

Energy Efficiency and Environmental Friendliness of University Campuses

Y Podoprigora¹, T Zaharova², A Eliseev¹ and D Crozat³

¹Tomsk State University of Architecture and Building, 634003, Tomsk, Russia

²National Research Tomsk State University, 634050, Tomsk, Russia

³Paul Valéry University of Montpellier, Department of Geography, Montpellier, France

E-mail: y.v.p@rambler.ru

Abstract. The article discusses theoretical foundations and practical applications of the program-oriented method in the context of university campuses' energy efficiency improvement. Best practices of foreign and Russian universities in the field of energy and resource efficiency are considered. In Russia, the use of innovative energy-efficient projects in public sector is obstructed in a number of ways. In the situation when prices for fuel and energy resources are rising and public institutions' budgets are lacking funds energy management becomes particularly crucial for universities. The article attempts to generalize trends in energy efficient design and maintenance of sustainable university campuses and to propose measures to improve energy efficiency of university campuses in Russia.

1. Introduction

Nowadays, there is a number of institutional, managerial, information, technological, investment and educational hindrances in Russia that prevent widespread introduction of energy-efficient technologies. Meanwhile, university campuses are creating the most favorable environment for new approaches' in the field of energy efficiency testing, knowledge generation, various researches and their transfer [1, 2]. Higher education institutions act as tools transforming society by means of intellectual development. This role implies social responsibility, responsibility for sustainable development.

In universities' real estate management a new function has recently appeared – provision of rational (efficient) consumption of energy resources, which is achieved by implementing a system of measures aimed at saving energy and improving energy efficiency of equipment and campus building structures [3].

Novosibirsk and Tomsk regions have recently been selected pilot regions for world-class scientific and educational centers (SEC) creation within "Science" national project.

According to "Educational Export" Federal project it is planned to increase the number of foreign students by 2 times (from 210 000 to 425 000 people) by 2024, so campuses development becomes "one of the key elements of this goal". "Educational Export" Federal project is going to provide budget funds in the amount of 102.2 billion rubles for designing, constructing and reconstructing student campuses from 2019 to 2024. Student campuses for foreign and nonresident students, scientific and pedagogical workers are to accommodate at least 77.6 thousand people.

Tomsk is one out of a hundred best cities for students in the world according the QS world ranking. Students from 79 countries and 78 regions of Russia study in Tomsk. Tomsk Governor S.A. Zhvachkin announced an international competition for the student campus concept [4]. Therefore, solution of problems related to reconstruction and design of energy-efficient campuses is an important direction in the development of university cities in Siberia.

2. Topicality of the issue, scientific actuality given with brief literature review

In the research of Delft University of Technology Professor Alexandra den Heijer (Netherlands) it is noted that in cities where technological campuses are located, there are innovations and there is a positive impact of university's presence on economic growth, demographic profile and cities and regions' socio-cultural objects [5-6]. Adequate campus conditions produce a positive impact on university goals, financial resources, performance and user satisfaction.

High-quality buildings leave a smaller ecological footprint. However, more than a half of university buildings in Europe were built in the middle of the last century and are in poor technical and functional condition and energy inefficient. Inadequate space utilization, underutilized areas' high cost requires smart planning tools.

Russian scientists have also made a significant contribution to the solution of resource conservation methodological and practical issues. Problems of energy saving in universities were studied in the works of E.M. Dorozhkin, L.V. Primak, A.V. Sinko, N.A. Tsvetkova, etc. [1-2,7-8].

From our point of view, energy saving programs in universities are a strategically important direction for the economy, ensuring Russia's national security and helping to reduce energy intensity of GRP. In addition, a university campus built on the basis of energy-efficient technologies is a brand, a competitive advantage in the struggle for human resource in university cities. Lack of scientific study of these issues in new circumstances determines the work's relevance.

3. Aim setting

The aim of the research is to study theoretical foundations and practical utilization of energy saving and energy efficiency improvement programmes based on the example of university campuses and analyze practices of introducing ecological innovations in Russia.

4. Theoretical part

The new Repsol student campus, located in Madrid (Spain), can rightly be called an example of energy-efficient technologies' introduction. The complex was built in 2013 on 123 000 m² area. The facility was awarded the prestigious Green Building Council (USGBC) Award. The LEED NC Certificate received by the university means that the building is designed and built in accordance with the highest energy efficiency requirements.

