

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
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QUALIFICATION PAPER

on the topic “IMPLEMENTATION OF THE GREEN UNIVERSITY CONCEPT AS
A WAY TO STRENGTHEN THE POSITION OF HIGHER EDUCATIONAL
INSTITUTION IN WORLD RANKINGS”

Specialty 292 “International Economic Relations”

Student 4 course _____ D.A. Lysenko
group ME72 аН

It is submitted for the Bachelor’s degree requirements fulfillment.

Qualifying Bachelor's paper contains the results of own research. The use of the ideas, results and texts of other authors has a link to the corresponding source

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Sumy, 2021

ABSTRACT

on bachelor's degree qualification paper on the topic

“IMPLEMENTATION OF THE GREEN UNIVERSITY CONCEPT AS A WAY TO STRENGTHEN THE POSITION OF HIGHER EDUCATIONAL INSTITUTION IN WORLD RANKINGS”

Lysenko Daria Anatoliivna

The main content of the bachelor's degree qualification paper is presented on 30 pages, including references consisted of 28 used sources, which are placed on 3 pages. The paper contains 4 tables, 6 figures.

Keywords: WORLD RANKINGS OF UNIVERSITIES, THE CONCEPT OF GREEN UNIVERSITY, ENVIRONMENTAL SUSTAINABILITY, SOLAR ENERGY.

The purpose of the bachelor's degree qualification paper is to research prospects for strengthening the position of higher education institutions in world rankings through the implementation of solar energy projects.

The object of the study is the concept of green universities.

The subject of the study is the implementation of a solar energy project in higher education institution to strengthen its position in world rankings.

Research methods: causal analysis, method of logical generalization, factor analysis, method of logical generalization, calculation-analytical, methods of investment analysis.

The information base of the research is data from world rankings of universities, regulations of Sumy State University, official statistics of consulting and engineering companies with practical experience in implementing solar energy projects in Ukraine, scientific works of domestic and foreign scientists.

According to the results of the research, the following conclusions are formulated:

1. Obtaining high scores by universities in international rankings helps to increase their competitiveness on the world stage, increase the number of

international partners, develop research priorities and increase revenues. Sumy State University is represented in most of the world's leading rankings, indicating high results in educational, scientific, international, environmental, and other areas.

2. It is established that the leading institutions of higher education implement the concept of green universities in their activities. Simultaneously, in Ukraine, green university initiatives are only at the stage of their formation and cover only certain areas of their activities. At the same time, Ukrainian higher education institutions have significant potential to implement a wide range of sustainable development strategies and can serve as examples of green development centers.

3. Improving the position of Sumy State University in the world rankings is possible by implementing environmental initiatives, particularly the involvement of renewable energy resources in energy production processes. To test the implementation of the solar energy project, Sumy State University proposed technical and economic data for estimating the cost of electricity generation from solar radiation and a scientific and methodological approach to assessing economic and environmental benefits.

4. The implementation of the solar power plant project by Sumy State University is economically justified, as the payback period of the project does not exceed the power plant's life cycle, and the projected increase in electricity tariffs will have a positive impact on its reduction.

5. Replacement of traditional electricity by own energy generation based on solar energy will help reduce emissions in 1178,2 tons of CO₂-eq. throughout the life cycle of a solar power plant, which will positively impact curbing global warming and climate change.

6. It is proved that the implementation of the solar energy project will positively impact the university's image, including improving its position in world rankings, increasing competitiveness in research, and achieving the national and international policy goals of Ukraine.

The results of approbation of the main provisions of the qualifying bachelor's thesis were considered at:

1. All-Ukrainian scientific-practical conference "Strategic prospects for the development of economic entities in an unstable economic environment" (Kremenchuk, March 13-15, 2020);

2. International scientific-practical conference "Strategic-innovative development of subjects of economic system in the conditions of globalization" (Kremenchuk, November 6-8, 2020);

3. International scientific-practical conference "Ukraine in world globalization processes: culture, economy, society" (Kyiv, 24-25 March 2021);

4. International Scientific and Practical Conference (Irpin, March 18, 2021).

Based on the results of research, a section of the monograph was published: Theoretical approaches to shaping an organizational and economic mechanism for managing the renewable energy development in higher education institutions / Power supply for educational institutions: efficiency and alternatives: monograph / edited by Prof. M.I. Sotnyk, Hamilton, Canada, Accent Graphics Communications & Publishing, 2020. – pp. 93–100.

The qualification paper was performed as part of the research work "Solar energy for green universities: estimation of economic, environmental and image benefits" under the Czech Republic Development Cooperation project: "Interuniversity cooperation as a tool for enhancement of quality of selected universities in Ukraine".

The obtained results can be used by the management of higher educational institutions of Ukraine in making decisions on the implementation of solar power plant projects to increase positions in world rankings.

The year of fulfillment is 2021.

The year of paper defense is 2021.

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TASKS FOR BACHELOR'S DEGREE QUALIFICATION PAPER

(specialty 292 “International Economic Relations”)
student 4 course, group ME 72 аН

Lysenko Daria Anatoliiivna

1. The theme of the paper is “Implementation of the green university concept as a way to strengthen the position of higher educational institution in world rankings”.

approved by the order of the university from _____.

2. The term of completed paper submission by the student is 14.05.2021.

3. The purpose of the qualification paper is to research prospects for strengthening the position of higher education institutions in world rankings through the implementation of solar energy projects.

4. The object of the research is the concept of green universities.

5. The subject of research is the implementation of a solar energy project in higher education institution to strengthen its position in world rankings.

6. The qualification paper is carried out on materials of official statistics, legislative and normative acts, and scientific publications of domestic and foreign authors.

7. Approximate qualifying bachelor's paper plan, terms for submitting chapters to the research advisor and the content of tasks for the accomplished purpose are as follows:

Chapter 1 World universities rankings and their impact on competitiveness of higher education institutions.

