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Позиционирование экологически ориентированных университетов как субъектов «зелёной» экономики

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Positioning environmentally oriented universities as actors of the “green” economy

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Introduction

Relevance of the research topic. The assessment of the impact of environmental indicators in the implementation of sustainable university strategies for the development of a “green” economy is of key importance.

Over the past decade, China, the European Union (EU), and South Korea have been leaders in green economy initiatives. Starting from 2026, the EU will officially introduce a cross-border carbon tax for exporting enterprises, including Russian ones. In the Russian economy, the introduction of “green” technologies is carried out by industries such as the oil and gas industry, the leaders of 2021 Zarubezhneft, Tatneft, as well as banking structures such as the Moscow Credit Bank and Sberbank. From 2010 to 2023, the number of “green” universities in the world have increased by more than 10 times, and in Russia by more than 50 times. This study focuses on environmental sustainability in green universities and a green regional economy. These two areas are aimed at the introduction of low-carbon energy, reduction of CO_2 emissions, rational management of water resources and waste, sustainable infrastructure, environmentally friendly transport systems, educational and research activities.

It is important to establish a scientific relationship between the "green" university and the "green" economy as the ability of the ecological system to cope with the problem of environmental and climate degradation.

The level of environmental sustainability of universities is quantified by the university's environmental maturity. The university's environmental maturity is the degree to which universities introduce environmental sustainability into their educational practices.

“Green” universities — these are universities that implement environmentally sustainable initiatives aimed at improving environmental quality and sustainable development. The chosen research topic is aimed at motivating universities' aspirations (university positioning) to achieve high places in the rankings of “green” universities and the development of a “green” economy.

Degree of development of the research topic

Theoretical and methodological approaches to green universities and green economy were formed by both economists and ecologists, such as E. B. Barbier, S. N. Bobylev, P.A. Kiryushin, L. Saikku, V. Brand, F. Caprotti, A. Hamdush, A. Jones, P. Strem, K. Schultz, K. Pitkanen, R. Antikainen, N. Droste, L.V. Matraeva, B. Leimona, A. Kenis, M. Livens, O. Fedotkina. Other researchers - J. Corder, B. McLellan, T. Fujita - have made important contributions to the theoretical aspects of the green university and green economy. Scholars such as S. Lee, T. Ngnianedema, G. S. Kushwaha, N. Sharma, H. Zhang, and K. K. Tan have studied the impact of green initiatives on environmental sustainability. V. S. Bochko, L. G. Yolkina, D. Yu. Dvinin, N. H. Tien, E. B. Barbier, S. Cook, R. Mustafu, S.-Y. Peng, V. Plotnikov, N. Kirsanova, Y. A. Kozlov, A. V. Vertakova, E. V. Vertakova, E. A. Tretiakova, O. Lavrinenko, O. Smirnova, E. Agapova, O. V. Kudryavtseva, V. A. Bondarenko, G. P. Butko, E. V. Goncharova, L. S. Shakhovskaya, E. A. Yakovleva, V. V. Krivorotov, E. R. Magarill, L. A. Mochalova, V. P. Anufriev , Yulkin M.A. are scientists who have made a significant contribution to the research of problems related to the application of green economy approaches to various aspects of the general economy.

Despite the growing interest of researchers around the world on the issues of the “green” economy and “green” universities, there is practically no work in the literature that takes into account the adoption of sustainable university initiatives as a basic element for the development of a regional “green” economy. Since 2021, the Program for concessional financing of “green” projects and initiatives in the field of sustainable development has been launched in Russia. The relevance of the topic and the analysis of scientific literature determined the purpose of the study, its subject and object.

The purpose of the research is to develop a methodological toolkit for positioning environmentally oriented universities as subjects of the “green” economy.

Research objectives:

1. To improve the approach to strengthening the position of environmental sustainability of the university by developing a mechanism for the continuous development of environmental initiatives.
2. To propose a strategic management algorithm to strengthen the position of environmentally oriented universities.
3. To develop a conceptual model of positioning the university as a key subject of the development of "green" economy of the region/territory.
4. To expand the methodological tools for assessing the sustainability of universities UI Green Metric (UI GM) by introducing new additional indicators.

The object of the study is environmentally oriented universities participating in international rankings of "green" universities (UI GM), striving to become subjects of the "green" economy.

The subject of the study is a set of environmental and socio-economic relations arising in the process of applying sustainable university initiatives in the "green" economy of the region.

Territorial framework of the dissertation research. The study used statistical data on green university initiatives of 16 Russian universities, including data on energy consumption of UrFU and revenue of small innovative enterprises related to sustainable development with the participation of UrFU.

The theoretical and methodological basis of the research was based on the use of scientific works of leading scientists (both foreign and domestic) in the field of sustainable development economics, theories of the development of the "green" economy and the, as well as carbon footprint accounting in educational institutions.

The following analytical methods were used in the study: econometric methods such as the fixed effect and random effect methods, conceptual approaches and SWOT analytical tools.

Information and empirical base of the thesis. The information and empirical base of the study was formed on the basis of regulatory legal acts of the Russian Federation, reviews of state statistics, methodological documents of federal legislative and executive authorities, scientific papers of Russian and foreign scientists published in specialized journals and posted on the Internet, statistical data of the Ural Federal University.

The Field of the study corresponds to the passport of scientific specialty 5.2.3 — Regional and sectoral economics (economics of nature use and land management): 9.7 Development and improvement of methods and techniques of economic assessment and compensation of ecological damage; 9.19 The problem of combating climate change. Issues of development of “green”and low-carbon economy.

Provisions submitted for defence:

1) The mechanism of continuous annual improvement of environmental sustainability of universities has been improved, which differs from similar ones in that it allows ranking and identifying the most effective environmental initiatives of universities from the UI GM rating— "education and research” and “energy and climate change” and taking into account these data in the preparation and implementation of the environmental program of the university. Practical application of this approach will allow universities to evaluate the six categories of the UI GM rating and recognize their key role in strengthening the environmental sustainability of the region (item 9.7 of the Passport of Specialties of the Higher Attestation Commission).

2) The algorithm of strategic management to strengthen the position of environmentally oriented universities is proposed, which differs from the known ones in that it allows universities to determine the level of their own environmental maturity according to the UI GM indicators, as well as to justify their competitive advantages in the implementation of the concept of a “green” university. The application of this approach will allow universities to assess their status as a “green” university (item 9.7 of the Passport of Specialties of the Higher Attestation Commission).

3) The conceptual model of positioning the university as a key subject of development of “green” economy of the region/territory has been developed. The peculiarity of the proposed model is that it is focused on the new mission of “green” universities: responsibility for environmental sustainability not only of the university

itself, but also of the region in which it is located. Practical application of such a model will allow universities, including teachers, students, researchers, to contribute to the transition to a “green” economy (p. 9.7; 9.19 of the Passport of Specialties of the Higher Attestation Commission).

4) The methodological toolkit for assessing the sustainability of universities in the UI GM rating was expanded by more fully taking into account the carbon footprint and the contribution of environmentally-oriented universities to the development of green economy in the region. The recommended approach will make it possible to more reliably calculate the environmental impact of universities and effectively manage it, as well as to assess the progress in the interaction between universities and enterprises of the “green” economy (item 9.19 of the Passport of Specialties of the Higher Attestation Commission).

Scientific novelty of the dissertation consists in improving the approach to strengthening the position of environmental sustainability of the university by developing a mechanism for continuous development of environmental initiatives, developing a strategic management process to strengthen the position of environmentally oriented universities, developing a conceptual model of positioning the university as a subject of “green” economy of the region/territory, as well as improving the methodological tool for assessing the sustainability of universities UI Green Metric by introducing the following methods.

The theoretical significance of the study is due to the fact that the applied methodological toolkit contributes to the comprehensive assessment of the impact of green university initiatives on the sustainable development of the territory. The algorithm of continuous improvement of environmental management systems in universities, the model of development of a “green” university as an important component for the transition to a “green” economy of the territory and the contribution to improving the assessment of university sustainability through UI GM indicators, which are annually adjusted, are proposed.

The practical significance of the study lies in the objective assessment of green university initiatives, the use of UI GM indicators as a basis for the development of a green university, the assessment of carbon footprint, environmental actions and lifestyle of students, as well as the development of a model linking a green university with the development of a green economy of the territory. The dissertation work proposes a draft model roadmap for implementing the concept of an environmentally oriented university for educational institutions planning to participate in the UI GM international ranking. The University of Energy and Natural Resources (UENR, Ghana) has confirmed its agreement to apply the proposed roadmap. A certificate of implementation of CarbonLab LLC on the use of the thesis results in the following training courses of MGIMO and Higher School of Economics (Russia) was also received: 1. Carbon accounting and reporting. 2. Decarbonization and low-carbon development.

The degree of reliability of the results. The high degree of reliability of the research results is due to the use and correct processing of reliable sources of theoretical, methodological and statistical information, and obtaining results according to modern scientific methods and testing the results at international forums and conferences.

Approbation of the research results. The main provisions and results of the dissertation were reported, discussed and received a positive assessment at international scientific and practical conferences and forums: International Forum "Culture and Ecology —the Foundations of Sustainable Development of Russia. Green Bridge across Generations" (Ekaterinburg, Russia, April 12–15, 2019); International forum "Culture and ecology — the basis of sustainable development of Russia. Cultural and environmental imperatives of the modern economy" (Ekaterinburg, Russia, April 12–15, 2020); International forum "Culture and ecology — the basis of sustainable development of Russia. There is no alternative to the "green" strategy" (Ekaterinburg, Russia, April 12–15, 2021); International Conference on Numerical Analysis and Applied Mathematics ICNAAM 2021 (Rhodes, Greece, September 20–26, 2021).

Publications. The main provisions and conclusions of the dissertation research are reflected in 7 scientific publications, including 2 articles published in peer-reviewed scientific journals defined by the Higher Attestation Commission of the Russian Federation and the Attestation Council of UrFU, including 4 articles published in the editions indexed in the SCOPUS and WoS databases. The total volume of publications is 4,78 pages, of which 2,24 pages represents the author's contribution.

The author's personal contribution consists in conducting theoretical and empirical research on the thesis topic, developing the author's approach to improving the environmental sustainability of the university, characterized by the continuous development of university environmental initiatives, developing a methodological approach to the prioritization of factors that provide the university with competitive advantages when implementing the concept of environmentally oriented university, developing a new conceptual model of positioning the university as a subject of "green" economy The author proposes an addition to the methodology for assessing the sustainability of UI GM universities, which proposes to more fully take into account the carbon footprint, energy efficiency and the contribution of environmentally oriented universities to the development of a "green" economy in the region.

Structure and scope of the work — the formulated research objectives determined the structure of the dissertation work. The dissertation consists of an introduction, three chapters, conclusion, and list of 224 sources of literature. The work contains 141 pages of the main text, 26 tables, 18 figures and 6 appendices.

The relevance of the research topic, as well as its practical significance, are noted in the **introduction.**

In the first chapter, the scheme of continuous annual improvement of green universities' initiatives is developed and the feasibility of assessing the environmental impact of the results of green universities' initiatives based on the results of analysing the categories of the UI Green Metric rating of 16 Russian green universities according to the principle of continuous improvement based on the concept of integrated environmental management is substantiated.

In the second chapter, a methodological approach for justifying the factors that provide a university with competitive advantages when implementing the concept of an environmentally oriented university is developed, which differs from the known variants in that it allows the ranking of the necessary factors in order of importance. Chapter 2 also develops a conceptual model in which ‘green’ universities act as a necessary component of building a ‘green’ economy of the territory, and presents a draft model roadmap for the implementation of the concept of environmentally oriented university for educational institutions planning to participate in the international rating UI Green Metric, as well as shows the benefits of this participation.

Chapter Three presents an improved methodology for assessing the sustainability of UI GreenMetric universities that more fully considers the carbon footprint, energy efficiency, and contribution of environmentally oriented universities to the development of the region's “green” economy. Calculations have been made for a number of proposed indicators for the Ural Federal University.

The conclusion formulates inferences in accordance with the set goal and objectives, as well as recommendations and prospects for further development.

The appendices present materials that supplement and illustrate the provisions of the dissertation research.

Chapter 1 University sustainability and approaches to its assessment and improvement

1.1 The overview of concepts and initiatives of universities in the field of sustainable development

Historical review of sustainable development

According to Prizzia [1],Thai et at.[2], Danilov-Danilyan [3] the Stockholm Declaration of 1972, which was attended by 113 states and representatives of 19 countries, marked the first official recognition of sustainable development issues in a global forum. The conference was held with the aim of addressing environmental sustainability issues and this resulted in the formulation of 26 principles that covered various aspects of environmental sustainability [4]. Md Imtiajul, [5] noted that the Stockholm Declaration paved the way for the creation of several other environmental sustainability programs, including the United Nations Environment Program (UNEP). According to Brundtland, [6] the UNEP's mandate is to «provide leadership and encourage partnership in caring for the environment by inspiring, informing and empowering countries and people» in order to improve the quality of life without compromising future generations. Additionally, Prizzia et al. [1] reported that the Stockholm Declaration played a pivotal role in the preparation of the 1987 Brundtland Report, which placed environmental issues on the global agenda and provided a set of principles and an action plan for environmentally sound management. Indeed Anufriev et al.[7] noted that he term “sustainable development” was fully formulated by the International Commission on Environment and Development (Brundtland Commission) in 1987.

However, the Stockholm Declaration had some limitations in terms of its effectiveness. This was due to the perception that environmental protection and development, particularly in developing countries, were in conflict with each other [1]. As reported by Md Imtiajul [5], the focus of the declaration was on achieving a balance between environment and development rather than promoting a mutually beneficial relationship between environmental protection and development.

In the 1980s, the International Union for Conservation of Nature and Natural Resources introduced the «World Conservation Strategy» which brought the term «sustainable development» to the forefront of public discussion. Brundtland argued that this conversation only focused on environmental sustainability and failed to connect sustainable development to social and economic issues [6]. It wasn't until 1987 when the Brundtland report was released that sustainable development was defined as an environmental goal that also encompassed economic and social dimensions. According to Md Imtiajul [5], this concept was ground breaking because it proposed the possibility of development while also maintaining environmental sustainability. Therefore, in the Brundtland Report, sustainable development is defined as a form of development that satisfies the economic, social, and environmental needs of both present and future generations. This definition envisions a common future that requires a more comprehensive process of change, involving cultural and lifestyle changes, along with technological and institutional transformations, to address economic, environmental, and social issues. For example Mochalova et al. [8] contextualized sustainable development in the context of ESG, where they opined that investing in ESG takes into account environmental, social, and economic/ management strategies.

Since the publication of the Brundtland Report, numerous global events that focused on sustainability have occurred. One notable example is the establishment of the United Nations Conference on Environment and Development (UNCED) at the 1992 conference held in Rio de Janeiro, Brazil. Md Imtiajul noted that the conference brought together 114 heads of state, over 10,000 legislators, and more than 1,400 non-governmental organizations from 178 countries[5]. This was followed by the 1997 Kyoto Protocol in Japan and the Paris Agreement, both of which set a global consensus to reduce greenhouse gas (GHG) emissions to recommended levels. In response, the United Nations developed the Millennium Development Goals (MDGs), which had a greater emphasis on sustainability, but were limited in scope and fell short of their intended purpose.

Consequently, the UN Sustainable Development Goals (SDGs) were created to address the gaps in the MDGs and ensure environmental sustainability (as shown in Fig. 1)[1]. The SDGs represent a significant improvement over the MDGs.

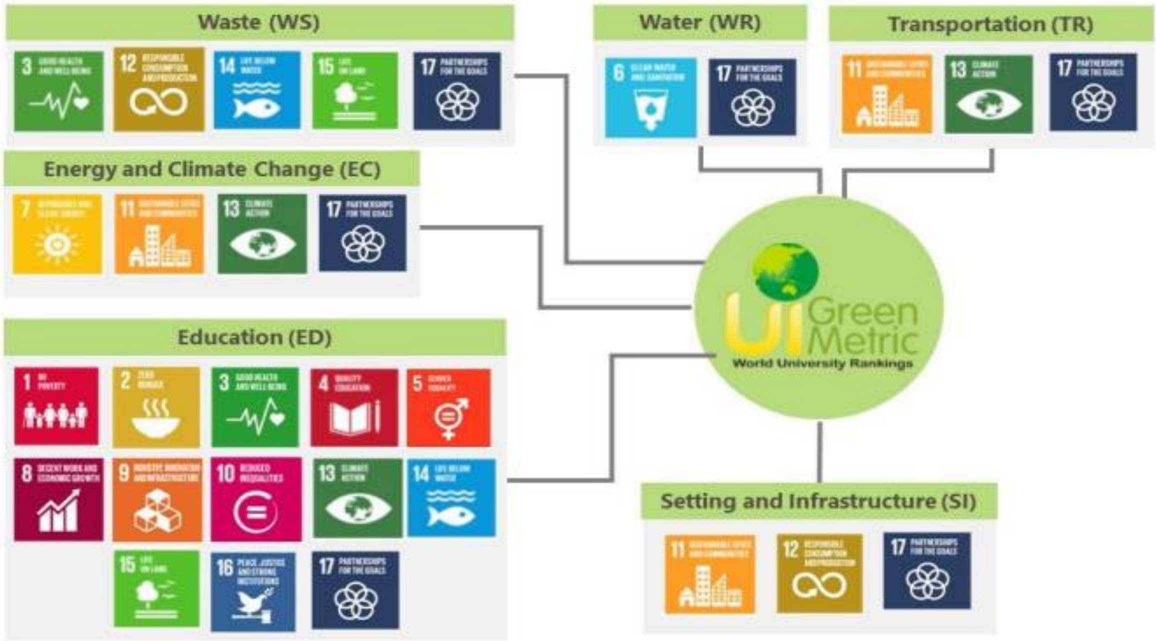

Figure 1– UI GreenMetric Categories and United Nations Sustainable Development Goals (UI GM guidelines, 2021)

The concept of campus sustainability in universities

Researchers opined that universities have a significant impact on the environment due to unsustainable activities associated with the consumption of resources [9–11]. This impact has a negative effect on the environment, which leads to a decrease in its quality. In the past decade, universities have implemented several initiatives to improve their environmental performance. These initiatives have aimed at reducing the environmental impact on and off-campuses and they are referred to as "sustainable university". Due to the complexity of the term "sustainable university", several researchers have tried to provide a suitable definition by contextualizing the term. For example, Deleye [12] define sustainable university as an institution that integrates sustainability into its core functions—teaching, research, and community engagement—while aiming for

[1] https://greenmetric.ui.ac.id/publications/guidelines/2021/english

continuous improvement in its sustainability practices and policies. The author further noted that sustainable university refers to a university that actively involves its stakeholders, including students, faculty, and the local community, in sustainability initiatives, fostering a culture of sustainability through collaboration and shared responsibility. Adopting a more holistic definition, Wright[13] defined sustainable university as an embodiment of holistic approaches to sustainability, integrating environmental, social, and economic dimensions into all aspects of its operations and educational programs.

With regards to a transformative learning environment, Deleye [14] define sustainable university as a place that not only imparts knowledge but also transforms students' values and behaviors towards sustainability through experiential learning and critical thinking. Grecu and Ipiña, [15] note that a sustainable university is one that is characterized by its commitment to conducting research that addresses global sustainability challenges while also applying this research to improve its own practices. Harvey et al. [16] opine that a sustainable university is one that highlights the importance of social equity in sustainability efforts, asserting that a sustainable university must address issues of justice and inclusion within its policies and programs. Ruggerio [17] define sustainable university as one that a employs adaptive management strategies to continuously assess and improve its sustainability efforts in response to changing environmental and social conditions. With regards to the civic responsibilities of universities, Alexander et al. [18] define sustainable university as one that recognizes its civic responsibility by engaging with local communities to promote sustainability initiatives beyond campus borders. University sustainability is a vision of transforming campuses into “learning organizations” and “living labs” for the practice and development of environmental sustainability [19,20].

Clearly from the definitions presented thus far, it is obvious sustainability university is defined differently by various researchers based on specific scopes and targets. However, the ultimate objective is to reduce the negative impact of universities on the environment and promote sustainable practices. In summary, a sustainable university embodies a holistic integration of sustainability across its operations, focusing on education, research, and community engagement. It fosters an engaged community that promotes sustainability literacy among students, utilizes innovative green technologies, and commits to social responsibility and equity. Governance structures prioritize sustainability in decision-making, while campus operations emphasize waste reduction and energy conservation. Additionally, it encourages a cultural shift towards environmental stewardship and prepares students to be global citizens who understand their role in addressing interconnected sustainability challenges.

Although the concept of sustainable university can be broken down into three dimensions (Fig. 2), it is often perceived differently in various situations, making it challenging to develop a unified theory for this concept [21]. As a result, several initiatives and commitments have been developed, and agreements between universities have been created to promote it. These collaborations extend beyond universities and includes global organizations, such as UNESCO, whose declarations on education for sustainable development emphasize the importance of scaling up its education [22]. Additionally, the UN Decade of Education for Sustainable Development instructs parties, UN agencies, the private sector, and educational institutions to cooperate in integrating SD into education [23]. The Declaration of Talloires was signed by university leaders in 1990, highlighting the need for greater sustainability efforts on university campuses.

At the local level, universities have committed to sustainable transformation through the implementation of initiatives such as those outlined in [24–26]:

(i) developing and implementing policies and strategies that ensure the effective management of environmental issues on campus in a consistent and systematic manner;

(ii) incorporating sustainable development initiatives into their curricula and research activities to emphasize the important principles of sustainable development;

(iii) organizing cooperation between universities, non-governmental organizations involved in sustainable development strategies, as well as other public and private sectors.

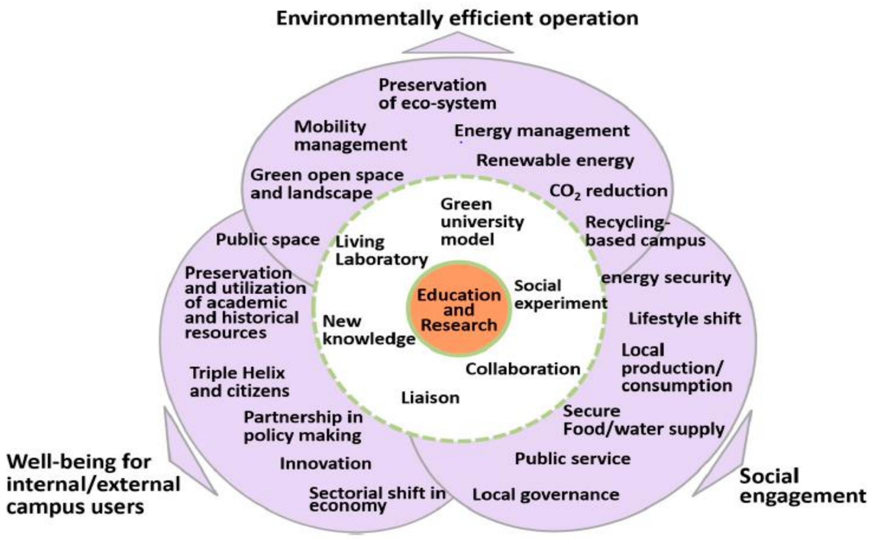

Figure 2– University sustainability concept [21]

The concept of "green" (environmentally oriented) university

Similar to the definitions of "sustainable university", "green" university does not have a universally accepted definition. Researchers have proposed definitions for the concept based on targeted needs and objectives. Therefore, numerous scientific studies have defined this concept in different ways, emphasizing various environmental aspects. For instance, Shriberg, [27] describe "green" university as an institution that acknowledges its central role in preserving the ecological, cultural, and economic fibres of the planet and its inhabitants. Cole [24] define "green" university as an organization that fulfils both its local and global responsibilities to safeguard and enhance the well-being of people and the ecosystem, while also taking measures to satisfy current and future sustainability needs. Velazquez et al. [28] describes "green" university as an educational institution that minimizes the adverse effects of resource utilization on the environment, economy, society, and human health in its teaching, research, outreach, partnership, and management activities to assist society in transitioning to a sustainable lifestyle. Abd-razak et al. [29] defines "green" university as one characterized by operations that promote the long-term survival of the environment structures. Fissi et al. [30] defined "green " university as an institution that integrates sustainability into all its operations, including teaching, research, and campus management. This approach aims to minimize environmental impacts while promoting social equity and economic viability. Safarkhani and Örnek, [31] define “green” university as one that prioritizes environmental stewardship by implementing practices that reduce waste, conserve energy, and promote biodiversity on campus. All of these definitions share a common feature that fits into three principles: economy, society, and environment [32].

Drawing down on the different definitions presented above, this study attempts to define “green” university as an institution of higher education that embodies specific aspects of environmental sustainability through an integrated approach encompassing environmental stewardship, innovative research, and a commitment to educating students about sustainable practices. It prioritizes eco-friendly campus operations, fosters a culture of student involvement in sustainability initiatives, and serves as a leader in promoting sustainable environmental development. By embedding environmental sustainability into its curriculum and infrastructure, a “green” university not only minimizes its ecological footprint but also empowers future generations to address pressing environmental challenges.

Higher education institutions have environmental impacts, including *the production of pollution* that leads to environmental degradation, *inefficient use of energy and water*, and *waste from teaching and research materials*. These issues also contribute to broader environmental challenges such as climate change[33]. The link between university impact and the environment underscores the importance of implementing university programs that prioritize “green” university goals. Specific “green” university goals critical to this study are further highlighted as follows:

Waste management: Waste management is integral to achieving the objectives of green university, as it directly impacts environmental, social, and economic dimensions of university operations. Universities are significant generators of waste due to their diverse activities, including research, teaching, and residential living. Therefore, implementing effective waste management practices is essential for promoting sustainability within higher education institutions. From an environmental perspective, proper waste management helps to reduce the ecological footprint of universities by minimizing the amount of waste sent to landfills and incinerators. By implementing waste reduction strategies, such as reduction, reuse, recycling, and composting, universities can reduce greenhouse gas emissions, and mitigate pollution. Socially, waste management initiatives within universities can raise awareness about environmental issues and foster a culture of sustainability among students, faculty, and staff. Elkina et al. [34] noted that the aggravation of environmental degradation with accumulated solid municipal waste in Russia as a socio-ecological problem, on the one hand, and the loss of valuable resources, on the other hand, determines the economic problem that requires the creation of a mechanism for managing waste production and consumption.

Environmental impact of transport systems: The rise in urbanization and population growth globally has led to an increase in resource use and waste, resulting in severe environmental problems. This has made sustainable development more relevant than ever [35–38]. This direction was most clearly developed in the dissertation work of Anufriev [39]. The work comprehensively examines the theoretical and practical aspects of the rational use of energy resources and shows its positive impact on the volume of emissions of pollutants and greenhouse gases at the level of regions and enterprises. Higher education institutions play a critical role in the growth of countries and improving living standards. As such, they have an essential part to play in achieving sustainable development goals. According to Ali and Anufriev [40], universities, which resemble large cities with vast campuses and residents, have both short-term and long-term environmental impacts. Consequently, universities should incorporate the Sustainable Development Goals (SDGs) into their strategies, policies, and activities. They should also serve as social benchmarks in their actions to deepen society's understanding of sustainable development. While transportation offers great prospects for social and economic growth, the transport networks of both developing and established countries have critical vulnerabilities that threaten global sustainability [41]. Universities are highly mobile due to their students, staff, and visitors. Therefore, developing environmentally friendly ways of transportation is crucial in achieving sustainable campuses. Creating campus living conditions that encourage sustainable mobility is essential because it can encourage students to adopt environmentally friendly habits after graduation. According to Maduekwe et al. [42] sustainable transport refers to meeting people's mobility needs in ways that cause minimal environmental damage and promote meeting future generations' mobility needs.

Several higher education institutions are implementing sustainable transportation systems through policies such as managing car parks, improving walking and cycling paths, promoting public transport and public vehicles, reducing vehicles running on fossil fuels, and reducing overall fuel consumption [43–45]. By incorporating sustainable transportation practices, universities can contribute to sustainable development goals and promote environmentally friendly habits among students. Integrating sustainability into their strategies and policies can set an example for society and contribute to a more sustainable future. The importance of sustainable development has never been more significant, and higher education institutions have a critical role to play in achieving it. Universities can serve as social benchmarks in their actions to deepen society's understanding of sustainable development. Furthermore, creating sustainable transportation systems can not only help universities achieve their sustainability goals, but it can also inspire students to adopt environmentally friendly habits in their daily lives.

In recent times, there has been an increasing focus on enhancing the environmental sustainability of university campuses through the development of sustainable mobility systems. As an important institution within cities that attract a large number of visitors, universities have a significant role to play in addressing environmental concerns[46,47]. In recent years, mobility has emerged as a significant challenge faced by universities, particularly the overreliance on private cars by students, teachers, and administrative staff at the expense of public transport. Recognizing that mobility issues extend beyond campus boundaries, universities are striving to enhance mobility systems on their campuses to promote a positive environmental image. Finlay and Massey[45], argue that promoting sustainable transportation systems and reducing car usage on university campuses can generate a wide range of benefits for the environment, society, and the economy. By reducing greenhouse gas emissions, improving air quality, and reducing traffic congestion, universities contribute to a cleaner and healthier environment for all. At the same time, sustainable mobility systems can help to enhance social cohesion by creating more equitable and accessible transportation options for all members of the university community, including those with disabilities, low-income individuals, and those who live in areas with limited access to public transport. Moreover, sustainable mobility systems can generate significant economic benefits by reducing the cost of transportation and improving the attractiveness of university campuses. This can help universities to attract and retain talented students and staff, while also contributing to the growth of local businesses that provide sustainable transport services. Ultimately, universities that prioritize sustainable mobility systems can serve as powerful drivers of sustainable development, both on their campuses and beyond.

Energy efficiency: In recent years, countries have witnessed a significant expansion of its higher education institutions, leading to the construction of new campuses and a surge in both the size of university buildings and the student population. For example, in China, between 1997 to date, the number of higher education institutions more than doubled to over 2,845. The total building area of these institutions have reached more than 788 million square meters, with an additional 102 million square meters of independently owned university property. This rapid expansion has heightened the demand for energy, making higher education major consumers, accounting for 8% of the nation's total energy consumption [48]. In line with the global surge in interest surrounding energy consumption and efficiency, numerous researchers have directed their efforts towards estimating energy efficiency. Predominantly, these studies have employed two well-established methodologies: data envelopment analysis (DEA) and stochastic frontier analysis (SFA). The DEA is a non-parametric linear method used to gauge efficiency by considering multiple influential indicators. Hu and Kao [49]and Hu and Wang [50] utilized the DEA model to estimate a total factor energy efficiency (TFEE) index. This approach has found application in other studies estimating TFEE in various countries such as Japan [51] and Taiwan [52]. Zhou [53] employed the DEA approach to define the energy efficiency of 21 OECD countries between 1997 and 2001. Goto et al.[54] employed the DEA approach to define energy efficiency in 47 regions of Japan. On the other hand, SFA is a parametric approach used to delineate the impact of indicators on energy efficiency based on specific econometric functions, first developed by Aigner et al.[55]. Buck and Young [56] introduced a cross-sectional model with SFA to estimate the energy efficiency of commercial buildings in Canada. Filippini and Hunt [57] delved into discussions about energy efficiency for OECD countries and the US residential sector across 48 states[58], employing the stochastic frontier analysis approach.

Energy efficiency is widely regarded as one of the most cost-effective methods for universities to improve energy security and reduce emissions of greenhouse gases and other pollutants [59]. In the building sector, the [59] for example, identified buildings as having the greatest potential for energy savings. Consequently, promoting energy efficiency in buildings has become a key objective of the European Union's energy and climate policy [60]. Reducing energy consumption in buildings heavily depends on users' awareness of their energy usage. Numerous studies have explored how resident behavior affects energy consumption. For instance, Fabi et al. [61,62] examined the impact of different behavior patterns on indoor climate quality and energy consumption. The first study focused on residents' window opening and closing behaviors in relation to building control systems, while the second study introduced a probabilistic approach to realistically simulate occupant behaviors.

Dahle and Neumayer [63] emphasize that raising environmental awareness within university communities is essential for overcoming barriers to “greening”. Consequently, user behavior is crucial in developing a sustainable culture. Barata et al.[64] argue that university campuses can serve as vital laboratories for testing and implementing new strategies to reduce infrastructure costs and minimize negative impacts on surrounding areas. They also highlight the often-overlooked potential of academia to influence not only students' behaviors but also their long-term environmental awareness and habits, shaping future societal patterns.

János [65] observes that energy lectures have a long-term impact on students' intentions to engage in energy-saving measures, exerting a stronger influence than campaigns in the mass-media. Thus, higher education plays a critical role in sustainable education, offering an ideal environment for multidisciplinary activities that promote sustainability education. An example of such activities is the Green Campus — Energy Efficiency Challenge in Higher Education, the largest energy efficiency competition in Portuguese university campuses. This competition aims to encourage students, faculty, and staff in the Portuguese higher education network to collaboratively assess the energy efficiency of their buildings and propose actions to reduce energy consumption. However, on an international scale, the development of the category energy and climate change EC (2), presents universities worldwide, the opportunity to adopt energy efficiency strategies and technologies to help reduce energy consumption and improve environmental sustainability.

Water use: Sustainable water consumption is crucial globally today, as water shortages have hindered economic growth in many regions [66]. Population growth has driven the demand for freshwater to unprecedented levels. By 2025, the world population is expected to reach 8 billion, thereby increasing student population with a resultant effect increasing per capita demand for water by 50% [67]. Universities can be considered small cities in terms of population, size, and daily activities, all of which have direct and indirect environmental impacts [68]. They typically consume large amounts of water, necessitating effective water management. Occasionally, new environmental policies are formulated in response to crises [69]; thus, a water crisis can be viewed by university authorities as an opportunity to develop and test new water conservation strategies. Like many other organizations, universities are implementing environmental management systems (EMS) to mitigate their environmental impacts [70].

The rationale for advancing environmental sustainability in higher education is also based on the belief that universities are influential global institutions with the leadership capacity and internal responsibility to improve society [71]. According to Alsharif et al. [72] university stakeholders can become politicians or other influential people in society after graduation, contributing to sustainable development in society. The importance of "green" university development is evident in the fact that they form the core of the initial phases of the implementation process. Education and research, the primary goals of every university, provide the fundamental basis for environmentally sustainable campus development.

Different metrics or categories are used to measure campus sustainability efforts due to the lack of consensus in adopting a unified theory of campus sustainability. According to Lauder et al. [26], various ranking systems utilize different indicators. For instance, the GREENSHIP rating system, developed by the "green" Building Council in Indonesia, prioritizes appropriate area development, energy efficiency, energy saving, water saving, material resources and cycle, indoor health and comfort, and "green" Building management. On the other hand, the Sustainable Tracking, Assessment and Rating System (STARS) adopts education and research, activities, planning, administration and interaction, and innovation as its indicators. However, the University of Indonesia has developed the UI GM ranking since 2010 to assess the sustainability of campuses among global universities. This ranking system allows universities from different countries and continents to compare their sustainability efforts using metrics that are relevant to their specific situations. It comprises six main categories, which are illustrated in Fig. 1, and align well with the SDGs, as mentioned in [40].

Thus, in this section, the author examined various concepts of sustainability including the concept of sustainable university (campus) and "green" (environmentally oriented) university. Although, these two concepts seek to achieve the same goal in the long term, researchers are of the view that "green" university forms a subset of sustainable university. In order words, while a "green" university focuses mainly on environmental sustainability, a "sustainable" university incorporates a more comprehensive approach that includes social and economic dimensions as well. Given the differences between Sustainable university and "green" university, this study chose to focus on the latter due to the following reasons:

i. *Scope:* The scope is more limited to environmental concerns. Its primary focus is on minimizing the university's environmental footprint—through energy conservation, renewable energy, waste management, water conservation, and promoting green spaces.

ii. *Quick and tangible results:* The scope is more immediate, focusing on practical actions to green campuses, reduce environmental degradation, and foster eco-friendly practices such as switching to solar energy, installing recycling systems, or improving infrastructure to reduce energy consumption. These steps yield visible results in a short period, which can increase motivation and engagement among students and staff.

iii. *Ease of implementation*: Implementing the "green university" concept may be easier in terms of administrative management and coordination, as the focus solely on ecology helps avoid the complexities associated with balancing environmental, social, and economic aspects, which is typical of the broader sustainable development concept.

iv. *Stakeholder engagement:* The scope is often limited to those directly involved in university operations, such as facilities management and environmental sustainability committees, focusing mostly on internal changes rather than broad societal engagement.

1.2 Approaches of university sustainability, including environmental sustainability assessment

Sustainability assessment tools for universities are structured frameworks designed to evaluate and enhance the sustainability performance of higher education institutions (HEIs). These tools provide a set of indicators that allow universities to collect, analyze and communicate their sustainability efforts effectively. They encompass various dimensions of sustainability—environmental, social, and economic—and facilitate benchmarking against established standards or peer institutions[73]. Notable examples include the Sustainability Tracking, Assessment & Rating System (STARS), which offers a comprehensive self-reporting framework for measuring sustainability across multiple criteria[73]. These tools not only help in assessing current practices but also guide strategic improvements and foster transparency among stakeholders, thereby promoting a culture of sustainability within academic environments[74]. Alghamdi et al. [75] have in the past identified a list of assessment tools for sustainability in universities.

However, their study failed to categorize these assessment tools into "green university assessment tools and sustainable university assessment tools. Having already established the difference between sustainable university (broad) and "green" university(narrow) concepts, this study further classifies the various tools according to the two concepts established in this study.

Tools for university sustainability assessment

These tools encompass a wide range of sustainability aspects, including environmental, social, and economic dimensions. They aim for comprehensive assessments and strategies that integrate sustainability into the overall operations and culture of the institution. Below are some notable university sustainability assessment tools:

1) *Sustainability Tracking, Assessment and Rating Systems* (STARS): Launched in 2009, STARS was created to provide a transparent and accessible way for higher education institutions (HEIs) to measure their sustainability efforts[76]. It emerged from the need for a standardized assessment tool that could facilitate benchmarking and promote continuous improvement in sustainability practices across campuses. The primary objective of STARS is to encourage institutions to adopt sustainable practices and integrate them into their operations, academic offerings, and community engagement. By providing a structured assessment, STARS aims to foster accountability, enhance institutional reputation, and drive progress toward sustainability goals. STARS evaluates sustainability across several key areas, including:

i. Academics: Curriculum, research, and student engagement in sustainability.

ii. Operations: Energy use, waste management, water conservation, and transportation.

iii. Engagement: Campus engagement activities and public outreach initiatives.

iv. Planning and Administration: Governance structures that support sustainability initiatives.

Each area is assessed through specific indicators that institutions report on, allowing for a comprehensive evaluation of their sustainability performance. For example, under "Operations," indicators may include greenhouse gas emissions or sustainable procurement practices[73]. The STARS employs a self-reporting mechanism where institutions provide data on their sustainability practices. The tool uses a point system to score performance across various categories, which encourages institutions to improve their scores over time. This design promotes transparency and allows for comparisons among institutions at different stages of sustainability implementation.

2) *Sustainable university model* (SUM): This model emphasizes continuous improvement through a structured approach that includes vision setting and strategy development across multiple sustainability phases. The model was developed by Luis Velazquez in 2006[75]. According to Alghamdi et al. [75], the SUM was developed to give a distinct outlook on how the managers of university sustainability initiatives are able to achieve initial sustainability targets in their long tern effort to transition to a sustainable university. As reported by Velazquez et al. [77] the SUM consists of four distinct phases, namely: (1) *Phase 1: developing a sustainable vision for the university*: This phase consists of the mere imagination or envisioning of the need for members of the university to behave in accordance with the philosophy of sustainable development. At this point, there are neither barriers nor constraints, only imagination and creativity; (2) *Phase two: the mission*: In this phase, the mission statement accounts for the inspiration and motivation of the vision. To develop a good mission statement, three key questions: who, what, and why are addressed to lay a good foundation for future actions and concepts of sustainability; (3) *Phase 3: sustainability committee: creating policies, targets, and objectives:* As reported by Velazquez et al. [77], this stage necessitates the establishment of a committee to oversee the tasks of creating and establishing comprehensive policies, objectives, and targets; (4) *Phase 4: sustainability strategies*: here, sustainability measures are incorporated into education, research, and outreach activities.