After analysis of foreign campus design practices it becomes possible to distinguish main ways of energy saving improvements [9-14]:

- introduction of innovative buildings' structure types,
- utilization of efficient heat-insulating materials, solar, wind, geothermal types of energy.
- utilization of geothermal energy for heating and cooling of buildings by means of thermal pumps,
- disposal of ventilation emissions' heat,
- gardens included into buildings' ventilation system,
- energy efficient external building envelopes, for example, windows with improved heat- and sun-protective characteristics.

It should be noted that, in European countries, the issues of energy saving are put at the forefront of energy production, minimizing negative impact on the environment and allowing not to depend on external energy sources. European countries that do not have their own oil and natural gas reserves are interested in finding alternative energy sources. For example, the use of renewable sources is one of the priorities of energy complex development of modern France.

In Russia, energy saving is primarily a matter of reasonable energy consumption, including construction, ensuring minimal energy consumption in the process of construction and maintenance of buildings.

Adoption of a number of legal acts on energy saving at the federal, regional and municipal levels in recent years has served as a powerful signal for strengthening the use of administrative and organizational mechanisms in energy saving management in public sector, including education. Energy saving in universities is conducted in accordance with No.261-FZ Federal Law and the Ministry of Education and Science Decree No.309, which refer to development of legal, economic and organizational framework to promote energy conservation and efficiency. At the moment, many universities have approved energy saving and energy efficiency action plans.

Development of an energy saving program is based on the program-oriented method, which in comparison with estimated planning has a number of advantages and allows providing:

- concentration of resources on priority complex tasks solution;
- long-term planning horizon;
- a systematic approach to formation of a set of activities interrelated in resources and timing;
- control over expenditure efficiency.

5. Practical importance

Further there is a list of best energy efficient practices adopted in Russian universities.

Federal State Autonomous Educational Establishment of Higher Professional Education “Far Eastern Federal University” (FEFU). FEFU campus on Russky Island is the most modern university campus in the Russian Federation (2013). FEFU pays special attention to issues of energy saving and efficiency. The university implements a comprehensive program on energy saving and new energy saving technologies introduction, and its campus is a testing ground for the use of alternative energy sources.

FEFU has the most powerful university solar installation in Russia, which provides hot water to residents of one of the student residential buildings, saving traditional resources by almost a third. In 2015 FEFU reached the final of the all-Russian competition in the field of energy saving with this project; in addition, FEFU is the Russian leader in the world ranking of environmentally friendly universities.

The university is installing energy-efficient equipment and is planning to equip the premises with motion sensors. Introduced modern technologies in the field of energy saving are used in educational process for training of specialists, as well as for scientific research.

National Research Tomsk Polytechnic University (NR TPU). In 2015, TPU became one of the five most energy-efficient universities in the field of energy saving among subordinated to the Ministry of Education and Science of Russia [3]. In matters of energy saving the university is based on compliance with Russian and international standards of organization quality management, and in particular, provisions of ISO 50001:2011 “Energy management systems (Energy Management). Requirements. Recommendations for introduction” international standard.

The university has developed “Energy saving in the National Research Tomsk Polytechnic University for 2010-2018” target program. These are some TPU energy-saving measures in the field of electricity (table 1).

Expected final results of NR TPU program for all types of energy resources:

- reduction of specific power consumption by 30%;
- reduction of specific heat consumption by 20%;
- improvement of working conditions;
- reduction of environmental pollution.

Table 1. The list of TPU energy-saving activities in the field of electricity [15].

No	Action plan	Expenses, thousand rubles	Annual saving of fuel and energy resources thousand kWh	thousand rubles
1.	Introduction of automated information-measuring system of electric energy control and accounting	1 200	486	1 130
2.	Replacement of lighting systems with energy-efficient ones	1 040	832	2 238
3.	Regularization of lighting systems use	5 800	434	1 170
4	Introduction of pump and fan drives private management	5 600	811	2182
	Total	13 640	2563	6720

National Research Tomsk State University (NR TSU). The developed projects “Program of energy saving and energy efficiency of TSU for 2015-2020” and “Concept of modernization and development of TSU premises up to 2020” include advanced developments in the field of energy saving and energy efficiency:

- utilization of renewable energy sources: heat pumps, solar collectors, etc.;
- utilization of automatic resource consumption control systems with feedback based on wireless technologies;
- a single data center and a single campus management center;
- secondary turnover of industrial water, utilization of rain and melt water;
- infrared ceiling heating systems;
- combining developments in the field of resource saving;
- experimental in-house use of TSU developments;
- commercialization of developments and import substitution [16].