Chapter 1 deals with analyzing world universities rankings, their impact on competitiveness of higher education institutions on international arena, positions of Sumy State University in world universities rankings; till 10.04.2021.

Chapter 2 Green universities: towards environmental sustainability.

Chapter 2 deals with the investigation of theoretical aspects of implementing the concept of green universities, foreign experience of ecological transformation of higher education institutions, and the green strategy of Sumy State University; till 27.04.2021.

Chapter 3 Implementation of solar energy project by Sumy State University as one of the ways to be more eco-friendly.

Chapter 3 deals with economic justification of the implementation of the solar energy project by Sumy State University, assessment of environmental and image benefits from installation of the solar power plants; till 14.05.2021.

8. Supervision on work:

Chapter	Full name and position of the advisor	Date, signature	
		task issued by	task accepted by
1	T.O. Kurbatova, Senior Lecturer of International Economic Relations Department	26.02.2021	26.02.2021
2	T.O. Kurbatova, Senior Lecturer of International Economic Relations Department	04.03.2021	04.03.2021
3	T.O. Kurbatova, Senior Lecturer of International Economic Relations Department	15.04.2021	15.04.2021

9. Date of issue of the task: 15.03.2021.

Research advisor _____ T.O. Kurbatova

The tasks have been received _____ D.A. Lysenko

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INTRODUCTION

Relevance of the research topic. Reputation plays an important role for every higher education institution. It affects the attractiveness of the institution in the eyes of applicants and employers. It is believed that the high position of the university in world rankings increases the image and competitiveness of higher education institutions.

Today, Ukrainian higher education institutions occupy low positions in international rankings or are not represented in them at all. To strengthen its position in the world rankings, the main focus of universities is on ensuring such indicators as the quality of the educational process, the appropriate amount of research funding, a high degree of integration into international activities, and more. However, the improvement of the university's position in the world rankings, including possibly through the implementation of environmental measures, including solar energy projects.

Given the above, it is essential to research the prospects for implementing solar energy projects by higher education institutions to strengthen their positions in world rankings, ensuring their energy independence and environmental sustainability.

The study of the problem. The following foreign scientists studied theoretical and practical aspects of the concept of the green university: Dlimbetova G., Bulatbayeva K., Abenova S., Fakhrutdinova G., Khuziakhmetov A., Kiryushin P., Bolokhova K., Alinov, M. Sh., Stefanovich M., Jimenez P. Kaminov A.A., Anufriev V.P., Nikitin M.V., Oborin O.A. However, the problems and prospects of implementing the concept of the green university in higher education institutions of Ukraine to strengthen their position in the international arena remain unexplored.

The purpose of the bachelor's degree qualification paper is to research prospects for strengthening the position of higher education institutions in world rankings through the implementation of solar energy projects..

In accordance with the purpose of the bachelor's degree qualification paper, the following tasks were set:

- to analyze the impact of world rankings of universities on the competitiveness of higher education institutions in the international arena;
- to analyze the position of Sumy State University in world rankings and its environmental strategy;
- to consider the leading foreign experience in implementing the concept of the green university in higher education institutions around the world;
- to calculate the cost of generating electricity generated by a solar power plant and the payback period of the investment project;
- to assess the university's economic, environmental, and image benefits from implementing the solar power plant project.

The object of the study is the concept of green universities.

The subject of the study is the implementation of a solar energy project in higher education institution to strengthen its position in world rankings.

Research methods: causal analysis, method of logical generalization, factor analysis, method of logical generalization, calculation-analytical, methods of investment analysis.

The information base of the research is data from world rankings of universities, regulations of Sumy State University, official statistics of consulting and engineering companies with practical experience in implementing solar energy projects in Ukraine, scientific works of domestic and foreign scientists.

The results of approbation of the main provisions of the qualifying bachelor's thesis were considered at:

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The qualification paper was performed as part of the research work “Solar energy for green universities: estimation of economic, environmental and image benefits” under the Czech Republic Development Cooperation project: “Interuniversity cooperation as a tool for enhancement of quality of selected universities in Ukraine.”

The obtained results can be used by the management of higher educational institutions of Ukraine in making decisions on the implementation of solar power plant projects to increase positions in world rankings.

1. WORLD UNIVERSITIES RANKINGS AND THEIR IMPACT ON COMPETITIVENESS OF HIGHER EDUCATION INSTITUTIONS

1.1 World universities rankings: distinctive features

In a general sense, the ranking of higher education institutions is the location of university groups in certain ranking order. To do this, various criteria are used, which comprehensively evaluate universities and place them in a list from conditionally “best” to conditionally “worse”. Ratings are characterized by different target audiences (main consumers of information), the method of providing results, and evaluation methodology.

There are different ways to typology international rankings. For example, E.V. Balatsky and N.A. Ekimov distinguish four groups of ratings [1]:

- traditional – are compiled on the basis of objective indicators of university activity: activity indices of scientific publications and citations, indicators of resource provision, career success of graduates, etc. Such rankings include Academic Ranking of World Universities, Performance Ranking of Scientific Papers for World Universities, and Leiden Ranking;

- reputational (personalized) – are based on the results of special surveys of experts. Today there is only one such rating – the World Reputation Rankings from Times Higher Education;

- virtual – reflect the popularity of university online resources. Evaluate such indicators as the frequency of visits, the number of links, etc. This type of rating includes Webometrics;

- mixed – are a combination of the three options described above. These include the Times Higher Education World University Rankings and QS World University Rankings.

- environmental – aimed at quantifying efforts to maintain the sustainability (environmental friendliness) of higher education. An example of such a rating is the UI GreenMetric World University Rankings.

In addition, there are ratings formed by calculating the final score and ratings of higher education institutions for specific disciplines or programs. The typology and methodology of international rankings are presented in Table 1.1.

