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Transition to Climate Neutrality at University Campus. Case Study in Europe, Riga

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Abstract **– 100 cities in Europe have committed to being pioneers and achieving climate neutrality by 2030. It is crucial to start with the decarbonization of cities because, although they cover only 3 % of the Earth's land, they produce 72 % of all greenhouse gas emissions. This paper contributes to the city decarbonization research but on a smaller scale. We study the decarbonization potential of a university campus. It is a unique part of a larger urban area. It represents a cross-section of the population of different socio-economic backgrounds and ages, generating irregular schedules and constant movements of people and goods throughout the day. Riga Technical University is one of the pioneer universities in Latvia that has decided to achieve climate neutrality by 2030. This study aims to provide a qualitative review of the potential for improvements and describe the preliminary CO_2 simulation model that includes Scope 1, Scope 2, and Scope 3 emissions. A particular challenge is the Scope 3 emissions, which focus on changing user habits. A survey of Riga Technical University students and employees was developed and conducted to analyse the most effective solutions for this type of emission. Survey results and future work recommendations are presented together with the model outline.**

Keywords **– Cities; climate neutral; decarbonization; university campus**

1. INTRODUCTION

Europe has already experienced an average surface air temperature rise of 0.8 °C during the 20th century [1], and simulations show that the future expected rate of temperature rise per decade will be between 0.1 and 0.4 °C [2], caused by anthropogenic greenhouse gases (GHG) [3]. It is a significant risk and challenge for the European economy, ecosystems, and social systems, hence in all sectors in the future [4]–[6], because, with the rise above 2 °C compared to 1990 levels, heat extremes to critical tolerance thresholds and natural disasters would happen more often [7]. The global mean temperature in 2021 (from January to September) was already about 1.1 °C above the 1850–1900 average temperature [8]. All European Union countries have ratified the Paris Agreement and have committed to reducing emissions by at least 55 % by 2030 compared to 1990 levels and being climate-neutral by 2050 [9]. Meanwhile, 100 European cities have committed to becoming climate neutral by 2030 [10].

It is crucial to start with the decarbonization of cities. Although they cover only 3 % of the Earth's land, they produce 72 % of all GHG emissions, and urbanization is escalating city growth even faster [10]. Riga, the capital city of Latvia, is one of those pioneers to inspire

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others to follow their example. Still, it is a very challenging mission to perform, realizing the complexity of the cities.

Perhaps the most confusing question is where to start this decarbonization and how this could be simulated to a lesser extent in real life before making a strategy for the whole city to avoid irreversible mistakes. One of the options is to focus on a narrower scale. University campuses are a unique part of larger urban areas, representing a cross-section of the population of different socioeconomic backgrounds and ages, generating irregular schedules and constant movements of people and goods throughout the day [11], [12].

This study aims to develop a methodology for CO_2 calculation on the university campus. The method has been developed and tested on the example of Riga Technical University (RTU) in Latvia. The practical result of the research is a computer simulation tool for analyzing CO_2 scenarios, which can be used to develop the university's climate neutrality strategy. RTU is the first university in Latvia to set a climate neutrality goal by 2030. The modeling method has the potential to be transferred to larger systems than the university campus, such as a company, city, municipality, and other units.

1.1. Research Boundaries

Environmental Protection Agency (EPA) guidance for emission calculation includes three types of emission sources:

- Scope 1 – Direct emissions, which come from sources located within the area or limit the inventory (consumption of fossil fuels in fixed/mobile sources, unintentional leaks from air conditioning equipment, etc.) [13];
- Scope 2 – Indirect emissions, where the consumption of electricity produces GHG emissions, steam/air conditioning within the area or limit of the inventory, but which have been generated outside the area by third parties) [13];
- Scope 3 – Other indirect emissions, which are produced outside the area or limit of the inventory as a result of an activity carried out within it (journey of workers to their workplaces, transportation of goods by sea, air, land to consumption points, etc.) [14].

Scope 1 and Scope 2 emissions are narrower. They can be measured with such indicators as decreased energy consumption, the centrality of sustainability education, cross-functional integration, or cross-institutional integration [15]. And the primary sources of concern that need to be addressed are energy consumption, waste generation, and mobility [16]. Scope 3 emissions include changes in university governance and university user habits. It has been proved that the emissions within Scope 3 can account for up to 35 % of total emissions [17]. These are indirect emissions from activities on the campus, such as construction, transport, and life cycle emissions [18]. Within the university, it includes waste, wastewater, business travel, staff, and student commuting; international students travel from/to home address, student accommodation, home working, and procurement [19].

