportation, reducing both carbon emissions and traffic congestion. Providing electric vehicle charging points and promoting the use of electric or hybrid vehicles further supports sustainable transportation practices.

In addition to physical measures, continuing education plays a crucial role in fostering a culture of sustainability. Higher education institutions can offer specialized courses and programs in sustainability and energy conservation as part of their continuing education curriculum. These courses educate students, faculty, and staff on the importance of sustainable practices, energy-efficient technologies, and the impact of individual actions on

the environment. By equipping individuals with knowledge and skills, universities empower their community to make informed decisions and actively participate in energy conservation efforts.

Moreover, it is important to emphasize the transformative potential of students when considering sustainability in their careers. By incorporating sustainability principles into their professional lives, students can make an even greater impact on promoting sustainable practices. Encouraging discussions on how sustainability can be integrated into various fields and industries should also be an integral part of these lectures. By inspiring students to think about the long-term implications of their future careers and encouraging them to seek innovative solutions, higher education institutions can empower the next generation to drive positive change and contribute to a more sustainable society.

Energy conservation also extends to online lecture environments. Universities can promote responsible energy use by encouraging students to utilize energy-efficient devices like laptops or smartphones instead of power-hungry desktop computers. Enabling power-saving features and charging devices during off-peak hours help minimize energy consumption. Furthermore, choosing energy-efficient streaming platforms and optimizing streaming quality contribute to reducing energy requirements during online lectures.

In conclusion, higher education institutions can lead by example in energy conservation and sustainability. By implementing strategies to improve energy usage in lecture halls, promoting sustainable transportation options, and integrating sustainability education into the curriculum, universities create a greener campus environment. Ongoing monitoring, regular energy audits, and tracking progress towards energy reduction goals ensure continuous improvements. Through these collective efforts, universities inspire students, faculty, and the wider community to embrace sustainable practices and contribute to a more environmentally conscious future.

[Implementation of ranking and competition system](#)

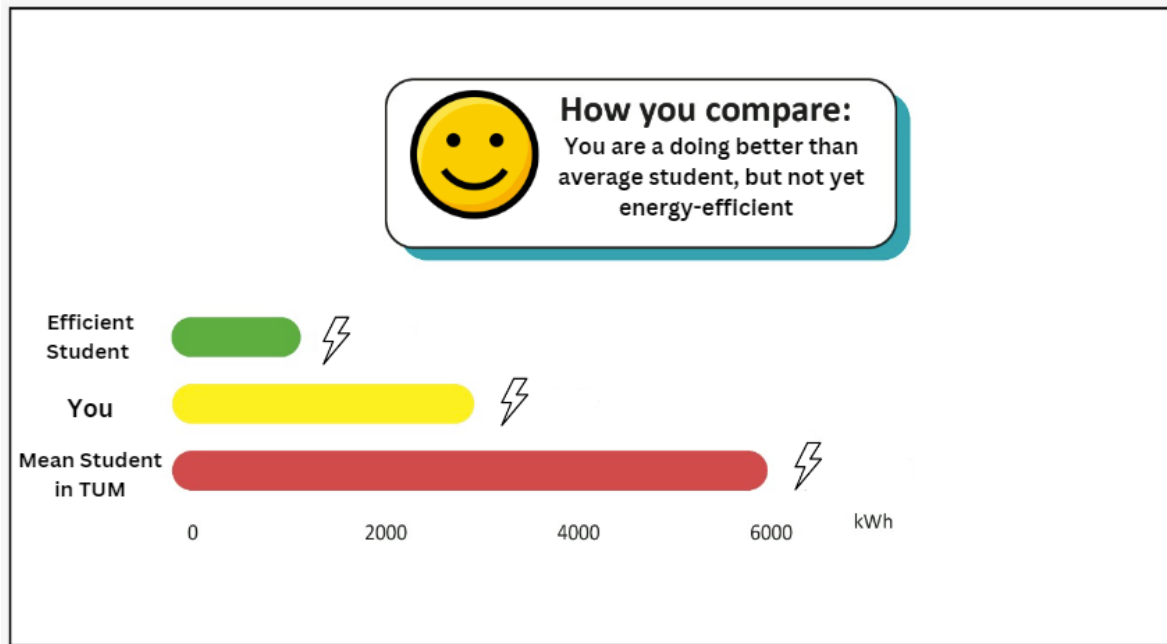
Revamping the Website User Interface and experience:

ElecTUM calculator uses a website as a medium to offer a tool for TUM students to calculate their energy consumption with regards to different lecture types. User experience (UX) is a comprehensive concept encompassing a range of methodologies that yield

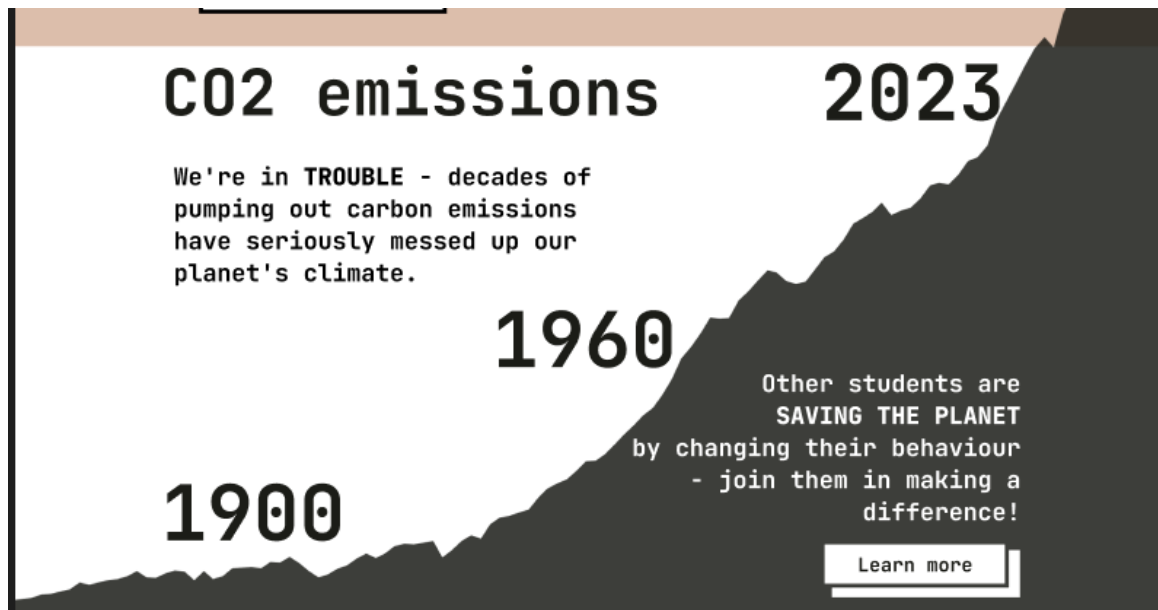
quantifiable outcomes such as user acceptance, user satisfaction, usability, and user motivation. In the context of website design, the significance of good user interface (UI) design cannot be overstated, as it plays a pivotal role in augmenting the overall user experience (Ashaari, 2018). So, it is important to use design elements that facilitate, educate and benefit users (Castaneda et al., 2007). Digital nudge and gamification are also considered to be important aspects to elevate User experience (UX). In simpler terms, digital nudging refers to how certain elements on a website can influence users' choices (Jesse & Jannach, 2021). These elements are part of the website's software applications' user interface (UI). On the other hand, Gamification is the process of implementing game mechanics and dynamics in non-game situations. It aims to change people's behaviour by integrating gaming elements into websites, business services, online communities, or marketing campaigns (Hsu et al., 2017). The goal is to drive participation and engagement by encouraging users to specific perform tasks and, in the case of ElecTUM, students are encouraged to be more sustainable. In the proceeding section, we are going to explain how we used nudge theory and gamification to encourage the usage of the calculator and become more sustainable.

Digital Nudge:

The revamped user experience of the ElecTUM website would incorporate descriptive social norms as a digital nudge. Any behaviour that is deemed suitable and is expected as a norm within a group is said to be a social norm, whereas a descriptive social norm is all about how most people behave in a situation. It has been shown often that descriptive social norm encourages people to adopt sustainable behaviour (Cialdini & Jacobson, 2021; Demarque et al., 2015; Gerber & Rogers, 2009; Goldstein et al., 2008). The new design uses descriptive social norm messages and visuals. The resulting output of the calculator showcases the consumption of students relative to the average consumption of other students and students with the lowest energy consumption. This would nudge students to be more sustainable.