3) *Unit-based sustainable assessment tool* (USAT): USAT is a tool designed to established to what level universities have integrated sustainability concerns in teaching, research and community service, but also considers organisational level and management unit contributions, student initiatives and policy statements[78]. The tool focuses on the different functional units of the university (e.g., departments, research units, and management units), how they are integrating sustainability concerns into their core functions of teaching, research and community engagement and university management operations. The USAT therefore facilitates a quick identification of departments leading, and departments lagging in sustainability as well as detection of the areas in which they are leading or lagging. The main objective of USAT is to serve as a guide for educating and aiding university towards sustainability but also to be a flexible tool used at the departmental, faculty and unit level[75]. The USAT consists of four parts, namely: *Part 1: Teaching*: this part is for use in academic department, or research and teaching units. This part consists of 20 indicators that are classified under 5 clusters; *Part 2: operations and management*: The first part is designed to target teaching departments and hence emphasises the core functions of the university leaving out other management practices. The second part is dedicated to other university operations and management practices; *Part 3: Student involvement*: This part takes into account students' involvement in the operational management in the university (e.g. are student groups involved in recycling, waste management or energy saving initiatives on campus?), and how students think about and participate in sustainability issues; and *Part 4: policy and written statements*: is designed to assess sustainable development related policy at various levels, and other university written statements[78].

4) *Sustainability assessment questionnaire* (SAQ): The SAQ is designed to assist colleges and universities to assess the extent to which they are sustainable in teaching, research, operations and outreach. The SAQ serves primarily as a "qualitative teaching tool" that stimulates sustainability debate and discussion in higher education. It offers a brief overview of the current sustainability status on campus and encourages dialogue about the future actions your institution should take. The SAQ is composed of

25 questionnaires in seven broad categories of sustainability, namely, curriculum, research and scholarship, operations, faculty and staff development and rewards, operations, faculty and staff development and rewards, engagement and service, student opportunities, and administration, mission and planning[79].

5) *Graphical Assessment of sustainability in university* (GASU): This tool enables university leaders, sustainability experts, and other stakeholders to assess and track their institution's sustainability performance over time, as well as to compare their progress with that of other institutions[80]. The GASU operates using a worksheet that allows users to evaluate each indicator across the economic, environmental, social, and educational dimensions of the adapted Global Reporting Initiative (GRI) guidelines. This worksheet then produces nine charts:

i. one general chart, which presents the performance of economic, environmental, social and educational dimensions;

ii. one for the economic dimensions;

iii. one for the environmental dimensions;

iv. five for the social dimensions: one overall, one for the labour practices and decent work, one for human rights, one for society, and one for product responsibility; and;

v. one for the educational dimensions

The GASU provides the institution with a visual representation of various sustainability dimensions, making it easier to compare and evaluate the university's sustainability efforts both internally and with other universities.

Tools for university environmental sustainability assessment

These tools are crucial for universities seeking to improve their environmental efforts. They offer structured assessment methods, allowing institutions to pinpoint areas that need enhancement while promoting a culture of environmental responsibility within the academic environment. Here are some notable "green" university assessment tools:

1) *University Environmental Management System* (University EMS): The University EMS was proposed by Alshuwaikhat and Abubkar. This encompasses the

collection of practices, procedures, processes, and resources used for developing, implementing, achieving, evaluating, and sustaining a university's policy for creating a sustainable environment[68]. The University EMS includes an organizational structure, procedures, and resources necessary for effective environmental management and can be closely compared to quality management systems, from which they are originally derived. One key advantage of this assessment tool is that it can enhance environmental awareness of university managers and staff, while clearly defining each person’s responsibility for making environmental improvements. This university EMS can initiate a transformation process within universities, ensuring that resource use, investment strategies, technological development, and institutional changes are aligned with both current and future needs. The University EMS consists of 8 initiatives, namely, *environmental management and improvement; green campus; public participation and partnership; community services; social justice; conferences, seminars and workshops; sustainability in courses and curriculum; research and development*[68].

2) *Assessment Instrument for Sustainability in Higher Education* (AISHE): The AISHE is an evaluation tool designed to measure sustainability in higher education institutions. It was originally developed by the Dutch Committee on Sustainable Higher education (CDHO) and Niko Roorda in 2001[81]. Following several identified challenges in the initial AISHE, a review was conducted in 2012, resulting in its improvement which was later called AISHE 2012[81]. The review had two main goals. The first was to make it less prescriptive, allowing organizations more flexibility in how they integrate sustainability into their study programs. The second goal was to update the framework to better align with the current educational context, making it more relevant and user-friendly. The AISHE can serve as a tool to evaluate the current status of a university or its departments and to help a representative group of staff envision a future where sustainability is fully integrated. This assessment can thus be used to enhance support for sustainability efforts and to initiate or refine a sustainability policy plan. The framework is divided into five separate modules (criteria), each addressing essential aspects of a university and capable of being used independently. The assessment results can be

displayed through a reporting tool, offering a clear summary of the university's sustainability initiatives. This evaluation helps determine whether the university or specific areas within it meet the standards for certification[75].

3) *The green Plan*: The Green Plan is more than just an environmental initiative; it is a comprehensive sustainable development strategy that originated in France. It was developed through collaboration between university associations (such as the *Conférence des Grandes Écoles* and the Conference of University Presidents), the French government, and non-governmental organizations as part of the Grenelle Environment Roundtable[2]. It encompasses a series of goals and actions inspired by the European Sustainable Development Strategy, along with an assessment framework based on ISO 26000 to direct and evaluate the execution of these actions:

i. A Green Plan Outline to establish an institution's sustainable development policy. It sets specific objectives for each institution and includes elements that can be gradually implemented based on their pace, status, partnerships, and unique circumstances. This outline is tailored to incorporate the key challenges of the European Sustainable Development Strategy;

ii. A Green Plan Framework to evaluate the implementation of an institution's sustainable development policy. It serves as a tool to measure the progress and effectiveness of sustainable development initiatives within the institution. This framework includes a self-assessment, a scorecard, a strategic guide, and a foundation for certification, potentially serving as the initial step toward obtaining a label. Shared by universities, it focuses on operational capacity and considers key aspects of the institutions' activities, including *strategy and governance*, *social policy and regional engagement*, *environmental management*, *teaching and training*, *and research activities*.

4) *UI GreenMetric ranking (UI GM)*: The UI GreenMetric World University Ranking is a ranking on green campus and environmental sustainability initiated by Universitas Indonesia in 2010. Through 51 indicators in 6 categories, UI GreenMetric World University Rankings prudently determined the rankings by universities'

[2] The Platform - The Green Plan - the first step (eauc.org.uk). Assessed on 13.10.2024

environmental commitment and initiatives. It was intended to create an online survey to portray sustainability policies and programs for universities around the world. The aims of the UI GM ranking are to:

i. Contribute to academic discourses on sustainability in education and the greening of campus;
ii. Promote university-led social change about sustainability goals;
iii. Be a tool for self-assessment on campus sustainability for higher education institutions (HEIs) around the globe;
iv. Inform governments, international and local environmental agencies, and society about sustainability programs on campus.

The six categories of the UI GM ranking include, settings and infrastructure, energy and climate change, waste, water, transportation, and education and research. Each of these criteria are further classified into indicators. In the last ranking (i.e., 2023 ranking), the category settings and infrastructure consisted of 11 indicators; energy and climate change had 10 indicators; waste had 6 indicators, water had 5 indicators; transportation consisted of 8 indicators; Education and research had 11 indicators. Respective points are assigned to each of these indicators which sums up to a total of 1800 points. Ranking of universities in the UI GM ranking occurs via an online survey where interested universities provide data according to the six categories and 51 indicators. The system can be utilized to measure sustainability in higher education institutions through its ranking system, allowing for the benchmarking of campus sustainability best practices worldwide.

Although there are several tools for assessing "green" university initiatives, this study focuses on the UI GreenMetric ranking as the best tool available tool. The choice of the UI GM as the best assessment to for this study lies in the following reasons:

i. *Internationalization and recognition*: The UI GreenMetric can support a university's internationalization efforts and enhance its global recognition by showcasing its sustainability initiatives. It can lead to increased traffic to the university's website, more references to the institution's sustainability efforts online, greater opportunities for collaboration with other institutions, and acknowledgment from alumni and the public as a university that prioritizes sustainability.

ii. *Increasing awareness of sustainability issues*: It can increase awareness both within the university and in the broader community about the importance of sustainability challenges. The world is confronted with major global issues, such as population growth, climate change, depletion of natural resources, reliance on fossil fuels, and shortages of water and food. Higher education institutions (HEIs) play a crucial role in tackling these challenges. UI GreenMetric supports this role by evaluating and comparing initiatives in sustainability education, research, campus greening, and community engagement, thus encouraging greater awareness and action.

iii. *Social change and action*: The UI GreenMetric go beyond merely raising awareness; it aims to inspire tangible change. It is essential to translate understanding into action to address the emerging global challenges. By collaborating, it helps to effectively confront the global issues related to sustainability.

iv. *Ease of application and reporting*: The UI GreenMetric ranking is considered relatively straightforward compared to many other sustainability assessment tools for universities due to its user friendliness aided by a structured questionnaire; fewer barriers to participation aided by self-reporting mechanism by universities; broad and flexible categories which are applicable to a wide range of institutions both in large and small universities without needing to meet highly specific or technical requirements; accessibility to a wide range of institutions with different levels of resources and capacities; clear scoring system with clear guidance on how the institutions are scored and ranked.

Figure 3 and 4 show the progress made by participating Russian universities in the UI GM ranking over the past decade, as well as in comparison with international universities. It can be seen that the number of participating countries has increased over the years, which suggests that the sustainable development of the campus (“green” campus) is gradually being considered as a roadmap to achieve environmental and economic sustainability.

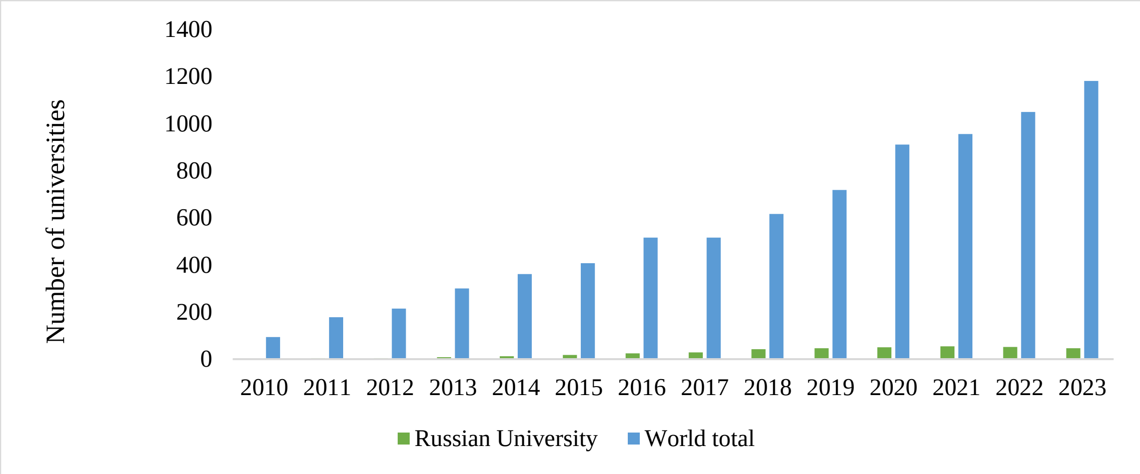

Figure 3– Participating Russian universities compared to the total number of participants

Source: Author's compilation

Figure 4 shows the number of participating universities by country. It is noted that the participation of each country has gradually increased over the years since the 2010 rankings were compiled. All countries more than doubled their participation in the ranking. Whereas in the 2015 ranking the largest number of participants was registered in the United States, in the 2021 ranking they were overtaken by Indonesia. As expected, Ghana has only "green" university (i.e., the University of Education, Winneba) since the beginning of the ranking in 2010.

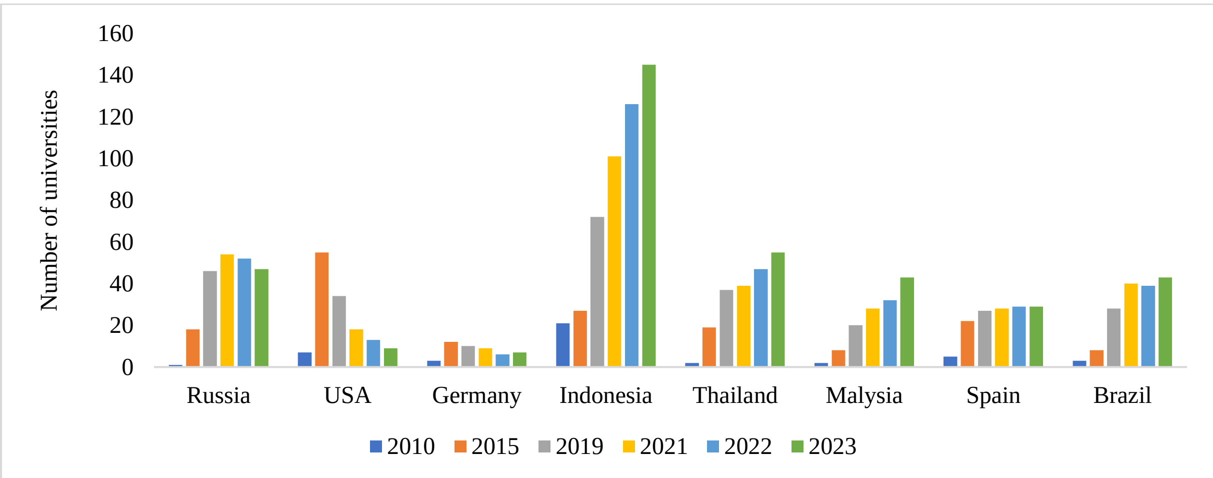

Figure 4– Participating universities by country

Source: Author's compilation

1.3 Proposed approach for continuous improvement of the university's environmental sustainability with annual verification of green university initiatives

A university changing according to the principles of the UI GM concept of environmental sustainability must focus not only in particular on the way of thinking and the interaction model of the university community, but also on the environmental sustainability of the university. And with such an approach, the role of universities grows considerably and the competitiveness of "green" universities grows as well. Until recently, a special programme «Project 5-100», launched by the Ministry of Education and Science in 2013 and aimed at increasing the competitiveness of Russian universities among the world's leading research and educational centres, was in force in Russia. It was supported by the Resolution of the Government of the Russian Federation «On measures of state support of leading universities of the Russian Federation in order to increase their competitiveness among the world's leading research and educational centres» of March 16, 2013, No. 211.

The "green" university Initiative is a programme or set of programmes aimed at promoting sustainable development built on the UI GM rating categories and environmentally conscious behaviour in the university. The six categories of the UI GM rating alongside their percentage points are presented in Table 1.

Many human activities that have a negative impact on the environment differ in their characteristics and thus affect the quality of the environment to varying degrees. In recent years, there have been several initiatives to improve the quality of the environment through the introduction of "green" (environmentally oriented) initiatives on university campuses, most of which have not brought the desired results. This may be due to a lack of resources or a lack of commitment on the part of the university administration to implement environmentally sustainable programs.

Table 1– UI GM rating categories

№	Category	Percentage of total points (%)
1	Setting and Infrastructure (SI)	15
2	Energy and Climate change (EC)	21
3	Waste (WS)	18
4	Water (WR)	10
5	Transport (TR)	18
6	Education and Research (ED)	18
	Total	100

Source: UI GreenMetric [45]

The dissertation suggested an algorithm for the continuous annual enhancement of environmentally focused university initiatives (Fig. 5), modeled after the environmental management system framework used for enterprises. While these environmental management systems can be applied by any organization, they lack specific environmental strategies for adoption. The author tailored the use of environmental management systems to suit "green" universities within the context of the UI GM ranking, which serves as an equivalent to this environmental management standard and includes the following steps:

1. Development of the university's environmentally sustainable development policy;
2. Planning and inclusion of "green" university initiatives in the UI GM, according to the six categories.
3. Implementation of "green" university initiatives.
4. Control and correction of initiatives of the "green" university.

Analysis of "green" university initiatives — annual report — verification of results within the framework of the UI GM rating.

The algorithm symbolises continuous growth and development, which obliges participating universities to ensure continuous improvement of the environmental and climate situation on campus through annual verification of the results of "green" university initiatives as part of the UI GM ranking. The international UI GreenMetric ranking is also of a spiral nature: continuous improvement across the ranking categories with annual verification of the results of the university's environmental initiatives when summarising the UI GM ranking.

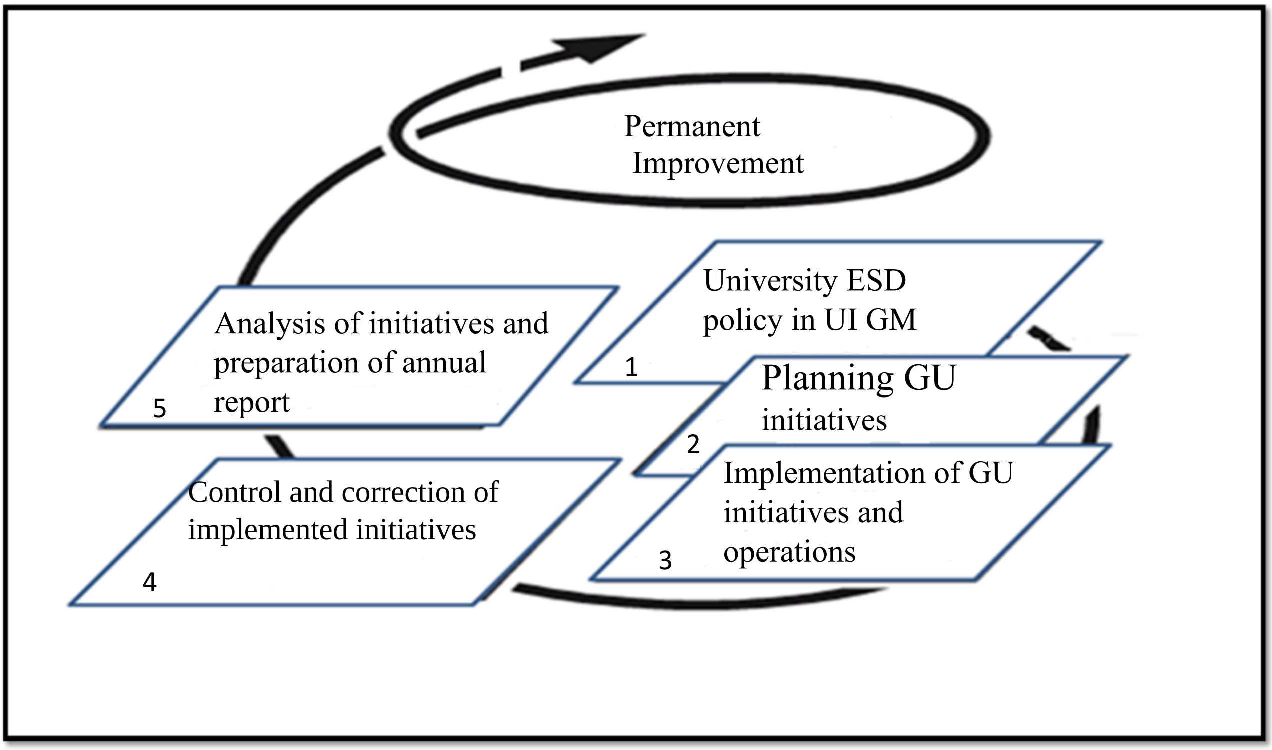

Figure 5– A mechanism for continuous improvement of the positioning of environmentally oriented universities in the UI GM ranking

Sources: Author's compilation

It is this concept, rather than the quantitative contribution of the university to the ecological situation of the territory, that determines the significance of the proposed scheme. This approach in the study allowed us to propose a model of transition from a resource-exporting economy to a "green" economy of the territory, the basic and necessary component of which is a "green" (environmentally oriented) university.

Stage 1: In the first stage, universities must develop environmental sustainability policy within the framework of the UI GM ranking. That is, these policies should be based on six (6) UI GM Ranking categories. By developing these policies, universities will need to join the UI GM rankings. The policy of environmentally sustainable development (ESD) planning at universities within the framework of the UI GM rating has been determined. To develop a policy for a environmentally oriented universities within the framework of the Green Metric rating, it is necessary to set ESD goals. This is a critical first step for any organization, including universities, to achieve long-term sustainability. The ESD goals help to set direction and focus, guide decision-making and track progress towards desired outcomes. The following are some points to broaden the discussion on setting ESD goals for universities:

i. The Importance of Setting Specific Goals: Setting specific ESD goals is important for a university to be clear about what it wants to achieve. Specific goals help focus attention, prioritize actions, and create a sense of urgency. For example, reducing your carbon footprint by 50% over the next five years is a specific and measurable goal that can be broken down into smaller targets to track progress.

ii. The Need for Measurable Goals: Measurable goals are critical to monitoring progress and evaluating success. By setting measurable goals, universities can track their performance and make data-driven decisions. For example, tracking energy use or waste reduction can provide a clear indication of how a university is progressing towards its sustainability goals.

iii. The importance of achievable goals: Setting achievable goals ensures that the university sets goals that are realistic and achievable within the given time frame. Unrealistic goals can lead to frustration and lack of progress, while achievable goals can provide a sense of accomplishment and motivate further efforts towards ESD.

iv. Relevance of the goals: The ESD goals should be consistent with the values and mission of the university. They must be tailored to the specific context and needs of the university community. For example, a coastal university may prioritize ocean health goals, while an urban university may focus on reducing greenhouse gas emissions from transportation.

In conclusion, setting sustainable development goals is an important first step for universities to achieve long-term sustainability. Objectives must be specific, measurable, achievable, relevant and time bound, and consistent with the values and mission of the university. By setting clear and meaningful sustainability goals, universities can create a roadmap for a more sustainable future.

Stage 2: In this stage, the university management must develop a comprehensive plan that will ensure the proper implementation of the policies developed in stage 1. For example, this stage includes the establishment of an environmentally oriented university management commission, the organization of financial support for the project, etc. This the phase includes putting the policy into practice and ensuring that the necessary resources and structures are in place to achieve the policy objectives. One important aspect of this phase is the establishment of an environmentally oriented university management commission or similar body that will oversee the implementation of the policy. This committee should include key stakeholders from all departments of the university, including administrators, faculty, staff, and students. Another important task at this stage is the organization of financial support for the projects. This may include raising funding from external sources such as grants or donations, or reallocating resources within the university budget. At this stage, it is also necessary to consider environmental aspects, including legal and institutional requirements. The university will need to comply with relevant environmental laws and regulations and may need to develop new policies and procedures to ensure compliance. At this stage, the goals and objectives of environmental programs should also be determined. These goals should be specific, measurable, achievable, relevant and time bound (SMART) and should be consistent with the overall policy objectives. Finally, environmental management programs should be developed to ensure that the university's environmental impact is actively managed. This may include initiatives such as waste reduction and recycling programs, energy efficiency measures and sustainable transport options.

Stage 3: At this stage, the implementation of the developed policies is required. That is, universities must put the policy into action. In other words, projects and programs must be implemented that will ensure the practical implementation of policies to ensure the environmental sustainability of the university environment. For example, once a sustainable development policy has been developed, universities must implement it effectively. This involves the implementation of projects and programs that ensure the implementation of policies and the ESD of the university environment. For the practical implementation of the policy, universities need to create structures and determine the responsibility for the implementation of “green” initiatives. This may include the creation of a dedicated department to oversee ESD activities, and the appointment of staff to direct and coordinate these activities. In addition, universities should provide training and awareness programs to ensure that staff and students have the necessary environmental competencies to implement policies. It is also necessary to establish communication, documentation and control processes to track progress and ensure the effectiveness of sustainable development efforts. Finally, universities should put in place operational controls and emergency preparedness to ensure they can quickly respond to any problems that arise during the implementation of “green” initiatives. By taking these steps, universities can create a culture of sustainability and ensure that the impact of their activities on the environment is minimal.

Stage 4: This stage is mainly used to analyse the implemented initiatives. That is, the effectiveness of implemented initiatives is evaluated and the necessary adjustments are made to ensure the best environmental outcome. This step evaluates the effectiveness of the initiatives implemented in the previous steps to determine if they have achieved the intended environmental outcomes. This involves collecting and analyzing data on the performance of initiatives, as well as feedback from stakeholders, and using this information to identify any gaps or areas for improvement. Based on the results of the assessment, corrective actions can be taken to address any issues identified and optimize the environmental performance of the initiatives. These actions may include modifying or refining initiatives, reviewing environmental policies and procedures, or providing additional training and support to staff involved in initiatives. In general, the assessment phase is an important part of the environmental management process as it helps to ensure that initiatives are effective in achieving their environmental objectives and that any issues are addressed in a timely manner to minimize negative environmental impacts.

Stage 5: A general analysis of the implemented initiatives is carried out and an annual report is prepared. This is actually an evaluation stage that allows you to understand the progress of implemented initiatives. The evaluation phase is an important step in the process of implementing initiatives. It includes evaluating the progress and effectiveness of initiatives to determine if they are achieving their intended goals and results. The annual report prepared as part of the assessment phase usually includes a detailed analysis of the implemented initiatives, including their goals, key performance indicators and results achieved. The report may also include recommendations for improvement based on the results of the evaluation. By conducting regular assessments, organizations can identify areas where they have excelled and areas where they need to improve. This information can be used to improve existing initiatives and develop new ones that are more effective in achieving the desired results. Overall, the assessment phase is critical to ensuring that organizations are using their resources effectively and are making progress towards their goals. It helps determine what works and what doesn't and provides a foundation for continuous improvement. In step 6, the cycle begins anew.

The proposed scheme of initiatives for continuous annual improvement of environmental sustainability in universities may be faced with the problem of setting appropriate goals that will allow universities achieve high ranks in UI GM ranking (stage 1 fig. 5). To deal with this this problem, it is proposed to find an approach that allows universities to prioritize the initiatives of environmentally oriented universities in terms of their contribution to the position of the university in the UI GM. Such approach is described in the next section.

The impact of environmentally oriented university initiatives on university performance in the UI GM

In this dissertation the author used a panel data set based on the six indicators from the UI GreenMetric world university rankings, covering 16 Russian universities. The study included the following universities: RUDN University, Siberian Federal University, Perm National Research Polytechnic University, Immanuel Kant Baltic Federal

University, Volgograd State University, Irkutsk National Research Technical University, Voronezh State University, Bashkir State Agrarian University, Russian State Agrarian University – Moscow Agricultural Academy named after Timiryazev, Nizhny Novgorod State University. Timiryazev State University, Nizhny Novgorod State University named after K. Minin, Altai State Agrarian University. K. Minin State University, Altai State University, A.A. Ezevsky Irkutsk State Agrarian University, Petrozavodsk State University, I.S. Turgenev Orel State University, Moscow State University of Food Production, Perm State University. These universities were chosen for the study due to their continuous participation in the UI GM rankings since 2015. It is important to note that one of the main limitations of the data set is that, despite the fact that the ranking was compiled back in 2010, the lack of consistency in the participation universities made it impossible to obtain data for the first year of the ranking for most universities.

With this in mind, the study assessed the impact of "green" university initiatives on improving the performance of Russian universities in the GM ranking. To assess the impact of categories on the Russian university's performance in UI GM (depended variable), we used scores assigned to sustainability categories based on the GM ranking methodology, and these are independent variables (Table 2). As stated in the GM ranking methodology, there are several indicators in each category against which data is collected and measured.

Energy and climate change: According to the UI GM ranking guide, energy and climate change is a metric used to reduce greenhouse gas emissions. Universities are significant contributors to greenhouse gas emissions due to their activities. For instance, a study conducted in Chile revealed that the average greenhouse gas emission on a campus was 1.0 tCO_2e, while the Norwegian University of Science and Technology produced approximately 4.5 tCO_2e per student. Similarly, the University of Minnesota in the US produced about 3.6 tCO_2e per student. As student numbers worldwide, especially in higher education, continue to increase, it is crucial to put these emission levels into perspective and implement "green" strategies that can help reduce greenhouse gases. Reducing greenhouse gas emissions on university campuses is essential to achieve the goal of «energy and climate change», leading to an improvement in the quality of the environment on campus.

Table 2– Investigated categories (independent variables) of UI GM and their definition

Categories	Definition
Energy and climate change	Improvement in campus-based environmental quality
Setting and infrastructure	Development of campus-based “green” technology
Waste	Development of sustainable waste management systems on campuses
Water	Sustainable use and management of water campus
Transport	Transport Development of environmentally friendly transport
Education and research	Development of water conservation programs and use of water efficient technologies

Source: Author’s Compilation

It is crucial to recognize that reducing greenhouse gas emissions on university campuses is paramount in promoting sustainable environmental development globally. The implementation of “green” strategies on campuses can help to mitigate the impact of greenhouse gas emissions on the environment. By reducing the emission of greenhouse gases, universities can contribute to the goal of “energy and climate change” and improve the quality of the environment on campus. Therefore, it is essential to continue to develop and implement “green” initiatives to reduce greenhouse gas emissions on university campuses worldwide. In conclusion, the quality of the environment on university campuses can be measured using the concept of “energy and climate change”, which aims to reduce greenhouse gas emissions. Universities have a significant role to play in reducing greenhouse gas emissions as they are responsible for emitting a considerable amount of greenhouse gases into the atmosphere. Therefore, it is essential to implement “green” strategies that can help reduce these emissions and promote sustainable environmental development globally.

Setting and Infrastructure: The UI GreenMetric guidelines define this category as providing fundamental information about the university's approach to promoting a "green" environment. The indicator reflects the campus's classification as a "green" campus. The goal is to encourage participating universities to create more "green" spaces to protect the environment and promote sustainable energy. The requirements for conditions and infrastructure take into account critical factors such as the area of the campus covered with forest vegetation and planted vegetation. Forests play a crucial role in mitigating climate change through groundwater conservation, carbon sequestration, environmental clean-up, soil conservation, and biodiversity[82,83]. Specifically, forests store approximately 60% of the total carbon stock contained in terrestrial carbon pools, playing a significant role in reducing the amount of carbon dioxide released into the atmosphere [84,85]. Creating more "green" spaces on university campuses is essential in promoting sustainable environmental development globally. The UI GreenMetric guidelines encourage universities to establish more "green" spaces as part of their efforts to protect the environment and promote sustainable energy. Forests are critical in mitigating climate change and conserving groundwater, and they also have numerous other benefits. By incorporating more forest vegetation and planted vegetation on campuses, universities can contribute to reducing greenhouse gas emissions and protecting the environment. In conclusion, the UI GreenMetric guidelines define this category as providing fundamental information about the university's approach to promoting a "green" environment. The requirements for conditions and infrastructure take into account critical factors such as forest vegetation and planted vegetation coverage. Forests play a vital role in mitigating climate change and conserving groundwater, making it essential to establish more "green" spaces on university campuses. Incorporating more "green" spaces can promote sustainable environmental development globally and contribute to reducing greenhouse gas emissions.

Transport: University campuses have a significant carbon footprint, with transportation policies playing a crucial role in reducing it. Limiting the number of private vehicles on campus can greatly improve the environment. Encouraging students and staff to walk or use environmentally friendly public transportation systems can help reduce emissions and improve the campus's environmental quality. Ridhosari and Rahman [86] study in Indonesia found that campus transportation systems are among the largest carbon emitters, accounting for about 7% of total carbon emissions in campuses. This highlights the need for universities to prioritize sustainable transportation systems to reduce their carbon footprint. Grubler et al. [87] research on the impact of transport on economic activity revealed that while transport systems have a significant positive impact on all sectors of the economy, they also have a significant negative impact on the environment's quality. Therefore, it is important to explore how better transport systems can benefit the economy while also helping to improve environmental quality. In conclusion, universities need to prioritize sustainable transportation policies to reduce their carbon footprint. Encouraging the use of environmentally friendly public transportation systems and walking policies can help reduce emissions and improve the campus's environmental quality. By implementing better transport systems, universities can also benefit the economy while improving environmental quality.

Waste: The proper recycling and disposal of waste is crucial for establishing a sustainable environment. As universities tend to produce a substantial amount of waste, they are now adopting eco-friendly measures, such as recycling and waste management programs, to manage it sustainably. This study argues that the implementation of sustainable waste management strategies or initiatives within the framework of "green" university strategies can significantly reduce environmental pollution and improve environmental quality. By incorporating sustainable waste management practices, universities can help create a more sustainable future. In conclusion, universities have a significant role to play in promoting sustainable waste management practices. By adopting eco-friendly initiatives such as recycling and waste management programs, universities can help reduce environmental pollution and improve environmental quality.

Water: sustainable water management forms an integral part of sustainable development[88,89]. Water usage on campus is another important indicator in the UI GreenMetric. The aims are to encourage universities to decrease groundwater usage, increase water conservation programs, and protect habitats. Water conservation programs, water recycling programs, water-efficient appliances usage, and treated water usage are among the criteria.

Education and research: The university's commitment to sustainable development is measured by the number of sustainable development programs, conferences, lectures, seminars, and scientific publications offered. Education and research play a crucial role in providing a platform for students, faculty, academics, and other stakeholders to develop innovative strategies and share ideas to enhance campus sustainability. Through sustainable development programs and events, universities can encourage and promote sustainable practices, inspire creativity and innovation, and foster a culture of environmental responsibility. By prioritizing sustainable education and research, universities can make a significant contribution to creating a more sustainable future for all. In summary, universities must offer sustainable development programs and events to promote sustainable practices and provide a platform for stakeholders to develop innovative strategies. Education and research play a critical role in fostering a culture of environmental responsibility and creating a sustainable future.

To examine the effects of “green” university initiatives on the positioning of universities in the GM rank, the author employed both random and fixed effects models. These types of regression models are commonly used in econometrics to analyse panel data [90,91]. The fixed effects model was utilized to estimate the net impact of explanatory variables on the outcome variable by removing the influence of time-invariant characteristics [92,93]. The assumption is that these unchanging characteristics are unique to each variable and should not be correlated with other characteristics [92,94]. It is important to note that since each university is unique, the error term and the constant must not be correlated with those of other universities. If this is not the case, the fixed effect model can yield inaccurate conclusions, and a random effects model may be more appropriate. This is the basis for the Hausman test.

To clarify, the fixed effect model used by the author is expressed in equation 1 as follows [92]:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} + \alpha_{it} + u_{it} \quad (1)$$

Where; Y_{it} denotes the dependent variable, which is the position of universities in the UI GM, the subscript i denotes universities or panels (16 Russian universities). The index t denotes the time variable years. β_0 denotes a constant parameter. X_{it} denotes predictor variables (energy and climate change, environment and infrastructure, waste, water, transport, education and research). β denotes the coefficients for the predictor variables, and they are the parameters to be estimated. $\alpha_{it}(i - 1 \ldots . n)$ represents the unknown intercept for each entity n (entity-specific intercepts, that is the intercept for each of the individual universities) andu_{it} denotes the error term. Because, each university has its own individual characteristics that may or may not affect the outcome variables, the fixed effects model assumes that these are characteristics of individual universities that we do not know. Therefore, the fixed effect model addresses this problem by removing this unknown effect from the equation so that the results are consistent and reliable.

Random effects models differ from fixed effects models in that they assume that inter-subject variation (in this case, between universities) is random and unrelated to predictor variables [92,95]. If there is variation between entities that impact the outcome variable, then a random effects model is more appropriate. This type of model assumes that the error term of the object being studied is not correlated with the predictor variables [92]. Additionally, findings from a random effects regression can be generalized beyond the sample used in the regression. As stated by Torres-Reine [92], the model for random effects is expressed in equation 2 below.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} + \alpha_{it} + \varepsilon_{it} \quad (2)$$

Where; ε_{it} denotes an error term between objects; and denotes an error term within an object. All other variables are defined previously.

The result of the pairwise correlation test is shown in Table 3. The maximum correlation between variables is 0.54 and the minimum is 0.19. The correlation coefficients between most of the variables are less than 0.5, indicating a low correlation between the variables. This indicates the absence of multicollinearity in the model [96].

Table 3– Pairwise correlation test results.

	Rank of university	Energy & climate	Sett. and infrastructure	Education & research	Transport	Waste management	Water management
Rank of university	1						
Energy & climate	0.440***	1					
Sett. and infrastructure	0.444***	0.451* **	1				
Education & research	0.403***	0.533* **	0.471*	1			
Transport	0.518***	0.544***	0.487***	0.528***	1		
Waste management	0.330***	0.429***	0.226* *	0.194**	0.488***	1	
Water management	0.397***	0.408***	0.458***	0.299***	0.445***	0.526***	1

Source: Author’s compilation

To determine whether to use fixed effects or random effects regressions, the Hausman test (Table 4) was conducted. The null hypothesis of the test is that random effects are the more appropriate model, while the alternative hypothesis is that fixed effects are the preferred model [92]. The Hausman test examines whether there is a correlation between the unique errors and regressors by assuming the null hypothesis as no correlation. Table 4 shows that the chi-square result of the Hausman test is not significant. Therefore, the null hypothesis cannot be rejected, and it can be concluded that the random effects model is the more appropriate choice.

The Breusch-Pagan test's null hypothesis assumes that there are no variances between entities (universities), suggesting that there are no noteworthy differences between departments/universities (no panel effect).

Table 4– The Hausman test

VARIABLE	Coefficient		
	(b*)* (Fixed)	*B* (Random)	(*nB*) Difference
Energy and climate change	-0.219725	-0.0367401	-0.020136
Settings and infrastructure	-0.1422635	-0.0090538	-0.13321
Transport	0.2110908	0.1815054	0.029585
Education and research	0.3476683	0.3223417	0.025327
Waste management	0.2817909	0.238307	0.043484
Water resources management	0.0113812	0.0983183	-0.08694
b = consistent under Ho and Ha; obtained from xtreg			
B = inconsistent under Ha, efficient under Ho; obtained from xtreg			
Test: Ho: difference in coefficients not systematic			
chi2(5) = (bB)'[(V_b-V_B)^(-1)](bB)			
Prob>chi=0.532			

Source: Author's compilation

In Table 5, the chi-square is significant at the 1% level. Therefore, the null hypothesis is rejected, indicating that a panel effect exists in the data, implying that there are significant differences between universities. Based on this conclusion, it is suggested that the random effects regression is appropriate. While both the Houseman test and the Breusch-Pagan test indicated that the random effects model is useful, the study presented both the results of the fixed and random effects models, along with the combined scoring model, for the sake of comparison and clarity.

Table 5– Random effect test with the Breusch-Pagan LM test

	Var	sd = sqrt(var)
Rank of university	39950.21	394.309
E	6155.22	167.327
U	12915.79	125.984
Test:		
Var(u) = 0		
Chibar 2(01) = 13.73		
Prob > chibar2 = 0.0001		

Source: Author's compilation

As suggested by [96,97], two models — a fixed effects model and a random effects model were utilized to estimate the parameters. Table 6 displays the outcomes of these models. The results indicate that the models are suitable for explaining the data, as the F-test and Chi-square values are significant at the 1% level. The adjusted R-square values depict the proportion of variation in the dependent variable explained by the explanatory variables in the random effects and fixed effects models, which are 42.6% and 38.7%, respectively. This implies that the random effects model explains more of the variance in the dependent variable than the fixed effects model. It is essential to consider these findings when selecting the appropriate model to use. While both models have their advantages and disadvantages, the random effects model may be more useful for generalization and prediction beyond the observed data. The fixed effects model, on the other hand, may be more suitable for assessing the effects of time-varying predictors on the dependent variable. Ultimately, the choice of model should depend on the research question and the characteristics of the data being analyzed.

The results show that the variable "education and research" has the highest coefficient. As expected, education and research, such as the number of sustainability-related programs hosted by the university, as well as the number of conferences, lectures, seminars, and scientific publications related to sustainability, significantly affect the improvement of the performance of universities in the UI GM for these two models. Thus, education and research are highly significant in the fixed effects and random effects model at the 1% significance level. A unit increase in education and research leads to an improvement in the position of universities in the UI GM ranking by 0.35% and 0.32%, respectively, in fixed effects and random effects models. Given that universities are seen as the ultimate agents of change, the organization of programs related to sustainable development provides an excellent platform for all participants in the education system to exchange ideas on environmental issues and therefore develop solutions to solve them. In addition, these programs, as mentioned earlier, educate university participants about the state of the environment and help develop their sense of environmental awareness, thereby taking steps at the individual level to achieve environmental sustainability. Geng et al. [98] argue that with the advent of rapid industrialization and the growing pace of the environmental crisis, governments and industries are demanding that graduates gain knowledge on broader issues, especially environmental and sustainable development.

Secondly, the coefficient of energy and climate change is statistically significant for both the fixed effects model and the random effects model. This suggests that 1% increases in energy and climate change would increase the performance of universities in the UI GM ranking by 0.27% under the fixed effects model and 0.25% under the random effects model. This is plausible because, the implementation of energy and climate change initiatives directly deals with a reduction in carbon emissions via activities undertaken by the universities such as increasing energy efficient activities and decreasing energy intensive operations of the university, which has the highest weight in the UI GM rating. Indeed, UrFU which is the largest university in the Ural regions has started the implementation of energy and climate change initiatives by installing the largest educational solar plant in Russia. The installed solar power plant consists of 144 panels with a capacity of 65 kilowatts. The installation is done on a total area of 300 sq. m.