1.2. Review of the Existing Research in the Field

Achieving climate neutrality requires addressing the potential for reducing emissions, maximizing the capture and storage of difficult-to-avoid emissions, and working hard to ensure the active participation of both staff and students in achieving this goal. It is essential to look at the situation to achieve climate neutrality, not just energy consumption in the isolation [20]. It must be remembered that all processes are interconnected, and that each activity affects the consumption of resources such as water, which in turn affects energy consumption.

Although promoting energy efficiency and introducing renewable energy technologies is essential, universities around the world have found other ways to address this in addition to traditional forms and use, for instance, tree and shrub planting as a method to offset emissions [21]–[24]. Studies have identified the carbon sequestration efficiencies of different trees, allowing the strategic selection of the most appropriate and efficient varieties in a given climate zone [25]. Green walls can perform a similar function. Although their construction is more complex and the economic feasibility must be carefully considered before installing it, it can perform several valuable additional functions in warm climates [26]. In buildings, it can help improve energy efficiency, and in warm climate zones, it reduces the energy consumption due to ventilation. For example, temperature reductions were recorded at 0.8–4.8 °C from an active green wall at the University of Seville, Spain (depending on the distance from the wall) [27]. These walls also improve urban landscape, biodiversity, and UV and wind pressure [28]. There are not only environmental and economic benefits but also social and health benefits mainly derived from the aesthetic and therapeutic aspects [28]. Compared to green roofs, the future of green walls is more promising since there is more area for vegetative cover in buildings [29]; therefore, it is possible to use rooftops for solar thermal collectors or PV panel placement [30]. To increase green walls' efficiency, sustainability, and usefulness, it is possible to use the system for the treatment of greywater [28].

Energy consumption should not be isolated because it is interlinked with such resource flows as waste and water [20]. In this case, some universities have introduced intelligent energy monitoring and renewable energy generation to reduce their impact on the environment [20]. Solar energy between renewable energies is almost carbon dioxide emission-free technology and can be easily installed on virtually any building's roof or facades. It is an integral part of transitioning to sustainable management in every suitable region [31]. The Polytechnical University of Madrid aims to develop and implement its transformative agendas for establishing green and low-carbon campuses by 2030. It proves that the optimal PV power to be installed to maximize both emission savings and economic profitability would result in an annual reduction of between 619–1400 tCO_2eq, which is about 30 % of the total CO_2 emissions of the campus [31].

As the widespread reduction in building energy consumption is an indispensable fragment to carbon neutrality, the importance of energy use assessment of educational buildings to move towards sustainable management of university campuses is emphasized [32]. The Leuphana University of Luneburg (the pioneer in inter-and transdisciplinary sustainability research since the '90s and home of the UNESCO Chair for higher education for sustainable development) switched to renewable energy supply with the first climate-neutral energy balance for heat, electricity, cars, and business trips already in 2014 [33]. Usually, the shift to emission-neutral units involves integrating fluctuating sources of various renewable energy sources. It can be done using smart grids and storage, energy-efficient heat pumps, and low-temperature 4th generation heating networks to achieve energy-efficient buildings with minimized losses [33]. Triggered by the EMAS procedure to become a climate-neutral and sustainable university, several user-oriented measures have been taken to reduce resource consumption. PV installations and refurbishment of the heating network resulted in savings of 125 tCO_2 emissions per year [33]. Unfortunately, user-centred savings were lost after the campaign. Most of the total university emissions originated from transport, which means that these actions are insufficient for such goals [33]. It is crucial to recognize the sectors that need the most significant attention at the university from the outset. The university cannot reform the transport sector alone, so the university needs to expand cooperation with the city by setting shared goals and a roadmap. This model has also been followed by The American University, which achieved carbon neutrality in 2020 [34].

From the available research, it can be concluded that since each university is a different case, there is no single universal plan that would serve as a guide for other universities that want to follow the example of going climate neutral. All papers emphasize the transition to renewable energy sources, waste sorting, promoting more environmentally friendly mobility, and reducing resource consumption. Changing user attitudes because research on the energy efficiency of universities shows that user attitudes determine a building's energy efficiency, which can vary up to 84 % for ventilation, 35 % for lighting, and 30 % for total annual consumption between active and indifferent consumers [35]. In addition to technical solutions, one must also pay attention to changing users' habits, gaining interest, and participating in a common goal.