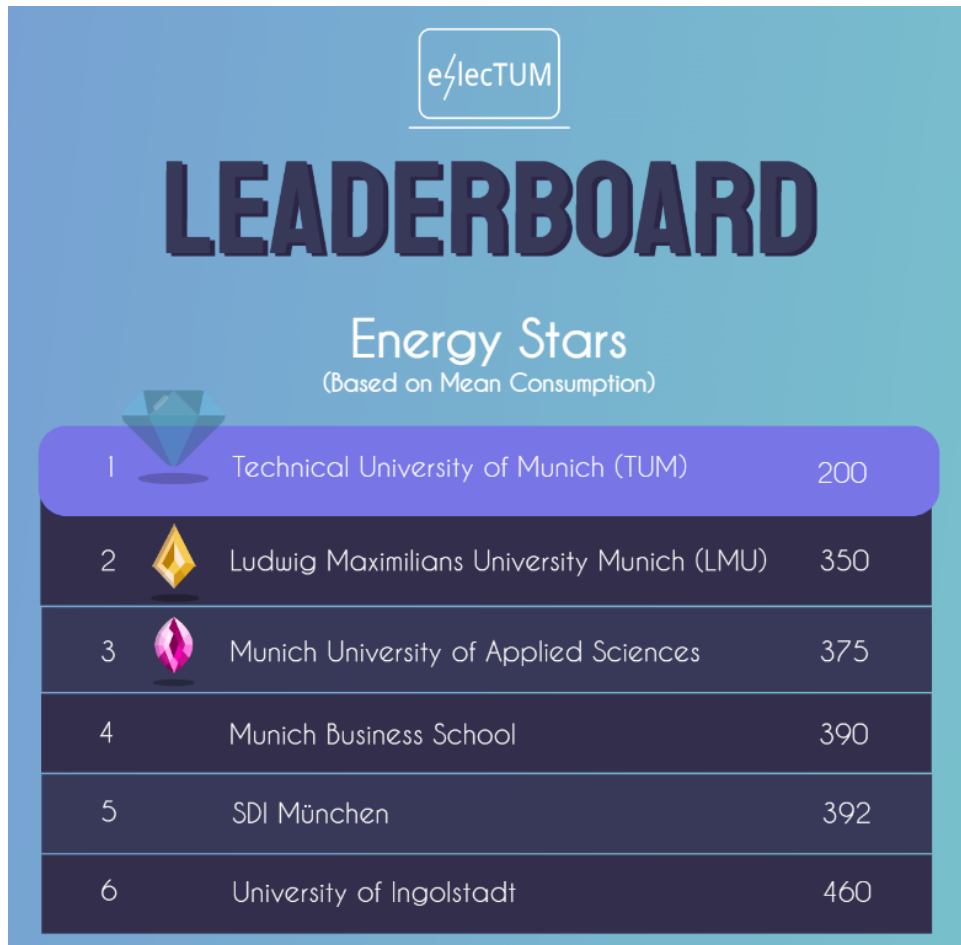


On the homepage students are nudged by using the dynamic social norm statement “Other students are SAVING THE PLANET by changing their behaviour- join them in making the difference”. Dynamic social norm has been shown to encourage minority behaviour (Sparkman & Walton, 2017). Dynamic social norms give information on how behaviour is changing over time. Next to the dynamic social norm, the visualization of the carbon emissions would tap into the loss aversion bias of the students. The upward graphical trend in carbon emission is complemented with a warning message. This framing of the message in alarming visualization and wording would result in actions to avoid the loss (Knobloch et al., 2019).



Gamification

ElectTUM calculator could play an important role in spurring competition amongst students and universities. Students usually love to compete with students from other universities and this spirit of competition could be used to encourage sustainable behaviour. On the other hand, universities in Munich need to include sustainability as their strategic objective. Competition is an important part of pushing universities toward a sustainable direction. The use of Gamification elements, like leaderboard, has been shown to encourage competition among users (Kiryakova et al., 2014). We revamped the result output section and included a leaderboard below the resulting output.



The leaderboard would calculate the average energy usage of the students and rank their university accordingly. This would encourage students and universities to rank higher on the leaderboard by implementing and encouraging energy-saving practices for bragging rights. The leaderboard could also be used by top-scoring universities to promote their position in the education market, encouraging students to opt for that university. This process will make ElectTUM more relevant among universities and students. While universities at the bottom of the board would be forced to rethink their strategy to become more sustainable.