Table 6 further shows that the campus-based waste management is significant at the 5% level and positive for the two models and has the third highest coefficient. Fixed effects and random effects models showed that a percentage improvement in waste management would lead to an improvement in the position of universities in the UI GM rating by 0.28% and 0.24%, respectively. This is not surprising, given that some of the critical metrics for measuring campus waste management efforts include university recycling programs, organic, inorganic, and toxic waste treatment, and programs that reduce the use of paper and plastics, glass, PET bottles, polystyrene, food waste, leaves and others on campuses. According to Tysiachniouk et al. [99] and Tangwanichagapong et al. [100], the Asian Institute of Technology (AIT) produces about 1.3 tons of waste per day, which corresponds to a per capita waste production of 0.5 kg. Thus, this finding gives a clear picture of the amount of waste that is likely to be generated by Russian universities (i.e., if we take 1.3 tons as the default waste generated by a single university).

Fourth, the significance of the transport coefficient is evident in both fixed effects and random effects models. While the directions of the signs and coefficients are consistent, the magnitudes are distinct. According to the fixed effects model, an increment of 1% in campus-based environmentally friendly transportation systems yields a 0.21%

enhancement in a university's ranking in the UI GM at a 10% significance level. Similarly, the random effects model indicates that an increase of 1% in campus-based environmentally friendly transportation systems leads to a 0.18% unit increase in a university's ranking.

These findings underscore the critical role of environmentally friendly transportation systems, such as bicycles, skateboards, and manual and electric scooters, in reducing campus emissions levels that would otherwise arise from conventional transportation systems. The use of these sustainable transportation methods for commuting on campuses can significantly contribute to improving the campus environment's quality, thereby increasing their ranking in the UI GM. Therefore, promoting the use of sustainable transportation methods should be a priority for universities and colleges, which can play a vital role in reducing their carbon footprint and creating a healthier campus environment and improve their ranking in the UI GM.

Lastly, the coefficients for Infrastructure and water management were the fifth and sixth highest respectively. This indicates a 1% increase in settings and infrastructure development initiatives on universities would increase their position in the UI GM raking in the fixed effects by 0.14% and in the random effect by 0.01%. With regards to water management, a 1% increase in water management initiatives would increase a university's position on the UI GM ranking by 0.01% in the fixed effects model and 0.02% in the random effects model. It is important to note that all of the combined factors can have a positive impact on the environmental sustainability of the region.

Table 6– Evaluation results for models with fixed and random effects.

Variables	Fixed effects		Random effects	
	Coefficient	standard error	Coefficient	standard error
Energy and climate change	0.267**	0.104	0.254***	0.093
Setting and infrastructure	0.142*	0.033	0.009*	0.025
Transport	0.211*	0.013	0.181*	0.017
Education and research	0.347***	0.092	0.322***	0.089
Control waste	0.281**	0.016	0.238**	0.093
Control water resources	0.011*	0.048	0.098*	0.015
Constant	257.6948	127.746	0.419	216.731

* Denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level

Source: Author’s compilation

It is important to note that the sum of the values of the coefficients in Table 6 does not equal 100%, since there may be other environmental factors in the econometric analysis that are unaccounted for that could potentially affect the positioning of universities in the ranking. Thus, an error is allowed. This error considers all potential factors that were not taken into account in the model.

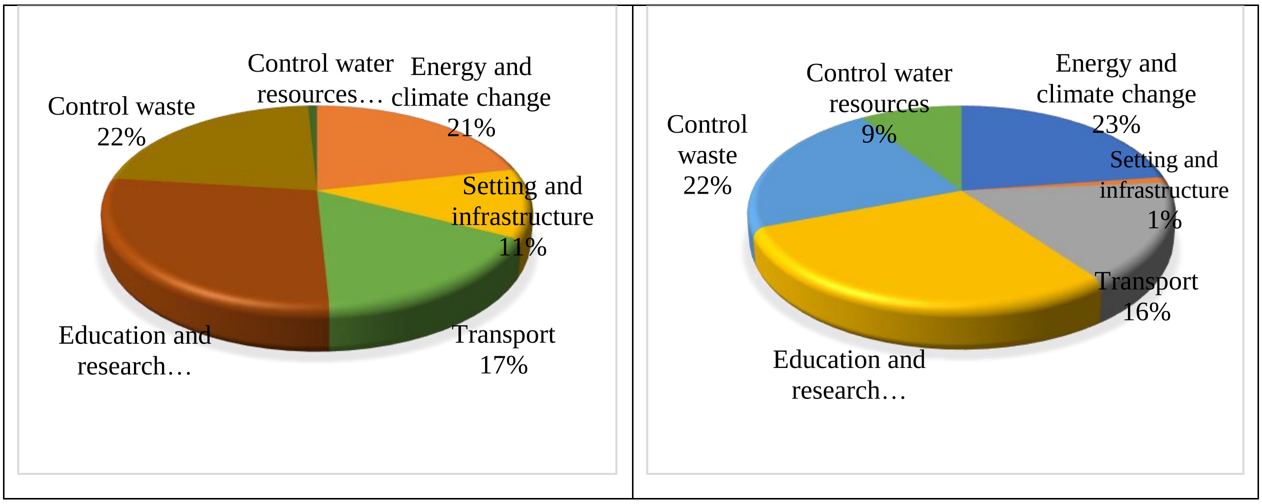

Figure 6– Contribution of “green” university initiatives to university performance in the UI GM rating.

Over the past decade, Russian universities have provided data on sustainability initiatives on their campuses, which formed the basis of the ranking. Table 7 shows the result of the UI GM ranking for the top 20 “green” universities in Russia. The first place is taken by the RUDN university with 8425 points, followed by the Siberian Federal University with 7975 points and the Perm National Research Polytechnic University in third place with 8850 points. Compared to other universities, Perm National Research Polytechnic University, despite the 3rd place, ranks first (1725 points) in the successful implementation of initiatives in the field of energy and climate change. In the “Waste” rating, RUDN University took first place with 1650 points. These results show that while a university may rank high in overall performance, it may prioritize certain aspects of campus sustainability.

Table 7– Top 16 “green” universities in the world

Rating world / Ru	University	Setup and infrastructure	Energy and change climate	Waste	Water	Transport	Education
28/1	RUDN University	1175	1525	1650	850	1650	1575
73/2	Siberian federal university	1275	1500	1200	850	1625	1525
140/3	Perm National Research Polytechnic University	1350	1725	1275	550	1375	1300
174/4	Immanuel Kant Baltic Federal University	1100	1600	1350	650	1375	1300
202/5	Volgograd state university	1100	1300	1200	650	1600	1325
225/6	Irkutsk National Research Technical University	1050	1525	900	650	1475	1450
237/7	Voronezh state university	950	1250	1350	650	1300	1500
249/8	Bashkir state agrarian university	1200	1175	1050	700	1400	1425
279/9	Russian State Agrarian University - Moscow Agricultural Academy. Timiryazev	1300	550	1125	850	1450	1550
308/10	Mininsky university	700	1100	1575	600	1725	950
336/11	Altaic state university	950	1250	1200	600	1300	1150
366/12	Irkutsk State Agrarian University named after A.A. Yezhevsky	1175	1125	675	450	1400	1425
378/13	Petrozavodsk state university	875	1125	975	450	1375	1350
395/14	Oryol State University I.S. Turgenev	850	1100	750	700	1325	1325
422/15	Moscow State University of Food Production	900	825	750	650	1325	1425
428/16	Permian state university	825	1025	1125	550	1175	1150

Source: Author’s compilation

The suggested econometric approach may help Russian universities to prioritize their initiatives and choose those, that help them to improve their performance in the UI GM. This procedure may be performed every year on the stage of setting sustainable development goals (stage 1 in Fig. 5) and on the stage of analyzing the initiatives performed (stage 5 in Fig. 5.)

In conclusion, this chapter looked at the history of sustainable development, and the concepts of "green" university and sustainable university. Also, the tools for sustainable university assessment and "green" university assessment were tackled in this chapter. Based on this, a historical overview of sustainability development was considered, as well as the definitions and distinctions between "green" and sustainable university were established. Additionally, the classification of various assessment tools under the two concepts were established, leading to the enumeration of the reasons for which the study focused on the concept of "green" (environmentally oriented) university and the UI GM as the best assessment tool.

The model for the continuous improvement of the positioning of environmentally-oriented universities in the UI GM was developed. The impact of implementing "green" university initiatives on the ranks of universities in the UI GM ranking was also established. Using an econometric model to assess the impact of "green" university initiatives on universities' performance in UI GM, the result suggest that in order to improve the ranking of universities in the UI GreenMetric rating, universities should implement initiatives related to the development of educational programs in the field of environmental sustainability, such as organizing conferences, seminars and workshops on environmental sustainability to educate and raise awareness among students and employees. In addition, universities should introduce energy-saving measures and encourage staff and students to be energy-efficient. All of the above combined can have a positive impact on the environmental sustainability of the region.

Chapter 2 Methods for validating the factors of environmentally oriented university and the linkage with “green” economy development

2.1 Strategic management process of green university development

Strategic management of green university development refers to the systematic approach that educational institutions adopt to integrate eco-friendly practices into their operations, curriculum, and community engagement. This involves aligning strategic goals with environmental stewardship. Universities are increasingly viewed as pivotal players in promoting eco-friendly practices and educating future leaders on environmental issues. They utilize frameworks such as Strategic Management Accounting (SMA) to assess and enhance their eco-friendly performances[101]. The integration of eco-friendly practices into university strategies can manifest through initiatives like green building certifications, sustainable campus operations, and the incorporation of environmental sustainability into academic programs[102,103]. Moreover, universities can foster partnerships with local communities and industries to advance sustainability goals, thereby enhancing their societal impact[104]. The shift towards green universities also reflects broader societal trends, where institutions are held accountable for their environmental footprints and are expected to serve as models of eco-friendly practices. As such, strategic management in this context not only addresses compliance with regulations but also seeks to cultivate a culture of eco-friendliness that influences both internal stakeholders and the wider community[102]. This holistic approach ensures that universities contribute meaningfully to environmental efforts while enhancing their institutional resilience and relevance in an evolving educational landscape.

Developing a strategic management process for green university development is essential for several reasons. Firstly, it enables universities to systematically integrate eco-friendly practices into their core operations, aligning institutional goals with environmental stewardship. This structured approach helps allocate resources efficiently, ensuring that initiatives such as waste management, energy conservation, and sustainable curriculum development are effectively implemented[105,106]. Secondly, a strategic framework fosters innovation by encouraging universities to adopt creative solutions and partnerships that enhance their environmental sustainability efforts, such as public-private partnerships aimed at achieving overall Sustainable Development Goals[105]. Thirdly, strategic management enhances accountability and reporting mechanisms, allowing institutions to track progress and demonstrate their commitment to eco-friendly practices to stakeholders[101,106]. Additionally, it positions universities as leaders in the global movement towards environmental sustainability, influencing societal norms and practices through education and outreach[102]. Finally, by embedding environmental practices into their strategic planning processes, universities can improve their resilience against environmental challenges and regulatory pressures while enhancing their reputation and competitiveness in the higher education landscape[101].

In line with the importance of management processes for green university development as outlined above, this study developed a comprehensive strategic management system for green university development (Figure 7).

The initial stage of the strategic management process for establishing a green university involves three critical steps within the "Emerging" phase, as illustrated in the Figure 7. The process begins with the commitment to establish a green university, where stakeholders or institutional leadership formally decide to prioritize sustainable practices and environmental stewardship.

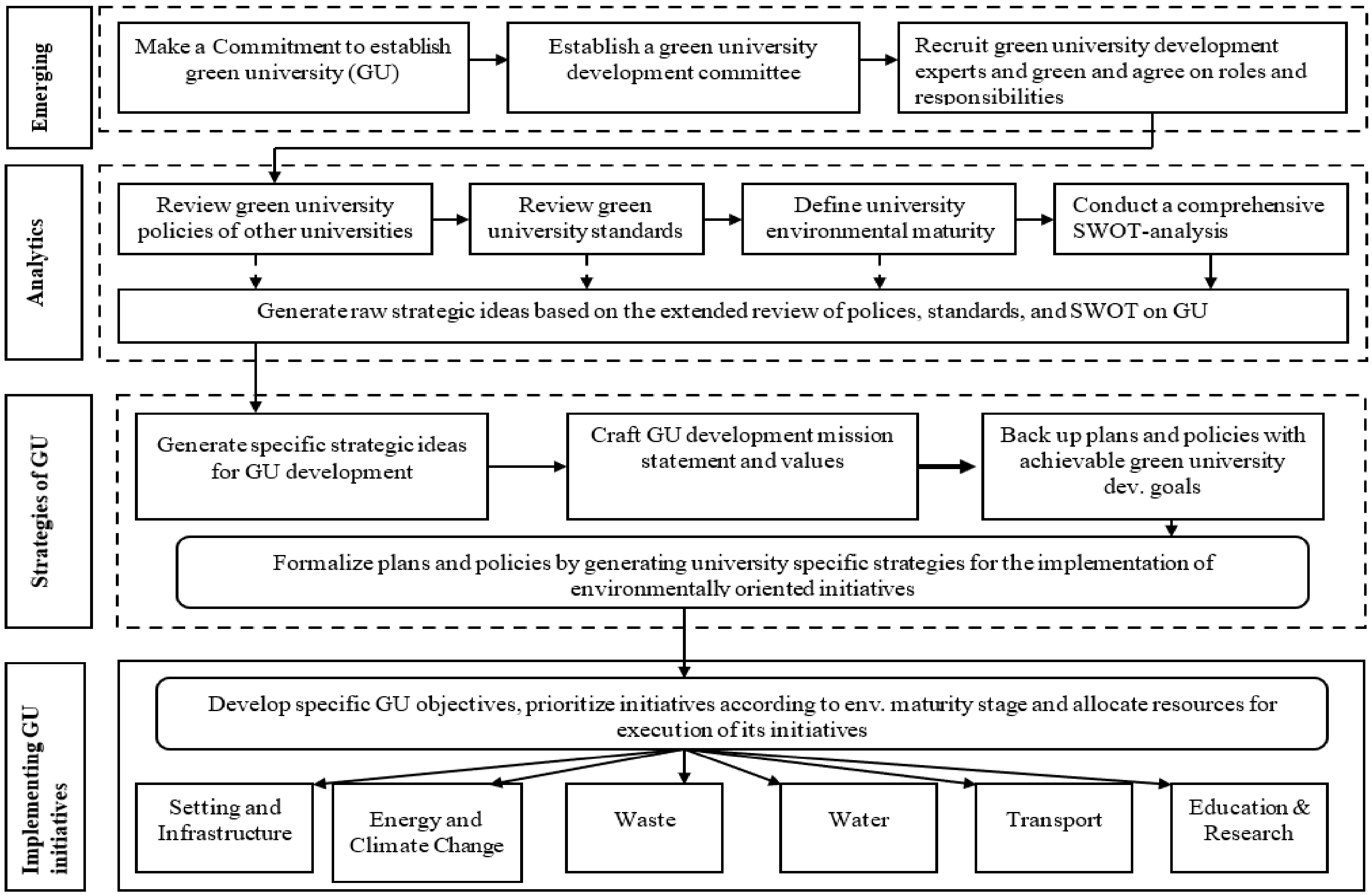

Figure 7– Strategic management process for green university development
Source: Author’s compilation

This commitment reflects a strategic shift towards creating an academic environment that embraces long-term eco-friendly practices, focusing on reducing environmental impact, promoting green infrastructure, and integrating sustainability into educational practices.

Following this decision, the next step is to establish a green university development committee. This committee acts as the core body responsible for planning, coordinating, and overseeing the transformation process. It ensures that the vision for an eco-friendly institution is translated into actionable strategies, guiding the university through the necessary steps to achieve green certification and goals. The committee's role is crucial as it serves as a platform for collaboration, where ideas and strategic objectives are discussed and refined, ensuring alignment with the broader vision of sustainability.

The third step involves recruiting green university development experts and defining roles and responsibilities. At this stage, the focus is on assembling a team of specialists in areas like sustainable building design, environmental management, and curriculum development. These experts bring in the necessary technical knowledge and industry best practices required to transition the institution into a green university. It is vital to clearly define the roles and responsibilities of each team member to ensure efficiency and accountability. This enables a streamlined approach to managing various aspects of the development process, from infrastructure planning to curriculum integration.

The figure 7 represents the second phase of the strategic management process for green university development, focusing on the analytical stage. This phase involves three critical activities: reviewing the green policies of other universities, assessing green university standards, and conducting a comprehensive SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. Together, these steps enable the university to develop a deep understanding of the external and internal factors influencing its environmental strategy.

The first activity the second phase is to review the green policies of other universities. This benchmarking process allows the university to learn from best practices and identify successful strategies that have been implemented elsewhere. By studying the initiatives and policies of peer institutions, the university can gather insights into what works well and what might be avoided, ensuring that its own strategies are informed by the successes and challenges of others.

Following this, the university conducts a review of green university standards. This involves understanding recognized environmentally oriented frameworks, certifications, and guidelines, such as UI GreenMetric Ranking. These standards provide a basis for setting benchmarks for environmental performance, ensuring that the university's strategies align with globally accepted practices.

The third activity in this analytical phase is to conduct a comprehensive SWOT analysis. This analysis helps the university assess its internal strengths and weaknesses, such as existing environmentally oriented practices or resource limitations, while also identifying external opportunities and threats, like emerging environmental regulations or climate-related risks. The SWOT analysis provides a structured way to understand how the university can leverage its strengths to capitalize on opportunities and address weaknesses to mitigate potential threats.

The insights gathered from these reviews and the SWOT analysis culminate in the generation of raw strategic ideas. These ideas form the foundation for the development of specific strategic plans aimed at making the university more environmentally friendly. By basing these ideas on a thorough review of external policies, internal standards, and strategic analysis, the university ensures that its green strategies are well-informed, context-specific, and poised for effective implementation in the subsequent phases of strategic management. This analytical stage is crucial for aligning the university's sustainability goals with realistic capabilities and external expectations, paving the way for a successful transition to a green campus.

Furthermore, the third phase of the strategic management process for green university development, focuses on the formulation of specific strategies to achieve a green campus environment. This stage involves three primary activities: generating strategic ideas, crafting a development mission, and backing up plans with achievable goals. The process begins with generating specific strategic ideas for green university development, where diverse, creative concepts are put forward to enhance environmental practices within the university. This might include initiatives like reducing carbon emissions, promoting renewable energy, and increasing biodiversity on campus.

The next step is to craft a mission statement and define the core values that align with the university's vision for sustainable development. This mission statement serves as a guiding framework, emphasizing the university’s commitment to environmental stewardship and integrating eco-friendliness into its academic and operational ethos. A well-defined mission statement helps to align the stakeholders—students, faculty, and staff—towards a shared green vision.

Following the creation of the mission, the university needs to back up these plans with clearly defined, achievable development goals. This involves setting measurable targets, such as reducing energy consumption by a specific percentage or achieving zero waste by a particular date. These goals ensure that the mission can be translated into concrete actions, allowing the university to track progress effectively in “green” university development.

The figure 7 emphasizes the importance of formalizing these plans and policies into a cohesive strategy for the practical implementation of environmentally oriented initiatives. This means converting the strategic ideas and mission into actionable plans that are tailored to the university's specific context and capabilities. It ensures that the environmental objectives are not just aspirational but are backed by practical steps that can be integrated into the university's broader strategic framework. The holistic approach outlined in the figure helps universities transition from planning to actionable strategies, fostering a culture of eco-friendliness that permeates all aspects of campus life.

The Figure 7 illustrates a critical aspect of the fourth phase of the strategic management process for green university development, emphasizing the implementation of specific green university initiatives. This phase focuses on developing targeted objectives and effectively allocating resources to support various environmental goals. The core of this stage lies in identifying key areas for sustainable improvements, including campus settings and infrastructure, energy and climate change, waste management, water conservation, transportation, and education and research.

Each area is treated as a strategic focus point where the university can apply its resources to achieve measurable progress. For instance, improving settings and infrastructure may involve the construction of green buildings, enhancing green spaces, or retrofitting existing structures for better energy efficiency. In the context of energy and climate change, the focus might shift to reducing greenhouse gas emissions, implementing renewable energy projects, and adopting climate-resilient practices.

The figure 7 also highlights the importance of waste management, where strategies could include waste reduction programs, recycling initiatives, and proper waste disposal mechanisms. Water conservation is another significant objective, aiming at reducing water consumption through efficient use of water resources, such as rainwater harvesting systems or water-efficient appliances.

Transportation initiatives focus on promoting sustainable commuting options, such as cycling, carpooling, or using electric campus shuttles to reduce the carbon footprint associated with travel. Education and research play a pivotal role by embedding environmentally oriented practices into the curriculum and fostering research on environmental issues, thereby equipping students with the knowledge to address future challenges.

Overall, this stage of the strategic management process involves a systematic allocation of resources towards these specific areas, ensuring that the university's environmental sustainability efforts are well-rounded and integrated. By defining clear objectives for each area, universities can monitor progress, adapt their strategies as needed, and ensure that their initiatives have a tangible impact on both the campus environment and the broader community. This approach helps to align the university's operational activities with its mission for environmentally sustainable development, creating a roadmap for achieving a greener campus.

Together, these steps establish a solid foundation for the green university, moving from a high-level strategic intent to a structured and practical plan of action. This approach ensures that the university's commitment to eco-friendly efforts is backed by a capable team and a well-organized framework, which is critical for successfully implementing green initiatives and fostering a culture of environmental responsibility. Through these efforts, the university can effectively position itself as a leader in environmental sustainability, setting an example for other institutions to follow.

University Environmental maturity

The modern economy's progression has led to a heightened emphasis on eco-friendliness, positioning universities as key players in reducing environmental impact. Environmental maturity in other sectors has become crucial.

Originally developed in software engineering, environmental maturity has since been applied to many areas, such as environmental management. Environmental maturity offer a systematic way to evaluate and strengthen organizational capabilities, outlining a progression from basic, ad hoc practices to fully optimized, continuously improving processes [107].

In logistics, environmental maturity reflects the degree to which logistics providers have embedded and formalized environmental management practices within their operations. This idea stems from the wider field of environmental management systems (EMS), which involves organized frameworks for handling environmental responsibilities [108]. Regardless of the use of maturity models in other fields, specific models for university environmental management does not exist. The author, therefore introduces the term "university environmental maturity" in this study.

The author defines *University Environmental Maturity as the extent to which higher education institutions incorporate environmental sustainability into their operation and* *educational practices*. This concept can be assessed using various assessment tools, such as the UI GreenMetric rating. This assessment highlights the need for a strategic framework that can serve as a roadmap for developing green universities. Despite challenges such as resource constraints, universities have significant opportunities to innovate and lead in sustainability efforts. By adopting structured approaches like the Environmental Maturity Model, universities can systematically evaluate their progress and enhance their capabilities in integrating environmentally sustainable practices into their operations. Ultimately, advancing environmental maturity not only reduces ecological impact but also positions universities as leaders in fostering a sustainable future through education and research initiatives that address pressing global challenges[109,110].

According to Zhu et al., and Ferreira et al. [111,112], environmental maturity can be structured across three levels maturity levels. Figure 8 illustrates these maturity levels within environmental supply chain management.

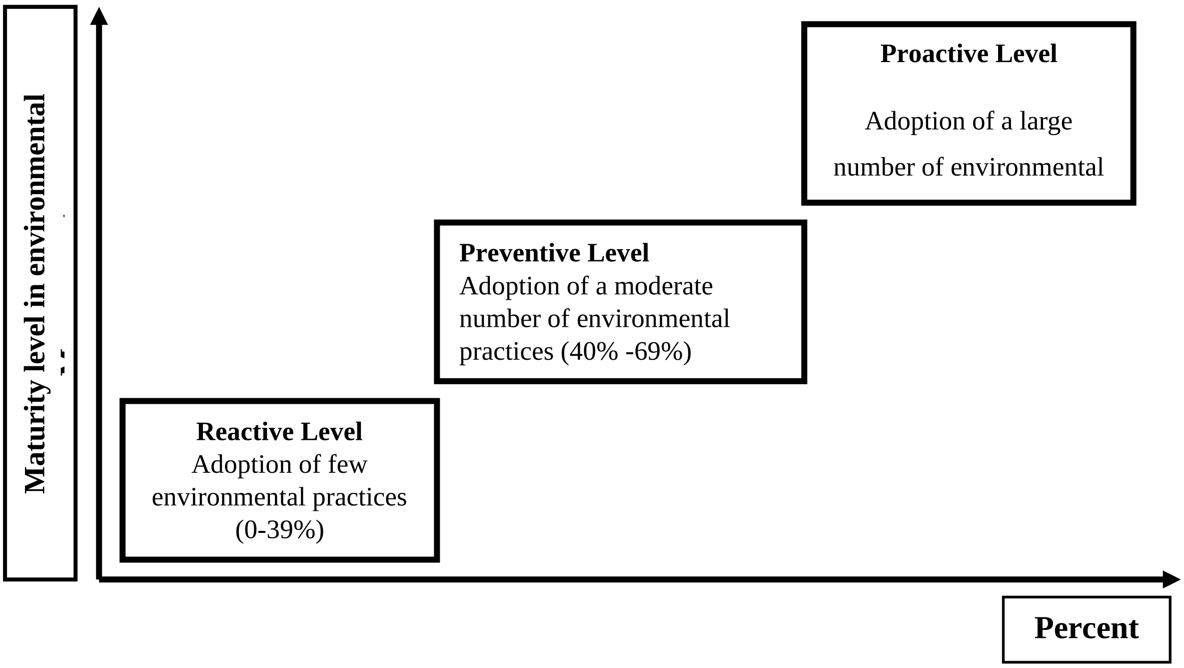

Figure 8 – Environmental maturity levels[110]

According to Ferreira et al. [111], the reactive stage of environmental maturity involves establishing environmental practices within an organization to ensure compliance with basic environmental regulations.

At the preventive stage, the organization goes beyond mere compliance, shifting its focus toward operational improvements, such as reducing waste and pollution while boosting productivity [113]. At this stage, external stakeholders can exert normative pressures that motivate further changes [114].

In the proactive phase of environmental management, companies recognize environmental management as a key competitive advantage [115]. At this advanced level of maturity, environmental considerations are woven into the organizations core strategy, with well-defined goals that are embraced at all levels—from top management to front-line staff.

In view of the environmental maturity presented in Fig 8, and the fact that universities are at different stages of green university strategy implementation, the author proposes the university environmental maturity classification as shown in Table 8.

Table 8 – University environmental maturity classification

Stages of Environmental Maturity	Percentage score of Environmental Maturity	Score in UI GM — max 10 000 points
High environmental maturity (“green university”)	76–100%	7501–10000
Нет	51–75%	5001–7500
Low env mat (“first success”)	26–50%	2501–5000
Very low env mat (“beginner”)	0–25%	0–2500

Source: Compiled by the author

Table 8 summarises the different maturity levels of green universities. A university with a percentage point between 0 and 25% is considered a university with very low environmental maturity. A university with a level of 26–50% is a university with low environmental maturity. A university with 51–75% is a university with medium environmental maturity. And, a university with a level of 76–100% is a university with high ecological maturity — a ‘green’ university.

The author proposes equation 3 for calculating the environmental maturity of the university, representing the ratio of criteria already available at the university to the total number of criteria accepted in the UI GM rating:

$$UEM_k = \frac{\sum_i^n No.of\ criteria\ implemeted_{i,k}}{\sum_i^n Total\ no.of\ criteria} \times 100 \qquad (3)$$

Where UEM is university environmental maturity, k depicts the individual categories of the UI GreenMetric ranking, n stands for various criteria, $i = (1, 2, \dots, n)$.

The level of environmental maturity calculated for UrFU, according to the above formula, is as follows:

$$UEM_k = \frac{20}{51} \times 100 = 39.2\%$$

UrFU's environmental maturity of 39% indicates that the university is still categorised as ‘low environmental maturity’. This means that UrFU is likely to receive a score between 2501 and 5000 if it joins the UI GreenMetric ranking at present. For data on UI GreenMetric indicators implemented according to the author's analysis at UrFU, see Appendix A.

2.2 Method for analyzing strengths, weaknesses, opportunities and threats

SWOT analysis, encompassing Strengths, Weaknesses, Opportunities, and Threats, stands as one of the oldest and most universally embraced strategic instruments globally. Delving into the literature offers insights into SWOT's origins and its enduring relevance in strategy formulation for over half a century. While its roots trace back to the 1950s and 1960s, it gained official recognition in the 1980s as a pivotal strategic management tool, thanks to Weihrich Heinz. Weihrich initially advocated for SWOT as an integral component of strategic planning, enabling practitioners to assess internal resources (strengths and weaknesses), scrutinize external environmental factors (opportunities and threats), and analyse these elements through a matrix format conducive to strategy formulation. Even after decades, SWOT maintains its pre-eminence among strategic management tools, retaining its singular efficacy in facilitating a crucial phase of the strategic management process. Its efficacy can be attributed to its comprehensive approach to strategy, wherein the scrutiny of internal resources and external influences resonates with strategic theory rooted in the resource-based view.

The resource-based view (RBV) focuses squarely on the internal assets of an organization. According to this perspective, an organization's primary strategic goal is to secure and manage resources that possess the attributes of value, rarity, imperfect mobility, inimitability, and non-substitutability to attain competitive superiority. By directing attention inward during the strategic planning process, the RBV aligns with the internal resource audit (i.e., strengths and weaknesses) component of SWOT analysis. This approach of the RBV complements SWOT by conceptualizing the organization as a reservoir of resources operating within a broader environment replete with threats and opportunities. Over subsequent years, this approach evolved, illustrating how the RBV is applied to SWOT delineates three strategic courses: fortifying existing strengths, addressing weaknesses, and leveraging strengths to exploit opportunities. In essence, conducting SWOT through the RBV framework conceptualizes the situational assessment, enabling an organization to deploy internal resources (i.e., strengths and weaknesses) in response to external environmental factors (opportunities and threats) to attain a competitive edge.

The known method for identifying the factors that provide the university with competitive advantages in the implementation of the concept of environmentally oriented university is not effective, since the existing method cannot distinguish between the most important factors and the least important factors. In the implementation of such factors, universities must be able to prioritize the most important factors to allow for an effective implementation process. Due to the fact that the known method does not identify the most important factors, this study developed a methodical approach to identify and rank the factors.

The general scheme of this task is shown in Fig.9. This study is based on a systematic qualitative analysis. SWOT analysis is used to identify and present each factor that has a potential impact of the development of “green” university initiatives. A multi-criteria analysis method based on the Analytical Hierarchical Process (AHP) is used to prioritize SWOT factors in order to determine the relative importance of the factors.

SWOT is an acronym for Strengths, Weakness, Opportunity, and Threat. SWOT analysis is a popular strategic planning tool that is used to identify internal strengths, weaknesses, and external opportunities and threats for countries, organizations, industries, projects, products, or individuals. From the point of view of a region or a country, SWOT analysis is used in various sectors of the energy sector, municipal solid waste management, electric power and transnational water systems, policy revision in the field of renewable energy sources, etc.

The analytical hierarchical process method is a multi-criteria complex decision tool to help the decision maker to rank preference levels and make the best decision that has been introduced [116].

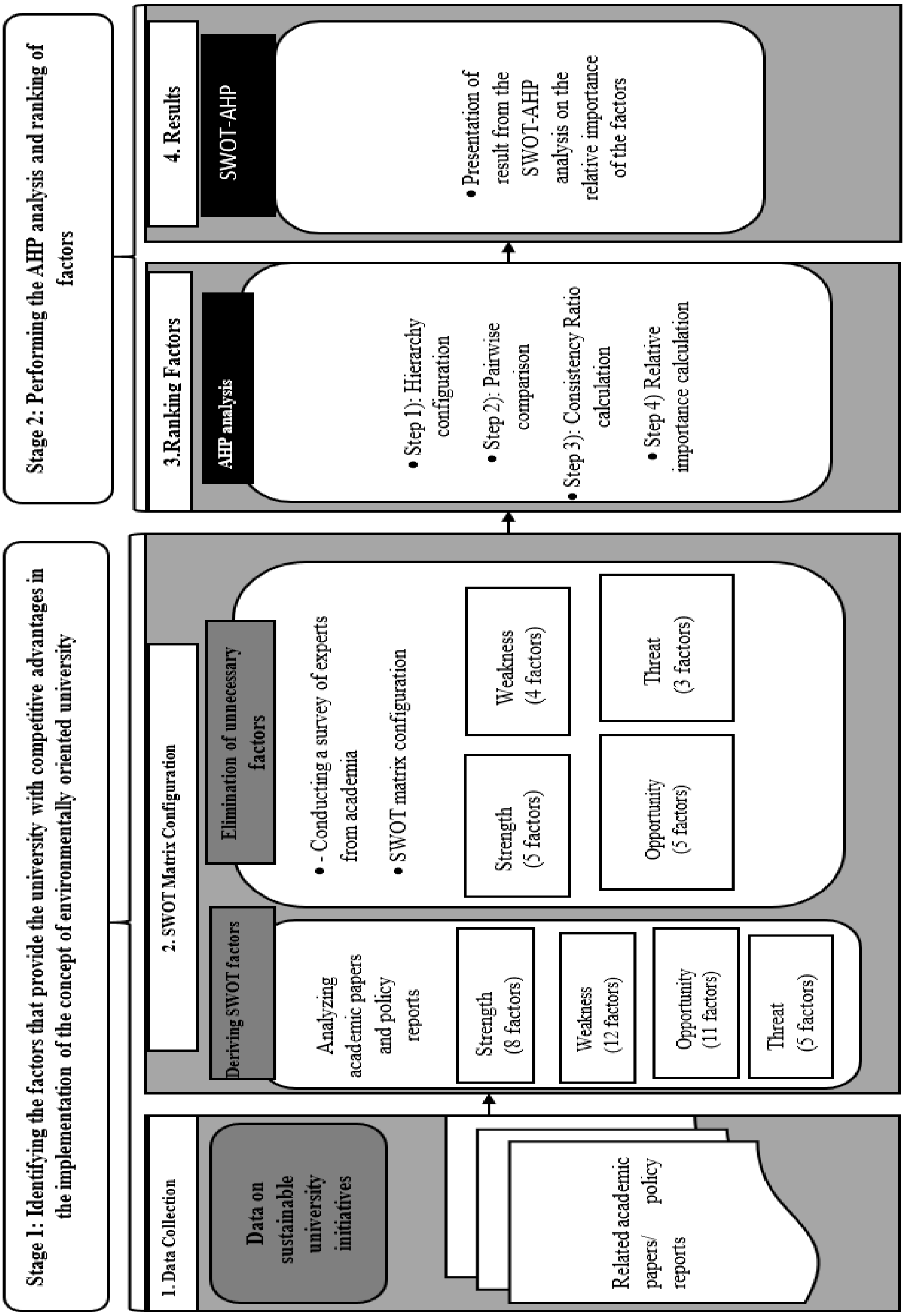

Figure 9– Stages of the methodological approach to identifying and ranking factors
Source: Author compilation

The first step in the analysis of the SWOT-analytical hierarchical process is to obtain the SWOT-factors. These factors may be obtained from secondary literature, a well-designed stakeholder workshop, interviews with experts, structured questionnaires, other sources. Identifying the factors is an important step; the selection of samples or stakeholders should be unbiased and balanced. Further, each SWOT factor requires detailed study in order to understand the mechanism by which the factor influences “green” university initiatives. The next step is to compare the identified SWOT factors within each SWOT group. Factors are compared using a Saaty scale ranging from 1–9, which reflects the degree of importance of one factor over another (Table 9).

Table 9– Scale of relative importance

Assessment	Explanation	Inference
1	Equal significance	Two criteria contribute equally to objectives
3	Moderately more significant	One criterion slightly favoured over another
5	Strongly more significant	One criterion strongly favoured over another
7	Extremely more significant	One criterion favoured very strongly over another
9	Enormously significant	The evidence favouring one criterion over another is of highest possible order of affirmation
2,4,6,8	Intermediate values	Used to represent a trade-off between the priorities listed above
$1/2, 1/3, \dots, 1/9$	Reciprocal	If one criterion has one of the above non-zero numbers assigned to it when compared to criteria, then it has the reciprocal value when compared with criteria

Source: Author’s compilation

AHP uses pairwise comparison. According to Miller (1956), there is an upper limit to the human ability to compare objects simultaneously, and this limit is seven plus or minus two objects [117,118]. After completion of the pairwise comparisons, the relative priority of the factors in each SWOT group is evaluated based on the eigenvalue method, as presented in equations (4) – (8). The results of a pairwise comparison is displayed in square and inverse matrices, often referred to as the Saaty matrix (equation (4). Where the values of the elements a_{ij} mean the extent to which the compared object x_i is preferable to the object $x_j$and$a_{ij} > 0$.when $i = j$, the values of the diagonal elements of the Saaty matrix are 1, i.e. $a_{ij} = 1$ [116,119,120].

$$A = (a_{ij})n \times m \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \frac{w_i}{w_j} & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \quad (4)$$

When the matrix A represented by Equation (4) is multiplied by W (the transpose of the weight vector), we get the resulting vector nW (Equation (5).

The eigenvalue formula can be written as

$$\mathrm{AW} = \mathrm{nW} = \lambda_{max}\mathrm{W} \quad (5)$$

Given that n is the number of rows or columns, $\mathrm{W} = (\mathrm{w}_1, \mathrm{w}_2, \ldots, \mathrm{w}_n)^T$ and λ_{max} is the largest eigenfactor or trace of matrix A. Equation (4) can be rewritten as:

$$(\mathrm{A} - \mathrm{nI})\mathrm{W} = 0 \quad (6)$$

According to [121] cited in [117], the maximum eigenvalue of λ_{max} mutually inverse matrices A is always greater than or equal to n (number of rows or columns). If the paired comparative judgments of the respondents are consistent, then it λ_{max} is equal to *n* [122]. In case of inconsistency in paired comparisons of respondents, then $\lambda_{max} \neq n$. Therefore, it is necessary to check the consistency of the comparison matrix. Following [116], estimating the consistency index CI (equation (7) and the consistency ratio CR (equation (8) for each comparison matrix is an important element of the AHP analysis. Their values demonstrate the degree of mutual consistency in the estimates provided by an individual respondent.

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (7)$$

$$CI = \frac{CR}{RI} \quad (8)$$

Where RI is a random index, the value of which depends on the dimension of the matrix (n). Table 10 shows the average RI for 500 matrices [123]. Saati suggests that the RI value should be less than or equal to 0.10. A discrepancy of 10% implies that there is a 10% chance that the decision maker will randomly answer the questions. If CR is much greater than 0.1, then this is considered inconsistent results of pairwise comparisons. Therefore, the CR needs to be improved by repeating all or some of the paired comparisons until the desired value is obtained. Following [124] the global priority of each factor is calculated using equation (9).

$$\text{Global priority factor}_{ij} = \text{Prioirty value factor}_{ij} \times \text{Scaling value of SWOT category} \quad (9)$$

Where $i$is equal to the number of factors in the SWOT category, and $j$is equal to 4 (strengths, weaknesses, opportunities and threats). This formulation is based on the assumption that all categories are independent of each other.

Table 10– Random values of the consistency index for n from 1 to 10

N	1	2	3	4	5	6	7	8	9
R.I.	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Source: Author compilation

Analysis of strengths, weaknesses, opportunities and threats

A SWOT analysis was conducted to assess the chances of Russian universities to adopt “green” university initiatives that will serve as the basis for the development of a “green” economy in the country (Table 11). The analysis covers internal drivers and obstacles, as well as pressures from external sources. The “green” university initiative has a number of strengths (Table 11). One of the driving forces of the “green” university is the possibility of international cooperation with foreign universities in the field of sustainable development. Recently, international cooperation between universities has grown exponentially, and Russian universities have made significant progress in this direction. For example, St. Petersburg University is well known for its international cooperation in environmental policy and sustainable development. Indeed, a statement on the official website of the university points to the fact that the university cooperates with 15 international universities from 10 different countries, including the USA, China, Germany, France, Italy, the Netherlands, Uruguay, Switzerland, Canada and the Czech Republic[3].