1.3. Case Study Description

This study aims to create a theoretical framework for assessing and forecasting CO_2 emissions on the campus of Riga Technical University. According to the RTU environmental aspects assessment summary, the most significant impact on the environment has been determined for electricity consumption, heat energy consumption, and generated municipal waste [36]. The impact of transport energy use and water consumption is estimated to be 20 % and 50 % lower than the impact of heating, electricity, and waste [36]. The total area of RTU is 210 423 m^2; it manages 40 buildings, of which 12 buildings are renovated, six are partly renovated, four are new, but 18 are not renovated. There are around 1400 employees and 15 900 students. Currently, RTU has three natural gas cogeneration units with a total installed capacity of 12 MW and natural gas consumption of about 102 000 m^3 in 2019. District heating is mainly used for heating buildings, but seven buildings are heated with electricity. Currently, RTU practically does not produce renewable energy. Heat energy consumption in 2019 reached 16.4 MWh, electricity consumption 9540 MWh, while water consumption was around 140 000 m^3. In 2019, about 2050 t of municipal waste, 16 tons of cardboard and paper, 1.4 tons of plastic, and 6.1 tons of glass were generated, which means that only slightly above one percent of all waste is sorted. Various measures for sustainability have already been taken at RTU, such as electric cars purchased for the university, sorted waste bins have been placed, and plans have been made for building renovation. The university's climate neutrality strategy aims to understand how these measures drive the achievement of the goal and what initiatives need to be implemented as a matter of priority.

2. METHODOLOGY

The study aims to develop and test a tool for estimating CO_2 emissions at a university campus. The CO_2 calculation methodology is based on EPA guidelines. It includes emissions of Scope 1, Scope 2, and Scope 3 according to the international methodology and covers:

1. Direct emissions from the combustion of fuel in the boiler house and fuel consumption in university vehicles,
2. Electricity consumption on-campus buildings,
3. Indirect emissions from fuel consumption related to the commuting of university staff and students.

An outline of the university's current emissions according to the EPA international methodology is given in Fig. 1. The third group also includes waste management. In the future, it is planned to add sections on procurement of goods and services and other indirect emissions not included in Scope 2 to the model.

The *RTU-CLIMATE 2022* model was built using the international GHG protocol methodology for CO_2 accounting. The CO_2 calculation methodology was integrated into a computer simulation software Stella Architect using system dynamics modelling approach. System dynamics is a methodology for the research of complex dynamic systems.

According to the university's climate neutrality vision, the model consists of four sub-modules. The following sections describe the design of the model and the main assumptions and measures to reduce CO_2 emissions. Model input data comes from two sources. The available documentation, including readings of electricity and heat meters and utility bills, and accounting data on the mileage and fuel consumption of the university fleet, were collected every month for the last two years. In addition, a survey of university staff and students was conducted to include behavioural factors presenting attitudes and habits that affect energy consumption and waste generation. The survey was conducted in April 2022 and was completed by 521 University students and staff. In this case, the survey serves more as the first test of the proposed methodology to adapt the questionnaire format to the structure of the model. The surveys are planned to continue twice a year to independently assess progress and increase the number of respondents as part of the university's climate neutrality campaign.

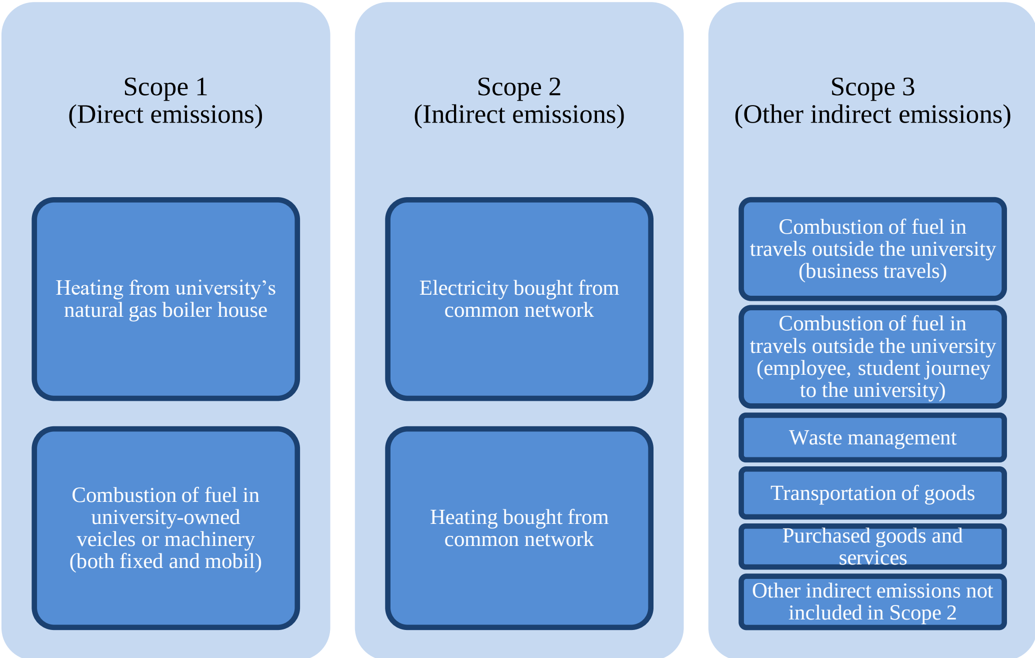

Fig. 1. Case study emission break-down according to the EPA GHG protocol methodology.