Web design template

The described above benchmark analysis was driven on following websites:

1. ENERGY STAR (www.energystar.gov): The official website of the ENERGY STAR program, which provides energy efficiency resources, including an energy consumption calculator and tips for saving energy.
2. Carbon Footprint (www.carbonfootprint.com): A website that offers carbon footprint calculators, energy-saving advice, and information on renewable energy options.

3. MyEnergy (www.myenergy.com): A platform that provides personalized energy insights, energy-saving recommendations, and a comprehensive energy consumption calculator.
4. CoolClimate Network (coolclimate.org): This website offers a carbon footprint calculator, energy-saving guides, and tips for reducing environmental impact.
5. National Geographic's Footprint Calculator (www.nationalgeographic.com/environment/impact-calculator): An interactive tool that calculates an individual's ecological footprint and offers suggestions for reducing environmental impact.
6. Green Energy Consumers Alliance (www.greenenergyconsumers.org): A website that provides energy-saving tools, resources, and a home energy calculator to help users understand their energy consumption and make sustainable choices.
7. EarthEasy (www.eartheasy.com): An online platform that offers sustainable living advice, eco-friendly products, and energy-saving tips.
8. GoodGuide (www.goodguide.com): A website that provides information on sustainable products, including energy-efficient appliances and devices.
9. Carbon Trust (www.carbontrust.com): An organization that offers carbon footprint calculators, energy-saving solutions, and sustainability services for businesses.
10. Sustainable Energy Authority of Ireland (www.seai.ie): The official website of SEAI, which provides energy-saving tips, grants, and an energy calculator for households and businesses in Ireland.

Key findings that are common for all websites and may lead to positive development of the existing product are:

- *Intuitive User Interface*: The benchmarked websites featured user-friendly interfaces with clear navigation, intuitive design elements, and easy access to relevant information.
- *Comprehensive Energy Consumption Calculator*: The benchmarked websites included robust energy consumption calculators that provided users with the ability to input relevant data and obtain accurate insights into their energy usage. Key metrics considered in the calculators included electricity consumption, water usage, carbon emissions, and energy costs.

- *Real-time Data Visualization:* Effective data visualization techniques, such as charts, graphs, and interactive dashboards, were employed to present energy consumption data in a visually appealing and easily understandable format. This allowed users to track their progress, identify patterns, and make informed decisions.
- *Sustainability Guidelines and Recommendations:* The benchmarked websites incorporated sustainability guidelines and recommendations to educate users on energy-saving practices, renewable energy adoption, waste reduction strategies, and environmentally conscious behaviors. These guidelines were aligned with recognized standards such as LEED, BREEAM, or ISO 14001.
- *Educational Resources:* The benchmarked websites offered a range of educational resources, including articles, guides, videos, and case studies, to empower users with knowledge and promote sustainable living.
- *Social Media Integration:* Successful websites integrated social media platforms to expand their reach, engage with users, share updates, and encourage discussions on sustainability topics.

Based on those key findings website design template was created:



Figure 2 Front page of the calculator



Figure 3 Educational part of the calculator

SMM strategy

Our primary focus was to analyse our primary audience's characteristics, preferences, and behaviours and develop a targeted marketing campaign for our energy consumption calculator website. Through research and data analysis, we gained valuable insights that have guided the development of our approach. We discovered that our primary audience consists largely of environmentally conscious individuals, including students, faculty members, and sustainability enthusiasts. They are actively engaged on social media platforms such as Instagram and Twitter, where they seek educational content, tips for sustainable living, and updates on environmental initiatives. Understanding their needs and motivations, we tailored our marketing campaign to reach and engage with them effectively. This involves leveraging these platforms to deliver engaging and informative content highlighting the benefits of using our energy consumption calculator. Additionally, we recognized their receptiveness to collaborations with student organizations and faculty members, providing an opportunity to foster partnerships that promote the calculator and encourage widespread adoption. By aligning our marketing efforts with the characteristics and preferences of our primary audience, our targeted strategy aims to create awareness, generate interest, and drive the adoption of the calculator, empowering individuals to make informed decisions about their energy usage and contribute to a more sustainable future.