Table 1.1 – Types and methodology of compiling international rankings of higher education institutions [1, 2]

Rating characteristics	Rating name				
	QS World University Rankings	Times Higher Education World University Rankings	Academic Ranking of World Universities	Ranking Web of Universities (Webometrics)	UI GreenMetric World University Rankings
Research direction	Scientific and educational activities				Environ-mental activities
Ccharacteristic	Developed on the basis of all previous evaluation tools	Developed on the basis of all previous evaluation tools	It is based on certain indicators of the university	The popularity of the university's websites and electronic resources is estimated	Criteria that are considered important for universities dealing with sustainable development are assessed.
Formation methodology	One-dimensional ranking	One-dimensional ranking	One-dimensional ranking	One-dimensional ranking	One-dimensional ranking
Types of ratings	Global, by subjects, by faculties, by regions, young institutions of higher education, student cities	Global, by subjects, by regions, young institutions of higher education, student cities	Global, by subjects, by disciplines	Global, by regions	Global, by country by region, by category, by campus settings
Frequency of research	Annually	Annually	Annually	Twice a year	Annually

Continuing Table 1.1

Research organizer	Consulting company Quacquarelli Symonds	Times Higher Education; Thomson Reuters	Center for WorldClass Universities of Shanghai Jiao Tong University	Cyber-metrics Lab	University of Indonesia
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The methodology used in the formation of ratings is designed so that it is possible to determine the institution of higher education in comparison with those institutions for which the assessment was conducted. The algorithm for calculating international ratings takes into account a significant number of factors and criteria. Each rating has its own list of indicators for evaluating higher education institutions. Indicators are combined into groups, each of the indicators has its own level of importance. Performance indicators are added, taking into account the weighting factor. Scores are normalized to the maximum value and are reduced to a scale of one hundred points. Then the universities are ranked from highest to lowest. The higher education institution cannot influence the ranking, as the information for evaluation is obtained from external sources.

All the above ratings are not similar. Therefore, it is advisable to determine the overall level of international competitiveness by several ratings because each of the ratings assesses the different activities of higher education institutions: educational, scientific, methodological, environmental international, etc.

1.2 Influence of world universities rankings on competitiveness of higher education institutions on international arena

Given the globalization processes in the world, competition between universities is constantly growing. As a result, the requirements for increasing the competitiveness of higher education institutions, improving the level of educational services, research, etc., are increasing. The competitiveness of higher

education institutions reflects the effectiveness of their activities, resulting in recognition of the university in the world educational and scientific space.

International rankings are tools for monitoring and assessing the competitiveness of higher education institutions; the purpose of such monitoring is to encourage the university to get the highest position, which enhances the image, provides competitive advantages, determines the amount of funding, and more.

Participation in the world and national university rankings has become a common practice in university life today. Rating becomes an important tool to increase the competitiveness of universities, the basis of its economic and environmental sustainability; a tool for shaping the status of a world-class university, which can be achieved only based on its recognition by the world university and expert community.

World rankings of universities directly affect the competitiveness of higher education institutions as follows:

- *Obtaining high indicators by the university in international rankings affects the amount of budget funding.* According to the formula for the distribution of state budget expenditures between higher education institutions based on indicators of their scientific, educational and international activities [3].

The calculation of the amount of funding in 2020 was made by the Ministry of Education and Science on specific indicators, which also take into account the positions in international rankings and the amount of funds for research that the university attracts from business or international grants. From 2021, the employment of graduates will be added to these indicators, which the Ministry of Education and Science will monitor through the online system [3].

The presence of Ukrainian universities in international rankings is an incentive to work on international recognition and reputation, increasing the chances of attracting foreign students. The Ministry considers positions in the QS World University Rankings, The Times Higher Education World University Rankings and the Academic Ranking of World Universities. Currently, the five

free economic zones included in the rankings have received additional funding for this indicator [3].

It is also worth remembering that the Law of Ukraine “On Higher Education” states the need for the presence of universities in international rankings to obtain research status [3].

- *Entry of the university into the world rankings helps to increase financial income through participation in international projects.* Investors prefer successful and promising higher education institutions by investing in the best projects. This is also relevant for Ukraine. Confirmation, for example, is a letter from the Embassy of Turkmenistan in Ukraine, which states that entrants from Turkmenistan this year can study in several specialties in those universities of Ukraine, which are included in the Times Higher Education World University Rankings.

The second example concerns the competitive selection of executors of the state order for the training of masters in higher education institutions within the scope of management of the Ministry of Education and Science of Ukraine. The approved criteria for this competition include the “integrated criterion of staffing quality, training quality and international recognition,” which is equal to 1.1 if the higher education institution took place in the last published issue of at least one of the ratings (QS World University Rankings, The Times Higher Education World University Rankings or Academic Ranking of World Universities), and 1.0 in other cases.

- *International rankings are the most powerful tools for building the reputation of the university in the international arena.* Representations and places in the rankings influence the decisions of entrants regarding the choice of university and direction of training. If tens of millions of young people around the world see the universities of a country in the top 100, 50, 10, then naturally, a positive image of higher education in this country is formed, even without a detailed analysis of how universities measure the ratings. For teachers and researchers, a positive image of the university is one tool in determining the

desired place of work and making decisions about collaboration with other scientists and organizations. Thus, high positions in the ranking allow attracting the most highly qualified specialists and intellectual elite to work at the university.

In addition, the recognition of the university brand promotes the development of international cooperation, increasing the number of internships and academic exchanges between Ukrainian universities and partner universities from other countries, strengthening cooperation between higher education institutions and international business structures.

Thus, the university's high performance in international rankings helps to increase the number of international partners, develop research priorities and increase financial revenues through participation in international projects. In general, the brand of the higher education institution is becoming recognizable, and the reputation of the university is significantly improving.

At the same time, low indicators of international rankings can negatively affect the competitiveness of the university. Due to low international rankings, a higher education institution may lose applicants, public funding, and so on.

1.3 Sumy State University in world universities rankings

Today, the success of higher education institutions can be assessed by indicators of national and world rankings of universities. In recent years, Sumy State University occupies a leading position among the best free economic zones in the country and is represented in prestigious international rankings.