2.1. Energy Production

Heat production takes place centrally in the boiler house. Natural gas is used as fuel. The measures considered in the climate neutrality scenarios include abandoning the use of natural gas in scenarios with different transition speeds:

1. Biomass boiler scenario,
2. Solar collector scenario,
3. Combined scenario.

2.2. Energy Consumption in Buildings

Metered electricity consumption or utility bills specifying electricity consumption in kWh are used as the data source to calculate CO_2 emissions from electricity consumption in buildings. The university campus consists of 40 buildings that has a different range of electricity consumption (kWh/m^2). Grid-average emission factor in Latvia corresponding to 0.109 tCO_2/MWh is used to calculate CO_2 emissions from electricity consumption in buildings.

The analysis of climate-neutral scenarios is based on two types of measures that electricity consumers can use to reduce CO_2 emissions. The first is reducing electricity demand with behaviour change measures. The second is increasing the speed of electricity supply transition to low-carbon technologies such as wind or solar energy.

2.3. Transport Emissions

In transport energy consumption, the division between staff and students is essential, as both groups' behavioural trends and needs differ. Employee travel is broken down into business trips by air (plane) and road (car), and CO_2 emissions from fuel consumption from daily commuting trips (Fig. 2). In the case of students, only commuting trips are counted. Information on business trips comes from the university's accounting and technical department.

Important factors influencing the result are mileage per person per day, the number of days to work or study at university, travel mode choice, type of car fuel, and average fuel economy. Such data were not available at the university so far. These data were collected with the help of the survey (results presented in Section 3). Measures to reduce CO_2 emissions in the model include a shift in the demand for transport (mileage decrease), a shift towards more environmentally friendly modes of transportation instead of cars (public transport, cycling, walking), and the broader use of electric vehicles in the university fleet.

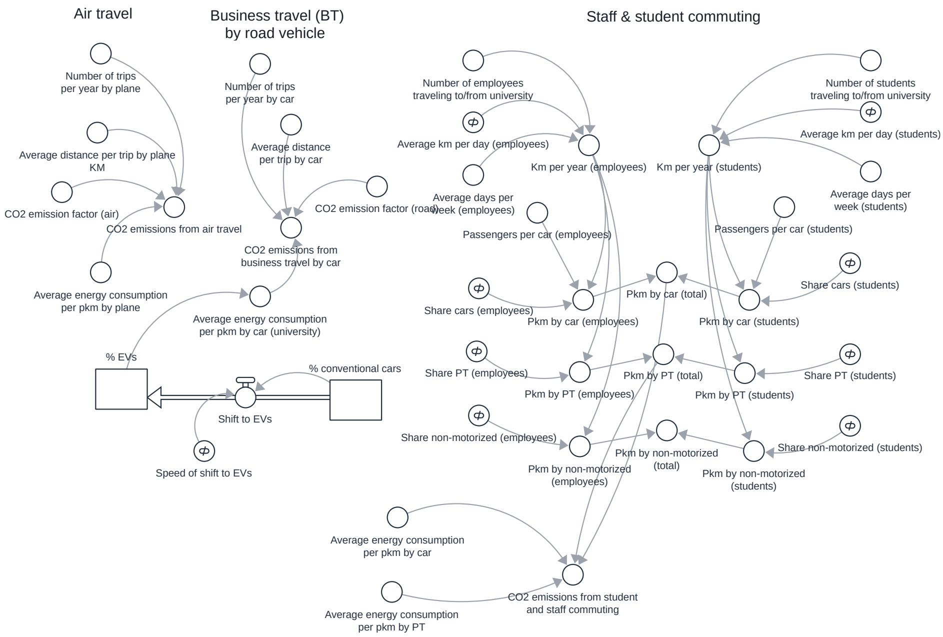

Fig. 2. CO_2 emission calculation in the travel module.

2.4. Waste Management

In the waste management sector, as only 1.15 % of all university waste is sorted, the university aims to reduce the amount of waste generated and increase the amount of sorted waste. In terms of waste sorting habits, preliminary survey results show that 7 % of university staff and students currently sort waste. The reasons for not sorting waste includes 38 % lack of infrastructure, 31 % lack knowledge, and 24 % do not consider waste sorting important. Accordingly, the model is complemented by the possibility to analyze the impact of measures to improve these factors:

1. Improvement of waste sorting infrastructure (speed of improvement),
2. Measures to improve the availability of information on sorting (information campaign strength), and
3. Accumulated experience (the higher the proportion of sorted waste, the greater the accumulated experience and the greater the positive attitude towards the need for waste sorting.