Furthermore, our objective is to enrich our account on Instagram and Twitter by analysing similar sustainability-related accounts and their content, allowing us to enhance our own content strategy. In our methodology, we conducted thorough research to identify accounts related to sustainability with a significant following and engagement. We then analysed the types of content these accounts share to gain insights into successful strategies and content themes. The results revealed several common content types: educational infographics, tips and tricks, sustainable product recommendations, success stories and case studies, inspirational quotes, and news and updates. Based on engagement metrics, educational infographics and tips and tricks received the highest engagement.

In the next phase, after analysing the primary audience and trends, we adapted Content Plan to Trends; our objective was to align our content plan with the online trends, ensuring our content remains relevant and engaging. We followed key steps in this process, starting with identifying key trends from the analysis of similar sustainability accounts. To adapt, we incorporated trending content types into our plan, creating a balanced mix of educational, inspirational, and practical content. We also integrated audience engagement elements such as polls, questions, and challenges to foster participation and community involvement.

The table below shows parts of the content that could follow the introduction phase of the calculator funder:

Post Type	Written Content	Visual Content
Educational	Discover how ElecTUM guides you to reduce energy consumption for a greener future.	Infographic highlighting the impact of reducing energy consumption.
Inspirational	ElectUM is dedicated to creating a sustainable and inspiring future.	Photo of a majestic landscape with an inspiring quote overlay.
Shareable Content	Spread the word about ElecTUM's mission and join us in making a positive change.	Shareable graphic featuring ElecTUM's logo and tagline.

Industry News	Stay informed with the latest updates on reducing energy consumption solutions.	Article or blog post from a reputable source, providing a summary and link.
Employee Spotlight	Get to know the innovative minds driving ElecTUM's sustainable solutions.	Photo and a brief interview introducing an ElecTUM team member.
Call-to-Action	Ready to embrace reducing energy consumption? Use our calculator and contact ElecTUM today.	Graphic displaying ElecTUM's contact information and a compelling call-to-action.
Fun Fact	Small changes in our daily lives, like using energy-efficient appliances and turning off lights, can significantly reduce energy consumption.	Infographic with exciting and entertaining facts about the impact of reducing energy consumption.

To go more in detail and implement our analyzing phase and adoption of the content plan, we developed two weeks marketing campaign. Our campaign aims to maximize awareness and engagement with the calculator among the target audience, focusing on encouraging sustainable energy consumption practices. Below we outline the two-week marketing campaign and the specific tactics we will employ to achieve the desired outcomes.

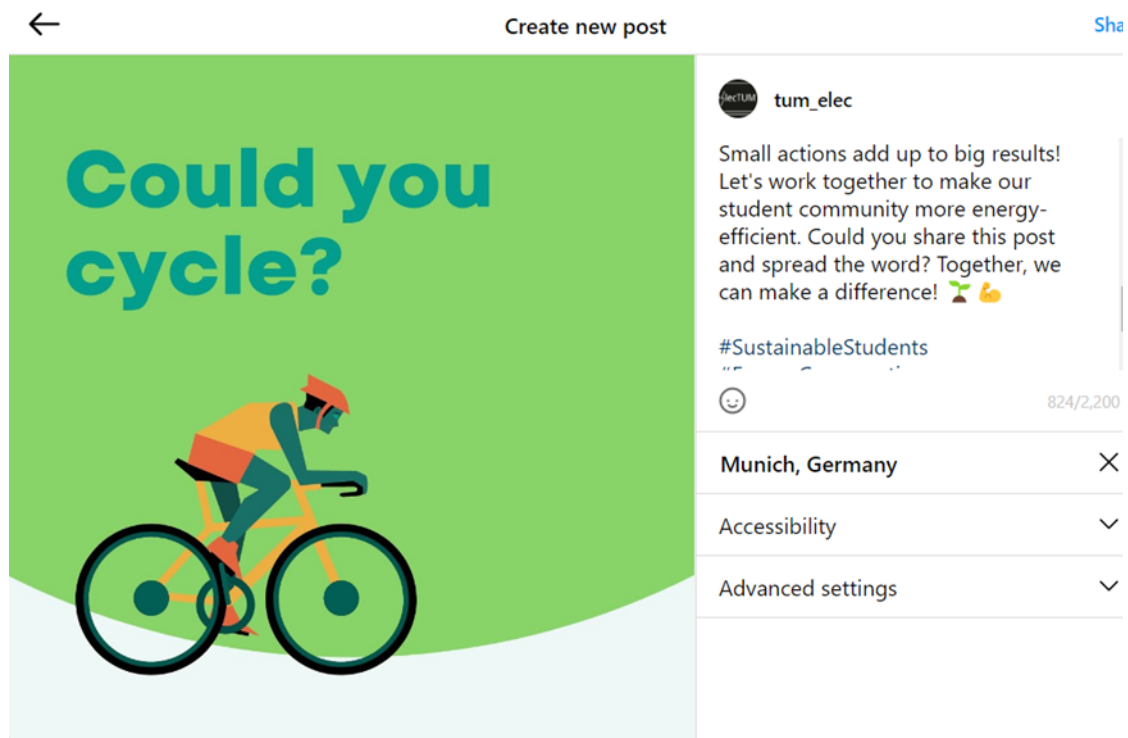
The marketing campaign for our energy consumption calculator consists of a two-week plan divided into the Awareness Phase in Week 1 and the Promotion Phase in Week 2. Each phase has different objectives and strategies to promote and encourage the calculator's adoption.