Sumy State University is included in the World Higher Education World University Rankings in 2020 at 501-600 and 1-2 positions among Ukrainian universities. According to the University Impact Rankings from World Higher Education World University Rankings 2020, the university is among the TOP-300 universities in the world in terms of socio-economic impact; the industry rankings

of World Higher Education World University Rankings are noted by Sumy State University on the position 401-500 in the field of “Business and Economics,” on the position 501-600 in the field of “Engineering” (1-2 place among the Free Economic Zones of Ukraine) and on the position 1001+ in the field of “Physical Sciences” [4].

According to the international ranking of higher education institutions QS World University Rankings 2020, Sumy State University is in the top group of 701-750 leading universities in the world, shares the fourth-fifth position among Ukrainian higher education institutions, and is classified as a university with high research performance. The rating also ranked the university 101-150 among the “young” universities in the world, which are “growing rapidly” [4].

For the fourth year in a row, Sumy State University confirms its leading position in the ranking of young universities from QS World University Rankings and entered the corresponding ranking from Times Higher Education. Currently, university is the only representative of Ukraine in this category of ratings [4].

In 2017, Sumy State University successfully passed the audit and was included in the catalog of research universities around the world, which annually publishes an authoritative Shanghai ranking. The university was evaluated on 35 indicators that characterize all aspects of the modern research university. The university received a score of 500+ in the overall Shanghai ranking.

According to the international ranking Webometrics Ranking of World Universities in 2020, the university ranks 3rd among free economic zones of Ukraine and also occupies high positions in the European rating U-Multirank, which identified most indicators of educational, extracurricular, international, and other aspects of Sumy State University as exceeding the world average [4].

The University is the first in Ukraine to pass an independent external audit of QS World University Rankings in 2014 and received the highest marks (5 stars) for the quantitative and qualitative composition of teachers, student satisfaction with the quality of education, learning conditions, and accessibility, social orientation, and E-learning [4].

According to the international SciMago Institutions Rankings 2019, Sumy State University is among the top 250 universities in Central and Eastern Europe [4].

According to the international environmental rating UI GreenMetric 2020, Sumy State University is among the top 250 universities in the world. The university became the first Ukrainian university to be included in this ecological rating [4].

According to the scientometric database Scopus, according to the number of citations by the world scientific community of publications of scientists of the university and the Hirsch-Sumy State University index among the leaders of the scientific and educational space of Ukraine in 2020 [4].

In terms of the number of scientific and scientific-pedagogical workers who have five or more publications in publications indexed by Scopus databases and/or Web of Science Core Collection, the university has one of the highest indicators among the Free Economic Zones of Ukraine. These criteria refer to the QS World University Rankings..

According to a study published by Webometrics, in 2020 the university ranks 4th among Ukrainian universities in terms of citations of scientists in Google Scholar, Sumy State University repository of scientific works ranks first among Ukrainian free educational institutions and is in the TOP-40 best institutional repositories in the world, according to Ranking Web of Repositories from Webometrics in 2020 [4].

Thus, we can conclude that Sumy State University is actively competing for places in the international rankings of higher education institutions. The fact that the university is represented in most of the world's leading rankings indicates the university's interest in participating in these rankings and achieving high results at the international level. This, in turn, will help improve the university's image in the world, financial income from international cooperation, improve the quality of education, and increase the university's competitiveness for a decent entry into the world arena.

2 GREEN UNIVERSITIES: TOWARDS ENVIRONMENTAL SUSTAINABILITY

2.1 Theoretical aspects of implementing the concept of green universities

The green university is a higher education institution that implements measures to protect the environment, namely the development of environmental infrastructure, saving water and energy resources, waste sorting, the formation of environmental habits and patterns of behavior [5].

The history of this term and the greenest movement dates back to the middle of the twentieth century. In the 1950s, the rapid development of industrialization resulted in significant pollution of the environment. The first country to pay attention to this was the United States of America. In this country, environmental protection has gradually taken one of the main places on the political agenda. In one of his statements on environmental protection in the US Congress, President Richard Nixon stressed that citizens should receive environmental education and understand the basic concepts of environmental protection, and educational institutions should provide appropriate competencies.

In the 1970s and 1980s, the US Congress passed more than 20 environmental bills. This period was called the ecological decade in the history of environmental protection. Considerable attention will be paid to the implementation of the concept of environmental protection in universities. Since then, the role of higher education institutions in environmental protection and the promotion of sustainable development has been realized through the concept of green university [6].

Today, introducing the concept of a green university is one of the current trends in developing the world's leading higher education institutions. It provides for the integration of the principles of environmentally sustainable development in all aspects of the higher education institution (Fig. 2.1) [7].