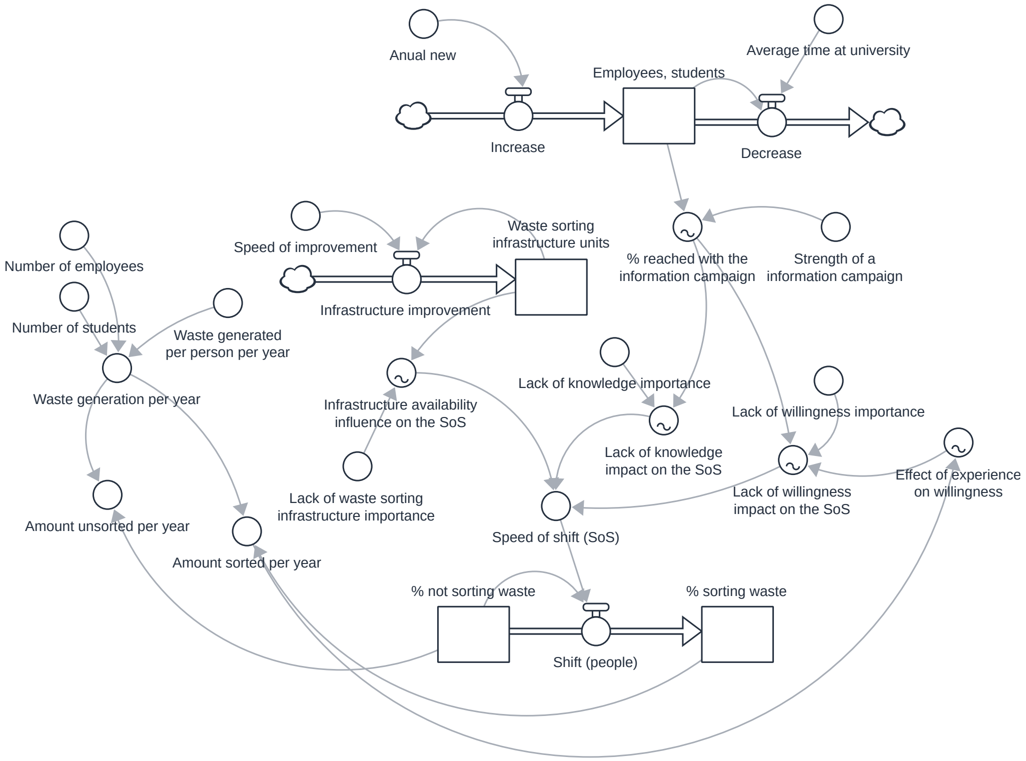

Fig. 3. Structure of the waste management module.

3. PRELIMINARY SURVEY RESULTS

Depending on user behaviour, university energy consumption can vary by up to 30 % [35]. As there is a lack of information on Scope 3 emissions, a survey was sent out to all Riga Technical University's employees and students to analyse the behaviour and habits of RTU users and determine the necessary improvements. The survey is also essential to obtain data for developing the model.

Five hundred twenty-one respondents took part in the survey – 180 employees, 252 students, and 89 people working and studying at the university. The survey consisted of 25 questions for employees and 23 questions for students in two languages – English and Latvian. It was made in Microsoft Forms and was sent out via emails, published on 'Ortus' and other official RTU platforms. Data was collected from March 2022 till the middle of April 2022.

To implement energy efficiency measures, the first step would be to invent an accurate data accounting system to know where energy consumption can be reduced [37]. To save heat energy, it is necessary to assess heat losses, insulate buildings that have not yet been renovated, and consider reducing the air and water temperature [38]. As the data on energy consumption available at RTU is very general, it is primarily necessary to ensure that the obtained data can be easily monitored and analysed in detail. Only then it will be possible to set specific energy efficiency measures, as university premises serve many applications and purposes. After such an analysis, it is possible to calculate and consider the replacement of old equipment and lighting, as the aging of electrical equipment can increase energy consumption by up to 27 % after 16 years [39] and identify management errors or even inefficient user behaviour. During the survey, respondents were asked to approximately what extent they are currently paying attention and implementing energy and water-saving at the university. Only 10.4 % of users believe that they are fully committed to saving water resources and energy. The majority admits that the implementation of resource and energy efficiency is only partially considered daily, while 11.5 % do not pay attention to it at all.