Similarly, the Ural Federal University, which is the largest university in the Urals and one of the largest in the Russian Federation, has been doing a variety of work on sustainable development and "green" economy for many years. The university organizes international conferences and forums where local and international experts, including students, exchange ideas and experiences on various topics related to sustainable development. In November 2017, the Ural Federal University and Al-Farabi Kazakh National University in the Republic of Kazakhstan signed a declaration on the creation of the international scientific and educational consortium "green" Bridge through Generations. The declaration between the parties recognizes the importance and significance of the values and principles of sustainable development and a "green" economy for future generations and the need to introduce adequate training and education systems for young people, as well as the functions of the scientific and academic community. This agreement is in line with the sustainable development goals adopted at the UN conference held in 2012 in Rio de Janeiro (Rio+20) and the Paris Agreement on Climate Change adopted in 2015. In article 3 of the declaration, the "green" university and "green" campuses take an important place in achieving this goal or objective.

According to Hawila et al. [125], a very important resource that is essential for the development of a "green" university and, for that matter, a "green" economy in the long term, is the availability of the necessary experience and the existence of modern research institutions. The training of people in this scientific field must necessarily be carried out at three levels: researchers, workers and technicians or specialists. In the higher education system of the Russian Federation, scientific technologies and research are given paramount attention. The presence of energetic academic faculties, such as the Faculty of Atomic Energy and Renewable Energy Sources of Ural Federal University, which can

[3] https://english.spbu.ru/education/graduate/master/90-program-master/3420-international-cooperation-in-environmental-policy-and-sustainable-development (Assessed on 18.10.2020).

make a significant contribution to the development of a "green" university [126], and the Faculty of Environmental Economics, as well as the creation of international laboratories, such as the international laboratory for the study of greenhouse gases in northern regions of the Russian Federation [126] represents a huge potential for the adoption of "green" university initiatives among higher educational institutions of the Russian Federation. The curricula in these educational institutions are designed in such a way as to provide the necessary human resource for the development of the sector. These institutions award degrees in renewable energy, environmental economics, nuclear energy, and more. at undergraduate, graduate and doctoral levels.

Table 11– SWOT analysis of the implementation of "green" university initiatives

Strengths (S)	**Weaknesses (W)**
S 1. International cooperation with foreign universities in the field of sustainable development S 2. Additional expertise and research institutes S 3. The development of smart / "green" buildings and technologies S4. Participate in international agreements on climate change S5. Incorporate the theme of "green" universities as a driving force of the "green" economy into the strategic directions and policies of environmental management.	W 1. Lack of a coherent internal sustainable development policy. W 2. Lack of sufficient domestic funding W 3. Lack of necessary structures for the development of "green" university mechanisms W 4. Lack of scientific literature and research related to the "green" university
Opportunities (O)	**Threats (T)**
O1. Membership in UI Worldwide Ranking Network Green Metric O 2. Availability of regional sponsors and partners O 3. Potential for increased "green" energy development. O 4. Growing awareness of the importance of "green" universities. O 5. Growing demand from universities for greening their universities.	T1. Low level of awareness of the administration of the university and other regions about the cost (expenses) of «greening». T2. Insufficient efficiency in the implementation of environmental legislation supporting "green" development. T .3 Lack of necessary collaboration between local universities to develop "green" universities.

Source: Author's compilation

Smart or "green" buildings are largely associated with the transformation of a "green" university and therefore a "green" economy. Although there is no specific definition for a “green” building, several definitions have been developed in the literature. For example, the European Building Efficiency Institute (BPIE) defines a “smart” or “green” Building as “highly” efficient and meeting its very low energy demand with on-site or district-wide renewable energy sources”[4]. The US Green Building Council also defines a “green” Building as a building “designed, constructed, and operated in a manner that promotes environmental, health, economic, and productivity developments over conventional buildings”. The development and transition to smart or “green” buildings has the potential to reduce the burden on energy systems and thereby lead to positive environmental benefits through reduced greenhouse gas emissions, social benefits through lower energy bills, and improved living conditions and economic effect through a smarter and more dynamic use of energy. According to Kaminov et al. [126], the Ural Federal University (UrFU) has begun converting university toilets to sensor-controlled faucets and switching to economical modes of water use. While this is a very small aspect of “green” Building development, it is a step in the right direction.

The commitment of the country to the discourse of the global and national agenda on environmental protection through reducing the negative effects of climate change is a necessary, but, most importantly, sufficient condition for the adoption and development of strategies at the local level, such as universities. Russia's commitment to global discourse is evident from the country's ratification of the Kyoto Protocol, which allowed the agreement to enter into force in 2005. According to Makarov et al. [127], by 2012 Russia achieved the largest absolute reduction (50%, which is 1.8 gigatonnes of CO_2-equivalent [$GtCO_2eq$]) of greenhouse gas emissions of any country in the world below the level of 1990. Although the country's stance in climate change negotiations has been widely criticized Makarov et al. [127], some attempts have been made at the national level, such as Putin's 2013 precedent decree to cut Russia's emissions by 75% by 2020. Even if this goal has not been achieved, local institutions such as universities can be

[4] https://www.innovationnewsnetwork.com/smart-building-technology/504/ (Assessed on 15.11. 2020)

motivated to make efforts, such as adopting “green” university initiatives, to help educate future leaders and create awareness among students about the need to improve the quality of the country's environment.

The general directions of Russia's national policy on the greening of the economy are strategically aligned with the principles of economic, environmental and social sustainability, which also corresponds to the principles of the “green” university and, accordingly, the “green” economy. For example, in World Bank [128] it is noted that the goals of the country's economic development are enshrined in the concept of long-term socio-economic development by 2020 adopted in 2008. According to the authors, the key elements of environmental action are set out to support the long-term socio-economic development of Russia. The climate doctrine of Russia (2009 and 2016), as noted in the World Bank [128], emphasizes the importance of taking into account the consequences of climate change in economic planning, through mitigation and adaptation in sectors most vulnerable to climate impacts. Natural resource strategies developed at the federal level promote energy efficiency and the use of renewable energy sources, more rational use of water resources, clean water, reduce waste generation and improve urban air quality [128]. These are key areas that “green” university initiatives seek to improve, and therefore the involvement of the federal government and regions in such matters only strengthens the goals of universities.

Despite the strengths of the mass introduction of “green” universities among Russian universities, this initiative may have some weaknesses (Table 12). The adoption and implementation of “green” university initiatives requires sufficient funding[129]. Initiatives such as the development of “green” Building technologies, landscaping, and the development and installation of renewable energy sources such as solar panels on campuses require relatively high initial capital in the short term, but pay off in the long term. The lack of sufficient funding for the development of such initiatives has greatly contributed to the fact that most universities or higher education institutions find it difficult to accept “green” university initiatives.

As rightly stated Leal Filho et al. [130], universities around the world are increasingly aware of the negative consequences of their activities for the environment and are taking steps to correct the situation, as evidenced by their participation in international declarations and obligations. However, these efforts do not reflect broader sustainability issues and, to a very large extent, international declarations and commitments signed by university leaders. This is because most HEIs do not have internal structures and policies in place to help them achieve their internal environmental goals. In some cases, universities demonstrate that their institutions have an «environmental policy». However, studies show that these environmental statements on the websites of universities in most cases are nothing more than "blank talk" [131]. There is always a temptation for universities to think that the very fact that they offer several courses in sustainability or environmental sustainability makes them sustainable, when in fact campus sustainability implies much more. According to [132], many ESD programs are adequate, but they usually depend on isolated individual actions rather than a community approach that links SD to other discourses in education.

In addition, the lack of literature and research on the "green" university, the paucity of materials on the "green" university and the low volume of research on this topic in Russian universities are considered as a serious obstacle to the implementation of the "green" university practice, given that less than the desirable theoretical and technical base makes the development of at least a minimally acceptable project unlikely. In addition, the lack of committees for campus sustainability or campus "green" initiatives is one of the major barriers to campus greening. The establishment of campus greening committees by universities enables them to adequately plan, prioritize, and appropriately implement the necessary activities and internal policies that can help them achieve campus greening goals.

Despite efforts to develop international cooperation, cooperation between domestic and local educational institutions is insufficient. It is very important that Russian universities cooperate with foreign universities on environmental sustainability and other topical issues related to greening campuses and, accordingly, the "green" economy.

However, it is critical for HEIs to first look for solutions in the local context by building partnerships with local HEIs before extending these efforts to overseas HEIs.

The adoption of “green” university initiatives as a basis for the development of a “green” economy has certain prospects. One very important campus greening opportunity is to become a member of the UI GreenMetric Global Ranking Network (UI GWURN). This network includes universities from around the world that have made campus greening a priority and, accordingly, are represented in the UI GreenMetric World University Rankings. UI GWURN brings together university leaders from around the world to discuss issues and share ideas on implementing “green” universities, and to offer global leadership as the leading sustainability architecture network for higher education, research and action. This opportunity helps participating universities improve their global reputation and form international allies who learn from their peers how best to improve the quality of the environment. Thus, the purpose and scope of UI GWURN is to: 1) help shape global higher education and sustainability research; 2) create global leaders in sustainability; and 3) form partnerships to find solutions to sustainability issues.

With the growing threat of global climate change and the desire to rectify the situation, several opportunities have emerged at the global level to address this problem. One very important factor that has been found to play a major role in addressing climate change and environmental degradation is financing. With the availability of global funds such as the Green Climate Fund and the Global Environment Facility, “green” campus and, not least, “green” economy initiatives can gain momentum through the application and evaluation of such funds by Russian universities.

Russia's renewable energy potential is a very strong indication that the country is moving from traditional “brown energy” to “green” energy or renewable energy. The country is the world's largest importer of crude oil, the second largest importer of natural gas, the third largest importer of coal, and the third largest nuclear power generator [133]. Greater use of renewable energy sources is seen as the best option for improving the country's energy efficiency. According to Namsaraev et al. [133] The bioenergy potential of the Russian Federation is 2225.4 PJ, with crop residues accounting for 42%, municipal solid waste (MSW) (25%), forest residues (23%) and livestock waste (95%). According to the authors, the bioenergy potential of the Russian Federation is equal to 30% of the current total consumption of heat and electricity in the country. At the same time, only 12% of the country's bioenergy potential is produced and used in the country [133].

Substantial pressures such as misconceptions about the high costs of greening and the lack of legal precedents for enforcing environmental standards pose a serious threat to “green” initiatives. Researchers such as Agyekum [134] argues that “green” initiatives such as the development and use of renewable energy sources, “green” Building technologies, campus greening, and sustainable waste and water management can have high initial costs in the short term but low operational costs value in the long run with significant benefits that outweigh the negatives. However, much attention is paid to short-term costs at the expense of long-term benefits. This jeopardizes the adoption and implementation of “green” campus initiatives, especially when combined with insufficient or no funding. Moreover, the lack of sufficient laws supporting the development of “green” universities puts universities in a reluctant position in the adoption and implementation of such initiatives. The existence of legal or constitutional support that obliges HEIs to green their campuses will make it mandatory for every HEI in the country to at least adopt some level of “green” initiatives that will help improve the quality of the environment on their campuses. In addition, having a legal or constitutional precedent for “green” university initiatives may be accompanied by the institutionalization of federal or state funding opportunities for “green” university initiatives.

Table 12–Ranked SWOT factors

Category SWOT	Factorial a priority					Mass, %
Strength	S1	S2	S3	S4	S5	
S 1 International cooperation with foreign universities in the field of sustainable development	1	5	3	7	2	45.7
S 2 Additional expertise and research institutes	1/5	1	1/3	2	3	14.1
S 3 High potential for the development of smart / “green” buildings and technologies	1/3	3	1	4	2	23.2
S 4 Participate in international agreements on climate change	1/7	1/2	1/4	1	1/2	5.7

Category SWOT	Factorial a priority					Mass, %
S 5 The need to include the topic of “green” universities as a driver of the “green” economy in the strategic directions and policies of environmental management	1/2	1/3	1/2	2	1	11.4
Weakness	W1	W2	W3	W4		
W 1 Lack of a coherent internal sustainable development policy.	1	5	3	7		58.8
W 2 Lack of sufficient domestic funding	1/5	1	1/3	2		24.7
W 3 Lack of scientific literature and research related to the “green” university	1/3	3	1	4		6.4
W 4 Lack of necessary structures for the development of “green” university mechanisms	1/7	1/2	1/4	1		10.1
Opportunities	O1	O2	O3	O4	O5	
O 1 Membership in UI Worldwide Ranking Network Green Metric	1	5	2	7	2	42.5
O 2 Availability of regional sponsors and partners	1/5	1	1/3	2	3	14
O 3 Opportunity to increase “green” energy development	1/2	3	1	4	3	27.1
O 4 Growing awareness of the importance of “green” universities	1/7	1/2	1/4	1	1/2	5.8
O 5 Growing need for universities to implement “green” initiatives.	1/2	1/3	1/3	2	1	10.6
Threats	T1	T2	T3			
T1 Lack of information of university administration, regional management, etc. about the cost (expenses) of "greening" and expected results	1	5	3			63.7
T 2 Lack of effectiveness of environmental legislation supporting “green” development and its implementation.	1/5	1	1/3			10.5
T 3 Lack of cooperation between local universities on the development of “green” universities.	1/3	3	1			25.8

Source: Author’s compilation

Based on the pairwise rating of the strengths of the respondents, a normalized pairwise matrix was obtained, which is presented in Table 12. It follows from the analysis that “International cooperation with foreign universities in the field of sustainable development”, defined as a strength, has the highest weight, with a percentage of 45.7, followed by “High potential for the development of smart / green buildings and technologies”, which amounted to 23.2%. “Additional expertise and research institutions, strategic directions and policies in the field of environmental management, as well as commitment to international agreements on climate change" amounted to 14.1%, 11.4 and 5.7%, respectively.

As for the weaknesses, the pairwise weaknesses matrix is also presented in Table 12. The results show that "Lack of a coherent internal sustainability policy" for "green" university initiatives was identified as the highest weakness, where it was 58.8%. "Lack of sufficient domestic funding" was also the second largest disadvantage (24.7%). "Lack of necessary structures for the development of "green" university mechanisms" and "Insufficient amount of literature and research on "green" university" accounted for 10.1% and 6.4%, respectively.

In addition, Table 12 shows that the most significant factor (opportunity) supporting the initiatives of "green" universities is "Membership in the UI GreenMetric global ranking network", where it gained the most weight — 42.5%. It is followed by "Potential to increase the development of "green" energy" with a weight of 27.1%. This is followed by "Presence of regional sponsors and partners", "Growing demand for "green" initiatives by universities" and "Growing awareness of the importance of "green" universities" with weights of 14%, 10.6% and 5.8% respectively.

Finally, calculations show that "Misrepresentation by the university, regional government, etc. about the cost (costs) of their "green" initiatives" ranks first in threats and accounts for 63.7%. "Lack of networking between local universities on the development of universities for greening" ranked second and accounted for 25.8%. "There are not enough laws that support "green" development" ranked third with a weight of 10.5%, to deal with this threat we need to analyze students' environmental behaviour and factors influencing it (see section 3.3.)

2.3 The role of the "green" economy in promoting environmentally sustainable development

The "green" economy as a new paradigm that differs from traditional concepts or models of sustainable development is discussed in detail by international organizations, including the United Nations (UN), civil society groups, academia and literature [126,135,136]. According to Barbier [137], the concept of a "green" economy is sometimes used interchangeably with “green”growth, thus denoting a range of ideas that are related to several economic and environmental issues, including low-carbon development in industries and institutions such as universities to the whole economy. In this concept, special attention is paid to the valuation of ecosystem services, achieving energy efficiency, decoupling the use of resources, etc. through technological change and innovation. Jänicke [138] associate “green” economy with positive changes in the “Eco-industry” sector, which deviates from conventional environmental protection technologies to resource-saving technologies.

In addition, there has been increased advocacy for a lifestyle revision beyond sustainable consumption programs and the need to move beyond the classical division into individualistic and systemic methodologies, as well as the role of technological and cultural factors and innovations[139,140]. Thus, much of the political and academic literature on greening growth and the economy combines environmental and sustainability discourse with industrial and economic policy in search of win-win solutions. Among international organizations, the United Nations Environment Program (UNEP) [141], has played a leading role in shaping and promoting the “green” economy as an “engine of growth” that creates jobs and eradicates poverty. The UNEP [141], defines “green” economy as “one that leads to improved human well-being and social fairness with a significant reduction in environmental risks and environmental deficit”. Anufriev et al. [142] define “green” economy as a system of economy management when economic growth is achieved owing to rational use of energy and natural resources, associated reduction of emissions of greenhouse gases and pollutants, as well as increase of the human capital significance (knowledge, creativity, culture). As noted by Anurfriev at al. [143] the term “green” economy has gained prominence in both domestic and foreign literature, in particular its “explosive development of 2012 in Rio de Janeiro publication the final development of the conference “The Future we want”, which is regarded as the solution to the so-called “brown economy,” which is characterized by a wasteful attitude towards natural resources. The issue of establishing a green economy is inextricably linked with sustainable development: the green economy is a reflection of sustainable development, its implementation tool. Accordingly, the history of the green economy is always considered in the context of the history of the formation of sustainable development.

Against the background of the numerous crises and new ideas for economic growth, 191 UN member countries gathered in Rio de Janeiro from 20 to 22 June 2012 at the United Nations Conference on Sustainable Development (UNCSD, hereinafter “Rio + 20”). According to Linnér and Selin [144], the “Rio + 20” made “sustainable development” an internationally recognized concept and normative goal, forty years since the United Nations Conference on the Human Environment. In preparation for Rio+20, a plethora of documents, data, scientific and advocacy assessments have been produced illustrating the state of the planet, its resources and its inhabitants. While the numbers and perspectives vary, the general argument is that the environmental crisis continues to worsen [145]. This is evidenced by the cumulative contribution of countries to the total CO_2 emissions since the 1880s. According to world data on carbon dioxide emissions, by 2019, the total amount of global CO_2 emissions was 35 billion tons. Russia is one of the top five emitters of CO_2, ranking fourth with an annual total emission of 1.69 billion tons in 2019. This suggests that the introduction of a “green” university as a component of the development of a “green” economy is crucial in the long term to create awareness and train students in environmental management systems.

Thus, the message of scientific leaders to the politicians and activists participating in Rio+20 was that the time had come for a “great” transformation and a new “approach to all three dimensions of sustainable development” [146] . In this context, the UN General Assembly called on Rio+20 to focus on two themes: the “green” economy in the context of sustainable development and poverty eradication, and the institutional framework for sustainable development. The biggest achievement of the conference was the recognition of the fact that environmental and development issues can no longer be considered separately. Sustainable development is about preserving natural ecosystems by meeting and meeting the needs of present and future generations without compromising the ability of the environment to meet its own needs. Five documents were adopted at the conference, the most significant of which are the “Declaration of Rio de Janeiro on the Environment” and “Agenda for the 21st Century”. Following “Agenda 21”, the governments of the countries of the world should develop their national sustainable development strategies — “Local Agenda 21”. Regardless of the effort the concept of “green’ economy is still relatively not well understood by people. For example, in a study conducted by Guryeva et al. [147], they noted that about 41% of their respondents had not idea about “green” economy. This notwithstanding, some institutions such as the oil and gas companies have since 2015 attempted to environmental innovation programs with the context of “green” economy[148]. Examples of such companies are Rosneft, Gazprom and ExxonMobil.

The economic content of sustainable development is the process of managing a set of assets to preserve and expand the opportunities available to people. The economic component of sustainable development includes processes that help manage people's capabilities. The interconnection and independence of finance, social responsibility and ecology are crucial for sustainable development [149–151]. In the same vein, the concept of sustainable development is usually considered from two points of view. On the one hand, the focus is on its environmental component, and on the other hand, sustainable development is called a process that means a new type of functioning of civilization. Focusing on the ideas of the process approach, sustainable development management is a set of techniques, methods and procedures of targeted impact that ensure a qualitative transformation of the system in the conditions of evolutionary functioning. Sustainable development is a new type of functioning of the production and economic system (society, organizations, industries, etc.), which allows to ensure strategic competitiveness in the long term [152,153].

As reported by the Kasztelan [154], the consequences of the increasing pressure on the environment caused by the exponential growth of the world's population has become a serious problem that needs to be addressed. The concept of a “green” economy consists of ideas from various economic and philosophical approaches related to sustainable development issues. “green” economy experts and scholars argue that while the current economic system has contributed to improving people's well-being, it is fraught with many shortcomings. Thus, Hawila et al. [125] noted that the current economic system has led to many environmental problems, including climate change, desertification, loss of biodiversity, depletion of natural capital and, most importantly, an increase in the average global temperature.

Therefore, the concept of “green” economy is seen as the only true way for the survival and sustainable development of mankind. This concept is a system of economic activities associated with the production, distribution and consumption of goods and services, which leads to an increase in human well-being over a long period and at the same time ensures that future generations will not be exposed to significant environmental risks. The concept of “green” economy appeared more than 20 years ago [137]. The implementation of the concept of a “green” economy has been described as a long-term strategy for the recovery of national economies from the crisis [137], with the goals of economic recovery, eradicating poverty, as well as reducing carbon emissions and halting ecosystem degradation.

Global organizations such as UNEP [141] consider the “green” economy as an economy that leads to improved social justice and improved living standards for people without harming the environment. Some of the “green” economy development goals are to help reduce carbon emissions and pollution, improve energy and resource efficiency, and stimulate economic growth and development [141]. In addition, the development of a “green” economy aims to support the progress of social development[155]. Thus, a “green” economy is an economy that improves human well-being, increases employment through public and social investment, reduces emissions and pollution, ensures energy and resource efficiency, and preserves biodiversity and ecosystems[156–158].

The role of UNEP in promoting the concept of a “green” economy that will lead to improved human well-being and social justice while reducing environmental risks and achieving a low-carbon, resource-efficient and socially inclusive economy [90] is highly recommended by experts. Therefore, “green”growth, consistent with the concept of a “green” economy, undoubtedly leads to sustainable development[150,154]. However, it is necessary to continue the implementation of certain tasks to develop global models and scenarios for assessing the strategies of the national “green” economy and “green”growth [154].

Like the “green” university concept, the three dimensions of sustainable development — environmental, social and economic are included in the definition of a “green” economy. There are many definitions of “green” economy or “green” growth. The “green” economy thus leads to increased human well-being and social justice, reduced environmental risks, and environmental scarcity» [159]. In addition, the “green” economy provides a better quality of life for everyone. Similarly, “green” growth means achieving economic growth and development without compromising the ability of natural assets to provide the necessary resources and environmental services on which human well-being is based [160].

The UNESDA [161] noted that the main elements that form the meaning of the “green” economy are repeated, although their definitions differ. These include the environment, ecology, social and economic aspects. The social dimension of a “green” economy or growth is about improving people's well-being and social justice: that is, providing a better quality of life for all. The environmental aspect includes the reduction of environmental risks and environmental deficits. The economic aspect of “green”growth is associated with the promotion of economic growth and development [161]. Thus, natural resources and the environment must provide services for human well-being [159–162]. “green”growth can be similar in concept to a “green” economy, as “green”policies are conducive to economic growth and development [160]. However, the concept of a “green” economy focuses on finite ecological limits[157]. The term “growth” indicates that countries attach great importance to the quantitative expansion of their economies in order to meet the ever-growing human population, development goals and poverty reduction [163]. It follows from the above that the concepts of “green” economy and “green”growth imply compatibility between achieving environmental sustainability and economic aspirations/goals [163].

Figure 10– Different points of view on the *"green" economy*

Sources: Compilation from [162]

As a result, "green" growth has recently been promoted in some regions, for example, in Asia[163,164] . Organizations such as the World Bank, the United Nations Economic Commission for Asia and the Pacific (UN – ESCAP), the Global Green Growth Institute (GGGI) and the Organization for Economic Co-operation and Development (OECD) consider and implement a "green" economy along with "green"growth or under "green"growth[164]. Fig. 10 shows different perspectives on the "green" economy, with environmental, economic and economic issues taking centre stage. Other focuses are environmental, welfare and social.

Principles and elements of transition to "green" economy

The concept of a "green" economy has principles embedded in the economic, environmental and social spheres [163]. Table 13 summarizes the principles of a "green" economy.

Table 13– "Green" economy principles [165]

Type	Principles
Economy	1. Recognizes natural capital and values. 2. Creates decent and "green" jobs. 3. Integration into models of economic development and growth. 4. promotes resources and energy efficiency. 5. Internalizes external effects.
Environment	1. Protects biodiversity and the ecosystem. 2. Invests in and supports natural capital. 3. Recognizes and respects planetary boundaries and ecological limits. 4. Promotes international environmental sustainability goals such as the Sustainable Development Goals (SDGs).
Social environment	1. Poverty reduction, wealth, livelihoods, social protection and access to basic services.

Type	Principles
	2. Ensures socially inclusive, accountable, transparent and stable distribution of environmental resources. 3. Fair, fair and just environmental resource use

Key elements of the transition to a “green” economy are the value of natural capital; appropriate economic norms and incentives; relevant environmental standards; sustainable production and consumption patterns; fair distribution of income and social standards; investment in training and environmental education [166]. The value of natural capital suggests that protecting ecosystems helps harness their economic value. This is critical for the poor in developing countries as they rely heavily on natural resources for their livelihood and are more vulnerable to pollution and environmental degradation [166].These elements also imply that a “green” economy seeks to create incentives for economic activity that ensures environmental sustainability and social inclusion [166].These elements suggest that the main purpose of the transition is to help move from the current paradigm of economic development to an economy that generates economic profits while maintaining environmental sustainability and social inclusion [167–169]. Although the “green” economy emphasizes the relationship between the environment and the economy, the social dimension has been refined by expanding the concept to inclusive “green” economy or inclusive “green” growth.

Benefits of “green” economy transformation

A recent study by GIZ [169] examined the benefits of “green” economy transformation and classified them into three categories: economic, social and environmental benefits (Table 14). “green” economy initiatives in most developing countries focus on the efficient use of natural resources, where the majority of the population finds a source of livelihood. The development of a “green” economy can help increase a country's gross domestic product (GDP) and reduce unemployment, leading to increased economic growth. This can be achieved by increasing agricultural productivity, reducing energy imports, improving the efficiency of land, water and natural resource use, and reducing the economic costs of pollution. A “green” economy implies the adoption of new approaches to work, which requires the workforce to acquire new skills. For example, the German government helps developing countries implement programs for “beneficial environmental management”[170]. Usually, the focus is on the safe and efficient use of resources to increase the profitability of companies. By focusing on environmental threats, companies raise their safety standards, thereby attracting new customers [170].

The development of a “green” economy allows rational and sustainable use of the country's natural assets. This can lead to the emergence of new markets through specialization related to natural assets. An example is the Namibian bio-trade initiative. Salter et al. [116] report that the development of a “green” economy has helped create niche markets for energy efficiency, renewable energy production or sustainable natural resource management products and services, such as low emission light bulbs, solar panel installers and agroforestry. Investment in “green” development involves the development of new technologies and the necessary knowledge that will increase efficiency and ensure sustainability, which will ultimately lead to increased productivity. Energy security is a major concern for developing countries as most of them depend on imported fossil fuels. This leads to high energy bills, vulnerability to global price fluctuations, supply constraints, high greenhouse gas emissions per unit of energy. “green” economy initiatives reduce these problems by focusing on effective measures to reduce energy imports. The “green” economy focuses on greening the energy supply through greater use of renewable energy sources, which can help improve energy security.

“Green” economy initiatives contribute directly to improving human health as it supports the reduction of pollution and improves the quality of the natural environment. An example is the policy of sustainable development of transport, which leads to a reduction in air pollution [171,172]. The “green” economy aims at the sustainable management of natural assets and resources such as landscapes, lakes, rivers, mountains and forests in order to maintain or enhance their benefits.

A “green” economy increases a country's resilience to environmental shocks, leading to better adaptation to climate change and natural disasters.

Table 14– Benefits of a "green" economy

Economic benefit	Social benefits	Environmental benefits
1. Reducing poverty and inequality. * 2. Increasing economic growth and employment. * 3. Improving training and skills. * 4. Development of new markets and specialization. 5. Increasing yields and increasing the yield of goods and agriculture. 6. Improving energy security. 7. Increasing competitiveness and trade balances.	1. Reducing poverty and inequality. * 2. Reducing social inequality. * 3. Increasing employment. * 4. Improving training and skills. 5. The best public service. 6. Improving health.	1. Sustainable management of natural assets and resources. 2. Reducing greenhouse gas and other emissions. 3. Better adaptation to climate change and resilience to natural disasters. 4. Improving the quality of the environment.

* Benefits marked with an asterisk can be divided into both economic and social benefits

Source: Author's compilation

This is the area of developing new products and markets, for example through green insurance. A "green" economy helps address the root causes of environmental problems by building systems that combat environmental degradation through measures such as recycling, reuse and recycling.

Relationship between environmentally oriented university and "green" economy

Since the financial crisis of 2008, the concept of a "green" economy has been mainly seen as a long-term solution to issues related to development strategies and economic growth around the world, but especially in developing countries. As discussed earlier, there have been several global events in the past that highlight the importance of the "green" economy concept for the development of the global environment and economy. The economic debate of experts indicates that the "green" economy is the final and sure way to achieve a sustainable future. However, these experts seem to exclude the local environment from the argument, thereby failing to take into account the impact of local societies and economies on the environment in a holistic way. For a holistic consideration of the concept of a "green" economy, it is important to start from the lower levels, such as local institutions, industry and higher education, and move towards the national economy.

The author considers the simple structure of the university system, which has a significant impact on the environment (as it was described in section 1.1), as shown in Fig. 11. The left side of the figure shows the actions that increase environmental and climate impacts, while the right side shows the algorithm for solving this problem (reduction of environmental and climate impacts) proposed by local «green» universities. It has been observed that the use of energy on university campuses, combined with the campus environment, including administration, teaching and learning, student accommodation, canteens, etc., contributes significantly to poor environmental quality through CO2 emissions. In order to solve this problem and create an environmentally oriented university that will help achieve a "green" economy in the long term, universities need to implement necessary university policies that can help reduce emissions, as well as adopt strategies to reduce CO_2 emission. Therefore, maximum participation of regional universities in the international UI GM ranking is necessary. And the more universities in the region participate in the UI GM ranking, the more accurate and verified the region's environmental policy can be built. This transformation of local universities, accumulated and constantly improved experience and skills and annually monitored results, will help the region's economy to shift to a "green" growth path in the long term. It is the new mission of universities to transfer in a practical way the environmental knowledge and know-how acquired by participating in UI GM rankings to the economies of the regions in which they operate. But here it is already necessary to adopt a university environmental protection strategy and to implement a university environmental policy to reduce the emission of CO2 and pollutants of the territory, already on a regional scale. Figure 11 also shows the relationship between the environmental policy of the environmentally oriented university and the "green" economy of the region.

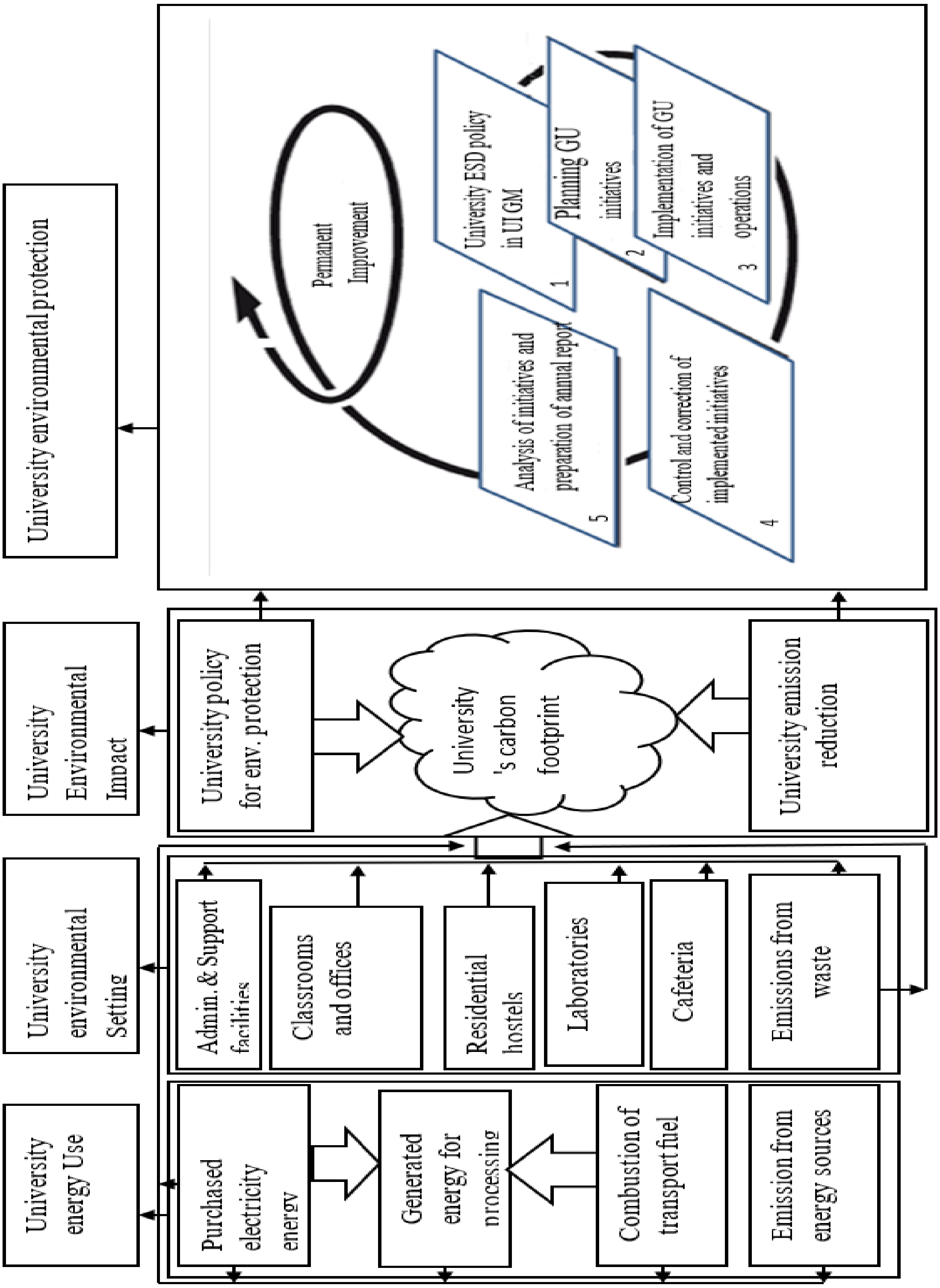

Figure 11– A simplified scheme of the university campus and its relationship with the environment
Source: Author's compilation

The development of a university environmental strategy is based on the annual improvement of environmental initiatives (as ranked by UI GM and is the final step in the preparation and adoption of a conceptual model that recognises the environmentally oriented university as a necessary component of the transition to a "green" economy in the region in the long term. The practical absence of examples in the academic literature of models involving “green” universities to address the region's environmental improvement has made it important to undertake this task.

Considering the work of Carayannis et al. [173], we discuss the relationship between the “green” university and the “green” economy in general and the 4-stage helix developed by Etzkowitz and Leydesdorff [174,175]. By definition, the Helix model is “a model that embraces and specializes in the sum of social interactions in a state with the aim of promoting and visualizing the collaboration of systems of knowledge, know-how and innovation for sustainable development”. Thus, the model is interdisciplinary and transdisciplinary, which makes it possible to achieve a complete analytical understanding of all levels of the spiral by involving the natural sciences (in connection with the natural environment), social and human sciences (in connection with the interaction of society, democracy and the economy) [173]. In fact, the original model of the spiral, which consisted of only three spirals, was called the “Triple Helix” and included universities (educational system), industry (economic system) and government (political system) [176]. This model, however, does not follow a holistic approach, as some important indicators are ignored. Thus, knowledge creation and sharing are limited, which has prevented many past sustainability initiatives. Based on the recognition of the limitations of the “triple helix” model, [177] expanded the model to include a fourth helix called “social dimension based on media and culture” (quadruple helix) in order to engage the public in the discussion not only to disseminate information, but also to help integrate the discussion into societal values, experiences, traditions and visions. While the quadruple helix represents a much better alternative and improvement in the discussion of sustainable development, there were still some limitations as it did not account for environmental interactions, hence the 5-stage helix was proposed.

The purpose of the 5-stage helix was to introduce a new subsystem (the natural environment). This is to ensure that “nature” is recognized as a vital ingredient for knowledge creation and innovation. The natural environment component is vital to knowledge creation processes. On the other hand, the creation of innovations is important because they serve as a source of preservation, survival of humans, as well as the development of "green" technologies. The 5-stage helix model is shown in Fig. 12.

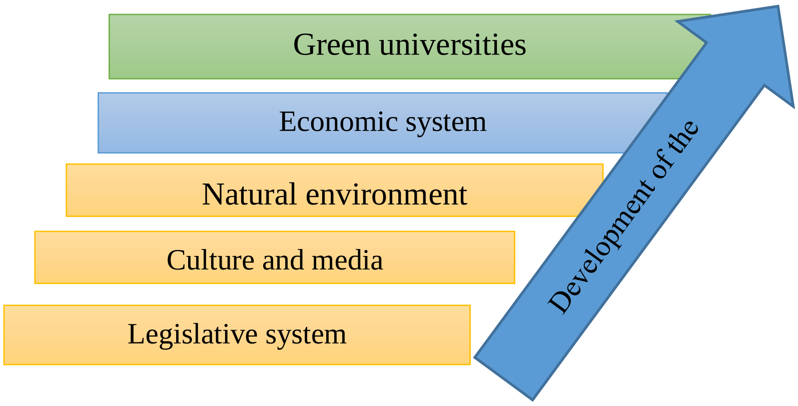

Figure 12– A five-step framework for a conceptual model of green economy transition [173]

One of the most important components of the "quintuple helix" is the fact that, in addition to relying on the interaction of man and the environment, the circulation of knowledge between social subsystems, changes in innovations and know-how in society and for the economy is of decisive importance[22]. Thus, the model establishes a complex network of interactions and knowledge sharing between the following systems: (1) education system, (2) economic system, (3) natural environment, (4) social and civil society based on media and culture, (5) ecological political system[22,178]. The ability to analyse stability in a quintuple spiral and determine the progress of economic development suggests that each of the 5 described components has at its disposal a special asset that is important for society and has scientific significance (Fig. 12).

1) Educational system: This subsystem is defined in terms of academia, universities and other systems of higher education. In this model, the most important human resources are students, teachers, scientists/researchers, academic entrepreneurs.

2) Economic system: It forms the second subsystem and consists of industries and firms. This focuses on economic capital or resources such as entrepreneurship, machinery, products, and technology of the economy.

3) Natural environment: As the third subsystem of the model, it is the most important for sustainable development. It is responsible for providing natural capitals such as natural resources.

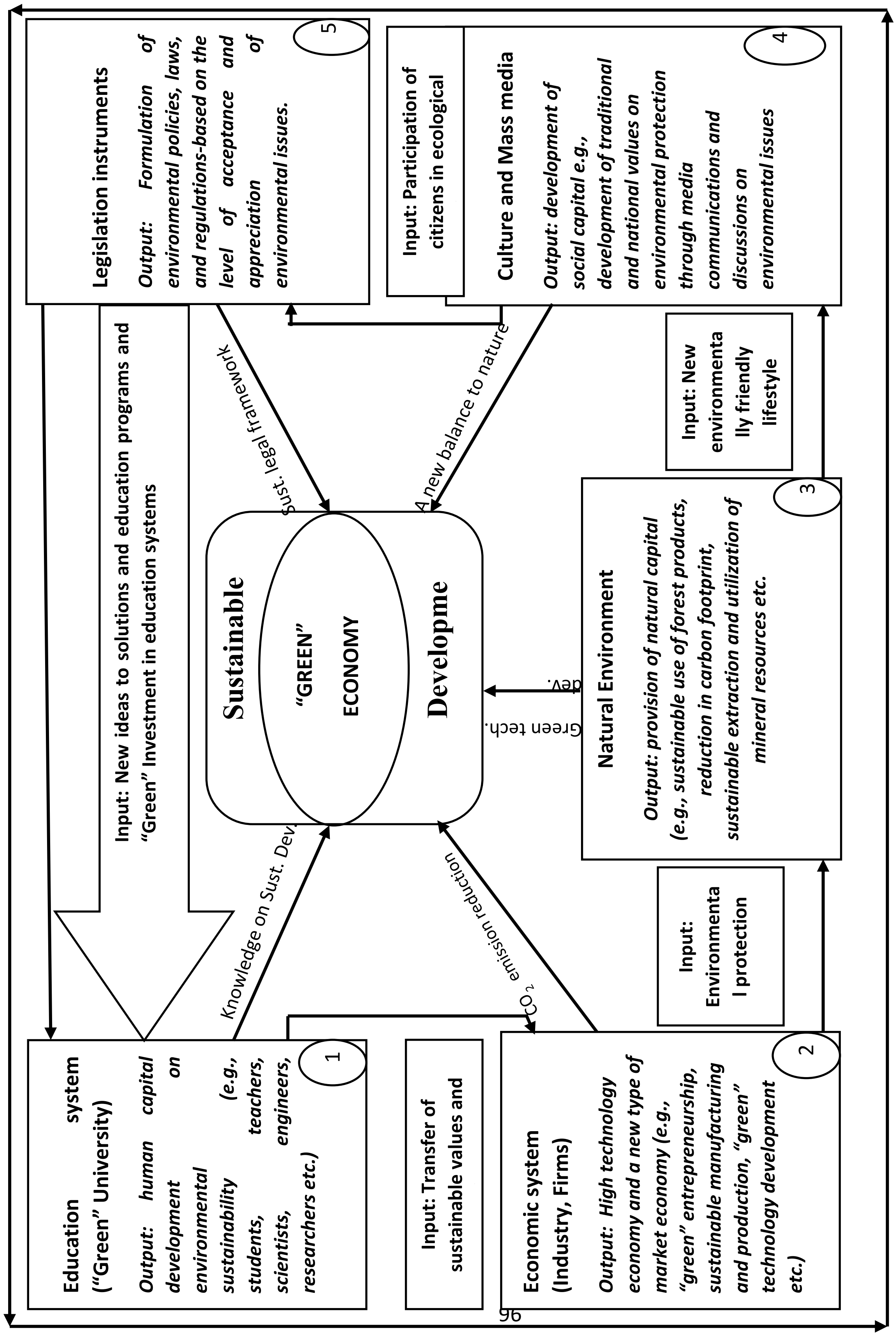

Figure 13– A conceptual model showing the link between environmentally oriented university and "green" economy
Source: Author compilation

5) Media and culture based public: This fourth component of the model combines two forms of capital or resources. First, the subsystem has a social capital component through a culture-based public such as traditions and values. Secondly, the public based on mass media such as television, the Internet, print media contains the capital of information such as news, communication, social networks.