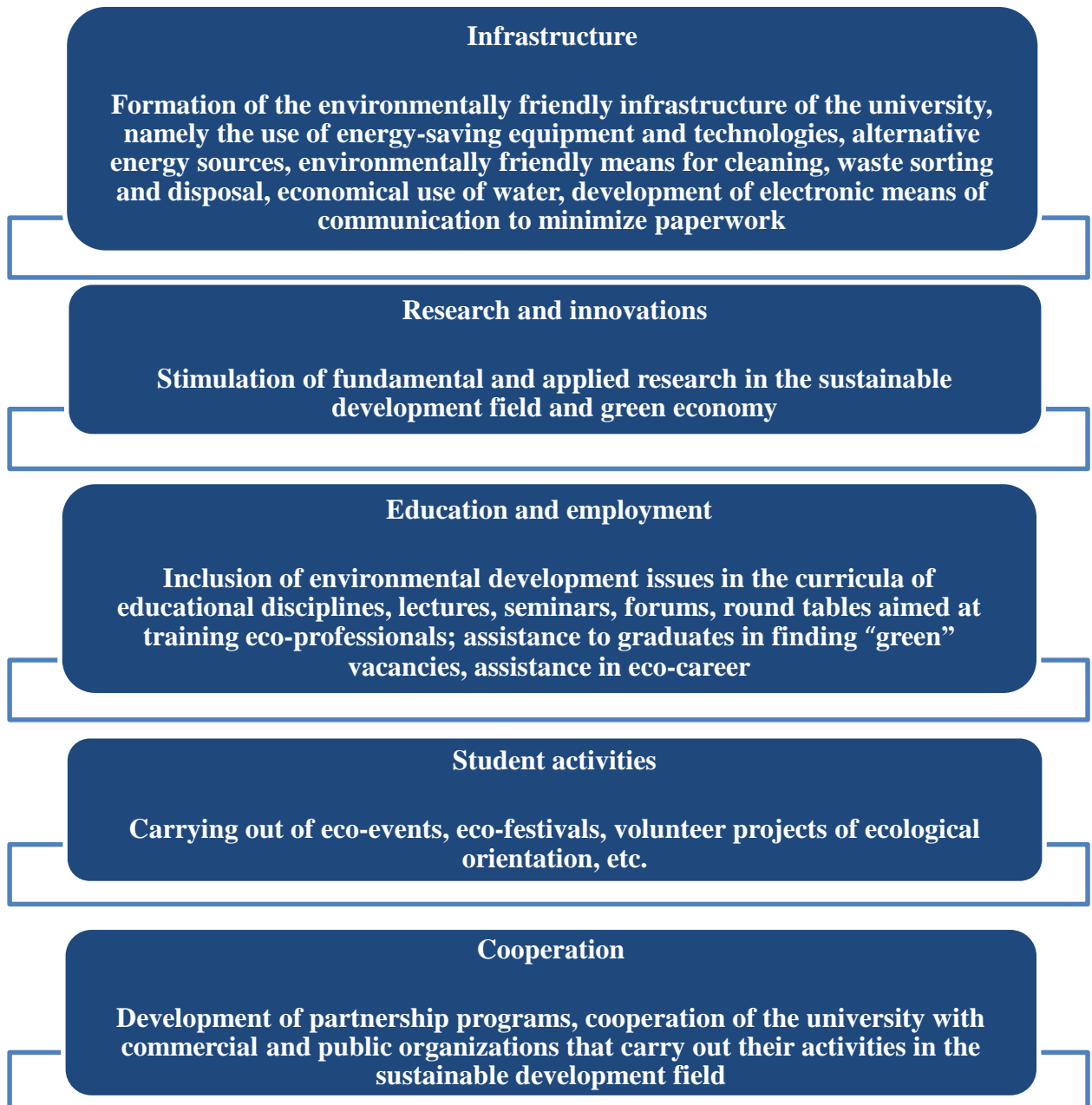


Fig. 2. 1 – The main elements and principles of the green university concept [7]

Thus, greening is, in essence, a model of a green economy based on higher education, which includes not only educational innovations but also behavioral, technical, and managerial aspects. Each of these components of the concept of a green university is an important component of sustainable development of higher education and requires a systematic approach and strategic planning while being part of the overall development strategy of the green university.

2.2. Foreign experience of ecological transformation of higher education institutions

Today, many foreign universities worldwide already have successful experience in implementing such a concept of the green university in their activities. The effectiveness of its implementation is assessed in the UI GreenMetric World University Rankings [8], which takes into account such criteria as infrastructure and green space in the university, energy consumption and savings, rational use of natural resources, storage and recycling, use of environmentally friendly vehicles, conducting training courses on environmental issues, implementation of research projects on sustainable development, etc.

The leaders of the implementation of sustainable development values according to the UI GreenMetric World University Rankings in 2020 were the universities of the Netherlands, Great Britain, and the United States (Table 2.1) [8]

Table 2.1 – Top-5 green universities in the world in 2020 [8]

Number in the rating	Name of the university	Country	Total number of points
1	Wageningen University	Netherlands	9150
2	Oxford University	Great Britain	8875
3	University of Nottingham	Great Britain	8775
4	University of Trent in Nottingham	Great Britain	8725
5	University of California at Davis	USA	8725

For two years in a row, Wageningen University ranks 1st in the ranking of green universities in the world. This is a university with excellent indicators of sustainable development. The university implements various projects in the field of energy, waste disposal, etc., aimed at reducing the negative impact on the environment and curbing the processes of climate change on the planet [9, 10].

The university annually evaluates its contribution to reducing carbon dioxide emissions. Between 2010 and 2019, Wageningen University halved its total emissions. Such indicators were achieved, first of all, due to the implementation of

renewable energy projects. Thus, in 2019, 100% of the energy consumed at the university was obtained with the help of alternative energy sources [9,10].

Oxford University ranks second in the ranking. Oxford University's Environmental Sustainability Strategy aims to achieve zero carbon dioxide emissions by 2035. The University has implemented some energy-saving measures that not only save energy but also significantly save financial resources [11].

The University of Nottingham is another well-known green educational institution that actively promotes the principles of sustainable development and instills in its student's interest in ecology. Every month at the university, there are competitions between student dormitories "Student Switch Off." The residence, from which students save the most energy and pay the most attention to recycling, wins prizes and a supply of ice cream "Ben & Jerry!". The university also has a "WasteNott" campaign aimed at reducing the use of disposable plastic tableware. According to surveys, 94% of students at the University of Nottingham are ready to switch to reusable glassware. Campus cafeterias offer a discount on drinks to those students who come with their glasses [10, 11].

The State University of California, Davis, is widely known for its commitment to sustainable development and has a platinum award under the Sustainability Tracking, Assessment & Rating System, which measures the level of sustainable development in higher education institutions in the United States. University campuses are certified according to the LEED (Leadership in Energy and Environmental Design) standard, equipped with energy-efficient technologies, charging points for electric vehicles, etc. In 2020, the University of California at Davis reduced greenhouse gas emissions to 1990 levels, ie reduced them by 50%.