As RTU owns many buildings with flat roofs, the installation of solar panels and/or collectors should be considered to promote the university's energy independence and sustainability, serve as an example to other universities and institutions and make full use of its potential [31]. Although there are universities that use such technological solutions as water sensors with an automatic sensor for a more excellent water economy, scientific evidence proves that such a system even slightly increases water consumption [40]. It is recommended to equip water taps with aerators instead that reduce the amount of water flowing out of the tap by up to 50 % while maintaining pressure and consider solutions such as a modern toilet flush system that releases only 3 L of water compared to up to 12 L in older systems [41]. Also, greywater, and rainwater system implementation on buildings for the use of water obtained from roofs and other solid surfaces for irrigation, laboratories, toilets, rinsing processes, cooling towers, construction works, and others [28]. However, to promote water economy, the main emphasis should be on changing user habits, which can be done by placing info-graphics that can attract a person's attention in just a few seconds, influencing their behaviour [42], [43].

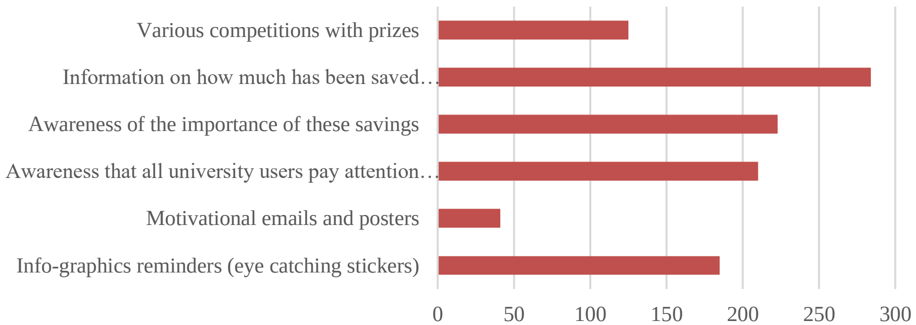

Fig. 4. Answers the survey's question: 'What would motivate you to reduce your water and electricity consumption daily?'

The survey also showed that people favour posting infographics that remind, encourage, and inform them daily about where and how to reduce consumption. However, the most significant importance was given to information on what has been the economic impact and how it has decreased compared to previous years. The answers show how important it is to be aware that these activities are carried out by all university users and the knowledge of why it is essential to make such savings. Although knowledge is the basis for a person to see the point in changing their habits, the survey revealed that 68 % believe that RTU does not provide its employees and students with sufficient information on these issues.

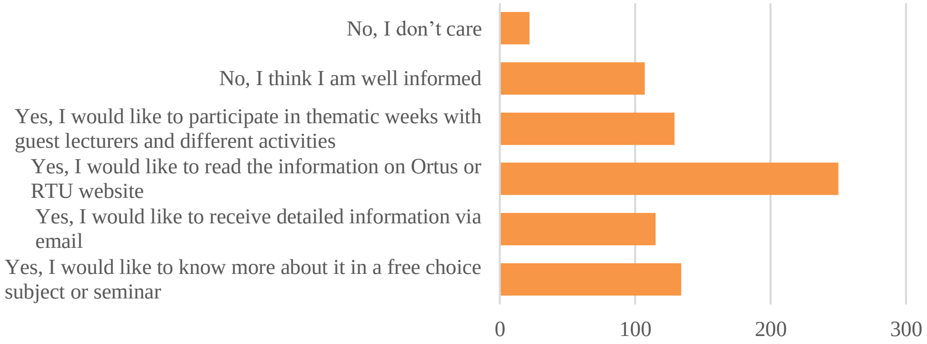

Fig. 5. Answers to the survey's question:' Would you like to know how changing your daily habits can reduce your impact on the environment?'

In the answers on how the respondents would like to receive this type of information, the possibility to view such information on the university websites gained the most popularity.

Lack of knowledge is also observed on the issue of waste sorting. As only 1.15 % of all university waste is sorted, although sorted waste bins are located on the university territory, the survey revealed that 14.78 % of respondents are afraid of sorting waste incorrectly, 23.80 % of respondents are not interested in it at all, which also indicates a lack of knowledge.

Although 6.91 % of respondents state that they sort 100 % of their waste, 37.81 % of respondents state that this activity does not provide sufficient infrastructure. In comparison, 16.70 % of respondents say they are not sure if the cleaners collect the sorted waste together. To improve waste management, work towards zero to landfill waste disposal needs to be done, and it can be achieved by increased on-site recycling. No less important would be to pay attention to decreasing waste production. In finding out in the survey what would motivate the complete sorting of waste, the most significant agreement was received on the need to place more sortable waste bins. As well as to put information on proper sorting at the containers and prove that sorting makes sense at the university, national and global level, and in the first place, introduce conditions which reduce the generation of waste, which are:

– place food exchange cabinets on campus, where it would be possible to share functional but unnecessary food in unopened packages;
– place an exchange point for stationery and various other materials;
– evaluate the implementation of a zero-waste policy;
– evaluate and reduce the use of different materials in the study process;
– improve the quality of RTU drinking water at all filling points (as almost 18 % do not use the opportunity to fill their bottle with water at RTU's drinking water points because they don't trust the quality of drinking water at those points);
– introduce the tare deposit points.