6) Legislative system: As the fifth component of the model, the political system is important because it articulates the economic ambitions of the economy by defining, organizing and managing the general conditions of the economy. Therefore, this subsystem consists of political and legal capitals, such as politics, ideas, laws and plans.

The relationship between the environmentally oriented university system and the "green" economy are represented in a more detailed in Fig. 13. It can be seen that the education system, which is the initial environment for the development and implementation of "green" university initiatives, creates and trains specialists with the necessary know-how on "green" initiatives that can help transform their campuses and the national economy as a whole. However, the training of experts with the necessary know-how in the field of "green" initiatives is motivated by the experience of national policies implemented by the political system, such as government and politicians.

A draft roadmap for a "green" university's transformation

Based on the data obtained in the study, a draft roadmap for the implementation of a "green" university, including the following steps, was proposed:

1. Creation of a working group on the transfer of state universities and private universities to "green", as a necessary component of the transition to a "green" economy of the country.

Decision-making at the national and regional level on the participation of universities in the UI GreenMetric International University Sustainability Ranking.

2. Drawing up a list of energy-intensive enterprises and exporting enterprises to prepare for the introduction of a cross-border carbon tax by EU countries.

3. Annual participation of universities in the UI GM ranking and preparation of environmental initiatives in six rating categories.

4. Analysis and selection of energy-efficient (energy-saving) technologies and optimal ones for use in the "green" universities and its administrative territories.

5. Development of a program to reduce the energy intensity (carbon intensity) and environmental friendliness of goods and services of the economy and its territories.

6. Conducting an inventory of greenhouse gases in accordance with accepted international methods.

7. Conducting a survey among students and university staff to assess their awareness of environmental sustainability and identify areas requiring improvement.

8. Establish partnerships with local communities and NGOs to promote sustainable practices and raise awareness of environmental issues.

9. The introduction of environmental sustainability courses in various university programs to develop knowledge and skills among students and future professionals.

10. Universities should calculate the carbon footprint according to the methodology specified by the author with the addition of the most carbon-intensive indicators in the calculations (change in energy intensity and "green" area of the facility per year).

In conclusion, this chapter explored the strategic management process of green university development. This represents a transformative approach to embedding environmental sustainability into the core operations and curriculum of higher education institutions. By systematically aligning environmental stewardship with institutional goals, universities can foster a culture of environmental sustainability and promote innovation. This approach positions universities as leaders in the global movement toward environmental sustainability and ensures they remain resilient and competitive in a rapidly evolving educational landscape. The outlined strategic framework, as demonstrated in this study, provides a comprehensive pathway for institutions to initiate and sustain their green university development journey, emphasizing the importance of commitment, structured planning, and stakeholder collaboration in achieving long-term sustainability goals.

The chapter further introduced the concept of University Environmental Maturity. This concept offers a structured framework for assessing and advancing environmental sustainability within higher education institutions. Categorizing universities into maturity levels based on their integration of eco-friendly practices, provides a clear roadmap for progress. The case of UrFU, with its current classification of low environmental maturity, underscores the need for further efforts to enhance sustainability initiatives.

Furthermore, using the SWOT analytical tool, the most important SWOT factors relevant for the implementation of "green" university initiatives were identified and rank in order of importance. Based on this, 5 strengths, 4 weaknesses, 5 opportunities and 4 threats were identified.

Finally, the role of the "green" economy in promoting environmentally sustainable development was examined. This allowed the author to develop and conceptual model that shows the links between environmentally oriented university and "green" economy. The need to develop this model is justified by the fact that CO_2 emissions have shown an upward trend over the past decades, which leads to climate change and environmental degradation. Therefore, developing a "green" economy by using environmentally oriented university as the starting point is seen as the best way to protect and improve the quality of the environment in the long term.

Chapter 3 Enhancing university sustainability assessment: proposed revisions to the UI GreenMetric

3.1 Enhancing the UI GreenMetric rating

Sustainability has become a paramount concern in today's world, and universities play a pivotal role in shaping a sustainable future. The UI GreenMetric is a widely utilized tool for evaluating the sustainability of universities, but recent scrutiny reveals limitations in capturing the holistic impact of these institutions on the environment and the economy. In light of this, a suggestion for enhancing the UI GreenMetric has been proposed, which aims at providing a more comprehensive assessment of a university's sustainability practices and their broader economic implications.

One of the primary critiques of the existing UI GreenMetric is that the carbon footprint assessment within the UI GM rating does not account for the absorptive capacity of university green areas, which distorts the assessment of the university's impact on climate. Therefore, it is suggested that the UI GreenMetric rating metric be improved by:

(1) Change the EC8 metric of UI GM rating: By introducing an additional metric (indicator) — annual change in the area of the university's green area in square kilometers/meters.

Inclusion of the following additional indicator— the ratio of the annual change in the energy intensity of the university in kWh per the total number of students, faculty and staff of the university. All energy units are converted to kWh through the "energy crystal" scheme developed by the International Energy Agency and finalized by the Ural Center for Energy Saving and Ecology (Fig. 14).

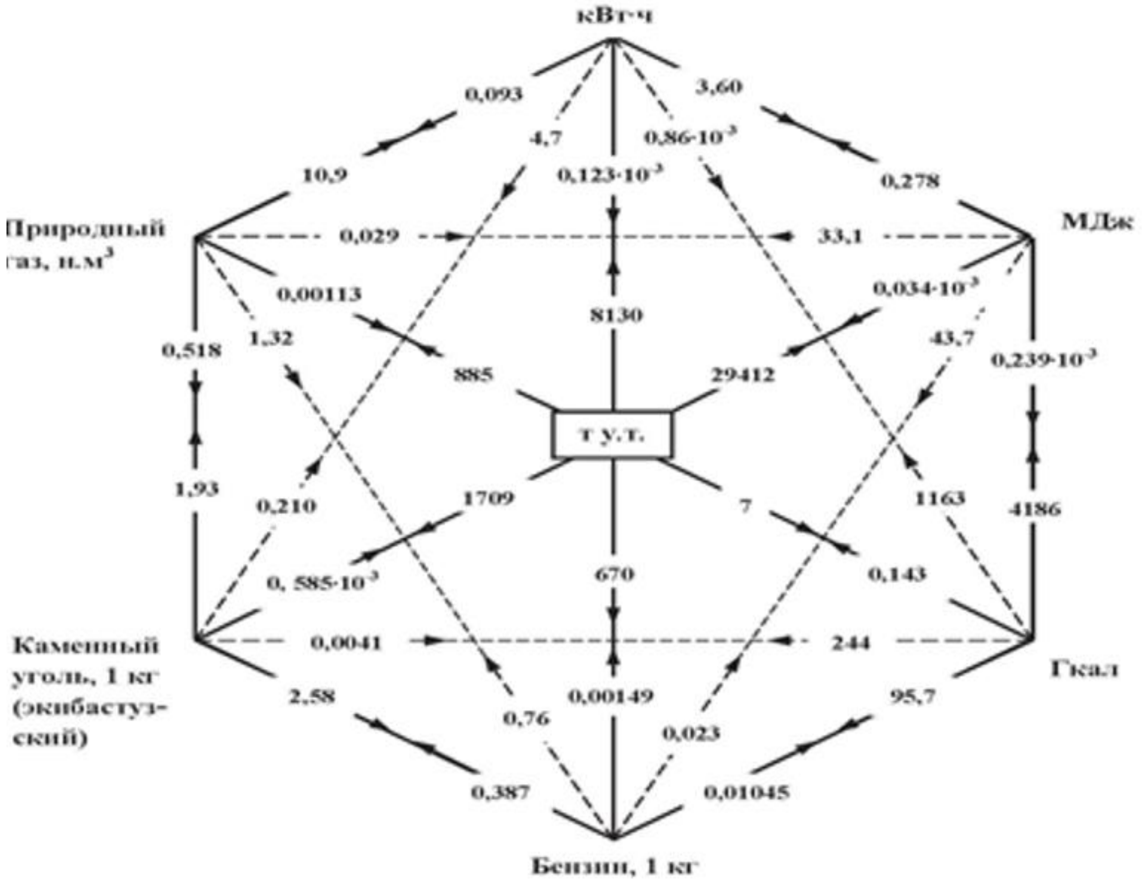

Figure 14 – Energy crystal (Relationship between different energy units)[143]

Both proposed indicators directly affect the size of the carbon footprint of the university. As is known, the vegetation cover of the green area reduces it by absorbing CO2-eq, and the growth of energy intensity increases it. Knowing the value of the proposed indicators (area of green space and energy intensity of the object) we can calculate such an informative indicator as “The ratio of the total carbon footprint to the total population of the campus, taking into account the ability to absorb carbon (tCO_2-eq/person)”.

Additionally, the proposed revisions extend beyond environmental considerations to encompass the economic contributions of universities towards sustainability. As a result, the author introduces two new indicators in the category 6: “Education and Research (ED)” of the UI GM rating. These include: (1) The revenue of small innovative enterprises related to sustainable development, created with the participation of the university (mln. rubles); (2) The share of R&D related to the sustainable development in total R&D (%).

These additional indicators reflect a commitment to foster economic growth in tandem with sustainable practices. These indicators highlight the university's role in driving innovation and supporting regional businesses dedicated to sustainable development, thus broadening the scope of the assessment to encompass both ecological and economic dimensions. Table 15 summarizes the categories and indicators of the UI GM rating to be improved.

Small Innovative Enterprises (SIE) — are enterprises that are developed and introduced into production knowledge-intensive technologies and products, created, among other things, with the participation of universities[5].

The development of small innovative enterprises (SIE) plays a key role in promoting the green economy in the territory. Green economy is focused on environmentally sustainable development, minimization of negative environmental impact and efficient use of resources. SIEs contribute to this process in the following ways:

1. Development and implementation of environmentally friendly technologies. SIEs are engaged in the development and implementation of innovative technologies that reduce emissions of harmful substances, reduce energy consumption and optimize the use of natural resources. For example, creating energy efficient systems, renewable energy sources and waste treatment technologies.

2. Accelerating the transition to a circular economy. SIEs are actively developing and deploying technologies that support the circular economy, where waste from one process becomes a resource for another. This includes recycling and reusing materials, which reduces the burden on the environment.

3. Integration of scientific achievements into industrial production. SIEs serve as a bridge between scientific research and its practical application in industry. This allows for faster and more efficient introduction of advanced environmentally friendly technologies into production.

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[5] Сухинов Александр Иванович, Угнич Екатерина Александровна Малые инновационные предприятия при университетах: барьеры и возможности развития // Университетское управление: практика и анализ. 2017. №4 (110).

4. Job creation and skills development. The development of the SIE contributes to the creation of new jobs in the field of green technologies and the improvement of workers' qualifications, including by involving university students in the work of the SIE through project-based learning. This stimulates economic growth and promotes human capital development.

5. Increasing the competitiveness and sustainability of the economy. The implementation of innovative technologies developed by SIE makes the economy more globally competitive and resilient to environmental and economic challenges.

6. Stimulating sustainable consumption and production. SIE develop products and services that are oriented towards sustainable consumption and production, which contributes to the reduction of the ecological footprint and the formation of an environmentally conscious society.

The suggested revisions to the UI GreenMetric represent a crucial step towards a more comprehensive evaluation of university sustainability. By addressing the limitations in the existing framework and introducing new indicators that consider both environmental and economic aspects, the proposed changes aim to create a more accurate representation of a university's impact on sustainability. Embracing these revisions will not only refine the assessment process but also encourage universities to adopt more holistic and impactful sustainability practices in the pursuit of a greener and economically resilient future.

Table 15– Categories and Indicators

	Categories and Indicators	POINT	Weight (%)
1	**SETTING AND INFRASTRUCTURE (SI)**		16%
SI1	The ratio of open space area to the total area	200	
SI2	Total area on campus covered in forest vegetation	100	
SI3	Total area on campus covered in planted vegetation	200	
SI3	Total area on campus for water absorption besides the forest and planted vegetation	100	
SI4	The total open space area divided by the total campus population	100	
SI5	Percentage of university budget for sustainability efforts	200	
SI6	Percentage of operation and maintenance activities of building in one year period	100	

	Categories and Indicators	POINT	Weight (%)
SI7	Campus facilities for disabled, special needs, and/or maternity care	100	
SI8	Security and safety facilities		
SI10	Health infrastructure facilities for students, academics, and administrative staff's wellbeing	100	
SI11	Conservation: plant (flora), animal (fauna), or wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities	100	
2	**ENERGY AND CLIMATE CHANGE (EC)**		21%
EC1	Energy-efficient appliances usage	200	
EC2	Smart building implementation	300	
EC3	Number of renewable energy sources on campus	300	
EC4	Total electricity usage divided by total campus' population (kWh per person)	200	
EC5	The ratio of renewable energy production divided by total energy usage per year	200	
EC6	Elements of green building implementation as reflected in all construction and renovation policies	200	
EC7	Greenhouse gas emission reduction program	200	
EC8	*The ratio of total carbon footprint to total campus population (tCO_2 eq per person)* ↓ *The ratio of total carbon footprint to total campus population, taking into account carbon absorption capacity (tCO_2 eq per person)*	*100*	
EC9	Number of the innovative program(s) in energy and climate change	100	
EC10	Impactful university program(s) on climate change	200	
3	**WASTE (WS)**		14%
WS1	3R (Reduce, Reuse, Recycling) program for university's waste	200	
WS2	Program to reduce the use of paper and plastic on campus	200	
WS3	Organic waste treatment	200	
WS4	Inorganic waste treatment	300	
WS5	Toxic waste treatment	300	
WS6	Sewage disposal	200	
4	**WATER (WR)**		11%
WR1	Water conservation program & implementation	200	
WR2	Water recycling program implementation	200	
WR3	Water-efficient appliances usage	200	
WR4	Consumption of treated water	200	
WR5	Water pollution control in the campus area	100	
5	**TRANSPORTATION (TR)**		19%
TR1	The total number of vehicles (cars and motorcycles) divided by the total campus' population	200	
TR2	Shuttle services	200	
TR3	Zero-Emission Vehicles (ZEV) policy on campus	200	

	Categories and Indicators	POINT	Weight (%)
TR4	The total number of Zero-Emission Vehicles (ZEV) divided by the total campus population	200	
TR5	The ratio of the ground parking area to the total campus' area	200	
TR6	Program to limit or decrease the parking area on campus for the last 3 years (from 2020 to 2022)	200	
TR7	Number of initiatives to decrease private vehicles on campus	200	
TR8	The pedestrian path on campus	200	
6	**EDUCATION AND RESEARCH (ED)**		19%
ED1	The ratio of sustainability courses to total courses/subjects	200	
ED2	The ratio of sustainability research funding to total research funding	100	
ED3	Number of scholarly publications on sustainability	100	
ED4	Number of events related to sustainability	200	
ED5	Number of activities organized by student organizations related to sustainability per year	200	
ED6	University-run sustainability website	100	
ED7	Sustainability report	100	
ED8	Number of cultural activities on campus	100	
ED9	Number of university sustainability program(s) with international collaborations	100	
ED10	Number of sustainability community services projects organized and/or involving students	100	
ED11	Number of sustainability-related start-ups	100	
ED12	***The revenue of Small innovative enterprises related to sustainable development, created with the participation of the university (mln. rubles)***	*100*	
ED13	***The share of R&D related to the sustainable development in total R&D (%)***	*100*	
	Total	8500	**100**

Source: Author’s compilation

3.2 An evaluation of Ural federal university campus modified carbon footprint and energy intensity

Tools for measuring and reducing carbon emissions

Carbon footprint methodologies are a set of tools and frameworks used to measure and quantify the carbon emissions associated with an activity, product, or organization. These methodologies are important for understanding the impact of human activities on the environment and for developing strategies to reduce greenhouse gas emissions.

One common approach to measuring carbon footprints is to use the life cycle assessment (LCA) methodology. This approach involves tracking the carbon emissions associated with every stage of a product or activity, including raw material extraction, manufacturing, transportation, use, and disposal. The LCA methodology is comprehensive and can provide a detailed understanding of the carbon footprint of a product or activity.

Another popular approach is to use the carbon accounting methodology. This approach involves tracking the direct and indirect carbon emissions associated with an organization's operations, including energy use, transportation, waste, and supply chain activities. Carbon accounting is often used by organizations to set emissions reduction targets and develop strategies to achieve those targets. Carbon footprint methodologies can also be used to develop carbon offset projects. Carbon offsets involve investing in projects that reduce greenhouse gas emissions, such as renewable energy projects or forest conservation programs, to offset the carbon emissions associated with an organization's operations.

Carbon footprint methodologies are used to measure the emissions reduction associated with these projects and to verify that the emissions reduction has actually occurred. There are several carbon footprint standards and protocols[179] that have been developed to guide the use of these methodologies, including the Greenhouse Gas Protocol. These standards according to the IPCC [179] provide guidelines for measuring and reporting carbon emissions, as well as for developing carbon offset projects. Carbon footprint methodologies are essential tools for understanding and addressing the environmental impact of human activities. By tracking carbon emissions and developing strategies to reduce those emissions, individuals and organizations can play a crucial role in mitigating climate change and promoting sustainable development.

Assessment of existing carbon footprint methodology and proposed improvement for UI Green Metric

One of the most important consequences of the development of “green” universities is the reduction of the carbon footprint of campuses and their environment as shown in the indicator EC8 under the category «energy and climate change» of the UI GM ranking (Table 15). Worldwide, there are more than 17,000 universities engaging more than 200 million people, consisting of students, teachers, management and other stakeholders [180]. According to [180], the number of students worldwide acquiring university degrees is likely to grow exponentially, reaching over 260 million by 2025. A likely consequence of the global increase in the student population is a sharp increase in CO_2 emissions on campuses. University leaders around the world recognize that by prioritizing the reduction of CO_2 emissions, among students, staff and faculty, a number of environmental, economic and social benefits can be obtained [181]. For this reason, universities around the world have taken the initiative to calculate their carbon footprint in order to better inform management about the necessary steps to reduce them. Gao et al. [182] called the carbon footprint an estimate of the total amount of CO_2 emissions that result from direct or indirect activities. These activities on campuses may include electricity consumption, paper and plastic waste, food and drink waste, water use, etc. The calculation of the carbon footprint can be extended to calculate CO_2 emissions for large and small businesses, as well as for personal activities [86]. In terms of emissions calculation, university-wide analysis falls within the broader realm of low carbon design, operation, and management. This requires the application of appropriate methods for setting emission targets. When calculating emissions, most studies in the past simply divided gross emissions by population [183]. However, as pointed out by [183], the setting and distribution of emission targets must allocate responsibility for emissions, taking into account a complex set of accounting, socio-economic and socio-political issues. When considering these critical aspects, the terminology used to calculate emissions becomes the term «carbon footprint»[184]. A carbon footprint, in simple terms, is the sum of all greenhouse emissions that can be associated with an activity, process, organization, or enterprise. The idea of calculating an organization's carbon footprint is very flexible and depends largely on the specifications of both the scope and the method used.

Several authors in their studies have estimated the levels of CO_2 emissions of various institutions [180,184,185]. Other studies, such as [186–188], have used different scales and approaches to calculate the carbon footprint, especially for university sustainable energy consumption. While some studies have estimated carbon emissions from Scope 1 sources, i.e. direct emissions from sources owned and controlled by the reporting institution, in others from Scope 2 sources, i.e. emissions from electricity consumption, and Scope 3, i.e. indirect emissions from purchased and consumed goods and services [180]. Considering the evolution of organizational activities in recent years, there has been a shift in the focus of GHG inventory reporting from direct to indirect emissions. According to the researchers, the GHG inventory of institutions requires accounting and reporting on emissions falling on a territory defined by the organization. According to [189], the carbon footprint of an institution can be calculated using two approaches: bottom-up, which includes an assessment of the entire life cycle of an organization's activities, and top-down, which includes input-output analysis.

Based on the above two approaches, researchers have developed and adopted several methods for accounting for the carbon footprint of organizations under various scenarios for which data are available. However, these methods take into account the standards for GHG inventory protocols set out by the International Panel on Climate Change (IPCC). Accounting for the full range of emissions associated with an organization's activities can be very complex and difficult, especially in the area of data collection and access. According to [180,190], the availability of data and the complexity of the activities carried out by institutions or organizations, as well as the different nature of their operations, are among the main problems that stand in the way of accounting for emissions. To calculate an organization's total carbon footprint, it is necessary to have access to data on areas such as water consumption, waste management, electricity supply and consumption, and transport. Below are the methods for accounting for the carbon footprint of the various areas. The first step to calculate an institution's carbon footprint is to identify the institution's activities and sources of GHG emissions. Once this is done, the proposed methodology can be applied to calculate the carbon footprint of each activity based on the identified areas.

The general expression for calculating the carbon footprint (Equation 9) can be expressed as follows:

$$CF = \sum_{i=1}^{i=n} G_i \times EF_i \qquad (10)$$

Where CF $\left(tCO_{2eq}\right)$ is the universities' carbon footprintG_i, represents each energy consumption activity, EF is the emission factor.

This generalized expression in equation 10 can then be modified to account for the carbon footprint of universities' individual carbon emission areas. In particular, the calculation of the carbon footprint from specific sources are discussed in Table16 below.

Table 16– Methods for calculating CO_2 emissions from various university's sources

Emission sources	Method	Parameter Variables
Emissions from heating systems	$CF_h = G_h \times EF_h$	Were, $CF_h(tCO_{2eq})$ in the carbon footprint from heating systems, $G_h(toe)$ is the energy consumption from heating systems, $EF_h\left({}^{tCO_{2eq}}/_{toe}\right)$ is the emission factor from heating systems
Emissions from hot water supply	$CF_w = G_w \times EF_w$	Where, $CF_w\left(tCO_{2eq}\right)$ carbon footprint of water, $G_w(m^3)$ volume of water consumption $EF_w\left(tCO_{2eq}/m^3\right)$ is the emission factor from water consumption
Emissions from electricity consumption	$CF_e = G_e \times EF_e$	Where, $CF_e\left(tCO_{2eq}\right)$ is the carbon footprint from electricity consumption, $G_e(kW\,h)$ electricity consumption, $EF_e\left(tCO_{2eq}/kW\,h\right)$ is emission factor for electricity consumption

Source: Author's compilation

Based on the assessment of the existing approaches for calculating the carbon footprint, the present study proposed an additional indicator, "green" area in the method for calculating carbon footprint as follows:

$$CFmod = CFi - GA_i \qquad (11)$$

Where, $CF\ mod\left(tCO_{2eq}\right)$ is the modified universities' carbon footprint to be estimated, $CF_i\ (tCO_{2eq})$ is the carbon footprint according to the Equation (10), $GA_i(tCO_{2eq})$ is the carbon absorption capacity of the universities' "green" area, i is the list of categories whose carbon footprint is to be determined.

As for the carbon absorption capacity of the universities' "green" area ($GA_i(tCO_{2eq})$ it is proposed to calculate it using the Equation (12):

$$GA_i = \sum_{i=1}^{i=n} S_i \times AF_i \tag{12}$$

Where, $Si(m^2)$ is the space of universities' green area, AF_i (tCO_{2eq}/m^2) is the carbon absorption capacity factor of the universities' "green" area, i is the list of green area categories whose absorption capacity is to be determined.

In additional to the indicators beyond the modified carbon footprint, in the category "2 Energy and Climate Change" of the UI GreenMetric ranking of universities, the author also calculates the energy intensity and carbon intensity of a university campus. It is the ratio of the modified carbon footprint of the university to the total number of students on campus ($tCO_{2\ eq}$ per person), and as the ratio of total energy consumption to the total number of students on campus (kwh per person) (see indicator EC4 in Table 15).

An evaluation of UrFU carbon footprint from energy consumption

The main task was to estimate the total carbon footprint of energy consumption activities of the Ural Federal University campuses. Due to the lack of data for other activity sources like waste management and transportation, only the carbon footprint from UrFU buildings was estimated. Considering that the initial data received from the chief engineer of Ural Federal University covered January 2017 to December 2023, the author's first step was to organize the data by different categories of energy consumption. The categories include:

- Consumption of thermal energy for heating in academic buildings
- Consumption of thermal energy for heating in students' residential buildings
- Consumption of thermal energy for hot water supply in academic buildings
- Consumption of thermal energy for hot water supply in for students' residential buildings
- Electricity consumption in academic buildings

- Electricity consumption in student's residential buildings

All the assumptions the author used for the calculations, including categories and the emissions factors, can be found in Appendix E.

Table 17– Total carbon footprint of energy consumption in Ural Federal University

Category / Year	Carbon footprint (tCO_2 eq)									
	Thermal energy							UrFU's total carbon emissions (tCO2 eq)		
	Heating		Hot water supply		Eelectricity Total Electricity					
	Academic buildings	Residential buildings	Academic buildings	Residential buildings	Academic buildings	Residential buildings	Combined	Academic buildings	Residential buildings	Overall
2017	7186.3	3 842.1	492.3	1818.0	4384.5	2642.4	7026.9	12063.1	8302.5	20365.6
2018	8605.3	4 243.6	605.6	2083.3	4730.9	2943.8	7674.7	13941.8	9270.7	23212.5
2019	8849.9	4 142.3	565.7	2122.3	4674.4	2825.0	7499.4	14090.0	9089.6	23179.6
2020	7344.5	4 149.8	464.3	1533.9	3697.1	2382.9	6080	11505.9	8066.7	19572.5
2021	9067.5	4063.8	666.5	1930.5	N/A	N/A	6455	N/A	N/A	22994.8
2022	10047.4	4723.9	492.5	2119.4	N/A	N/A	6549	N/A	N/A	23932.5
2023	9335.1	4687.3	415.8	1658.5	N/A	N/A	7479	N/A	N/A	23576.2

Source: Author's compilation

The result from Table 17 reveals that carbon footprint from academic buildings exceed the "residential" carbon footprint for all the categories, except the one from thermal energy for hot water supply, and this may be attributed to the specific case of UrFU, where not all the students taking part in educational programs live in the university's dormitories. For instance, in 2017, while overall carbon footprint from academic buildings accounted for about 12063.1 $tCO_{2\ eq}$, that from buildings and other places for students' residential purposes accounted for 8302.5 $tCO_{2\ eq}$. similarly, in 2018, overall carbon footprint from academic buildings amounted 1394.8 $tCO_{2\ eq}$ while that from residential building was 9270.7 $tCO_{2\ eq}$. Although, there was a slight decline in overall emission levels for 2019, the trend still followed that of the previous years where emission from academic buildings exceeded that of residential buildings by about 5000 $tCO_{2\ eq}$ (i.e., 14090 $tCO_{2\ eq}$ for academic buildings and 9089.6 $tCO_{2\ eq}$ for residential buildings). In addition, academic buildings produced the highest carbon footprint in 2019 compared to the other years. Finally, a drastic drop in emission levels were recorded in

2020, with academic buildings producing 11505.9 $tCO_{2\ eq}$ and residential buildings producing 8066.7 $tCO_{2\ eq}$. It is important to note that due to the absence of separate data for electricity consumption for both residential and academic buildings from 2021 to 2023, the author did not estimate the total emission for residential and academic building but calculated the overall carbon emissions for the period.

Furthermore, Table 17 shows that the total carbon footprint for the year 2017 to 2023 amounted to 20365.6 $tCO_{2\ eq}$, 23215.5 to $tCO_{2\ eq}$, 23179.6 $tCO_{2\ eq}$, 19572.5 $tCO_{2\ eq}$ 22994.8$tCO_{2\ eq}$, 23932.5$tCO_{2\ eq}$, and 23576.2$tCO_{2\ eq}$ respectively. In Fig. 14, the author compares the total annual emissions from energy consumption for the two categories of buildings. The results show that the highest total emissions were recorded in 2018, which was marginally higher than that recorded in 2019. The trend shows an increase between 2017 to 2019, with a marginal decline in emission levels in 2019. Moreover, in 2020, there was a drastic decline in emission levels even below the levels recorded in 2017. This is expected given that 2020 was the peak of the Covid 19 pandemic where most academic activities came to a halt, as a result of a lockdown of educational activities on university campuses. Academic activities had to be conducted online, thus resulting in a decline in energy consumption and for that matter a decline in carbon footprint. Between 2021 to 2023, however, due to the full recovery of academic activities on university campuses and the reduction in online academic activities, the overall carbon footprint increased significantly, and in some cases, above the levels of pre-covid 19. Thus, in 2021, an increase from the 2019 level is recorded which further increased in 2022 but marginally decreased in 2023, although the 2023 level is still higher than the pre-covid 19 levels.

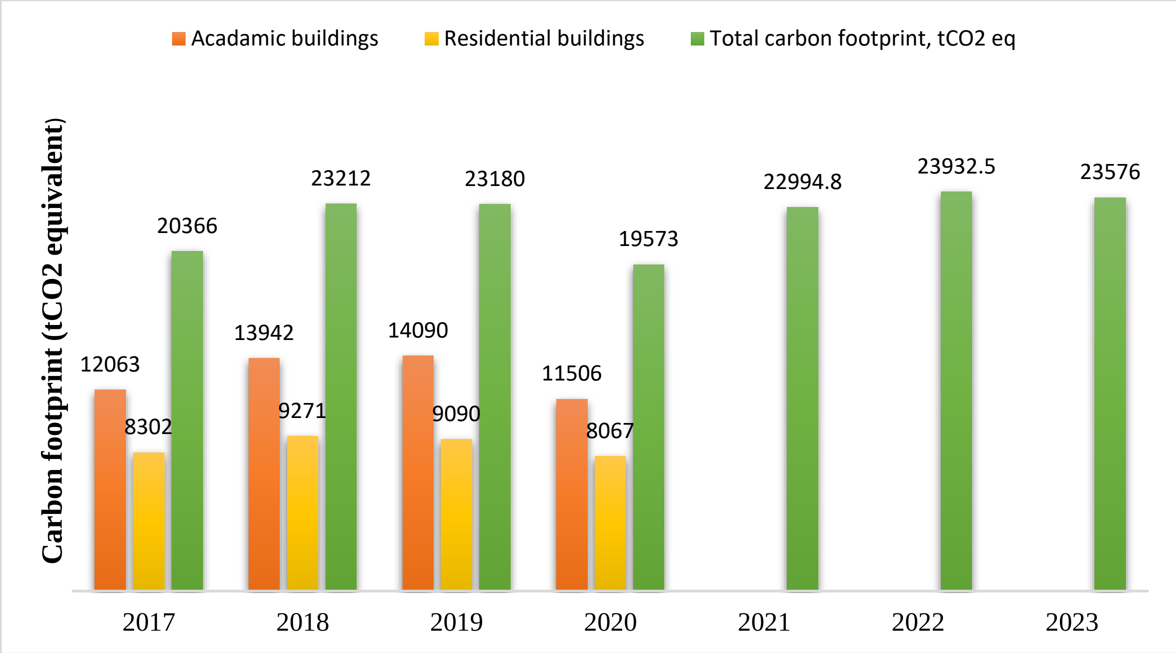

Figure 15– Annual trends for total carbon footprint

Source: Author's compilation

Furthermore, it was revealed that in 2017 academic buildings contributed about 65% (i.e., 7186 tCO2 eq) of the total carbon footprint from thermal energy for heating followed by 62% (i.e., 4384 $tCO_{2\ eq}$) of the total carbon footprint from electricity consumption. However, for carbon footprint from thermal energy for hot water supply, students' residential buildings accounted for the largest share of about 79% (i.e., 1818 $tCO_{2\ eq}$). A similar trend in terms of percentage share is recorded for the categories of carbon footprint from 2018 to 2019. Likewise in 2020, thermal energy for heating academic buildings produced about 63% (i.e., 7344.5 $tCO_{2\ eq}$) of the total share of emissions from heating, and 61% (i.e., 3697.1 $tCO_{2\ eq}$) of the total share from electricity consumption. But for emissions for hot water supply, student residential buildings produced the largest share of 77% (i.e., 1533.9 $tCO_{2\ eq}$) of the total emissions.

With regard to the total percentage share, it is observed that carbon footprint from academic buildings was the highest in all the years from 2017 to 2020. Figure 15 presents the annual percentage share of carbon footprint of UrFU energy activities for all buildings.

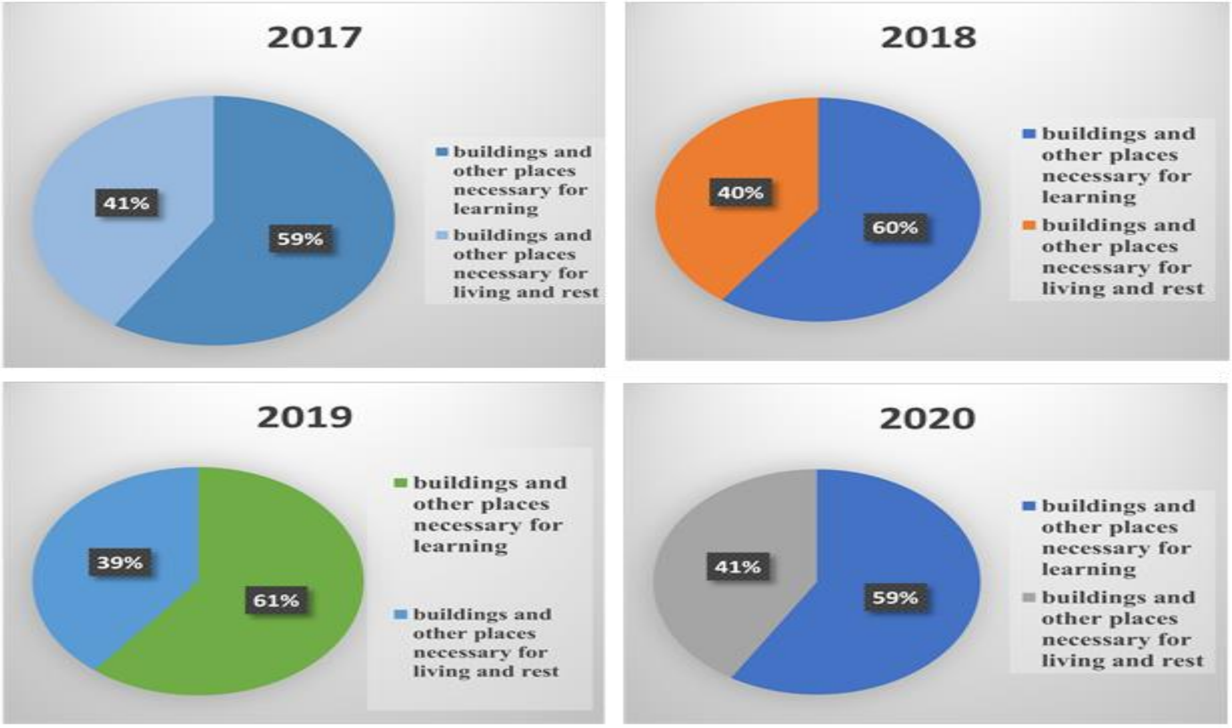

Figure 16 – Percentage of total annual carbon footprint

Source: Author's compilation

In furtherance to understanding the carbon footprint of UrFU, the author examined the annual trends of each of the energy consumption categories. As shown in Fig 16, in 2020, energy from thermal energy for heating of the two categories of buildings in UrFU recorded the highest carbon footprint from December to May. This is followed by the carbon footprint from electricity consumption for the two categories of buildings. Carbon footprint for 2020 appeared to be the highest during the winter and spring periods, where energy consumption is high. During these periods, a lot of indoor activities take place compared to the summer period where generally activities are outdoor. It is interesting to note that during the peak periods of winter, carbon footprint is highest (i.e., in January), then it begins to marginally drop from February to April. During summer no emission are generated from thermal energy for heating. This is because summer periods are characterized by hot temperature and therefore, heaters in buildings are usually turned off. Indeed, between June to September, carbon footprint from electricity consumption for the two categories of buildings is highest. It is imperative to note that the author only presented the annual trend for 2020 due to the fact that there is no much difference in trends compared to the earlier years (i.e., 2017 to 2019)[6].

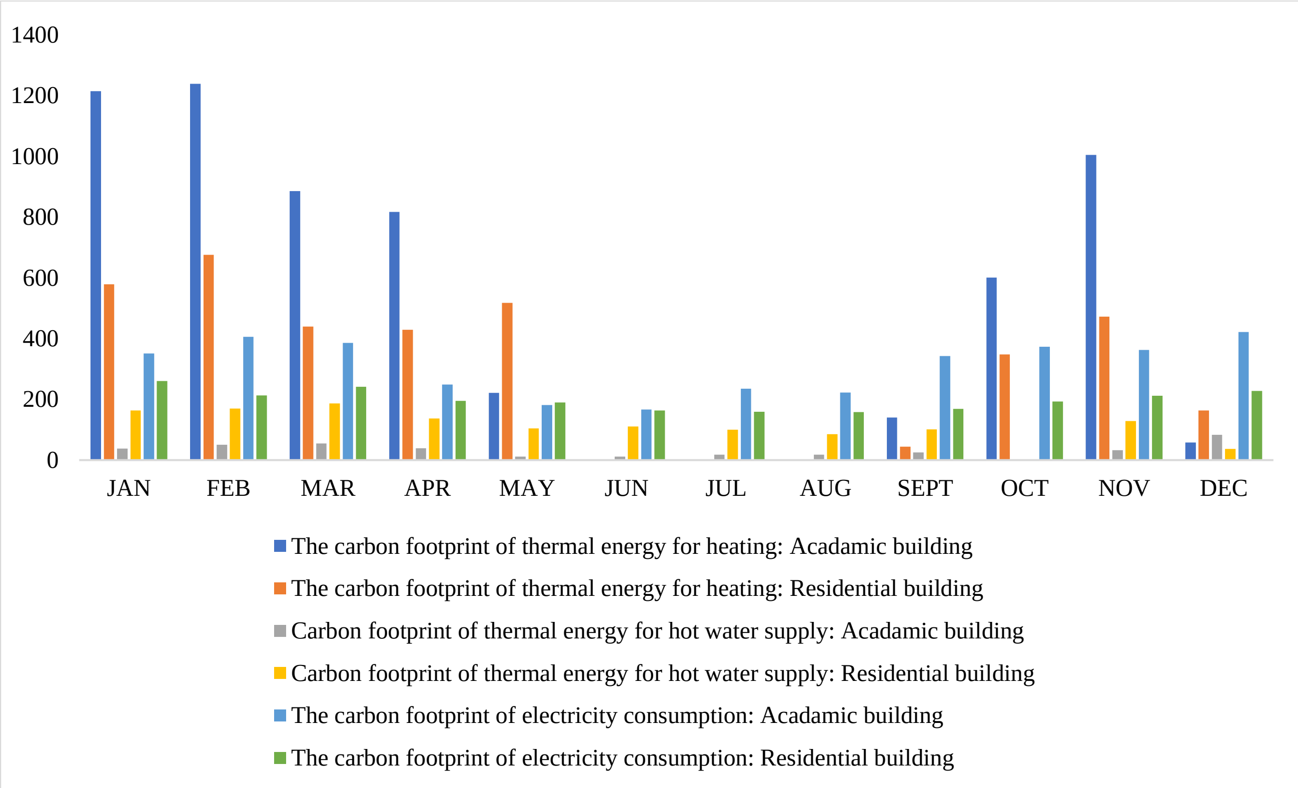

Figure 17 – Monthly trends of carbon footprint for 2020

An evaluation of UrFU "green" area absorption capacity

To calculate the UrFU "green" space absorption capacity we used the information about the area of "green" space along the perimeter of the university campus (Sofia Kovalevskaya, Malysheva, Mira, Pervomaiskaya streets) in QGis (Fig. 17). The total area of "green" space in between 2017 and 2023 is 0.058 km^2.