In the future, the university has more ambitious goals, namely to achieve zero greenhouse gas emissions and reduce drinking water consumption by 20% by 2022. It should be noted that the university pays considerable attention not only to the arrangement of campuses but also to the selection of curricula. The university offers students a number of educational disciplines related to sustainable development and environmental protection [11].

Thus, leading green universities implement a wide range of sustainable development strategies and are an example of green development centers and drivers of environmentally sustainable growth.

2.3. Green strategy of Sumy State University

Aware of the role of higher education institutions in shaping national and regional policies taking into account the goals of sustainable development, Sumy State University declares the priority of taking into account environmental aspects in its activities.

The environmental activity of the university is ensured through compulsory and voluntary activities. Mandatory is regulated by the requirements of current legislation and regulations of the university, voluntary – by taking and fulfilling additional voluntary environmental commitments.

The main directions of ecological activity of Sumy State University are approved by the order № 0912-I of December 13, 2019, according to which the university undertakes to implement a set of ecological measures in general organizational and administrative-economic activity, educational, scientific, and extracurricular activities [12].

In the general organizational and administrative-economic sphere, the ecological activity of the university is aimed at:

- introduction and continuous improvement of the environmental management system and consideration of environmental aspects in the activities of all structural units;
- reducing the burden on the environment by increasing the efficient use of electricity and heat, the use of renewable energy resources, increasing the volume of reuse of water, reducing the use of paper, plastic, disposable items, etc;
- reduction of environmental impact from motor transport by optimizing the planning of the educational process taking into account the needs for relocation of staff and students, the use of environmentally friendly transport (providing conditions for the use of bicycles, electric vehicles, etc.);
- consideration of environmental aspects in the arrangement of the campus of the university;

- cooperation on environmental issues with the authorities, scientific, educational, and other institutions at the local, regional, national, and international levels.

Implementation of environmental policy in the educational activities of the university involves:

- training of specialists with higher education, postgraduate and doctoral students in the field of ecology, environmental protection and sustainable development;
- increase students' understanding of the environmental aspects of their future professional activities by including environmental issues in the curricula of compulsory and elective courses.

Greening of scientific activity involves:

- development of existing and launch new areas of research and development of environmental orientation;
- not allowing research and development, the processes of which, or the use of the results of which may lead to negative environmental consequences
- cooperation with state and local authorities on the provision of consulting and research services in the field of ecology, environmental protection, and sustainable use of nature.
- carrying out actions for the popularization of ecological knowledge and support of volunteer initiatives of an ecological direction.

The clarity of the declared provisions of the environmental policy and their strict implementation was the result of the presentation of Sumy State University in the World Universities Rating UI GreenMetric. Thus, in 2020 the university took 409th place among 912 educational institutions from 83 countries. Sumy State University was highly praised for more than 40 criteria on energy efficiency, response to climate change, waste disposal, the level of environmental research, the implementation of environmental measures and sustainable development issues in educational programs, and more.

Among the 10 best Ukrainian higher education institutions included in the UI GreenMetric in 2020, Sumy State University took third place (Table 2.2) [8].

Table 2.2 – Top-10 universities in Ukraine in UI GreenMetric in 2020 [8]

Name of the university	Place in the ranking in 2020	Number of points by indicators:					
		Infrastructure	Energy and climate change	Waste	Water use	Transportation	Education and research
Ukrainian National Forestry University	1	1075	1050	1275	650	1325	1800
Uman National University of Horticulture	2	1150	1325	1050	550	1075	1000
Sumy State University	3	900	1325	675	525	1000	1125
Western Ukrainian National University Ukraine	4	500	1000	675	525	1175	1225
VN Kharkiv National University Karazina	5	775	875	675	625	975	1025
National University of Ostroh Academy of Ukraine	6	800	750	825	500	1075	775
Lviv Polytechnic National University	7	525	950	675	250	950	1025
Sumy National Agrarian University	8	1025	700	375	250	800	1175
National University of Life and Environmental Sciences	9	775	700	450	250	775	1300
Mykolayiv National Agrarian University	10	1000	625	300	550	775	975

Thus, it can be argued that today Sumy State University is one of the leaders in the green development of higher education institutions in Ukraine and, at the same time, has significant potential to improve its position in the ranking of UI Green Metric.

3. IMPLEMENTATION OF SOLAR ENERGY PROJECT BY SUMY STATE UNIVERSITY AS ONE OF THE WAYS TO BE MORE ECO-FRIENDLY

3.1 Economic justification of the implementation of the solar energy project by Sumy State University

One of the key areas of environmental policy of Sumy State University is to reduce electricity consumption, possibly primarily through the implementation of renewable energy projects. The most mature technology used for this purpose in the world is solar energy. Despite the fact that the implementation of solar energy projects in foreign universities has become widespread, Ukrainian higher education institutions do not have such experience [13].

The main reason for this is the peculiarities of Ukrainian legislation in the field of managing the development of green energy. Yes, according to the Law of Ukraine ‘On the electricity market’ [14], the main mechanism for stimulating the development of renewable energy is the feed-in tariff. It applies only to the generated amount of electricity not consumed for own purposes.

This approach makes it an attractive tool for projects: 1) in the business sector, namely for the construction of high-capacity solar power plants to produce and sell green electricity for profit, where the only source of consumption is the technological needs of power plants; 2) in households, the volume of electricity consumption of which for their own purposes is less than the amount of production by generating capacity [13].

Universities cannot take advantage of the feed-in tariff, because in most cases, they can only place low-power solar stations on the roofs of buildings, in which case the amount of electricity generation will not exceed its consumption by higher education institutions. Accordingly, universities cannot count on a quick payback period for investment projects, which is provided by the sale of electricity at a green rate, the rates of which are among the highest in Europe [15].

Given the above, we will conduct an economic assessment of the implementation of the solar power plant project by Sumy State University, taking into account the peculiarities of the state energy policy in the field of renewable energy.