For the university to become climate-neutral, it is necessary to pay attention to indirect emissions such as waste management and the purchase of various services and products, including reducing the ecological footprint in the catering sector. Although only about 48 % of respondents support introducing a vegan or vegetarian day in RTU cafes, 26 % still have doubts, and 26 % do not support such an idea; 92 % of respondents favour restaurants offering meals made only from seasonal, local products.

Focusing on simple yet effective solutions, it should be noted that there is a large green area in the territory of the university, which does not perform any function. Still, a perfect lawn is provided every year. As the development of a sustainable university must be nature-friendly and functional, the survey included the question of whether the university users are satisfied with the green area. It is one of the consumers of fossil resources due to mowing, but the use of the green regions is shallow due to the lack of recreation areas. Although 47 % of the respondents answered that they are satisfied with the green area, 35 % said they are not, and 18 % said it is irrelevant to them.

To move closer to climate neutrality and reduce the consumption of fossil resources, it would also be needed to consider seemingly small-scale alternatives, in this case, urban meadows. To maintain a perfect lawn, it must be mowed up to 20 times in one season, which causes sound pollution and emissions. An inefficient mower can emit 11 times more than a car [44]. Urban meadows, on the other hand, need to be mowed only twice a year, and it is also possible to do so with a scythe – in an emission-free way. Urban meadows can reduce fuel and water consumption [45]. Due to their much broader root system, they absorb significant amounts of water during rainfall and reduce the risk of flooding while allowing water to last longer in times of water scarcity [44]. Flower meadows serve as a more visually appealing environment for biodiversity conservation and as an anti-smog device, as meadow flowers absorb dust and improve air quality. Urban meadows are the future of every sustainable and modern city [44]. While until now, the prevalent view has dominated that trees serve as an anti-smog device in urban areas, it has already been shown that trees accumulate about 30 micrograms of suspended dust per square centimetre of the sample. In comparison, plants accumulate 80 micrograms of different types of dust from a flower meadow and permanently retain dust on its surface due to the waxes on the leaf surfaces of these plants [46].

However, to reduce the consumption of fossil resources to a greater extent, attention must be paid to the travel habits of staff and students. The survey showed that 66 % of employees work partly from home, and only 34 % work five days a week on-site. As the time of the Covid-19 pandemic has proved the possibility to work equally well for many RTU employees remotely, even a partially remotely organized work and training process would be able to solve the problem of transport emissions in the future partially.

The questionnaire also shows the readiness of employees to continue part-time work in the future, as only 16 % want to work only on-site. As most often fossil-fuelled private cars are used and public transport, the emphasis needs to be on finding solutions for these users. Moreover, only 13.63 % of respondents stated that they would not be ready to change their habits in the survey. At the same time, all the rest replied that they would be open to using such types of transport as bicycles, shared cars, public transportation, powered micro-mobility tools, and walking more often in terms of improvements. The university cannot reform the transport sector completely alone, so the university needs to expand cooperation with the city by setting shared goals and a roadmap. The American University has also followed this model, which already achieved CO_2 neutrality in 2020 [34].

Although more detailed information is needed to explore these issues, the survey shows that 10 % of respondents travel to university and home by private car for only 5 km a day, potentially the most accessible group to find transport alternatives. The situation is similar with 44 % of respondents who do not cover more than 20 km a day.

In addition, 53 % of respondents who travel in a private car daily said that most of the time they travel by car alone, which makes this journey even less efficient and less environmentally friendly, and only 4 % are hybrid, 5 % are running on gas, 39 % on petrol, but 52 % on diesel.