Awareness Phase During the **first week** of the campaign, the primary goal is to raise awareness about the importance of energy conservation and familiarize the target audience with the energy consumption calculator. The following tactics will be employed:

- Engaging and informative posts will be created and shared on social media platforms since we only focus on Twitter and Instagram. These posts will highlight the significance of energy conservation, present compelling statistics, and promote the features

and benefits of using our energy consumption calculator. The content we plan to post will aim to capture the audience's attention and generate interest in our calculator.

- Secondly: Faculty Engagement Email newsletters will be crafted and distributed to faculty members across the university. The newsletters emphasized the value of the energy consumption calculator in educating students about their energy usage and the potential for behaviour change. Our faculty members in the TUM building will be encouraged to actively promote the calculator to their respective students through their teaching materials and class discussions. The goal will be to leverage faculty members' influence to create a ripple effect and reach a broader student audience. The figure below shows one of the Instagram posts and Twitter tweet that will be sent to faculty to share with their students in TUM.





Following the first week, we will have the Promotion Phase in the campaign's **second week**. Now, our focus shifted towards promoting our energy consumption calculator and encouraging its adoption among students. The following strategies will be implemented:

- A contact list of all faculty members in TUM will be compiled, not only the engineering and design faculty, including their email addresses. Personalized emails will be sent to each faculty member, providing them with detailed information about the energy consumption calculator, its functionalities, and instructions on how to access it. Faculty members will be encouraged to actively endorse and promote the calculator to their students, emphasizing its value in raising awareness and promoting sustainable energy consumption practices.
- To ensure broad exposure and engagement, we will strategically distribute posters and flyers throughout the campus. These promotional materials featured eye-catching visuals, concise messages, and QR codes or website links to access our energy consumption calculator. The posters will be placed in high-traffic areas, such as the main entrance, and shared rooms, such as a library, while the flyers will be handed out during events or placed in locations frequented by students. The goal will be to make our calculator easily accessible and create visual reminders of its existence.

The below table a suggested post of our chosen contact list and how we will target them in social media:

Contact Group	Contact Name	Social Media Post	Accounts
Students	John Doe	"Attention, TUM students! Did you know that ElecTUM is leading the way in reducing energy consumption? Learn more and join us in making a difference!"	@TU Muenchen
Faculty	Professor Walter De Vries Faculty of Aerospace and Geodesy	"Thank you to Professor Walter De Vries and the TUM faculty for your commitment to low-energy research. We look forward to collaborating with you!"	Wt.de-vries @ed.tum.de
Alumni		"Calling all TUM alumni! Join us in making a difference by lowering energy consumption. Let's work together towards a better future for all."	@tum.alumni
Startups	TUM.AI	"Attention TUM startups! Want to join forces with ElecTUM in developing cutting-edge reducing energy consumptions solution? Let's connect and make a difference together."	@TUMai_official

Outlook for the future

The outlook for the future of this project is highly promising. As societies worldwide continue to recognize the pressing need for sustainable energy practices, the demand for tools that enable individuals and organizations to monitor and manage their energy consumption is rapidly increasing. The energy consumption calculator project provides a valuable solution by empowering users to track and analyze their energy usage, identify inefficiencies, and make informed decisions to reduce their carbon footprint. In the future it may become a common practice at every university, that will contribute to solving one of the sustainable development goals – climate change.