As for the carbon absorption capacity factors, we take into account the IPCC approach[7] , that allows us to use instead of the IPCC recommended coefficients, regional or national coefficients, if they are available and reliable (Tier 2). We use the data from

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[6] For the trend analysis of carbon footprint from 2017 to 2023, refer to Appendix E

[7] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. 2019. Retrieved from: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html (Date of access: 22.06.2024)

National Inventory Report 2023[8] for “Land Use, Land-Use Change, and Forestry” sector. The urban park areas we are considering contain perennial tree plantations (deciduous, coniferous trees, shrubs) and, according to the IPCC land categories, can be classified as managed forest lands and the specific annual capacity of this territory to absorb greenhouse gases is 3.6 tCO2 eq /ha. So, the UrFU “green” area absorption capacity for 2017-2023 is 21 tCO2 eq per year.

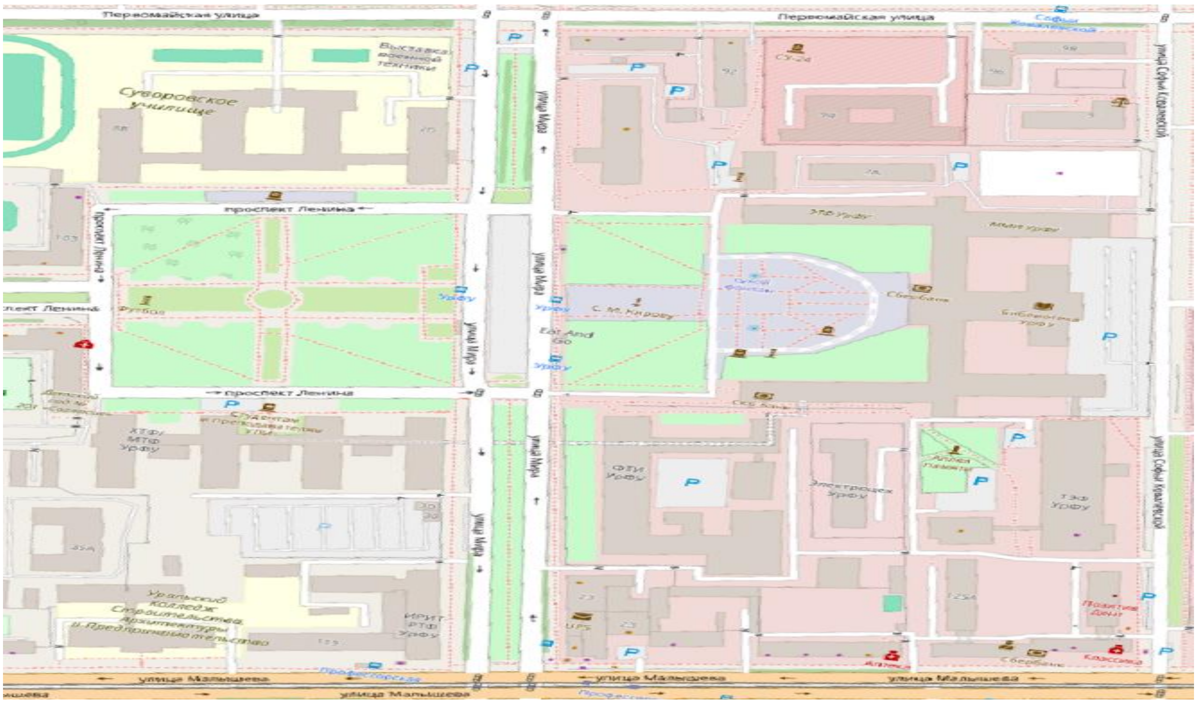

Figure 18 – Map showing the UrFU main campus area

Such a small value is due to the peculiarity of the current location of the campus within the boundaries of urban development, where opportunities for landscaping are very limited. At the same time, according to the authors, for a more adequate assessment of the carbon footprint, carbon absorption by green areas of the campus should be taken into account, especially since the university has begun to develop a completely new area of Novokoltsovsky campus, where the opportunities for landscaping is much wider. The university can also participate in reforestation projects that are implemented annually in the Sverdlovsk region. In particular, within the framework of the national project

[8] National report on the inventory of the anthropogenic emissions by sources and removals by sinks of GHGs, not controlled by the Montreal Protocol. Retrieved from: http://downloads.igce.ru/kadastr/RUS_NIR_2023.rar (Date of access: 01.07.2022)

"Ecology" the action "Let's Save the Forest" is regularly held. The University could actively participate in such actions involving a large number of staff and students. Carbon absorption resulting from such projects could be taken into account in calculations of the modified carbon footprint of the campus, reducing it.

An evaluation of UrFU campus modified carbon footprint

The modified carbon footprint of the UrFU campus can be presented in the Table 18.

Table 18 – Total modified carbon footprint of energy consumption in UrFU

Year/Category	Total carbon emissions, $tCO_{2\ eq}$			Overall	Total carbon absorption capacity of the universities' "green" area, $tCO_{2\ eq}$	Modified carbon footprint, $tCO_{2\ eq}$
	Heating	Hot water supply	Eelectricity			
2017	11 028.4	2310.3	7026.9	20 365.6	21	20 344.6
2018	12 848.9	2688.9	7674.7	23 212.5	21	23 191.5
2019	12 992.2	2688	7499.4	23 179.6	21	23 158.6
2020	11 494.3	1998.2	6080.0	19 572.5	21	19 551.5
2021	13 131.3	2597	6455.0	22 183.3	21	22 162.3
2022	14 771.3	2611.9	6549.0	23 932.2	21	23 911.2
2023	14 022.4	2074.3	7479.0	23 575.7	21	23 554.7

Source: Author's compilation

The data presented in Table 18 provides a comprehensive overview of the carbon emissions and absorption capacities at a university from 2017 to 2023. The total carbon emissions from heating, hot water supply, and electricity have shown significant variation, with an overall increase from 20,365.6 tCO2 eq in 2017 to a peak of 23,932.2 tCO2 eq in 2022, before slightly decreasing to 23,575.7 tCO2 eq in 2023. Emissions from heating consistently rose, suggesting increased demand or less efficient systems, while hot water supply emissions showed relative stability from 2019 onwards, possibly due to improvements in hot water systems or usage patterns. Electricity emissions fluctuated, peaking in 2018 and dipping in 2020. The carbon absorption capacity of the university's green areas remained constant at 21 tCO2 eq annually, highlighting their limited impact on the overall carbon footprint. The modified carbon footprint, calculated by subtracting the absorption capacity from total emissions, closely mirrored the trend of overall emissions, with a notable dip in 2020 due to reduced campus activities. To address the rising emissions effectively, the university should enhance green areas to boost carbon absorption, improve energy efficiency in heating and electricity usage, and promote sustainable practices among students and staff. These strategies, including upgrading heating systems, adopting renewable energy sources, and increasing sustainability awareness, are essential for reducing the university's carbon footprint and achieving long-term environmental sustainability.

An Evaluation of UrFU energy intensity

In addition to estimating the carbon footprint for UrFU using energy consumption data from different sources for different activities, the author went further to calculate the energy intensity as the ratio of the modified carbon footprint of the university to the total number of students on campus ($tCO_{2\ eq}$ per person), and as the ratio of total energy consumption to the total number of students on campus (kwh per person). This is essential as it makes significant contribution to the UI GM ranking methodology (i.e., indicator EC9 under the category (EC) Energy and climate change (see Table 16). To do this, the author used annual data on energy consumption, carbon footprint and the number of students from 2017 to 2023 (Table 19).

Table 20 illustrates the total energy intensity per student in UrFU, measured in kilowatt-hours (kWh) per student. Analyzing this dataset offers valuable insights into energy usage trends and potential areas for improvement in energy efficiency. The energy intensity per student increased from 676.18 kWh in 2017 to a peak of 723.75 kWh in 2018, followed by a gradual decline to 696.10 kWh in 2019. The most significant reduction occurred in 2020, where energy intensity dropped to 554.57 kWh per student.

Table 19 – Electricity consumption, modified carbon footprint and student population in UrFU

Category/ Year	Electricity consumption, t kWh			Modified carbon footprint, tCO_2 eq	
	Academic buildings	Residential buildings	Overall	Overall	Number of students
2017	13616.4	8206.0	21 822.5	20344.6	32273
2018	14692.3	9142.2	23 834.5	23191.5	32932
2019	14516.7	8773.3	23 290.0	23158.6	33458
2020	11481.6	7400.4	18 882.0	19 551.5	34048
2021	N/A	N/A	20 044.9	22973.8	34908
2022	N/A	N/A	20 339.4	23911.5	34883
2023	N/A	N/A	23 228.1	23555.2	38797

Source: Author's compilation

This substantial decrease is likely attributable to the COVID-19 pandemic, which resulted in reduced on-campus activities, remote learning, and fewer students utilizing university facilities. In the subsequent years, there was a modest rise in energy intensity, reaching 574.2 kWh in 2021, 583.1 kWh in 2022, and 598.7 kWh in 2023, indicating a gradual return to pre-pandemic energy usage levels as campus activities resumed. This trend highlights the impact of operational changes on energy consumption. The reduction in 2020 demonstrates that significant decreases in energy usage are possible with altered campus operations, suggesting that similar strategies could be employed to enhance energy efficiency moving forward. The gradual increase in the following years, however, emphasizes the need for ongoing efforts to maintain energy efficiency even as normal activities resume.

To further reduce energy intensity per student, the university could implement several strategies, including investing in energy-efficient infrastructure, promoting energy-saving behaviors among students and staff, and increasing the use of renewable energy sources. Monitoring and analyzing energy usage patterns will be crucial in identifying areas where improvements can be made, ensuring the university can sustainably manage its energy consumption while accommodating the needs of its student population.

Table 20 – Energy intensity based on electricity consumption

Category/ Year	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*
Total energy intensity, kWh/ student	*676.18*	*723.75*	*696.10*	*554.57*	*574.2*	*583.1*	*598.7*

Source: Author's compilation

According to calculations, the carbon intensity of the campus over the period decreased by 3.7% and in 2023 it was 607.1 tCO2 eq/1000 students (Table 21), which, on the one hand, indicates the application of energy–saving technologies in the university buildings, but may also reflect the trend of online learning, where some disciplines are taken by students remotely from home.

Table 21 – Energy intensity based on modified carbon footprint

Category/ Year	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*
Total modified carbon footprint, t CO_2 eq/ 1000 students	*630.4*	*704.2*	*692.2*	*574.2*	*658.1*	*685.5*	*607.1*

Source: Author's compilation

In any case, changes in the carbon footprint per 1000 students in the absence of pronounced shocks such as the Covid 19 pandemic, may be a clear reflection of the pattern of energy consumption from all the categories, including electricity and heat consumption. Thus, higher energy consumption is positively correlated with a higher carbon footprint. In other words, as energy consumption increases, the overall carbon footprint of an institution or organization also increases. The estimated carbon footprint for Ural Federal University can be considered high compared to the carbon footprint of universities such as the University of Leicester, the Universiti Teknologi Malaysia, Edith Cowan University in Australia, and Clemson University in the United States (See Appendix H). This analysis gives UrFU the opportunity to take action that will help reduce CO_2 emissions by adopting "green" university strategies as discussed in previous sections. A detailed analysis of the categories considered for carbon footprint assessment can be a useful input for decision making for "green" university initiatives. One useful way to reduce the carbon footprint of UrFU is to development green spaces on university campuses that can serve as regions or areas for carbon absorption. The absorption capacity of these green areas can be estimated and deducted from the total carbon footprint of a university to show actual emission levels. This will in effect enhance the development of effective policies under the “green” university development.

Analysis of information on energy intensity calculated using the carbon footprint per 1000 students allows the university management to draw the following conclusions: (1) The consistent increase in carbon footprint per 1000 students highlights the need for proactive measures to mitigate emissions and promote sustainability within the university's operations; (2) Addressing the rising carbon footprint per 1000 students may involve implementing energy efficiency measures, transitioning to renewable energy sources, green spaces development and adopting sustainable practices in building design and operation; and (3) Analyzing these trends can inform strategic planning and policy development aimed at reducing the university's environmental impact while fostering a culture of sustainability among students, faculty, and staff.

According to the data of the International Monetary Fund [170], the cost estimate of damage from emissions of one ton of CO_2 is assumed to be equal to 20 US dollars. Despite the fact that the university campus is not a significant source of greenhouse gas emissions in the Sverdlovsk region, the damage caused to the environment is quite high with the total over seven years amounting to 3137 thousand US dollars and an average of 448 thousand US dollars per year over the seven years (Table 22), which confirms the importance of implementing “green” initiatives, including those aimed at reducing the carbon footprint, as part of the process of the continuous improvement of the university's environmental sustainability.

Table 22 – Economic assessment of environmental damage associated with emissions CO_2

Yeah	Total modified carbon footprint of UrFU, $tCO_{2\text{-eq}}$	Valuation of damage in thousands of US dollars
2017	20344.6	406.9
2018	23191.5	463.8

Yeah	Total modified carbon footprint of UrFU, tCO_{2-eq}	Valuation of damage in thousands of US dollars
2019	23158.6	463.2
2020	19 551.50	391.0
2021	22973.8	459.5
2022	23911.5	478.2
2023	23555.2	471.1

Source: Author's compilation

3.3 An evaluation of Ural federal university economic contribution towards "green" economy

Proposed amendments to the UI GM rating also suggest adding additional indicators in the category 6: "Education and Research (ED)": (1) The revenue of small innovative enterprises related to sustainable development, created with the participation of the university (mln. rubles) — ED12; (2) Annual volume of research and development related to sustainable development conducted by the university for regional businesses (mln. rubles) —ED13 (see section 4.1).

Here the author will make calculations of these two indicators for the Ural Federal university for 2021–2023. To calculate the ED12 indicator we will use the data of the information system Contour. Focus and find the revenue of small innovative enterprises, created with the participation of UrFU, whose activities are related to sustainable development and green economy, for 2021–2023 (Table 23.).

Table 23 – Annual revenue from SIE in partnership with UrFU

Indicator	2021	2022	2023	Итого
The revenue of small innovative enterprises related to sustainable development, created with the participation of the university (mln. rubles) — ED 12	76.3	63.2	37.8	177.3

Source: Author's compilation

In total, as of the beginning of 2024, UrFU participated in the work of 38 small innovative enterprises, the activities of 9 of which are related to sustainable development and green economy. During the period under review there is a decrease in the revenue of such enterprises. In 2023 compared to 2021, the revenue decreased by 38.5 million rubles or by 50%. Such dynamics can be explained by the difficult socio-economic situation in the country, negatively affecting the activities of small businesses.

To calculate the ED13 indicator, we will use the information on the research and development works performed by UrFU related to the sustainable development topics, the information about which is available on the portal of the unified state information system for recording research, development and technological works for civil purposes (https://www.rosrid.ru/). Information on the cost of such works and their share in the total expenditures of UrFU on R&D activities is presented in the table below.

Table 24 – Annual volume of R&D related to sustainable development conducted by UrFU for regional businesses

Показатель	2021	2022	2023	Итого
Annual volume of R&D related to sustainable development conducted by the UrFU (mln. rubles)	56,85	170,4	264,5	491.75
Total expenditures of UrFU on R&D activities [9]	2343	3152	3776	9271
ED13— The share of R&D related to the sustainable development in total R&D, %	2.4	5.4	7.2	15

Source: Author's compilation

The analysis of the Table 24 allows us to conclude that the annual expenditures on R&D related to sustainable development are growing: in 2023 compared to 2021 they increased by 208 million rubles, or 4.7 times. The share of R&D on sustainable development topics in the university's total R&D expenditures has also tripled. These trends show that the interest of the state in the implementation of such works is growing,

[9] https://urfu.ru/fileadmin/user_upload/common_files/academic_council/docs/2023
2024/03/Vopros_1_Germanenko_A.V._US_25-03-2024_-_sai__t.pdf

which is reflected in the amount of funding by topic. Thus, out of nine priority areas of scientific and technological development of Russia, specified in paragraph 21 of the Strategy for Scientific and Technological Development of the Russian Federation, 4 are related to sustainable development and green economy, in particular:

- transition to environmentally friendly and resource-saving energy, increasing the efficiency of production and deep processing of hydrocarbon raw materials, formation of new energy sources, methods of its transmission and storage;

transition to highly productive and environmentally friendly agro – and aquaculture, development and implementation of systems for rational use of chemical and biological protection of agricultural plants and animals, storage and efficient processing of agricultural products, creation of safe and high-quality, including functional, food products;

- objective assessment of emissions and absorption of climate-active substances, reduction of their negative impact on the environment and the climate, increasing the possibility of qualitative adaptation of ecosystems, population and economic sectors to climate change;
- transition to the development of nature-like technologies that reproduce the systems and processes of living nature in the form of technical systems and technological processes integrated into the natural environment and natural resource turnover.

Student perceptions and attitudes towards campus greening (pro-environmental behaviour)

Recently, a lot of empirical research has been carried out examining the efforts of the "green" university or initiatives for sustainable campus development in universities. This section provides a comprehensive overview of recent research on this topic.

Lozano et al. [191], in an attempt to study the implementation of campus sustainability in universities, analyzed 60 peer-reviewed papers using a survey mechanism. Their study was divided into categories such as the institutional framework; campus activities; education; research; advocacy and cooperation; experience on campus;

evaluation and reporting. The study found that while most universities have adopted campus sustainability initiatives, these efforts have been fragmented. They also noticed a strong link between the institutions that signed the declaration or charter and the commitment to greening their campuses. Md Imtiajul [5], has examined various successful approaches taken by HEIs to achieve their campus sustainability goals. The study also examined the process of integrating sustainable development into the policy, pedagogy and research processes of a higher education institution, as well as the approaches used by universities aimed at influencing the perception and behavior of students. The results of the study show that the adoption of different approaches to the physical change of campus infrastructure and the educational transformation of students' mindsets are of paramount importance in achieving campus sustainability. Tan et al. [192] studied the development of “green”sustainable campuses in China. Their study provides a brief overview of sustainable campus development initiatives in China, with a particular focus on energy and resource efficient campuses, and the status of upgrading energy and resource efficient campuses to sustainable campuses. They also analyzed the challenges encountered during the development phase and explored possible approaches and action plans. It was found that Chinese universities have been expanding the development of energy and resource efficiency over the years through the application of energy efficient technologies and energy management initiatives on campuses, with extensive support from the Chinese government.

Another study [187] assessed sustainable development strategies in universities using the example of the University of Miño, Portugal. The results show that a blended bottom-up and top-down approach is key to the successful implementation of sustainable development strategies in higher education institutions. In addition, the study argues that the integration of cooperation networks and the institutionalization of sustainable development policies contribute to the consolidation and strengthening of the commitment to sustainable development. In their study evaluating Portland State University's campus sustainability initiatives and students' knowledge of campus sustainability, [193] noted that campus sustainability initiatives were funded in line with the University's long-term plans across 12 multilateral categories, namely administration, energy, water, climate action, green buildings, green purchasing, waste reduction and recycling, food and dining, transportation, land use, activities, education and student activism.

In Russia, several studies have assessed the efforts of the country's universities in the sustainable development of campuses. For example, [194] analyzed the implementation of sustainable development initiatives in Russian universities as a subsystem of the national innovation system. She noted that there is a discrepancy between the National Strategy for Education for Sustainable Development in the Russian Federation and the Russian education system. This means that the principles of sustainable development are considered separately from educational programs, which leads to a low level of adaptive strategies in universities. In addition, the study argues that the country has adopted a rather narrow interpretation of the concept of sustainable development. At the end of the study, a recommendation was made to include the principles of sustainable development in the national education system.

The role that students play in achieving environmental sustainability on and off campuses has been widely reported in the literature. For example, while some past studies have examined students' awareness of environmental sustainability on campuses [25,195], others have assessed students' perceptions of sustainability on campuses [196].

Abubakar et al. [25], in their study of student awareness of campus sustainability at Damman University in Saudi Arabia, noted that the majority (65%) of students had very little knowledge of environmental sustainability, while only 10% were good at aware of this issue. The study also showed that only 9% of students are willing to participate in sustainability initiatives. This is particularly unsurprising given the percentage of students with no knowledge of sustainability issues. Dagiliute et al. [196] assessed student perceptions of campus sustainability initiatives between “green”and “non-green universities”. They noted that while there were no significant differences between “green”and non-green universities in general aspects of sustainable development, students from “green” universities received more environmental information and were more involved in environmental activities on campus than their counterparts from «non-green universities». In their study assessing student perceptions of campus sustainability, Emanuel and Adams [197] selected 406 students from two US states. They noted that students in general have extensive knowledge of sustainability initiatives and express concerns about inefficient consumption and environmental pollution. They also noted that the majority of students are willing to participate in and support sustainability initiatives on their campuses.

In addition, [198] examined student perceptions of private and public universities in China and found that while students in general are highly concerned about their university's role in promoting campus sustainability, private university students have higher perceptions of commitment, knowledge, attitudes and practices regarding campus sustainability than public university students. Yuan and Zuo [199], assessing student perceptions of sustainability in higher education in China, reported that university students are generally aware of sustainability issues. The study also showed that students have a positive perception of environmental sustainability in universities that prioritize sustainability. Tuncer [200] investigated the perceptions of sustainable development among university students in Turkey and found statistical differences between male and female students regarding their perceptions of sustainable development. However, no differences were found in student perceptions of sustainable development between those who enrolled in environmental courses and those who did not.

The concept of environmental behaviour of students and influencing factors

In the literature, environmental behaviour (EP) is defined as a conscious behaviour of a person aimed at minimizing or reducing the negative consequences of his actions for the environment [201]. Pro-environmental behaviours (PEB) falls into three different groups: (i) activist behaviour, which includes joining an environmental organization or campaigning for the environment; (ii) good behaviour such as waste separation, recycling or reuse, and (iii) healthy consumer behaviour such as avoiding polluting products such as plastic [202]. A number of studies have addressed various issues focused on PES, including waste recycling [203], energy consumption (18) and sustainable consumption [204].

This task is based on the theory of planned behaviour [205] as a basis for studying the factors influencing pro-environmental actions. The decision to act environmentally is the most important determinant of an individual's actual behaviour [206]. The decision to act is then supported by some internal and external factors [201,207]. One group of internal factors influencing the decision to act sustainably includes demographic and socioeconomic factors such as gender, age, family size, educational level and income. Kollmus and Agyeman [201] demonstrated that women are generally more environmentally aware than their male counterparts and therefore more likely to take PEB than men. Regarding the issue of age, Lynn [208] found that as people get older, their decision to take PEB increases at home. Similarly, a study found that older people are more likely to recycle compared to younger people [209]. In addition, studies have shown that highly educated people are more prone to environmentally friendly behavior compared to relatively less educated people. Income has also been found to be positively associated with recycling behaviour [210]. In general, personality factors can influence behavior in a variety of ways, and these relationships differ across contexts.

Other identified personality determinants include cognitive, affective and dispositional factors [207,210,211]. Cognitive factors include knowledge and information about environmental problems and the mechanism for their prevention and elimination [210]. Although evidence suggests that awareness and knowledge can predict PES [212], others argue that knowledge transfer alone is not enough to induce changes in lifestyle and behavioural patterns [213,214]. Perceived control of behaviour refers to an individual's beliefs about what influences or hinders the desired behaviour [215,216]. It is the feeling that a person is in control of the behaviour that is expected of him[205], and this leads to such PEBs as recycling [217]. Affective factors are associated with shared values, environmental values, and attitudes towards the environment, including openness to change, conservatism, altruism, and self-improvement values [212]. In addition, people who show a great sense of courtesy and personal responsibility are more likely to participate in PEB[218]. People participating in PEB must be well aware of the consequences of their actions for the well-being of others and therefore must feel a sense of responsibility for these actions.

Another group of internal factors is dispositional factors. These factors consist of personal attitudes towards PEB, such as the willingness to dedicate individual resources to such activities. Attitudes define an individual's beliefs about the consequences of his behaviour or actions [217]. Studies have established that, although there is a strong relationship between an individual's attitude to the environment and PEB [219], the heterogeneity of this relationship is questioned [220]. According to Rivera-Torres and Garces-Ayerbe [210], participation in PEB requires prior historical effort. The author [210], share the view that environmental policy propensity is a precursor to PEB in recycling programs. Thus, it can be hypothesized that positive or negative attitudes and predispositions towards the environment can positively or negatively affect PEB. For example, people who may feel that they will not gain anything by participating in a given pro-environmental action [207,218] will not behave in an environmentally friendly manner. In addition, forgetfulness or laziness on the part of people can interfere with BSE activities, such as turning off lights or recycling waste [219].

Other authors argue that, due to external factors beyond human control, a positive attitude towards the environment does not always translate into PEB [214]. While a positive attitude towards the environment may appear in some areas, it may not manifest itself in others [201]. This shows that the decision to take PEB can be complex and is influenced by a number of internal and external factors [207,221]. In a university environment, «support infrastructure», «organizational culture» and «leadership support» are critical to engagement in PEB. Studies by Mtutu and Thondhlana [209] and Klockner and Oppendal [217] have noted that easy access to waste containers has a positive effect on people's waste disposal behaviour. This means that in the absence of environmental opportunities, people are less likely to act in the best interests of the environment [207]. Other barriers, such as physical obstructions, can also interfere with the PSP. For example, the location of a light switch or a trash can may influence a person's decision to turn off the lights or recycle trash despite their intention to do so, as this may be seen as an inconvenience [208,209]. Thus, reducing structural constraints to a minimum in favour of more supporting infrastructure is likely to encourage the development of PEB.

With regard to organizational factors, the literature on PEB emphasizes the impact of organizational culture and environmental policies on an individual's PEB [207,222]. Research has shown that incorporating environmental policy into organizational culture is likely to contribute to the development of PEB[222]. In addition, exemplary leadership in organizations is an important factor for the development of PEB [222,223]. Based on the foregoing, it can be argued that the lack of participation of university management in PEB can undermine the involvement of students in PES [201].

Self-reported behaviour among students

Respondents were interviewed on various questions regarding how often they engage in environmental activities. These issues have been classified into three main categories: energy conservation, waste management and water conservation. The results are presented in Table 25.

In terms of energy conservation activities of students, the majority of respondents: bachelor students (56%), master students (81%) and PhD students (79%) reported that they turn off the light when they leave the room. Most students also reported that they always turn off the lights when they go to bed: Bachelors (81), Masters (90), PhDs (89). A relatively smaller proportion of students reported different levels of energy saving practices. So, if 54% of graduate students sometimes close the windows when the heater is turned on in the room, then 57% of undergraduates and 54% of graduate students always close the windows. Similarly, when electronic devices are unplugged when not in use, different classes of students practice different levels of energy saving: 36% of graduate students always unplug their chargers when not in use, 44% of bachelors sometimes unplug their chargers, and 48% of undergraduates rarely unplug their chargers.

In terms of saving water, half (50) of the graduate students surveyed said they never use a cup when brushing their teeth. In contrast, the modal response for water conservation among undergraduate and graduate students is 41% and 48%, respectively.

When asked if they turn on the tap when washing their face, 53% of bachelors, 43% of masters and 39% of graduate students admitted that they sometimes turn off the tap when washing their faces. The adoption of a short shower as a means of saving water among students was noted by 59%, 48% and 46%, respectively, among bachelors, masters and graduate students for the answer «sometimes». In terms of waste management, a review of the modal responses among students indicates an overall low trend in waste management practices among students of all levels. However, in some cases, two answers are the most common among students. For example, while 47% and 33% of undergraduate and graduate students, respectively, occasionally use their shopping bags, 39% of graduate students either always or sometimes use their shopping bags. The results presented in Table 25 indicate a mixed response. Thus, while a significant number of students at various levels of education report always practicing environmentally friendly activities, others report sometimes, rarely and never.

In general, the modal responses for the general data showed that while some respondents admitted that they were always involved in environmental activities, the proportion of such respondents ranged from 27% to 86%. This result implies that most of the students did not take any steps to solve environmental problems in their daily activities. This result is consistent with the results of studies [209,224]. Other distinguishing aspects of the results: First, the proportion of students using side lamps for activities that require less directivity of light was very low. This result is contrary to the expectations of the study, which assumed that students would frequently use vision lamps. This can be explained by the fact that although most of the students did not have side lamps, others who could afford or had side lamps did not see the importance of using them. In cases where respondents admitted that they did not turn off the light, they explained this either by forgetfulness or fear of the dark (personal discomfort) [224]. Secondly, compared to common rooms, students tend to be more responsible about their private rooms. Perhaps this is due to the lack of consensus among students as to who is responsible for compliance with environmental standards in public spaces [11]. In addition, people may not be motivated to participate in PEBs in shared spaces due to limited chances for individual rewards[224].

Table 25 – Pro-environmental behaviour among students

Environmental Actions	modal response	Proportion of Response (%)			
		Bachelor	masters	PhD	Overall
energy saving					
Turn off the lights when you leave the room	Always	56	81	79	70
Turn off the lights before bed	Always	81	90	89	86
Turn off the lights when leaving the common room	Always	46	71	43	52
	Sometimes			43	
Make full use of daylight	Sometimes	50	57	50	52
Close the windows when the heater is on	Always	41	57		
	Sometimes			54	43
Use a sidelight	Rarely	34			
	Always			35	
	Sometimes		38		
	Never				27
Unplug chargers/devices when not in use	Always			36	
	Sometimes	44			
	Rarely	48			33
Saving water					
Use a cup when brushing your teeth	Never	41	48	50	46
Turn off the faucet when washing your face	Sometimes	53	43	39	46
Take a short shower	Sometimes	59	48	46	51
Waste management					
Follow the rules for handling garbage in the residence	Always	31			32
	Sometimes		38	32	
	Never				
Two-sided printing	Sometimes	50		39	41
	Rarely		38		
Use your own shopping bag	Always			39	
	Sometimes	47	33	39	41

Source: Author compilation

Reported reasons for and barriers to environmental behaviour among students: In order to fully understand the reasons for taking certain environmental actions or activities, open-ended questions were asked to allow respondents to indicate the reasons for such actions. A descriptive analysis of the reasons students gave for their actions is presented in Table 26. The results show that if students who turn off the lights when they go to bed or are the last to leave the common room said they do so to save energy (69%) and reduce costs electricity bills (11%), those who do not turn off the light explain their actions by forgetfulness (10%) and fear of the dark (11%). In terms of respondents' decision on whether they make full use of daylight, it was reported that those who answered yes did so to save energy (51%) and reduce the cost of electricity (27%).

On the contrary, 22% of those who do not make full use of daylight attributed their actions to the lack of sufficient daylight, especially in winter. This reason is an obstacle to pro-environmental behaviour among students. Respondents who do not close the windows when turning on the heater in the room explain this by the desire to ventilate the room with fresh air. This, however, qualifies as a barrier as it can lead to inefficient energy consumption. In the case of «using side lamps», respondents include “aversion to side lamps” (5%) and “no side lamp” (43%) as barriers. Those who use side lamps cited the following reasons: “energy savings” (13%), “good brightness” (26%) and “reducing the cost of electricity” (13%). All respondents who said they unplug their devices when not in use cited reasons such as “saving power”, “extending device life” and preventing devices from overheating, which could eventually damage them. However, laziness is indicated as an obstacle.

With regard to saving water, survey responses cited “reducing water wastage” and “saving money” as reasons for using cups when washing your face or brushing your teeth. One of the main barriers to students' pro-environmental water saving behaviour was that respondents who did not use cups felt that it was not necessary to use cups when brushing their teeth or washing their faces.

Respondents also cited “saving water” and “saving money’ as reasons for taking short showers. Those who took long showers reported that they felt it was not important for them to take short showers.

With regard to waste management, the identified barriers to the inability of respondents to follow the rules for waste management at the place of residence were related to the fact that either there were no waste recycling containers in the place of residence, or the respondents did not see the importance of recycling (separating) their waste. On the contrary, those who follow local waste management regulations reported that the practice helps to properly dispose of waste and promotes hygiene. Problems faced by respondents who choose to print on both sides of the paper include the unacceptability of such printing for official purposes and the fact that such printing does not look presentable. Finally, forgetfulness was cited as a major barrier to students' pro-environmental behaviour regarding the use of their shopping bags.

Table 26 – Reasons for the pro-environmental behaviour of students

Environmental inaction	Causes	Percentage %
Energy saving		
Switch the lights off	To save energy	69
	Forgetfulness (Barrier)	10
	Reduce your electricity bills	11
	Afraid of the Dark (Barrier)	10
Make full use of daylight	To save energy	51
	To lower your electricity bills	27
	Not enough daylight in winter (Barrier)	22
	To save energy	
Close the windows when the heater is on	To improve fresh air ventilation (Barrier)	19
	To avoid wasting energy	81
Use sidelights	To save energy	13
	To ensure good brightness	26
	I don't like side lights (Barriers)	5
	To reduce bills	13
	I don't have a parking light (Barrier)	43
Unplug chargers/devices when not in use	To save energy	14
	To save time (Barrier)	30
	To avoid overheating of devices	9
Saving water		
Use the cup when brushing your teeth / washing your face	To reduce water loss	36
	In order to economize	18
	Optional (Barrier)	46
Take a short shower	To save water	18
	Doesn't matter (Barrier)	59
	To save water costs	23
Waste management		
Follow the rules for handling garbage in the residence	Waste sorting bins are not provided (Barrier)	61
	I do not see the need for waste sorting (Barrier)	28
	It helps for proper recycling and disposal	7
	Promotes general hygiene	4
Two-sided printing	This is not accepted in my institution for official assignments (Barrier)	92

Environmental inaction	Causes	Percentage %
	It's not necessary (Barrier)	6
	It won't look good (Barrier)	3
	To avoid losses	1
Use your bag when shopping	For safety and convenience	44
	To avoid too much plastic waste	19
	Forgetfulness (Barrier)	25
	I buy a bag every time I go shopping (Barrier)	12

Source: Author compilation

Based on these findings, several recommendations can be made to promote pro-environmental behaviour among students. These include:

1. Education and awareness campaigns to address misconceptions and increase understanding of the environmental benefits of certain behaviours.
2. Providing infrastructure and facilities to support sustainable practices, such as recycling bins and energy-efficient lighting options, which can be implemented under the broad umbrella of “green” university initiatives.
3. Implementing incentives or rewards for environmentally friendly behaviours to motivate students and overcome barriers such as forgetfulness.
4. Collaboration between educational institutions and local authorities to promote waste management practices and provide resources for recycling.
5. Encouraging the development and adoption of environmentally friendly alternatives, such as reusable shopping bags and energy-efficient appliances.

By addressing these recommendations, we can work towards creating a more environmentally conscious student community and contributing to overall sustainability efforts.

Considering that universities play an important role in achieving environmental sustainability, this chapter first proposed an amendment to the indicator EC8 under the category energy and climate change (EC) as well as propose the addition of indictors ED12 and ED13 to the category, education and research (ED). The proposed changes to the methodology for evaluating green university initiatives may encourage the introduction of energy-saving measures and an increase in green space to reduce the carbon footprint of the campus, as well as the emergence of new small innovative companies at the university and an increase in sustainability-related R&D.

Following the proposed method, the carbon footprint from energy consumption in UrFU buildings for various activities, such as energy consumption for heating systems, hot water supply and electricity consumption from 2017 to 2023 was calculated and the economic assessment of environmental damage associated with carbon emissions was made. Also, the university's energy intensity using the information about electricity consumption as well as the carbon footprint per 1000 students from 2017 to 2023 was estimated.

Based on the findings, it is recommended for UrFU to improve the accounting of greenhouse gas emissions. There is the need to take into consideration all categories of carbon footprint and to estimate energy intensity per 1000 of students. Also, universities are encouraged to implement appropriate measures, such as the adoption of "green" university initiatives and participation in the UI Green Metric, in order to reduce campus carbon emissions and environmental damage.

Additionally, the examination of the pro-environmental behaviours of students reveals varying levels of engagement across different activities and student levels. While some practices, like turning off lights, are common among most students, others, such as unplugging chargers or using reusable shopping bags, show more disparity. Overall, there's a mixed response, with some students consistently practicing environmentally friendly activities while others do so less frequently. It is also revealed that a significant proportion of students do not actively engage in environmental actions, consistent with previous studies. It highlights unexpected findings, such as low usage of side lamps and differences in behaviour between private and shared spaces, suggesting potential reasons like forgetfulness or lack of motivation.

Finally, in exploring the reasons for and barriers to environmental behaviour among students across various activities such as energy conservation, water saving, and waste management, it is revealed that motivations for environmentally friendly actions include saving energy, reducing costs, and preventing device damage, while barriers include forgetfulness, fear of the dark, and lack of necessary resources like recycling containers. In terms of water conservation, reasons for behaviour range from reducing water wastage to saving money, with barriers including a perceived lack of necessity for certain actions. Similarly, waste management barriers include the absence of recycling infrastructure and forgetfulness, while motivations include promoting hygiene and proper waste disposal.

Conclusion

The significant increase in interest in environmental sustainability research among scientists around the world, especially in higher education institutions, is largely due to concerns about the increasing rate of environmental degradation and the declining quality of the environment around the world. The effects of environmental degradation have increased greenhouse gas emissions, waste production, inefficient use of water resources, pressure on energy sources and transport systems. Solving these problems has become a top priority for all stakeholders, including governments, researchers and university leaders around the world. One such strategy is the adoption of initiatives to create “green” campuses in universities and efforts to transition to a “green” economy.

In this study the author provides an evidence-based policy recommendations that contribute to the continuous improvement of environmental sustainability of the university with annual verification and prioritisation of “green” university initiatives. This study also analyses the impact of “green” university initiatives on “green” economy in Russia and presents a conceptual model that shows the important role of environmentally oriented universities in transforming to “green” economy.

Furthermore, the strategic management process of green university development, which represents a transformative approach to embedding environmental sustainability into university operations was studied. As a result, a strategic management framework for “green” university development was developed. Additionally, the concept of University Environmental Maturity, which allows universities to determine their level of implementation of environmentally oriented initiatives was introduced. Categorizing universities into maturity levels based on their integration of eco-friendly practices, provides a clear pathway for development. Based on this classification, the Environmental maturity of UrFU was determined. The case of UrFU, with its current classification of low environmental maturity, underscores the need for further efforts to enhance sustainability initiatives.

The study also makes it possible to assess the strengths, weaknesses, opportunities and threats that provide the university with competitive advantages in the implementation of the concept of environmentally oriented university. The study also evaluates the pro-environmental behaviour of students, studies the problems they face and gives recommendations for increasing student involvement in sustainable university practices.

Finally, the study suggests amendments to UI GreenMetric methodology to help to fully consider the carbon footprint, energy intensity, environmental damage associated with emissions, the revenue of Small innovative enterprises in collaboration with UrFU, and UrFU's share of R&D related to sustainable development. These suggested amendments to the UI GreenMetric methodology include "Category EC 8" which relates to "The ratio of total carbon footprint to total campus population, taking into account carbon absorption capacity (tCO_2 eq per person)", "Category ED12" which relates to "The revenue of Small innovative enterprises related to sustainable development, created with the participation of the university (mln. rubles)", and "Category ED13" which relates to the share of R&D related to the sustainable development in total R&D (%). Based on this, the carbon footprint, energy intensity and economic damage to the environment from carbon emissions of the UrFU, the annual revenue of SIEs created in collaboration with UrFU, and the annual volume of R&D related to sustainable development conducted by UrFU over the period 2017–2023 are assessed.

The results of the study indicate the high dynamics of "green" university initiatives development. The study showed that "green" university initiatives are very important in reducing the negative effects of environmental degradation by helping to ensure efficient waste and water management, clean energy production and energy efficiency, biodiversity conservation, pollution and greenhouse gas reduction. Universities can also play a significant role in conducting research and establishing small innovative companies that contribute to sustainable development. The contribution of universities to environmental education and the development of appropriate thinking and lifestyles is also great. Considering the significant role played by "green" universities in ensuring environmental sustainability, it can be argued that developed countries use the model of “green” universities as a basis for the long-term development of “green” economy initiatives, where “green” universities are the actors of the “green” economy.