We will estimate the cost of electricity generation by a solar power plant using the Levelized Cost of Electricity (LCOE) method. The LCOE indicator reflects the fixed unit cost of electricity throughout the life of the power plant, which equates the total discounted costs of construction and operation of the power plant to the total discounted revenue from the sale of electricity to consumers [16].

To calculate the cost of generating electricity from solar radiation in the scientific work will take into account the following components: investment and operating costs, the amount of electricity generated, the cost of decommissioning the solar power plant, and the discount rate.

Thus, the formula for calculating the LCOE will look like this:

$$LCOE = \frac{\sum_{t=0}^n ((I_t + Q_t + D_t) \cdot (1 + r)^{-t})}{\sum_{t=0}^n (E_t \cdot (1 + r)^{-t})}, \quad (3.1)$$

where $LCOE$ – fixed cost of electricity generation during the lifecycle of the solar plants, UAH/kWh;

E_t – the amount of electricity generated in the t year, kWh/year;

I_t – investment costs in the t year, UAH;

Q_t – operating expenses in the t year, UAH;

D_t – costs for decommissioning of the solar plant in t year, UAH;

n – service life of the solar plant, years;

r – the discount rate;

t – year of investment project implementation.

Consider in more detail the technical and economic data of a solar power plant, based on which the estimated cost of electricity generation will be calculated.

To collect them, statistical data on the implementation of solar energy projects in Ukraine were used [17, 18, 19]:

1. Technical characteristics of the solar power plant:
 - installed capacity – 50 kW;
 - coefficient of reduction of electricity generation – 0,8% annually;
 - projected annual electricity production (taking into account that photovoltaic modules will be placed on the university roof) – 48595,45 kWh;
 - life cycle duration – 25 years.
2. Projected investment costs – 867,180 UAH.
3. Projected operating costs – 21000 UAH / year.
4. Estimated decommissioning costs – 43,359 UAH.

The discount rate for calculating the LCOE is 8%. Its calculation was based on the weighted average cost of capital [20], assuming that the university would not attract credit resources to implement the project. Accordingly, the cost of borrowed capital and its share on the balance sheet in this study is zero. Valuation of equity was defined as the number of alternative investments in deposit accounts in state-owned banks (the average rate on hryvnia deposits in which as of 01.03.2021 was 8%) [21, 22, 23].

Based on the above data, the cost of electricity generation based on solar radiation, calculated by formula (3.1), is 2,12 UAH / kWh.

As mentioned above, according to the current legislation, the university can sell at a green rate only the surplus of electricity that is not consumed for its own purposes. Given that the university's electricity consumption exceeds that of 50 kW solar power plant, the entire amount of green electricity will be consumed for its own purposes.

The discounted payback period of the investment project is calculated as follows:

$$DPP = \sum_{t=1}^n \frac{CF_t}{(1+r)^t} \geq I_0, \quad (3.2)$$

where PP – the payback period of the investment project;

I_0 – initial investment, UAH;

CF_t – net cash flow in the t year, UAH;

n – duration of the project life cycle, years;

r – the discount rate;

t – the year of investment project implementation.

The results of calculating the payback period of the investment project in accordance with formula (3.2) show that at the current level of the electricity tariff, the university will reimburse the initial investment for 17,1 years.

Note that the payback period of the investment project was calculated at a fixed tariff for electricity (current tariff as of 01.03.2021 – 2,56 UAH/kWh) for the university in the coming years. Given that electricity tariffs are periodically increased, the payback period, taking into account their changes, will be shorter.

Thus, the obtained calculations allow us to state that the implementation of the solar power plant project by Sumy State University is expedient, as the payback period of the project does not exceed the life cycle of the power plant, and the projected increase in electricity tariffs will have a positive impact on its reduction.

3.2 Assessment of environmental and image benefits from implementation of the solar energy project

Economic feasibility is not the only motive for implementing a solar energy project. One of the key advantages of generating electricity from solar radiation is the absence of carbon dioxide emissions. Thus, the installation of a solar power plant will have a positive impact on reducing the man-caused load on the environment.

To assess the reduction of emissions from implementing the solar power plant project, we will use the method “ACM0002: Large-scale consolidated methodology for grid-connected electricity generation from renewable sources” [24].

According to the above method, the reduction of carbon dioxide emissions is calculated by the formula:

$$ER_t = BE_t - PE_t, \quad (3.3)$$

where ER_t – the emission reduction in period t , t CO₂-eq.;

BE_t – baseline emissions in the period t , t CO₂-eq.;

PE_t – projected emissions in the period t , t CO₂-eq.

Thus, according to [24] baseline emissions of carbon dioxide in the production of electricity by solar power plants are calculated as follows:

$$BE_t = QE_t \cdot EF_t, \quad (3.4)$$

where BE_t – baseline emissions in the period t , t CO₂-eq.;

QE_t – the amount of electricity generated by electricity by a solar power plant in the period t , MWh;

EF_t – specific emissions of carbon dioxide during the generation of electricity by thermal power plants that are part of the Energy System of Ukraine in the period t , t CO₂-eq..

According to the above methodology, the project emissions (PE_t) during electricity generation by solar power plants are zero.

Specific emissions of carbon dioxide in the electricity generation by thermal power plants are 1,063 tons of CO₂-eq./MWh [25].

Based on the above algorithms and actual data on the amount of electricity generated by the solar power plant, we have calculated the reduction of carbon dioxide emissions during the first five years of the life cycle of a solar power plant.

Table 3.1 – Reduction of carbon dioxide emissions when replacing conventional electricity with electricity generated by the solar power plant, t CO₂-eq.

The amount of electricity generated by electricity by a solar power plant in the period t, QE_t (MWh)	Specific emissions of carbon dioxide during the generation of electricity by thermal power plants that are part of the Energy System of Ukraine in the period t, EF_t (t CO ₂ -eq.)	Baseline emissions, BE_t (t CO ₂ -eq.)	Project emissions, PE_t (t CO ₂ -eq.)	Emission reductions, ER_t (t CO ₂ -eq.)
1108,37	1,063	1178,2	0	1178,2

Thus, replacing traditional electricity with own energy generation based on solar energy will help reduce emissions in the amount of 1178,2 tons of CO₂-eq. throughout the life cycle of a solar power plant, which will positively impact curbing global warming and climate change.