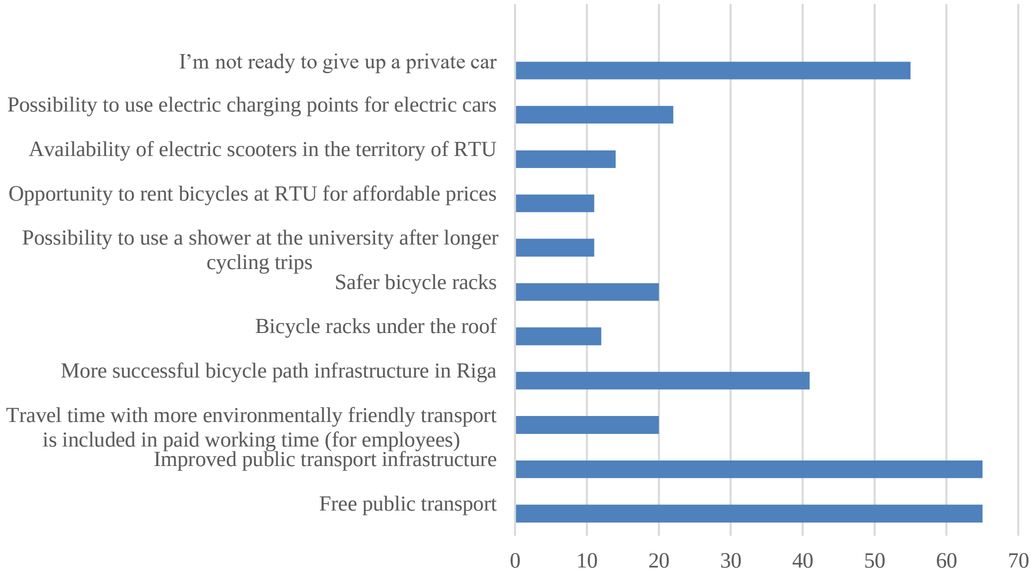

Fig. 6. Answers to the survey's question: 'If you mostly use a private car (petrol/diesel/gas), what would motivate you the most to use a more environmentally friendly means of transport?'

Although 16 % claim they are not ready to give up a private car, most say improvements in cycling and public transport infrastructure are needed to change habits. It is essential to consider all these solutions, as they depend on the distance travelled by the users, and these are:

- free public transport;
- improved public transport infrastructure;
- travel time with a more environmentally friendly vehicle is included in paid working time (for employees);
- more successful bicycle path infrastructure in Riga;
- bicycle racks under the roof;
- safer bicycle racks;
- possibility to use a shower at the university after longer cycling trips;
- opportunity to rent bicycles at RTU for affordable prices;
- availability of electric scooters in the territory of RTU;
- possibility to use electric charging points for electric cars.

When asked whether respondents would be willing to change their daily habits to reduce their environmental impact, only 3 % said they did not care. In comparison, 8 % said they were already sufficiently informed and doing enough to be environmentally friendly. Still, all the other respondents showed their interest and replied that they would be willing to change their habits if there was enough information or infrastructure.

An in-depth analysis of individual issues confirms that people want to change their habits. Still, it is necessary to provide a favourable environment with the infrastructure and the awareness that every university employee and student works in this direction. Unexpectedly low acceptance was of the need for different prize-winning promotions. Much more effective was the response of comparing previous year indicators so that users can visually see how their daily behaviour is affecting the university's move towards climate neutrality, such as collectively, but at the same time individually competing with yourself.

4. DISCUSSION

The European Union's green deal also motivates universities to consider climate neutrality. Riga Technical University is one of the first universities in Latvia to assess the potential for climate neutrality. One of the first steps has been taken: collecting energy consumption data and collecting missing data in surveys, which has never been done before. Further on, there is a need to develop a tool that allows the university to plan the activities that need to be carried out primarily and see the actual impact on the emissions created. Such a tool, called the *RTU-CLIMATE 2022*, is under construction. This paper presents the first results from the CO_2 simulation scenario tool concept. The model will be tested in the study's next steps by supplementing it with input data and performing simulations. The possibilities for climate change and environmental impact assessment will be analysed with the measures included in the tool. The overall goal is to assess the university's potential to achieve climate neutrality by 2030. From a scientific point of view, such a university campus climate neutrality simulation tool can be considered a miniature representation of a more extensive system, e.g., the city. Thus, in a broader context, the study has the potential to be pursued in the context of the study of urban climate neutrality scenarios.

The study also offers a methodology for including behavioral parameters in assessing CO_2 reduction potential. A questionnaire has been developed and tested to understand better the behaviour of energy users, which is usually a missing element in technical energy-economic models. The first results show that when asked whether respondents would be willing to change their daily habits to reduce their environmental impact, only 3 % said they did not care. In comparison, 8 % said they were already sufficiently informed and doing enough to be environmentally friendly. Still, all the other respondents showed their interest and replied that they would be willing to change their habits if there was enough information or infrastructure. An in-depth analysis of individual issues confirms that people want to change their practices. Still, it is necessary to provide a favourable environment with the infrastructure and the awareness that every university employee and student works in this direction. Unexpectedly low acceptance was of the need for different prize-winning promotions. Much more compelling was the response of being able to compare previous year indicators so that users can visually see how their daily behaviour is affecting the university's move towards climate neutrality, such as collectively, but at the same time individually competing with yourself.

Improvements that RTU could work on are locating more separate waste bins in the largest and most frequently used auditoriums and providing precise information on proper sorting, as people often avoid sorting waste due to insufficient knowledge. No less important would be to pay attention to decreasing waste production. It is possible by such activities as promoting existing drinking water extraction sites and evaluating the attention of the teaching staff in the study process to evaluate the need to use different types of materials. As well within the campus, to reduce food waste, by placing a community closet, students could put food that is still valid but not necessary for themselves.

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