National environmental policies that promote the creation of “green” universities and ensure their effective functioning through the modernization of institutional, technological, political and economic structures are very important. This can be achieved by investing in the development of innovative overall “green” economy development models that recognize “green” university initiatives as a critical block.

Currently, the number of “green” universities in the Russian Federation is growing, but it is still significantly lower than in other developed countries. This can be explained by the lack of research on the concept of “green” universities and how they affect the development of a “green” economy. As a result, a detailed theoretical understanding of the concept of a “green” university, an empirical development of their impact on environmental quality, as well as their relationship with the development of a “green” economy are of great importance.

Based on the results of the study, the author recommends that in order to achieve nationwide sustainability on university campuses, the Russian Ministry of Higher Education and Science should oblige all universities to adopt “green” university initiatives. This can be achieved by requiring all Russian universities to implement campus sustainability reforms that will allow university campuses to be used as “living laboratories” to educate and train students on issues related to sustainability. In addition, universities are encouraged to join the GreenMetric World University Rankings to create conditions for the regular evaluation of “green” initiatives on university campuses. It is important for university leaders to actively involve students in all aspects of campus sustainability, as they are the main agents of change in environmental sustainability in the future. It is also important to encourage universities to conduct research aimed at sustainable development and bring it to practical implementation. Local governments are encouraged to develop policies to integrate “green” university initiatives into regional and national policy agendas such as “green” economy development. This can be achieved by creating a funding opportunity that will help alleviate the initial financial burden in the early stages of implementing “green” universities initiatives. Student leaders are encouraged to create social groups and events, such as environmental clubs and environmental awareness weeks, that will encourage students to actively participate in campus “green” initiatives, as well as reward outstanding students for environmental action. Higher education institutions are encouraged to reorient their curricula to include various aspects of environmental protection or greening, not only in academic programs in environmental economics, but also in all other programs offered in universities. This will allow all students to have a certain level of environmental knowledge and help develop a sense of responsibility.

To further advance knowledge, future research endeavours should prioritize several avenues. Firstly, deepening the theoretical understanding of “green” universities and their interplay with the development of a sustainable “green” economy remains paramount, necessitating rigorous empirical investigations to bridge existing gaps in evidence. Secondly, empirical studies should scrutinize the tangible impact of “green” university initiatives on environmental quality, meticulously considering factors such as infrastructure, waste management practices, and campus conditions. Additionally, conducting a comprehensive SWOT analysis can offer nuanced insights into critical challenges and opportunities when adopting “green” university initiatives as a cornerstone for fostering a sustainable economy. Moreover, exploring the multifaceted role of students as key stakeholders in “green” initiatives and unravelling their pro-environmental behaviours can yield valuable insights for crafting effective campus sustainability strategies.

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List of Abbreviations

AHP— Analytic hierarchy process

GGGI— Global Green Growth Institute

GHESP— Global Higher Education Partnership for Sustainable Development

GHG— greenhouse gas

MDGs— United Nations developed the Millennium Development Goals

PEB— pro-environmental Behaviours

SD— Sustainable development

SDG— Sustainable Development Goals

STARS— Sustainable Tracking, Assessment and Rating System

SWOT— Strengths, Weaknesses, Opportunities, and Strengths

THE— Times Higher Education

UI GM— University of Indonesia green Metric

UI GWURN — UI GreenMetric Global Ranking Network

UN — United Nations

UNCED — United Nations Conference on Environment and Development

UNDESD— United Nations Decade of Education for Sustainable Development

UNEP— United Nations Environment Program

UNESCO— United Nations Educational, Scientific and Cultural Organization

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Appendix A

Table A1 – UI GM indicators implemented by UrFU

Categories and Indicators	**Yes**	**NO**
SETTING AND INFRASTRUCTURE (SI)		
The ratio of open space area to the total area	+	
Total area on campus covered in forest vegetation		-
Total area on campus covered in planted vegetation	+	
Total area on campus for water absorption besides the forest and planted vegetation		-
The total open space area divided by the total campus population	+	
Percentage of university budget for sustainability efforts		-
Percentage of operation and maintenance activities of building in one year period	+	
Campus facilities for disabled, special needs, and/or maternity care	+	
Security and safety facilities	+	
Health infrastructure facilities for students, academics, and administrative staff's wellbeing	+	
Conservation: plant (flora), animal (fauna), or wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities		-
ENERGY AND CLIMATE CHANGE (EC)		
Energy-efficient appliances usage	+	
Smart building implementation		-
Number of renewable energy sources on campus		
Total electricity usage divided by total campus' population (kWh per person)		-
The ratio of renewable energy production divided by total energy usage per year		-
Elements of green building implementation as reflected in all construction and renovation policies		-
Greenhouse gas emission reduction program		-
The ratio of total carbon footprint to total campus population (tCO_2 eq per person)		-
Number of the innovative program(s) in energy and climate change	+	
Impactful university program(s) on climate change	+	
WASTE (WS)		
3R (Reduce, Reuse, Recycling) program for university's waste		-
Program to reduce the use of paper and plastic on campus		-
Organic waste treatment		-
Inorganic waste treatment		-
Toxic waste treatment		-
Sewage disposal	+	
WATER (WR)		
Water conservation program & implementation	+	
Water recycling program implementation		-
Water-efficient appliances usage	+	
Consumption of treated water		-
Water pollution control in the campus area		-
TRANSPORTATION (TR)		
The total number of vehicles (cars and motorcycles) divided by the total campus' population		-
Shuttle services	+	
Zero-Emission Vehicles (ZEV) policy on campus		-
The total number of Zero-Emission Vehicles (ZEV) divided by the total campus population		-
The ratio of the ground parking area to the total campus' area	+	
Program to limit or decrease the parking area on campus for the last 3 years (from 2021 to 2023)		-
Number of initiatives to decrease private vehicles on campus		-
The pedestrian path on campus	+	

EDUCATION AND RESEARCH (ED)		
The ratio of sustainability courses to total courses/subjects	+	
The ratio of sustainability research funding to total research funding		-
Number of scholarly publications on sustainability	+	
Number of events related to sustainability		-
Number of activities organized by student organizations related to sustainability per year		-
University-run sustainability website		-
Sustainability report		-
Number of cultural activities on campus	+	
Number of university sustainability program(s) with international collaborations		-
Number of sustainability community services projects organized and/or involving students		-
Number of sustainability-related start-ups		-
Total	20	31

Appendix B

Table B1 – Electricity consumption in KWh in 2017 for UrFU

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
Мира,19	205912	179171	238360	221169	219417	195225	157373	171074	217412	239817	185453	261125	2491508
С.Ковалевской,5	89768	76128	96869	95967	277219	1	9	55297	79203	106031	97538	134531	1108561
С.Ковалевской,7/А	12104	16156	18764	15872	15381	17182	18552	20639	20906	20173	19633	23711	219073
Комсомольская,62	11672	14260	21215	21773	18106	13097	8371	7394	17999	19355	13236	21136	187614
Большакова,71	9050	5407	4881	4594	3350	3848	2733	2799	2819	2551	4525	4448	51005
ул.Мира, 28 лит.А	60743	34020	56332	54617	57039	47914	37799	37452	49844	54476	45380	55236	590852
Мира,29	34020	24022	24270	18761	39552	22215	1977	12454	25051	27862	13374	25608	269166
Мира,29/А	2118	2212	2820	2549	2532	2237	1791	2248	2228	2798	2692	2729	28954
Мира,17	31482	28138	31665	29691	26349	22362	10903	11843	25149	30708	32427	38470	319187
Мира,32	53144	30010	50042	51486	56197	52547	43966	43704	54896	58184	38620	58623	591419
Комсомольская,59, литер Ж,3	3484	4121	4326	3876	4507	4173	4040	8190	4463	3774	6312	3550	54816
С.Ковалевской,5/А	27156	22534	24011	24481	21105	17885	11656	9393	20060	21932	16442	24443	241098
Мира,36/А	6753	6382	7190	6143	6503	6456	2111	2402	6335	7558	7437	5372	70642
Мира,34/Г	1334	1378	1238	1119	1112	1245	889	870	1364	1264	1241	1299	14353
Мира,21	22830	27914	42695	41362	37768	25214	17791	24030	43525	47779	41813	46047	418768
С.Ковалевской,4	7259	6874	8794	8409	6990	7112	5308	6000	8205	7341	9682	8079	90053
Малышева,140/А	2064	2058	2324	1971	2138	1537	1451	1220	1914	2482	2537	2201	23897
Фонвизина,5	6992	6658	7466	6023	5820	3858	2685	3483	7101	9450	10533	9216	79285
Фонвизина,8	293	340	235	33	44	3	3	5	7	4	42	104	1113
Малышева,138	154	107	99	76	66	49	47	75	92	112	133	129	1139
Комсомольская,66/А	1724	2074	4150	1993	2333	1768	642	1234	2855	2914	3108	2184	26979
Мира,19	7082	5256	5656	5654	5633	5152	4658	4833	5678	5488	5625	5490	66205
С.Ковалевской,3/А	2381	1957	2307	2310	2911	2638	2168	2491	2083	2025	1974	1812	27057
Коминтерна,14	14740	16562	14986	14596	12587	5120	3922	5064	10532	16268	19865	16698	150940
Коминтера,16	7361	6295	8085	9069	6886	4811	2713	2926	7483	8310	9238	7960	81137
Комсомольская,61	1853	1594	2019	1539	1531	1603	1256	709	2595	1826	1873	2114	20512
С.Ковалевской,4	1780	1384	1420	1120	1488	1408	1214	1438	1337	576	340	1170	14675
ул.Фонвизина, д.9	0	0	21	0	0	0	44	0	22	67	4	0	158
Коминтерна, 3/1	3068	2940	3089	2252	1781	1239	935	911	1854	2645	2294	2108	25116
489	748	581	573	1322	0	643	1921	1390	1006	1051	10118	1051	20404
Малышева,140	285	53	45	160	346	210	155	35	357	8	8	80	1742
Малышева,127/А,литер А"	3191	2141	1784	1133	1338	1563	931	945	1243	1707	1484	1766	19226
Коминтерна,14/А,литер А	27118	21759	23547	23340	45051	60312	43874	51394	51359	25120	25790	23837	422501
Малышева,140	11218	20816	23793	20098	20921	17719	9959	12096	20184	22955	21854	21299	222912
Малышева,127/А	22711	19435	18895	16295	18170	16123	12705	15659	17358	19151	19078	18458	214038
Малышева,127/А,литер А	21594	16580	14271	13148	15591	14408	11437	13757	14537	14813	14927	14264	179327

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
Малышева,144	46385	33620	33311	40334	54409	47981	35357	32667	150143	76004	74704	70679	695594
Коминтерна,3	77349	64507	66430	52425	50596	41436	18870	17490	41870	53363	56400	63899	604635
Комсомольская,70	0	0	0	0	0	0	0	12080	58698	76875	78910	71671	298234
Фонвизина,8	9456	23203	31467	27062	29099	24190	11226	10686	20763	27075	16388	35345	265960
Ленина,66	24550	33964	31311	34172	29649	30681	20710	16273	30101	33056	35071	36752	356290
Коминтерна,5	17901	28112	33924	34444	31964	36308	23463	18262	24538	33513	33570	34506	350505
Фонвизина,4	17359	25057	31330	31131	36213	21775	17976	9331	23582	27675	29338	29455	300222
Комсомольская,66/А	38608	49026	49861	42872	39152	30226	23633	28900	31505	35264	24816	41892	435755
Коминтерна,1/А	47958	41413	43145	35764	24805	28308	29569	22009	35107	40841	43646	42852	435417
Ленина,66/А	3144	2942	3094	2900	3094	2720	2261	2734	2820	3059	2742	2461	33971
Малышева,127/А	4823	4295	4033	2863	2438	1832	1072	1162	1896	3594	4798	4745	37551
Ленина,66/А	1419	1127	1213	1124	1111	1077	889	1163	1164	1212	1321	1234	14054
Коминтерна,1/А	3348	3903	6757	6601	7473	7825	4428	607	7670	7473	8505	8322	72912
г.Березовский,Белоярская зона	21249	17739	12336	10511	7437	4725	3577	3348	5602	9172	13022	12650	121368
Большакова,77,литер В	4333	7434	4775	4045	2457	3822	2205	2713	3734	2541	5061	3695	46815
Чапаева,16/А	78470	61030	58310	58860	59220	38800	21990	21250	33190	48830	60370	47170	587490
Большакова,77,литер Б	32700	20900	22360	21700	23240	21160	13700	8900	18480	23220	27980	21680	256020
Большакова,79,литер А	27380	18360	19080	18560	19800	18100	11360	7640	11260	20720	21940	16380	210580
Ленина,51,литер В	33328	51350	53150	47224	47691	43234	32722	30637	46644	61398	55115	50405	552898
Ленина,13/Б/Маршала Жукова,1,литер А	5137	15835	9643	9511	9386	11149	5391	6017	9641	12425	9889	11656	115680
Чапаева,16	19908	16648	15061	15399	11750	567	520	915	18410	16286	7072	8794	131330
Чапаева,16,литер А	15005	10868	11987	11953	10007	9871	4179	5821	9993	9681	15341	13308	128014
Чапаева,20/фурманова,38,литер В	4668	7098	7035	9009	3948	5334	2814	3495	5577	6636	10794	8804	75212
Данилы Зверева,30,литер Б	7140	5820	5000	5000	2960	5720	2600	2060	4780	6200	6120	6350	59750
Большакова,71,литер А	85900	58990	43900	37170	33300	28930	20890	15080	25740	33960	49480	42880	476220
Сибирский тракт,36/А	10979	21332	16630	17487	9712	4994	1340	2274	5004	8791	13067	18461	130071
Народной воли,64/А	4035	3901	3599	3393	2773	1705	1727	1250	2259	3316	3411	2991	34360
г.Первоуральск,с.Слобода	19456	20637	15984	14461	12836	7993	7744	8165	12126	11447	13104	15799	159752
Сысертский район,п. Двуреченск	4505	5208	6093	5421	5757	7834	11682	4963	3130	3742	3680	4414	66429
Данилы Зверева,30	15813	40289	34889	34233	22486	31169	18291	13813	36067	46014	41604	40700	375368
ул. Коминтерна,5	5022	4408	4676	4514	4720	4550	3565	4360	4919	4805	5501	4249	55289
Тургенева,4,литер А	106922	107820	129224	120798	108272	87752	82724	87523	94844	126318	132888	130605	1315690
Куйбышева,48/А/Белинского,71/А	89575	195653	145490	153395	142512	136072	125556	126390	147102	163107	179653	179102	1783607
Мира,19	124	73	115	759	529	179	11	13	116	97	531	681	3228
Мира,21	11033	9387	8655	9294	10211	19441	23883	19559	6580	8292	9300	9315	144950
ул. С.Ковалевской, д.5	2436	2040	2299	2518	3046	2640	2864	2681	1715	2309	2671	3131	30350
ул. Малышева, д.138 литер Б	17	15	17	13	18	38	51	213	187	313	130	338	1350
ул. Малышева, д.138 литер Б	192	281	494	351	404	503	148	161	578	691	624	624	5051

Адрес потребителя	**январь**	**февраль**	**март**	**апрель**	**май**	**июнь**	**июль**	**август**	**сентябрь**	**октябрь**	**ноябрь**	**декабрь**	**год**
ул.Комсомольская, д.11/а	286	710	664	697	864	685	650	503	1087	783	856	749	8534
ул.Коминтерна, д.11	57602	50237	46187	40184	43846	39500	30429	34796	40331	46222	46951	47450	523735
ж/д район С-В берег оз.Песчаное	65328	64119	55284	35420	18211	46261	54682	49301	18560	39217	56586	64270	567239
г.Березовский,ул.Механизаторов,д.39	19842	20703	21959	7856	59043	94268	84400	84118	15890	13249	14593	17644	453565
ул.Мира, 28 лит.А	52124	72031	76352	79266	77765	66673	39908	30266	77515	80812	91396	79866	823974
ул. Мира, д. 36/пер.Отдельный, д.7 лит.Б	231	519	257	285	5	69	108	92	158	130	150	149	2153
ул.С.Ковалевской, 6б	2574	2086	2236	2075	2076	1224	1210	1393	1428	2631	1991	1880	22804
ул.Фонвизина, д.4	1341	859	348	318	1032	1679	1636	1989	1455	1603	1784	1942	15986
ул.Фонвизина, д.4	1968	1741	1197	849	1064	773	513	616	864	1035	1575	1763	13958
ул.Розы Люксембург, д.32/б	227	268	197	15	4	5	3	4	9	10	4	1	747
ул.Агрономическая, д.37	1401	1744	3383	5946	7105	9300	9019	7144	16534	15796	11594	14808	103774
	1815737	1836619	1942979	1824183	2013252	1609955	1241535	1298281	1840422	2039378	2012667	2174865	21649873
Гоголя, д.25	17224	14175	15715	15464	15985	16642	16388	13110	11536	10535	13366	12474	172614
ВСЕГО за 2017г.	1832961	1850794	1958694	1839647	2029237	1626597	1257923	1311391	1851958	2049913	2026033	2187339	21822487

Table B2– Electricity consumption in KWh in 2018 for UrFU

Адрес потребителя	**январь**	**февраль**	**март**	**апрель**	**май**	**июнь**	**июль**	**август**	**сентябрь**	**октябрь**	**ноябрь**	**декабрь**	**год**
Мира,19	294178	117323	339403	140643	151898	141527	135729	147270	183665	288141	258986	246144	2444907
С.Ковалевской,5	113752	58995	150695	96884	59878	59845	63084	65870	71625	114828	103947	82424	1041827
С.Ковалевской,7/А	30849	22995	28175	25709	24878	22267	21886	23009	24600	34294	26654	24372	309688
Комсомольская,62	24336	12206	26990	17447	13254	9419	8247	7832	15892	28143	18624	17086	199476
Большакова,71	5787	5709	5800	5011	3978	2672	2065	2095	2278	2733	4130	4646	46904
ул.Мира, 28 лит.А	65026	31723	65471	49379	35703	30205	26556	40057	41814	62578	58420	47398.2	554330.2
Мира,29	48802	22137	31691	23453	17011	5724	11157	13879	25961	47170	53431	24922	325338
Мира,29/А	2795	2453	2521	2201	2443	2234	1562	1660	2175	2356	2250	2203	26853
Мира,17	32576	25553	29006	25035	18658	20413	15693	13129	24880	39794	35388	32201	312326
Мира,32	85210	41249	68966	57470	35460	29633	35649	31837	39175	77086	62247	48365	612347
Комсомольская,59, литер Ж,3	6287	4406	4656	3792	9150	5685	2796	2925	9950	4131	4460	4461	62699
С.Ковалевской,5/А	22507	22461	24887	22374	12680	15534	13149	9215	23524	41298	34640	29259	271528
Мира,36/А	5375	4684	4707	4449	4402	4384	1161	1321	3224	4510	4310	5102	47629
Мира,34/Г	1492	1549	1475	1106	1268	1402	918	712	1328	1259	1121	1214	14844
Мира,21	50275	0	234127	129733	70627	82488	92050	92386	111677	192027	503592	401207	1960189
С.Ковалевской,4	7824	8047	7926	8244	7245	5445	6905	5279	7252	7931	8843	7456	88397
Малышева,140/А	1827	1734	2176	1718	1988	1523	1261	1361	1901	2486	2738	2547	23260
Фонвизина,5	7973	8621	9612	7147	6687	5239	3031	4412	6639	9037	9904	8507	86809
Фонвизина,8	40	34	59	48	49	51	21	12	63	81	36	73	567
Комсомольская,66/А	2002	2067	2487	2456	2284	1364	546	1118	497	581	604	659	16665
Мира,19	5582	5025	5041	5501	5754	5898	6213	5395	5474	5807	5839	5182	66711
С.Ковалевской,3/А	1871	1861	1894	2068	2341	2202	2947	2305	1950	2059	1747	1353	24598
Коминтерна,14	15448	16983	16748	15105	10800	6070	4736	4569	9614	17808	18229	18589	154699
Коминтера,16	7094	7221	9109	9698	6972	6485	2941	3520	6496	8942	10013	7707	86198
Комсомольская,61	1957	1851	2060	1728	1768	1806	1399	1358	1843	2099	1785	1987	21641
С.Ковалевской,4	570	1374	1589	808	592	430	1288	584	1225	1477	1178	1289	12404
ул.Фонвизина, д.9	105	0	0	0	0	0	0	0	0	45	0	0	150
Коминтерна, 3/1	2005	1784	2310	2036	1797	1420	589	943	1483	1986	1573	2099	20025
ул. Малышева, д. 136	903	750	900	863	883	1227	955	509	1296	1303	879	994	11462
Малышева,140	55	226	196	85	211	198	1125	1009	534	481	153	179	4452
Малышева,127/А,литер А"	2700	1718	1701	794	697	1118	455	569	518	931	719	981	12901
Коминтерна,14/А,литер А	27796	23673	23004	22334	47750	50687	48269	55402	44779	48540	24873	21275	438382
Малышева,140	22448	18113	21197	18671	19719	16190	14020	7799	5119	5739	5894	6495	161404
Малышева,127/А	44928	37425	38791	32652	37631	30496	26750	25486	38008	35559	35800	42320	425846
Малышева,144	79660	65486	79445	75085	86142	68346	78220	48617	79944	74335	74431	84860	894571
Коминтерна,3	75180	54611	63887	43380	49278	40697	21461	13642	40740	47336	54784	70927	575923
Комсомольская,70	74473	61560	67186	62284	76480	61807	49657	53824	61586	75427	89959	104780	839023
Фонвизина,8	25880	21161	24977	21742	25734	19951	13916	8899	21382	23751	22232	25889	255514

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
Ленина,66	36412	35140	34988	35855	32174	32813	20034	16372	29498	35013	39138	38855	386292
Коминтерна,5	32331	28873	30736	32144	29116	31998	18707	13985	24764	31398	33927	31709	339688
Фонвизина,4	25724	25142	25371	27675	24466	27330	14673	11493	20167	26593	29430	28058	286122
Комсомольская,66/А	41536	31577	32892	27999	34353	25659	24171	22029	31883	32536	33695	37746	376076
Коминтерна,1/А	34039	32074	31781	33988	30977	33241	23170	16290	30007	35684	39412	37743	378406
Ленина,66/А	4057	3486	3372	3137	3368	3262	2841	3011	2929	3686	3166	3526	39841
Коминтерна,1/А	6541	5374	7716	6456	6910	7391	4557	571	6493	5998	6673	6062	70742
г.Березовский,Белоярская зона	20375	16912	16352	11563	6346	5204	1954	3142	3842	0	0	0	85690
Большакова,77,литер В	4306	4158	4935	3591	3234	210	0	0	9954	2268	2604	3024	38284
Чапаева,16/А	62180	67140	69150	49730	45620	45110	24140	24250	36590	44480	53130	56510	578030
Большакова,77,литер Б	27040	25640	28920	23320	23460	20460	14620	13020	17740	22720	22560	26360	265860
Большакова,79,литер А	20800	19200	22300	18760	18840	17880	9960	6400	14700	17820	17740	19120	203520
Ленина,51,литер В	53673	45192	51734	45693	50685	41521	35274	32036	43147	56006	50546	38658	544165
Ленина,13/Б/Маршала Жукова,1,литер А	12778	7796	12989	9734	9950	8776	6736	5638	9260	10458	11017	11970.55	117102.6
Чапаева,16	9444	11718	16081	14332	16490	754	500	319	1103	9751	13005	12735	106232
Чапаева,16,литер А	14509	3749	13461	12191	11677	9957	7735	4180	9491	12094	12511	12826	124381
Чапаева,20/фурманова,38,литер В	8374	8358	8862	7980	7770	6360	4768	1976	6216	8120	9793	10257	88834
Данилы Зверева,30,литер Б	4290	6029	5214	4188	6004	3684	1951	1575	5189	4955	7157	6576	56812
Большакова,71,литер А	61800	65830	91500	34910	25850	27410	20270	16360	26210	33530	42370	52590	498630
Сибирский тракт,36/А	13601	21297	19932	18048	12384	4759	1285	2274	5003	11314	14979	1007	125883
Народной воли,64/А	5587	4249	4233	3251	3689	3654	32	406	1804	3571	3182	3170	36828
г.Первоуральск,с.Слобода	16914	18379	17036	14070	11989	7851	6426	7091	8147	12207	13059	16564	149733
Сысертский район,п. Двуреченск	3895	3527	3986	4657	5391	7834	10338	5574	2978	4658	4810	4414	62062
Данилы Зверева,30	33754	43392	37311	32801	34651	26916	12203	10583	36933	41073	37936	39485	387038
ул. Коминтерна,5	3702	4466	4583	4603	433	1	0	0	0	0	0	0	17788
Тургенева,4, литер А	125280	112968	127569	123435	108272	101226	101176	90805	100835	125724	123248	124993	1365531
Куйбышева,48/А/Белинского,71/А	154323	159088	175688	171576	142750	138782	132160	121808	145413	175058	171183	170935	1858764
Мира,19	256	0	0	0	0	0	0	0	0	0	0	0	256
Мира,21	11468	11728	12353	20800	20595	16083	17537	11584	16465	29429	27389	28779	224210
ул. С.Ковалевской, д.5	4349	3772	3628	0	0	0	0	0	0	0	0	0	11749
ул. Малышева, д.138 литер Б	403	431	50	82	129	19	27	28	28	43	33	0	1273
ул. Малышева, д.138 литер Б	432	424	346	329	391	563	115	23	566	715	887	0	4791
ул.Комсомольская, д.11/а	728	575	797	502	656	380	169	118	579	516	623	410.3	6053.3
ул.Коминтерна, д.11	56800	43207	46024	38402	42989	35232	34303	26624	39282	36503	40556	47981	487903
ж/д район С-В берег оз.Песчаное	81238	58142	60254	40904	18989	29611	28462	35485	10436	21353	28614	12677	426165
г.Березовский,ул.Механизаторов,д.39	22482	17604	19012	13184	52531	96699	122806	41890	14916	17539	22152	18828	459643
ул.Мира, 28 лит.А	66334	73054	75782	82858	77905	48870	45277	37255	57365	95698	93599	80288.4	834285.4

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
ул. Мира, д. 36/пер.Отдельный, д.7 лит.Б	284	79	514	129	129	0	194	26	86	0	0	0	1441
ул.С.Ковалевской, 6б	2148	2009	2475	2071	1821	1309	1831	765	1987	2231	2468	1502.4	22617.4
ул.Фонвизина, д.4	2249	2224	2285	2066	2382	1958	2309	534	3014	1194	950	914	22079
ул.Фонвизина, д.4	2036	1691	1473	997	739	809	442	442	1097	1117	1261	1689	13793
ул.Розы Люксембург, д.32/б	0	0	4	2	0	0	1	0	1	1	1	5	15
ул.Агрономическая, д.37	15409	7167	15655	10399	15105	22460	10986	11409	16213	16282	7923	13856	162864
	2301449	1747629	2540209	1927545	1795300	1656118	1482547	1297180	1712442	2303425	659978	2388976	23719960
Гоголя, д.25	8874	9584	11178	9997	9053	9100	7992	6956	9545	10482	7923	13856	114540
ВСЕГО за 2018г.	2310323	1757213	2551387	1937542	1804353	1665218	1490539	1304136	1721987	2313907	667901	2402832	23834500

Table B3 – Electricity consumption in KWh in 2019 for UrFU

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
Мира,19	199787	215542	196091	209608	286423	157055	136275	136405	149225	215949	352191	289151	2543701.53
С.Ковалевской,5	71452	83269	86636	97298.8	81501	70430	0	0	0	0	0	0	490586.75
С.Ковалевской,7/А	26549.4	21067.8	24316.2	28276	23568.9	24580.5	22335.7	21249.3	20877.6	21261	20304	21973	276359.4
Комсомольская,62	13747.4	15743.8	15677.8	17072.6	15254.5	11538.1	9520.2	8295.3	14917	19002	17623	18457	176848.7
Большакова,71	5952.32	5376.22	4219.77	4647.06	3000.76	2587.14	2004.35	2490.26	3280	3553	5558	5618	48286.893
ул.Мира, 28 лит.А	29381.5	38782.2	49275.9	56899.6	45365.8	41482.5	0	0	0	0	0	0	261187.5
Мира,29	35603.8	28153.8	28408.4	31082.8	25587.2	17596.4	6506.4	13443.2	21500.8	37274.4	50280	26778	322215.2
Мира,29/А	2079.6	2061.2	1928	2103.6	2094.4	1644	1362.8	1456.4	2151.6	2030	1763	1626	22300.6
Мира,17	26744.2	28501.8	24166	27886.2	23021	19985.4	15157.4	11823.4	23495	29613	30042	38538	298973.4
Мира,32	42924.4	50919.2	50564.4	55446	47759.6	40906	0	0	0	0	0	0	288519.6
Комсомольская,59, литер Ж,3	8849.5	5410	3241.8	3596	3167.4	3375.8	4124	3175.9	7599.6	6706	6785	7324	63355
С.Ковалевской,5/А	24241.2	24288	25807.2	27792	24866.4	22293	18676.2	17144.4	18266.4	25740	25343	28413	282870.8
Мира,36/А	5247.3	4613.6	3386.1	3876.1	3131.4	2991.2	1352.4	1523.4	3441	4522	4206	4737	43027.5
Мира,34/Г	1264.2	1527.9	1122.1	1475.6	1283.1	1308.2	1102.4	908	1245.1	1137	1031	1038	14442.6
Мира,21	85463.1	98751.5	138149	122679	101162	0	112353	82199.7	110355	147271	261399	182536	1442318.3
С.Ковалевской,4	6573.85	7886.7	6639.85	8761.75	7778.5	5544.75	6537.95	5067.15	7493.1	7676	8101	8135	86195.6
Малышева,140/А	2017.1	2028.42	1834.86	1826.09	1374.13	889.91	920.66	1003.72	1293	1815	1747	1745	18494.89
Фонвизина,5	7017	7719.75	7064.85	7198.95	5746.05	4332.9	2088	3361.8	5589	8523	7172	6423	72236.3
Фонвизина,8	61.8	34.5	16.6	21.4	17	3.7	2	0	477	285	18	18	955
Комсомольская,66/А	426.8	491.2	676	547.2	463.6	606.8	484.8	613.2	470.8	542	555	526	6403.4
Мира,19	5565.81	5381.34	5282.19	6002.22	5433.21	4867.98	4915.8	5155.56	5377.53	5956	5778	6272	65987.64
С.Ковалевской,3/А	1596.2	1392.5	1388.4	1915.8	1838.2	1823.5	2271.85	1998.33	1638.38	1961	1814	1936	21574.16
Коминтерна,14	15499.9	17235.9	16514.9	17079.2	11565.4	7458.5	6343.6	6182.2	15340	19837	18946	17719	169721.6
Коминтера,16	7975.2	8383.8	7591.9	9093.3	7085.2	6322.4	3005.5	4648.2	7042.1	10012	9918	8088	89165.6
Комсомольская,61	2040.45	2071.65	1582.8	1735.95	1499.55	1836.9	1437.15	1365	1528	1683	1733	701	19214.45
С.Ковалевской,4	1573.2	1298	644.4	727.6	415.6	1174	1296	1178.4	1064	609	1268	1365	12613.2
ул.Фонвизина, д.9	46.8	0	0	6.2	9.8	35	0	0	25	21.1	28	0	171.9
Коминтерна, 3/1	1613.1	1624.5	1577.7	1777.8	1919.1	1203.3	819.9	960	1195	2478	2753	2809	20730.4
ул. Малышева, д. 136	946.1	1011	673	836	710	1038	955	364	1208	992	1001	706	10440.1
Малышева,140	141.6	571.2	539.4	720.3	755.1	500.7	354.9	484.8	885	1350	1228	1527	9058
Малышева,127/А,литер А"	1803.53	757.68	678.81	726.86	653.46	1229.81	676.11	569	372	796	704	1063	10030.26
Коминтерна,14/А,литер А	26887.2	23624.4	22245	25439.4	51281.4	0	45072	66778.2	49446	49516.2	66468	27407	454164.8
Малышева,140	18758.1	16974.9	19782.3	19751.1	21194.7	17669.7	13172.1	15613.2	29232.3	33737	33592	35809	275286.4
Малышева,127/А	47980.6	32323.8	35626.4	37306.3	34296.6	33863.6	29381.5	29949.9	39159.5	35535	34435	34421	424279.2
Малышева,144	94395.9	63997	75029.7	83527.1	70258	74391.3	68443.8	60444.5	67918	69326.1	67274	67088	862093.35

Адрес потребителя	**январь**	**февраль**	**март**	**апрель**	**май**	**июнь**	**июль**	**август**	**сентябрь**	**октябрь**	**ноябрь**	**декабрь**	**год**
Коминтерна,3	77863.3	45229.8	52644	49095.9	41734.3	42323.2	25559.7	16796.5	39014.2	48906.3	49912	50219	539298
Комсомольская,70	103937	68188.2	86557	96981.8	78859.6	75967.3	64196.8	53776.9	71343.5	85745	84052	84291	953896.33
Фонвизина,8	25349.8	16612.3	26249.4	20693.4	21608.2	21190.7	13917.3	7056.8	6445.4	4979	4301	4195	172598.3
Ленина,66	37225.7	32126.1	32829	36162.5	35162.4	30875	26781.2	20998.5	28020.7	32273	33391	37685	383530.29
Коминтерна,5	29873.6	27826.8	32103.6	33994.4	31904	27380.8	19836.8	11951.6	25558.4	31599	33081	38669	343779
Фонвизина,4	25918.4	24304	25371.6	27518	26453	22237.2	15974.4	7766	21179	26506	27640	31040	281907.6
Комсомольская,66/А	41680	28345.8	28962.2	41292.6	39111.6	37593.8	34309	31898.4	39961.8	39510	39640	39871	442176.2
Коминтерна,1/А	35761	31482.2	33966	36702.8	36228	29467.6	27051.6	16081.2	37538	41746	43262	49240	418526.4
Ленина,66/А	3306.87	2913.66	2724.51	3112.46	3155.47	2902.87	2880.38	3210.13	3924.53	3332	3439	3248	38149.88
Коминтерна,1/А	4427.55	3892.5	5324.4	5734.35	6198.9	4615.65	1314	156	5227	6040	5799	5918	54647.35
г.Березовский,Белоярская зона	0	0	0	0	0	0	0	0	0	0	0	0	0
Большакова,77,литер В	4326	3423	3003	3003	3003	378	273	1176	2625	1638	2373	2205	27426
Чапаева,16/А	71210	66590	45270	51690	37890	40730	29780	22394	58070	37800	49140	49530	560094
Большакова,77,литер Б	30860	27740	21920	25980	19380	20200	14840	10700	20480	21120	24500	22300	260020
Большакова,79,литер А	22680	20040	15460	19600	15260	16508.7	11338.3	8447.74	14799	18850	19339	18055	200377.748
Ленина,51,литер В	57938	46454.7	44772.7	48352.1	41079.6	38885.9	28086.1	36632.6	40991	53406	58175	46547	541320.698
Ленина,13/Б/Маршала Жукова,1,литер А	10852.9	8989.95	9373.9	8890.1	6146.2	9978.7	5407.25	5153.2	9523	10165	8766	8299	101545.15
Чапаева,16	15105	11790	15315	13650	23361	22608	23361	15072	2481	12585	21480	4500	181308
Чапаева,16,литер А	10789	10362	6318	12210	9359	7511	5720	4780	9080	10740	13290	11670	111829
Чапаева,20/фурманова,38, литер В	9760	10240	6560	9680	6292	5828	4280	2720	4800	7600	11360	10080	89200
Данилы Зверева,30,литер Б	5186.6	5895.8	4221.8	4584.2	4353.4	1851.4	1920.2	1345	4967	6096	6848	7150	54419.4
Большакова,71,литер А	65981	62781	42742	42410	27161	27639	20650	16710	29800	32240	48020	51480	467614
Сибирский тракт,36/А	38798.2	17705.2	13292.4	13054.2	12382.7	2317.77	2557.49	3437.28	10977	11314	20671	8907	155414.225
Народной воли,64/А	4772.99	3330.16	3328.08	3571.67	2403.67	1362.67	1003.52	1393.9	2583	2446	3513	3828	33536.653
г.Первоуральск,с.Слобода	14426.7	18793	18111.5	12403.3	10902.8	7435.57	6279.81	5085.93	8160	10025	15260	54595	181478.592
Сысертский район,п. Двуреченск	4902.05	4963.14	4963.14	4902.05	5390.71	6581.8	9391.57	3344.47	3833	4658	4658	6795	64382.92
Данилы Зверева,30	38006.1	41646.8	31955.1	35348.2	34749.5	20498.6	11612.4	10261.9	36027	37694	39359	38291	375449.6
ул. Коминтерна,5	0	0	0	7.65	0	0	0	226.47	0	0	0	0	234.12
Тургенева,4,литер А	113549	108115	122802	117073	94148	92940	117134	82273	93863	123942	114898	115288	1296025
Куйбышева,48/А/Белинского,71/А	152241	152473	163651	153994	146074	128981	86231	113960	141310	170298	161517	163499	1734229
Мира,19	0	0	0	0	0	0	0	0	0	0	0	0	0
Мира,21	32556.9	29636.5	29525.8	36694.5	28716.1	0	25884.8	28865.3	22987	26573	64091	36353	361883.9
ул. С.Ковалевской, д.5	0	0	0	0	0	0	0	0	0	0	0	138965	138965
ул. Малышева, д.138 литер Б	46	263	202	336	186	128	107	188	253	348	278	289	2624
ул. Малышева, д.138 литер Б	1755.7	816.3	490.5	480.3	344.1	501.2	100.9	22.5	698	648	626	494	6977.5
ул.Комсомольская, д.11/а	524	359.1	358.1	345.5	253	275.5	141.8	119.8	561	573	524	485	4519.8

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
ул.Коминтерна, д.11	52138.3	34912.3	36771.8	37781.6	34206.8	34417.4	29828.5	29035.6	38752	37448	37620	38106	441018.3
ж/д район С-В берег оз.Песчаное	30538.9	17213.4	47595.9	28877.5	12519.4	20494.1	26513.2	7909.86	11783	11883	13390	18454	247172.27
г.Березовский,ул.Механизаторов,д.39	24157.2	17604	11177.2	4338.27	6737.05	6672.65	35150.5	90670.2	25396	21065	21162	20300	284430.148
ул.Мира, 28 лит.А	54922.8	66856.8	81580.8	99381.6	74596.8	59858.4	0	0	0	0	0	0	437197.2
ул. Мира, д. 36/пер.Отдельный, д.7 лит.Б	0	0	0	0	0	0	0	0	0	0	0	0	0
ул.С.Ковалевской, 6б	1736.4	1532.8	1277.2	1829.2	1196.4	934	1047.6	790	1022	1591	1524	1483	15963.6
ул.Фонвизина, д.4	899	836	738	952	1062	1154	826	689	685	653	664	664	9822
ул.Фонвизина, д.4	2001	1492	1578	1055	713	645	602	701	1023	946	817	817	12390
ул.Розы Люксембург, д.32/б	8	4	4	2	0	0	0	0	0	9	0	0	27
ул.Агрономическая, д.37	13855.8	12398	12142.4	11201	6560	14047.6	22533.4	16716.4	16966	19791	16458	18976	181645.6
ул. Комсомольская, 70	0	0	0	0	5783.5	6532	6609	6586	7211	7358	6823	6933	53835.5
ул. Малышева, 144	0	0	0	0	6161.7	6430.2	6331	6163.5	7584	9391	8069	8078	58208.4
ул. Комсомольская, 70	0	0	0	0	0	0	404.8	487.2	843	957	760	764	4216
ул. С. Ковалевской, 5	0	0	0	0	0	0	69409	63813	79987	123393	128934	89020	554556
ул. Мира, 28	0	0	0	0	0	0	36644	33204	48208	77114	80344	55045	330559
ул. Мира, 28	0	0	0	0	0	0	45568	41741	66841	100569	107620	86669	449008
ул. Мира, 32	0	0	0	0	0	0	21581	27285	45448	80567	85408	55696	315985
	2094075	1904995	1981612	2069706	1910269	1481447	1459918	1375644	1761938	2180839	2563854	2394933	23179227.7
Гоголя, д.25	7940	8904.8	10104.8	9219.4	8530	8156.8	7221.2	6547	10010.4	11355.6	11737.8	11040	110767.8
ВСЕГО за 2019г.	2102015	1913899	1991716	2078925	1918799	1489604	1467139	1382191	1771948	2192195	2575592	2405973	23289995.5