3.3 Analysis of the impact of the implementation of the solar energy project on strengthening the position in world universities rankings

The implementation of the solar energy project can bring the university economic and environmental benefits and have a positive impact on improving its image at the national and international levels.

First of all, increasing the share of renewable energy sources will allow the university to improve its position in the UI Green Metric World University Rankings, which assesses its efforts to reduce the negative impact on the environment. Sumy State University will be able to improve its results in the category “Energy and Climate Change,” which occupies one of the largest shares in the overall ranking – 21% [26].

The UI Green Metric World University Rankings contributes to the university's image against the background of other rankings in which the university already participates, as it largely shapes them.

Participation in UI GreenMetric can help the university enhance its image in internationalization and recognition by the fact that universities achieve sustainability on the global arena by competing with universities from around the world. Participation in the UI GreenMetric can increase the number of views on the university's website and promote correspondence with institutions interested in the university [27].

In addition, as a member of UI GreenMetric, the university automatically joins UI GreenMetric World University Ranking Network, where it can share its experience in project implementation and position itself as a leader of the green movement in the region [27].

Own solar power plant will allow students and graduate students to practice and engage in research work within the university, having access to the latest technological and metrological equipment. This will allow the university to increase its competitiveness in research and significantly increase the visibility and recognition of its brand in the scientific space, becoming an environment for modern research in the field of energy-saving. As a result, the university will be able to improve its position in the international Times Higher Education ranking by raising indicators such as “Research” with a share of 30% in the overall ranking and “Industry Income,” which has a share of 2,5% in the overall rating [28]. These indicators reflect the effectiveness of commercialization of scientific results and developments, the efficiency of technology transfer.

The Times Higher Education BRICS & Emerging Economies Rankings sub-rating should also be singled out. The Industry Income category is given special importance – its share is 10% in the overall score, which is identical to the share of the group indicators of internationalization in the same ranking.

The installation of a solar power plant will increase awareness and accumulate a theoretical and practical base in renewable energy, which will

positively impact the training of highly qualified specialists, including the Faculty of Technical Systems and Energy Efficient Technologies. This will help raise the university's image among higher education institutions in Ukraine that train students in related specialties and improve its reputation among employers and the business community.

Thus, we can conclude that the implementation of the solar energy project will positively impact strengthening the university's position in world rankings, making it an example of a center of green development and a driver of environmentally sustainable growth.

CONCLUSIONS

Obtaining high scores by universities in international rankings helps to increase their competitiveness on the world stage, increase the number of international partners, develop research priorities and increase revenues. Sumy State University is represented in most of the world's leading rankings, indicating high results in educational, scientific, international, environmental, and other areas.

It is established that the leading institutions of higher education implement the concept of green universities in their activities. Simultaneously, in Ukraine, green university initiatives are only at the stage of their formation and cover only certain areas of their activities. At the same time, Ukrainian higher education institutions have significant potential to implement a wide range of sustainable development strategies and can serve as examples of green development centers.

Improving the position of Sumy State University in the world rankings is possible by implementing environmental initiatives, particularly the involvement of renewable energy resources in energy production processes. To test the implementation of the solar energy project, Sumy State University proposed technical and economic data for estimating the cost of electricity generation from solar radiation and a scientific and methodological approach to assessing economic and environmental benefits.

The implementation of the solar power plant project by Sumy State University is economically justified, as the payback period of the project does not exceed the power plant's life cycle, and the projected increase in electricity tariffs will have a positive impact on its reduction.

Replacement of traditional electricity by own energy generation based on solar energy will help reduce emissions in 1178,2 tons of CO₂-eq. throughout the life cycle of a solar power plant, which will positively impact curbing global warming and climate change.

It is proved that the implementation of the solar energy project will positively impact the university's image, including improving its position in world rankings, increasing competitiveness in research, and achieving the national and international policy goals of Ukraine.

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SUMMARY

Lysenko D.A. Implementation of the green university concept as a way to strengthen the position of higher educational institution in world rankings. – Bachelor's qualification paper. Sumy State University, Sumy, 2021.

The qualification bachelor's paper is devoted to the study of aspects of the implementation of the concept of a green university to strengthen the position of higher education in the world rankings. The main world rankings of universities and their impact on the competitiveness of higher education institutions in the international arena are analyzed. The foreign experience of ecological transformation of higher education institutions and the green strategy of Sumy State University are considered. An assessment of economic, environmental, and image benefits from the implementation of the solar energy project by higher education institutions, and its impact on strengthening the position of Sumy State University in the world rankings.

Keywords: world rankings of universities, the concept of green university, environmental sustainability, solar energy.

АНОТАЦІЯ

Лисенко Д.А. Реалізація концепції “зеленого” університету як спосіб зміцнення позицій вищого навчального закладу у світових рейтингах. – Кваліфікаційна бакалаврська робота. Сумський державний університет, Суми, 2021.

Кваліфікаційна бакалаврська робота присвячена дослідженню аспектів впровадження концепції “зеленого” університету з метою зміцнення позицій вищого навчального закладу у світових рейтингах. Проаналізовано основні світові рейтинги університетів та їх вплив на конкурентоспроможність вищих навчальних закладів на міжнародній арені. Розглянуто закордонний досвід екологічної трансформації закладів вищої освіти та “зелену” стратегію Сумського державного університету. Проведено оцінку економічних, екологічних та іміджевих вигод від реалізації проєкту сонячної енергетики закладом вищої освіти, та його вплив на зміцнення позицій Сумського державного університету у світових рейтингах.

Ключові слова: світові рейтинги університетів, концепція “зеленого” університету, екологічна стійкість, сонячна енергетика.