Table B4 – Electricity consumption in KWh in 2020 for UrFU

Адрес потребителя	январь	февраль	март	апрель	май	июнь	июль	август	сентябрь	октябрь	ноябрь	декабрь	год
г. Екатеринбург, ул.Мира, д.19	132723	172634	165986.5	145268	43747	46555	98254	116674	186281	158905	162338	222071	1651437
г. Екатеринбург, ул. Ковалевской, д.5	70007	86449	66119	58298	43130	44920	46459	50781	60804	73728	76895	97444	775034
г. Екатеринбург, ул. Ковалевской, д.7а	18028	18527	19823.3	18705	18350	17439	17195	15586	21958	19905	22665	20937	229118.3
г. Екатеринбург, ул. Комсомольская,62	11419	14790	13971.7	5155	4841	10222	10327	7629	14686	13776	15464	21249	143529.7
г. Екатеринбург, ул. Большакова, д.71	5497	4495	3826	1731	822	514	1024	1505	358	3553	304	5	23634
г. Екатеринбург, ул.Мира, д.28	41524	45714	45031	21386	24157	25824	34689	28585	39862	43022	42894	50627	443315
г. Екатеринбург, ул.Мира, д.29	19545	27860	18541.8	1480	4009	2561	3321	4140	18931	11821	18128	13734	144071.8
г. Екатеринбург, ул.Мира, д.17, ул. Мира, д.17а	22907	28790	24813.56	7013	5948	8473	9767	9138	17771	18025	19757	18489	190891.6
г. Екатеринбург, ул.Мира, д.32	42280	44830	42638.9	24013	15678	21216	24532	22271	36148	37350	40381	50586	401923.9
г. Екатеринбург, ул. Комсомольская, д.59,ул. Комсомольская, д.59б	6819	6799	5014.5	3193	1561	3870	4680	5045	5282	6356	4871	5566	59056.5
г. Екатеринбург, ул. Ковалевской, д.5а	18928	21295	16619.8	2696	1682	1230	1268	1519	3457	13768	12289	10721	105472.8
г. Екатеринбург, ул. Мира, д.36а	4641	3432	4450.78	1029	1356	2214	1835	2213	1118	1087	1066	10850	35291.78
г. Екатеринбург, ул. Мира, д.34г	1061	927	1000	105	48	15	15	1657	1114	914	1162	1208	9226
г. Екатеринбург, ул. Мира, д.21	87764	113624	108893.1	67891	47013	0	129037	79617	129048	85932	88296	125595	1062710
г. Екатеринбург, ул. Ковалевской, д.4	7208	6575	7373.8	5074	4222	4271	4758	5205	5615	6477	5356	6310	68444.8
г. Екатеринбург, ул. Малышева, д.140а	932	1398	1251.89	582	400	439	503	584	939	1213	1117	1468	10826.89
г. Екатеринбург, пер. Фонвизина, д.5	4497	5450	4257	1247	1715	2118	1596	2622	4112	3892	4587	6026	42119
г. Екатеринбург, пер. Фонвизина, д.8	2	1	0.6	0	1	0	0	0	0	0	0	0	4.6
г. Екатеринбург, ул. Комсомольская, д.66а	401	521	494	0	73	57	100	275	491	479	479	419	3789
г. Екатеринбург, ул.Мира, д.19	4838	5314	4882.92	4050	3873	4242	4220	5035	4638	4929	6384	4768	57173.92
г. Екатеринбург, ул. Ковалевской, д.3а	1829	2164	1603.9	1829	1847	1911	2088	1996	1927	1879	1801	1965	22839.9
г. Екатеринбург, ул. Коминтерна, д.14	17419	14074	14341.3	2465	3222	3186	4291	6201	4300	28212	22568	12435	132714.3
г. Екатеринбург, ул. Коминтерна, д.16	6777	7597	6448.9	3390	517	205	90	188	1991	1369	126	1749	30447.9
г. Екатеринбург, ул. Комсомольская, д.61	715	910	3357.45	345	229	502	810	664	1436	1565	1221	1630	13384.45
г. Екатеринбург, ул. Ковалевской, д.4	696	1050	1025.2	1242	1190	1112	1383	1310	467	2004	1138	1204	13821.2
г. Екатеринбург, пер. Фонвизина, д.9	0	130	0	0	15	0	0	0	0	0	0	0	145
г. Екатеринбург, ул. Коминтерна, д.3	2941	2387	2461.5	1778	1490	1454	804	0	0	1064	2274	2276	18929.5
г. Екатеринбург, ул. Малышева, д. 136/ ул. Коминтерна, д.1	657	698	573	536	516	418	104	104	86	1094	300	308	5394
г. Екатеринбург, ул. Малышева, д. 140	855	1892	1248.6	691	536	521	143	300	1061	1029	915	1052	10243.6
г. Екатеринбург, ул. Малышева, д. 127а	1045	994	701.87	715	679	642	642	524	122	1267	1267	0	8598.87
г. Екатеринбург, ул. Коминтерна, д.14а	25673	26406	24144.6	23831	42741	42906	34936	46268	48936	25047	28737	23751	393376.6
г. Екатеринбург, ул. Малышева, д.140	34632	28316	33959.1	25098	22472	18852	17397	16383	28788	26754	29388	26263	308302.1
г. Екатеринбург, ул. Малышева, д.127а	45776	32508	38722.3	33585	35412	35042	27375	31767	29008	35804	38044	38065	421108.3
г. Екатеринбург, ул. Малышева, д.144/ул. Комсомольская, д. 66	75018	58545	76601.6	52749	63310	54294	61285	54739	61378	45624	60645	57332	721520.6
г. Екатеринбург, ул. Коминтерна, д.3	58574	41607	55876.25	36731	38505	23848	33160	10571	16671	56731	48519	48358	469151.3

г. Екатеринбург, ул. Комсомольская, стр.70	92054	71370	95461.22	66443	74135	66170	59993	59652	77126	63815	90032	83831	900082.2
г. Екатеринбург, пер. Фонвизина, д.8	4256	3334	4168.6	3190	3744	3681	3571	3816	3490	0	0	0	33250.6
г. Екатеринбург, пр. Ленина, д. 66	31970	27893	28895.1	30981	23696	23933	21137	20979	30399	33362	37076	37720	348041.1
г. Екатеринбург, ул. Коминтерна, д.5/ пер. Фонвизина, д.2	27203	23873	28017.6	24348	18679	19223	15072	12955	23491	24017	25780	26388	269046.6
г. Екатеринбург, пер. Фонвизина, д.4	24517	21891	24309.2	28024	19390	21665	16191	13905	18575	20539	21696	21118	251820.2
г. Екатеринбург, ул. Комсомольская, д.66а	52535	50403	61439.4	46555	57672	57830	28427	32003	31861	37736	42385	42352	541198.4
г. Екатеринбург, ул. Коминтерна, д.1а	42062	35766	39164.2	39764	31074	31406	22837	19551	24134	31500	36780	36208	390246.2
г. Екатеринбург, пр. Ленина, д. 66а	3857	3210	3190.57	2997	3202	3444	2724	2853	2853	3541	3010	3012	37893.57
г. Екатеринбург, ул. Коминтерна, д.1а	3408	3467	4170.6	1064	1001	1015	914	469	6015	5657	5402	5367	37949.6
г. Екатеринбург, ул. Большакова, д.77	2877	2331	1659	861	974	538	2068	1118	2207	3030	3062	4787	25512
г. Екатеринбург, ул. Чапаева, д.16а	62000	48370	45800	41026	31066	31302	30998	19670	29621	36464	44217	61703	482237
г. Екатеринбург, ул. Большакова, д.77	26400	20540	22560	19800	15100	14900	15460	10503	9806	16160	14300	19569	205098
г. Екатеринбург, ул. Большакова, д.79	21028	15857	17913.28	18545	15064	15002	15409	12287	6580	7801	7247	10727	163460.3
г. Екатеринбург, пр. Ленина, д.51	52333	43156	48451	23665	22866	18395	20108	19132	34812	46927	26839	35346	392030
г. Екатеринбург, пр. Ленина, д.136/ул. Маршала Жукова, д.1	10941	10992	10771	8203	1332	2701	4262	3008	5612	7327	5710	6904	77763
г. Екатеринбург, ул. Чапаева, д.16	15375	12435	16339	11531	5675	5455	5610	0	0	8590	11948	12551	105509
г. Екатеринбург, ул. Чапаева, д.16	11290	8720	10390	5310	3787	2394	3680	6076	7023	8236	5342	6987	79235
г. Екатеринбург, ул. Чапаева, д.20/ ул. Фурманова, д.38	9960	8160	8680	3400	2724	1676	2200	2937	3982	5604	4643	4718	58684
г. Екатеринбург, ул. Данилы Зверева, д.30	5196	6456	4961.6	4961	0	291	495	0	4437	7879	1785	1515	37976.6
г. Екатеринбург, ул. Большакова, д.71	62070	45430	41970	33820	22220	22030	22580	9491	17291	29398	37190	53250	396740
г. Екатеринбург, ул. Сибирский тракт, д.36а	17529	14507	10511	14102	5161	2777	1516	2578	10201	12293	17995	27895	137065
г. Екатеринбург, ул. Народной воли, д.64а	4465	3471	3213	3497	1886	2029	1051	1752	2706	3429	4256	5622	37377
г.Первоуральск, севернее села Слобода	278	5110	8038	11296	8972	7360	7314	5955	7882	12626	11876	15302	102009
Сысертский район, 2,8 км западнее п. Двуреченск	3894	5360	3802	5238	2550	2367	3283	3008	2825	2825	3069	2703	40924
г. Екатеринбург, ул. Данилы Зверева, д.30	32819	39745	28498	28458	3269	6701	9670	11122	21651	43838	15941	18667	260379
г. Екатеринбург, ул. Коминтерна, д.5/ пер. Фонвизина, д.2	0	0	0	0	0	0	0	0	0	0	0	0	0
г. Екатеринбург, ул. Тургенева, д.4	100764	101264	64833	49169	46559	47168	53809	54012	69301	82714	67842	72394	809829
г. Екатеотнбург, ул. Куйбышева, д.48а /ул. Белинского, д.71а	158349	201213	208956	105568	103313	104179	111250	103730	151541	187853	185293	200551	1821796
г. Екатеринбург, ул. Мира, д.21	35619	37181	35140.9	24829	27487	18184	14722	15746	22446	39558	29401	28017	328330.9
г. Екатеринбург, ул. Ковалевской, д.5	18430	31178	22749.6	22839	21312	14988	18212	17362	41780	43007	57024	62779	371660.6
г. Екатеринбург, ул. Малышева, д. 138	212	279	194	171	171	107	107	30	10	318	74	78	1751
г. Екатеринбург, ул. Малышева, д. 138	356	815	490	442	442	116	4	0	66	424	0	167	3322
г. Екатеринбург, ул. Комсомольская, д.11А	464	488	236	216	141	331	332	333	111	418	339	290	3699
г. Екатеринбург, ул. Коминтерна, д.11	44695	34740	41699	31821	27056	25749	23639	33302	26727	37532	38163	39287	404410
г. Екатеринбург, северо-восточный берег озера Песчаное, д.б/н	14495	15931	12160	14604	0	0	0	0	0	0	0	0	57190
г.Березовский,ул.Механизаторов, (поселок Шиловка), 39	19697	20655	16632	17249	58488	13322	50189	96305	40746	42808	43024	48241	467356
г. Екатеринбург, ул. Мира, д.28	65641	70368	70641.8	33026	21948	26124	27527	24925	55802	69926	74048	83258	623234.8

г. Екатеринбург, ул. Ковалевской, д.6б	1681	1427	1450.8	1233	995	845	824	1095	1452	1546	1487	1626	15661.8
г. Екатеринбург, пер.Фонвизина, д.4	629	534	762	472	784	936	722	805	466	56	18	0	6184
г. Екатеринбург, пер.Фонвизина, д.4	1186	929	1006	443	361	235	64	76	573	557	1030	1223	7683
г. Екатеринбург, ул.Розы Люксембург, д.32	0	2	0	0	0	0	2	0	0	0	2	0	6
г. Екатеринбург, ул.Агрономическая, д.37	19322	19807	16157	18673	16716	15789	14357	16262	18696	16348	18899	20673	211699
г. Екатеринбург, ул. Комсомольская, стр.70	6087	6011	8157	997	0	0	0	0	26	13	164	195	21650
г. Екатеринбург, ул. Малышева, д.144/ул. Комсомольская, д. 66	7678	7204	9176	4369	5150	4213	5321	4603	6501	5185	5599	5254	70253
г. Екатеринбург, ул. Комсомольская, стр.70	238	443	802.4	514	376	108	121	108	739	953	874	545	5821.4
г. Екатеринбург, ул.Мира, д.29	1360	793	1015	1015	0	0	0	0	0	0	0	0	4183
г. Екатеринбург, ул.Тургенева, д.4	0	0	38869	12782	2555	96	34	103	7223	13023	12437	14713	101835
г. Екатеринбург, ул.С.Ковалевской, 4, литер Д	0	0	0	1329	1809	2013	3375	3091	1414	1724	921	922	16598
	1890848	1911812	1939557	1372741	1146209	1019861	1219269	1177804	1578984	1751132	1775596	2008916	18792729
г. Екатеринбург, ул. Гоголя, д.25	8014	10046	9651	4511	5209	4979	5727	4831	7109	7059	11772	10374	89282
ВСЕГО за 2020г.	1898862	1921858	1949208	1377252	1151418	1024840	1224996	1182635	1586093	1758191	1786368	2019290	18882011

Table B5 – Total electricity consumption in KWh from 2021 to 2023 for UrFU

		2021		**2022**		**2023**	
№ п/п	**Период**	**Объем потребления, кВт/ч**	**Стоимость, руб.**	**Объем потреблени я, кВт/ч**	**Стоимость, руб.**	**Объем потребления, кВт/ч**	**Стоимость, руб.**
1	январь	1612333	6823319	1773921	7764443.17	1775744	9195479.78
2	февраль	1642487	7221218	1571745	7255993.93	1536729	8597167.78
3	март	1865037	7969426	1807183	8146367.76	1795662	9438173.05
4	Апрель	1702539	7262897	1769734	8068622.28	1755528	9130243.65
5	май	1480214	6158649	1634387	7013577.29	1653735	8605715.17
6	Июнь	1453034	6223528	1403657	6140813.19	1836153	9009772.85
7	Июль	1404352	6374372	1261355	5829017.44	1475910.378	7400284.4
8	Август	1413796	6860216	1453776	6953262.4	1374143.67	6840079.02
9	Сентябрь	1885357	8794293	1755296	8592195.97	1812568.299	9173972.72
10	Октябрь	1768019	8042574	1880800	8817890.33	2454246.962	13122029.34
11	Ноябрь	1826466	8449755	1909206	9084700.56	1909206	15258518.31
12	Декабрь	1991301	8958102	2118429	10777517.54	2802810.98	15728240.35
13	Итого	20044935	89138348	20339489	94444401.86	2954891.378	121499676.4

Appendix C

Table C1– Thermal energy consumption data for UrFU from 2017 to 2020

Наименование объекта	**2017**		**2018**		**2019**		**2020**	
	теплоэнергия отопление Гкал	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**
3 с/к, Малышева, 140	933.095	428.4	964.931	399.266	1017.38	345.653	1106.388	227.549
ИВЦ РИЦ С.Ковалевской,4	61.294	0	61.046	0.136	59.448	0	60.476	0.272
10 с/к (Ленина, 66) ЕКАТЕРИНБУРГЭНЕРГО	1530.12	155.7	983.45	688.5	0	1445.6	212.65	1044.79
11 с/к, Коминтерна, 5	791.698	676.92	735.222	707.398	681.307	651.42	667.608	438.601
12 с/к, Фонвизина, 4	768.312	517.13	790.042	599.537	784.006	571.297	736.535	422.272
13 с/к, Комсомольская, 66а	1207.775	808.64	1191.648	867.242	1225.43	769.075	1197.729	645.917
14 с/к (прочие) Коминтерна, 1а	28.37	0	1152.122	867.985	1157.94	864.629	1061.478	585.501
14 с/к, Коминтерна, 1а	1118.258	918.43	0	0	0	0	0	0
15 с/к,Коминтерна,11	1309.353	774.68	1352.977	850.764	1397.68	759.699	1312.833	646.011
5 с/к, Малышева, 144	1902.803	466.23	2090.77	289.269	2167.9	311.72	2848.879	235.53
5 с/к, Малышева, 144, ком. питания		0	0	0	25.903	0	61	0.223
7 с/к, Коминтерна, 3	1267.077	768.83	1185.593	913.894	1265.85	789.712	1213.344	576.698
8 с/к, Комсомольская, 70	868.793	28.167	2740.16	265.941	2908.35	348.493	2381.145	275.936
8 с/к, Комсомольская, 70 спорт.компл.		0	0	0	143.563	0.174	311.218	1.744
8 с/к, Комсомольская, 70 комб. Пит.		0	0	0	111.009	0.134	240.647	1.348
9 с/к, Фонвизина, 8	1061.439	539.42	1065.773	580.64	1081.64	363.446	618.819	7.027
№ 3 Мира, 28 (блок 1)	888.987	39.762	1202.891	123.83	1192.03	99.995	1050.137	24.589
№ 3 Мира, 28 (блок 2)	1091.139	5.969	1189.408	3.503	1198.05	3.866	1066.467	7.156
№ 3 Мира, 28 (блок 3)	1467.661	96.43	1423.064	98.336	1539.32	100.975	1322.95	58.534
№ 3 Мира, 28 (блок 4)	795.119	24.717	1381.637	36.41	1879.39	29.356	1545.199	32.68
№ 4 Мира, 17	1351.359	44.032	1218.676	54.56	1319.05	31.51	1026.91	27.737
№ 5 Мира,21 (ввод №1)	1060.254	42.266	1111.118	55.692	1137.31	23.446	976.251	24.768
№ 5 Мира,21 (ввод №2)	1143.133	78.123	1531.822	84.921	1731.59	67.207	1276.513	48.674
№ 6 Мира, 32	2054.776	114.56	2248.408	52.772	2222.72	40.681	1910.436	46.022
№ 7 Комсомольская, 62	567.141	18.826	752.492	21.571	738.329	22.357	648.126	14.299

Наименование объекта	2017		2018		2019		2020	
	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал
№ 8 С. Ковалевской, 5	3125.678	103.79	3600.952	114.85	4116.63	205.983	3248.347	137.014
АБК С.ковалевской, 7а	218.954	15.955	246.455	14.582	233.258	16.52	180.407	14.698
Бассейн Коминтерна, 14а	724.023	434.66	1289.883	475.31	1082.36	533.859	869.704	411.102
Башня (уч.корп) С.Ковалевской,4	133.173	0.024	143.542	0.303	139.686	0.036	142.202	1.003
Библиотека, Мира,34г	77.58	4.355	60.074	2.54	61.979	3.234	53.265	1.363
Высшая инженерная школа УрФУ Малышева, 127	119.658	1.66	201.46	0.492	291.502	0	270.879	2.772
Гараж легк. Машин, Мира,19	437.08	10.232	490.511	166.11	494.844	18.883	431.86	16.519
Гараж спец.машин + Надстройка танковых боксов С.Ковалевской, 4	308.311	260.25	571.846	266.872	600.746	260.324	506.122	261.688
Гараж, Мира,29а	329.961	0	328.622	0	320.023	0		0
ГУК Мира, 19 (библиотека)	1501.176	65.057	923.703	37.729	673.658	42.728	586.795	36.14
ГУК Мира, 19 (ввод №2)	648.212	51.938	677.326	50.314	667.923	50.976	545.294	43.705
ГУК Мира, 19 (ввод №6,ЭТФ)	189.502	35.155	141.965	40.56	138.25	38.724	140.639	42.807
ГУК Мира, 19 (ввод №1)	612.742	10.247	725.67	20.505	640.739	24.887	551.956	14.043
ГУК Мира,19 (ввод №4) Центральная часть		0	1009.667	38.533	1454.25	15.638	1244.857	27.448
Детский сад (Мира,36а)	188.667	38.348	191.843	41.969	205.497	39.282	172.711	36.803
Здание бытового обслуживания С.Ковалевской, 6	427.627	0	366.638	0.948	276.753	0	281.536	1.896
Комсомольская, 11а (УЭМЗ)	75.45	1.09	76.45	0.89	75.02	0.56	80.05	1.73
Малышева, 136 (1 с/к) Нежилые помещ.	128.154	2.533	133.509	0.886	74.509	0.916	72.487	2.603
Малышева, 138 (2 с/к) Нежилые помещ.	113.162	1.656	211.832	3.24	185.627	0.767	145.094	5.11
Малышева, 138 (жилые квартиры)		0	2.758	0.588	10.331	3.529	8.943	2.696
МАНЕЖ Мира,29 - Коминтерна, 4	932.024	41.319	1108.776	36.664	1060.08	46.702	1027.654	99.565
Мира, 36 (1 эт., +подвал) неж. пом.	116.323	2.999	41.013	0.091	116.465	13.46	1.597	0.148
ММФ (Мира,19) (ввод №5)	821.186	19.365	125.249	2.819	848.187	21.35	707.056	17.604
МСЧ Комсомольская, 59	481.162	40.011	823.932	22.376	56.836	0	57.818	0.13
МСЧ Комсомольская, 59 (ввод 1 + ввод 2)		0	0	0	451.964	40.072	361.6	36.287
ОГТ, Малышева,127а (1 корпус)	620.572	319.64	58.363	0	652.418	296.672	617.264	255.397

Наименование объекта	2017		2018		2019		2020	
	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал	теплоэнергия отопление Гкал	теплоэнергия ГВС Гкал
ОГТ, Малышева,127а (2 корпус)	633.627	292.83	483.068	45.157	649.28	299.994	609.41	279.861
Пост охранника автостоянки (Мира,19)	133.618	1.359	620.7519	344.321	0	0	0	0
Проблемная лаборатория (ПТЭ) С.Ковалевской, 4	15.319	0.098	15.249	0.139	14.849	0.108	15.106	0.177
Произв.корп. (ММИ) С.Ковалевской, 4	191.682	10.85	190.752	15.63	170.787	15.24	173.711	12.197
Ризография С.Ковалевской,4	56.273	8.316	55.205	10.204	53.764	10.08	54.693	10.825
СКИВС Коминтерна,14	329.934	53.492	771.53	49.789	763.237	102.117	659.425	55.539
Склады С.Ковалевской,4	60.559	0.84	65.726	0.144	64.007	0	65.113	0.292
Склады ОКС С.Ковалевской,4	174.374	1.544	173.511	1.872	157.118	1.86	161.013	8.915
Спортзал Малышева, 140а	208.41	31.012	228.056		234.008	25.29	204.282	21.219
СПОРТКОМПЛЕКС Мира,29а	224.482	11.638	226.405	13.563	199.379	0	103.191	0.343
Столовая №5 С.Ковалевской, 5а	303.326	77.524	850.606	88.134	357.109	93.058	294.99	31.135
Студенческая, 37 (нежилие помещения, ТП ЭПК)	0	0	5.531	0	0	0	0	0
Тенисный зал, Коминтерна,16	275.248	0	0	31.319	441.73	23.239	361.41	14.862
ТЕХНОПАРК Комсомольская,61	207.921	4.897	213.36	6.608	218.73	6.651	194.583	2.505
Трибуны-раздевалки, Мира,29	134.622	0	134.076	0.298	117.578	12.989	132.824	10.725
учебная лаборатория АЭ С.Ковалевской,4	110.866	0	110.417	0.246	107.527	0	109.385	0.492
Фабрика бережливого производства, С.Ковалевской,4	148.985	2.414	157.431	1.194	141.288	0.03	117.218	2.496
ФАРМАЦЕНТР Мира, 21	745.741	9.622	924.102	101.164	1142.67	26.091	966.61	53.388
ФОК Фонвизина,5 +Пристрой	352.069	11.279	399.944	10.988	375.178	14.23	320.077	14.998
Фонвизина,9, 3 под., 10 эт., помещение	2.91	0.79	7.246	1.842	0	0	0	0
Хоз.Корп. "Насосная", Фонвизина,9	24.16	0.356	36.281	0.432	35.331	0.432	35.942	0.45
Центр обработки материалов С.Ковалевской,4	41.18	3.81	173.511	2.9	39.939	0	40.63	0.182
Центральный склад С.Ковалевской,4	142.699	2.289	0	0	168.971	2.52	171.891	3.388
ЭТФ (Мира,19) (ввод№7)	729.644	7.156	750.688	8.544	752.237	6.077	660.925	12.723
ИТОГО с/к	14229.959	6733.4	15716.97	7716.014	15341.9	7860.355	15369.658	5681.208
ИТОГО у/к	26616.023	1823.5	31871.51	2242.848	32777.5	2095.198	27202.016	1719.471

Наименование объекта	**2017**		**2018**		**2019**		**2020**	
	теплоэнергия отопление Гкал	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**	**теплоэнергия отопление Гкал**	**теплоэнергия ГВС Гкал**
ИТОГО	40845.982	8556.8	47588.48	9958.862	48119.4	9955.553	42571.674	7400.679

Table C2– Thermal energy consumption data for UrFU from 2021 to 2023

Наименование объекта	**2021**		**2022**		**2023**	
	теплоэнергия отопление	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**
Комсомольская, 11а (УЭМЗ)	31.81	0.47	29.31	0.05	27.23	0.02
10 с/к (Ленина, 66) ЕКАТЕРИНБУРГЭНЕРГО	0	502.54	0	549.6	0	487.23
Малышева, 136 (1 с/к) Нежилые помещ.	24.851	0.355	28.263	0.646	0	0
Малышева, 138 (2 с/к) Нежилые помещ.	51.238	0.625	0	0	367.702	0
Малышева, 138 (жилые квартиры)	0	0	348.429	81.553	481.22	0
3 с/к, Малышева, 140	316.483	57.236	446.906	111.65	702.585	0
13 с/к, Комсомольская, 66а	431.304	135.239	774.679	0.012	22.908	0
5 с/к, Малышева, 144	700.436	0.486	26.022	0	869.737	0
5 с/к, Малышева, 144, ком. питания	23.53	0.015	946.818	0.052	85.692	0
8 с/к, Комсомольская, 70	850.034	1.803	95.678	0	110.818	0
8 с/к, Комсомольская, 70 комб. Пит.	85.907	0.181	123.735	0	399.413	0
8 с/к, Комсомольская, 70 спорт.компл.	111.099	0.234	329.225	120.472	1067.401	0
12 с/к, Фонвизина, 4	290.02	94.244	464.721	171.421	570.825	0
14 с/к (+прочие), Коминтерна, 1а	445.283	211.689	491.437	154.82	566.433	0
7 с/к, Коминтерна, 3	389.039	172.102	240.289	215.29	426.184	0
11 с/к, Коминтерна, 5	231.871	160.597	574.032	148.088	639.231	0
15 с/к,Коминтерна,11	488.644	146.52	257.832	62.093	300.919	0
ОГТ, Малышева,127а (1 корпус)	233.017	59.368	257.643	62.424	299.689	0
ОГТ, Малышева,127а (2 корпус)	253.025	64.93	72.466	9.291	78.815	0
Детский сад (Мира,36а)	66.158	9.641	80.094	2.198	70.634	0
МСЧ Комсомольская, 59 (ввод 1 + ввод 2)	129.1	7.66	64.221	3.533	59.245	0
МСЧ (переход) Комсомольская, 59	23.465	0	23.562	0	21.434	0
ММФ (Мира,19) (ввод №5)	287.811	12.982	314.663	4.37	268.96	0
ЭТФ (Мира,19) (ввод№7)	253.984	2.639	263.475	1.71	246.573	0
№ 4 Мира, 17 (+пристрой)	436.05	5.19	281.252	9.33	240.981	0
№ 5 Мира,21 (ввод №1)	377.179	13.464	191.061	0.859	177.36	0

Наименование объекта	**2021**		**2022**		**2023**	
	теплоэнергия отопление	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**
№ 5 Мира,21 (ввод №2)	692.17	7.498	388.996	13.86	362.999	0
№ 3 Мира, 28 (блок 1)	400.36	11.778	698.187	8.709	637.116	0
№ 3 Мира, 28 (блок 2)	421.094	0.973	352.867	0.058	285.226	0
№ 3 Мира, 28 (блок 3)	481.037	22.705	455.355	5.135	388.055	0
№ 3 Мира, 28 (блок 4)	741.956	10.42	451.934	0.721	384.274	0
№ 6 Мира, 32	703.489	7.331	556.816	20.859	425.055	0
№ 7 Комсомольская, 62	237.031	3.311	503.312	5.93	489.582	0
№ 8 С. Ковалевской, 5	1369.754	21.957	749.599	3.72	723.107	0
АБК С.ковалевской, 7а	82.829	3.504	232.12	2.36	298.084	0
МАНЕЖ +Спортком *Мира,29а (ввод1+ввод2)*	402.13	24.745	1450.775	69.922	1331.433	0
Спортзал Малышева, 140а	80.238	6.11	81.849	0.941	80.37	0
Тенисный зал, Коминтерна,16	53.784	4.077	394.633	25.193	212.746	0
СКИВС Коминтерна,14	268.552	32.497	38.244	1.632	101.159	0
Бассейн Коминтерна, 14а	411.404	155.722	80.335	8.822	70.886	0
ГУК Мира, 19 (ввод №1)	215.048	2.654	32.783	4.336	51.529	0
ГУК Мира, 19 (ввод №2)	220.415	7.858	208.772	33.328	219.735	0
ГУК Мира, 19 (ввод №6,ЭТФ)	57.077	9.227	404.526	141.196	521.722	0
ГУК Мира, 19 (ввод№4) библиотека+ автостоянка пост	235.791	13.992	231.333	3.823	232.168	0
ГУК Мира,19 (ввод №4) Центральная часть	506.717	5.817	242.157	9.274	219.053	0
Гараж легк. Машин, Мира,19 (ввод1 +ввод2)	156.72	8.02	53.639	9.227	59.414	0
Гараж спец.машин + Надстройка танковых боксов С.Ковалевской, 4	162.376	0.25	259.351	16.68	242.354	0
Котельная (Проблемная лаборатория ПТЭ) С.Ковалевской, 4	6.13	0.029	554.035	2.729	488.345	0
Произв.корп. (ММИ) С.Ковалевской, 4	104.359	2.626	32.542	0	30.522	0
Ризография С.Ковалевской,4	21.792	2.909	153.404	9.577	150.454	0
Склады W С.Ковалевской,4	26.425	0	208.856	0.06	193.075	0
Склады ОКС С.Ковалевской,4	69.76	5.241	5.761	0.029	5.444	0
учебная лаборатория АЭ С.Ковалевской,4	44.393	0	80.557	2.626	95.795	0
Башня (уч.корп) С.Ковалевской,4	56.46	0.181	20.86	2.909	22.486	0
ИВЦ РИЦ С.Ковалевской,4	24.544	0	24.833	0	0	0
Мастерские (Центр обработки материалов ЦОМ) С.Ковалевской,4	16.489	0	65.559	5.241	66.811	0
Фабрика бережливого производства, С.Ковалевской,4	45.462	0.413	41.719	0	39.217	0
Центральный склад С.Ковалевской,4	66.058	0.47	47.893	0.044	44.049	0
Трибуны-раздевалки, Мира,29	53.905	6.491	23.065	0	21.682	0
Столовая №5 С.Ковалевской, 5а	111.147	8.603	15.496	0	14.567	0

Наименование объекта	2021		2022		2023	
	теплоэнергия отопление	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**	**теплоэнергия отопление**	**теплоэнергия ГВС**
ТЕХНОПАРК Комсомольская,61	72.515	0.608	54.049	0	3.463	0
Здание бытового обслуживания С.Ковалевской, 6	114.258	0	68.917	0	63.165	0
Библиотека, Мира,34г	0	0	50.659	6.491	54.041	0
ФАРМАЦЕНТР Мира, 21	356.036	14.577	122.87	7.17	107.736	0
Высшая инженерная школа УрФУ Малышева, 127	84.063	0.368	85.158	0.564	68.789	0
ФОК Фонвизина,5 +Пристрой	119.638	2.757	107.378	0	47.064	0
Хоз.Корп. "Насосная", Фонвизина,9	11.072	0	337.169	9.251	371.862	0
Высшая инженерная школа УрФУ Малышева, 127			93.732	0	89.404	0
ФОК Фонвизина,5 +Пристрой			133.47	1.813	128.432	0
Хоз.Корп. "Насосная", Фонвизина,9			13.708	0	13.324	0
ИТОГО с/к	4915.85	1616.825	5449.912	1686.766	6691.339	487.23
ИТОГО у/к	4753.318	1065.064	11485.174	456.926	10866.44	0.02
ИТОГО	9669.168	2681.889	16935.086	2143.692	17557.78	487.25

Appendix D

Table D1 – UrFU carbon footprint categories and emission factors

ategory	Emissions from water consumption, (tCO_2eq)	Emissions from ventilation, (tCO_2eq)	Emissions from waste management, (tCO_2eq)	Emissions from transport, (tCO_2eq)	Emissions from heating, (tCO_2eq)	Emissions from Electricity consumption, (tCO_2eq)	Absorption of carbon by green area, (tCO_2eq)
Applicability for UrFU	Water is heated by a university boiler house that consumes natural gas. There is a separate accounting of energy for hot water for buildings and other places necessary for learning / buildings and other places necessary for living and rest	N/A. There is no separate accounting of electricity consumption for ventilation, is counted in "Electricity consumption"	N/A. There is no accounting for separate collection and subsequent disposal of waste.	N/A. The university does not have a significant fleet of vehicles.	Energy for heating is provided by a university boiler house that consumes natural gas. There is a separate accounting of energy for heating for buildings and other places necessary for learning / buildings and other places necessary for living and rest	Electricity is provided by Novosverdlovsk Thermal Power Plant that consumes natural gas and belongs to the first price zone of the electricity market. There is a separate accounting of consumed electricity for buildings and other places necessary for learning / buildings and other places necessary for living and rest	N/A. No inventory of green spaces was carried out at the university
Emission Factor	Natural gas calorific value is 0,008 Gcal/m^3. The efficiency of the UrFU boiler house is 85%. The natural gas emission factor is 1,85 t CO2/(thousand m^3). **Then for UrFU boiler the emission factor is 0,27 tCo2 eq / Gcal**	N/A	N/A	N/A	Natural gas calorific value is 0,008 Gcal/m^3. The efficiency of the UrFU boiler house is 85%. The natural gas emission factor is 1,85 t CO2/(thousand m3). **Then for UrFU boiler the emission factor is 0,27 tCo2 eq / Gcal**	Calculations of the greenhouse gas emission factor of the Russian energy system, carried out by the Association of NP "Market Council" in the context of price zones. The electrical energy consumed by UrFU is produced in the First Price Zone (Europe and the Urals. Emission factor for this price zone is 322.076 kg CO_2e/Mwt h or **0,322 tCO_2eq / thousand Kwh**	N/A
(Source)	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. 2019. Retrieved from: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html	N/A	N/A	N/A	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. 2019. Retrieved from: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html	https://www.atsenergo.ru/results/co2all	N/A

Appendix E

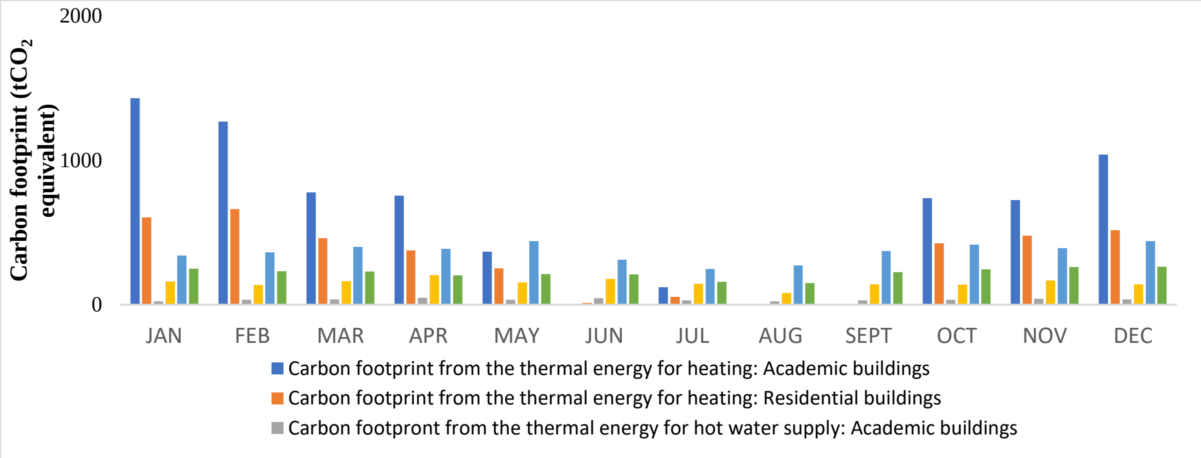

Figure E1 – Monthly trends of carbon footprint for 2017

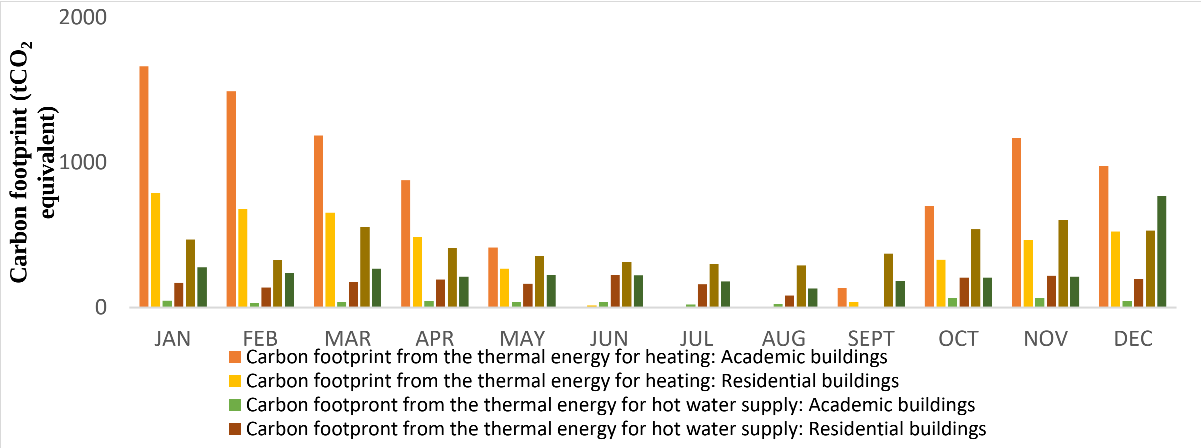

Figure E2 – Monthly trends of carbon footprint for 2018

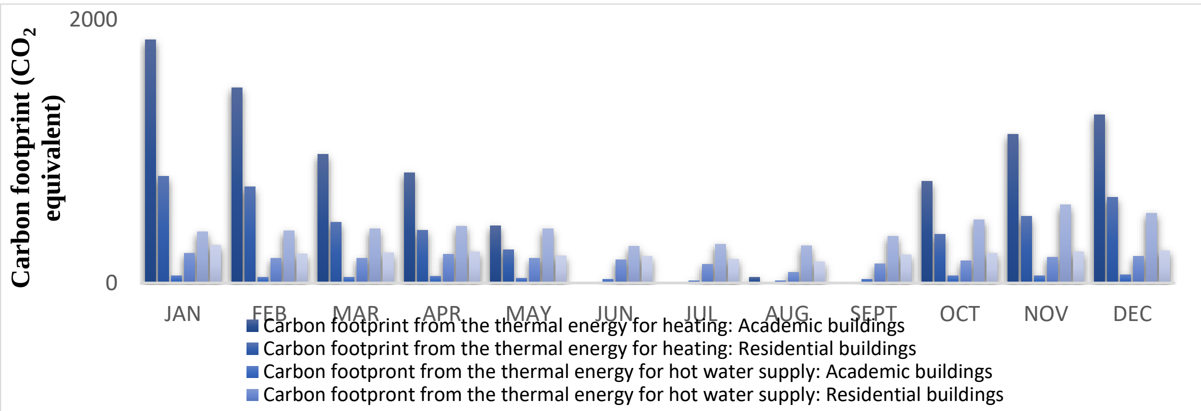

Figure E3 – Monthly trends of carbon footprint for 2019

Appendix F

Table F1– Comparison of CO_2 emission among universities

University	Country	Duration	Source of emissions (MTCO2eq)			
			Electiricity	Transportation	Waste	Total
Universiti Teknologi Malaysia	Malaysia	2013	48,241	7,284	2,051	57,576
Edith Cowan University	Australia	2015	16.99	0.072	0.4	17.46
University of Leicester	United Kingdom	2015-2016	16.26	6.9	0.039	23.2
Clemson University	United States	2017	38.72	27	0	65.72
University of Cambridge	United Kingdom	2015-2016	51,240.52	17,388.01	394.625	69,023.15

Source: Ridhosari and Rahman [86].