Tomsk State University of Architecture and Building (TSUAB). To improve resource efficiency of TSUAB facilities, an energy saving program has been developed. The system of heat consumption dispatching is put into operation in all educational buildings.

On the basis of TSUAB functions a center for modernization of housing and communal services of Siberia and the Far East. The main purpose of the center is to improve skills and training of personnel for housing and utility complex of Siberia and the Far East. Both students and workers of housing and utility services study in the center. This is the first center of this kind in the eastern part of Russia. Tasks of the center include promotion of energy efficiency and training of its partners in energy-saving measures.

6. Conclusions

Development of an energy saving and energy efficiency program is an important goal for universities. Energy saving and energy efficiency program allows reducing energy costs and increase energy efficiency, as well as overall level of comfort at university.

Among organizational measures to improve universities’ energy efficiency there are the following ones:

- introduction of energy management system (energy efficiency center);
- implementation of technical and economic passport;
- professional development of specialists in the field of energy saving.

Almost all “green” and energy efficient technologies are innovative. Therefore, legislative imperfections in the field of innovative solutions directly affect development of environmentally friendly technologies. Incentive measures, such as special taxation schemes, reduction of payments for

energy-efficient equipment introduction are among the most effective mechanisms of “green” technologies introduction.

Humanity is rapidly moving towards saving energy resources and innovative technologies. University campuses are places where future generations are brought up. “Campus of the future”, principles of its formation and operation must undoubtedly meet all modern technological requirements, contribute to development of technologies related to reasonable use of the environment.

In conclusion, it is worth noting that the use and replication of best practices of universities in the field of energy saving and energy efficiency, taking into account climatic characteristics of territories, will allow universities to effectively use their property complex and reduce cost of its maintenance, as well as win in the competition for human resources.

7. Acknowledgments

The reported study was funded by RFBR and FMSH according to the research project №18-510-22001.

8. References

- [1] Primak L V, Gareyev I F 2017 Educational institutions as institutes of promoting of energy saving: world practice and introduction in Russia *Mechanization of construction* 5 pp 5-11
- [2] Primak L V, Sinko A V et al 2013 *Energy saving and increase in power effectiveness in the state and municipal Institutions: Textbook* (Moscow: Academic Project) p 560
- [3] Sandler D, Klyuev A K 2018 *Management of economy and finance of higher education institution: practitioners of the Russian universities* (Yekaterinburg: Urals publishing house) p 250
- [4] "Dutch" residential district, student's campus and historicity: results of the Architectural forum in Tomsk <https://tomsk.sm-news.ru/gollandskij-mikrorajon-studencheskij-kampus-i-istorichnost-itogi-arkitekturnogo-foruma-v-tomske-4256/>
- [5] Curvelo Magdaniel, Flavia 2017 editors Den Heijer, Arkesteijn, De Jonge Campuses, Cities and Innovation – 39 international cases accommodating tech-based research (Delft: TU Delft)
- [6] Den Heijer A, Tzovlas G 2014 The European campus. Heritage and Challenges: information to support decision makers (Delft : University of tehnology) p 191
- [7] Krivoshein Y O, Richter I V, Tsvetkov N A 2017 Consumption of energy resources by automated objects of tomsk state architectural-construction university (TGASU) Selected reports of the 63rd University scientific and technical conf. students and young scientists pp 761-765
- [8] Dorozhkin E M, etc. 2017 Power politicians in higher education institution: theory, methodology, practice: monograph (Yekaterinburg) p 191.
- [9] Orlova M, Korsi I, Brodach M 2018 Projection of student's campuses. Energy efficiency and environmental friendliness Sustainable Building technologies 4 pp 36-43
- [10] Nuzhina I P, Egorova O V, Zolotareva M V 2015 Ecological innovations as a factor of competitiveness of modern construction business In collection Problems of economics and construction management in an environmentally oriented development. Mat. the second All-Russian scientific and practical online conf. with the international participation and elements of school of sciences for youth pp 249-255
- [11] Pakhomova N V, Malova A S, Titov V O 2015 Efficiency of economy, ecological innovations, climatic and energy policy: subjects of discussions at the international seminar in St.Petersburg State University *Vestnik SPbSU. Ser. 5* Issue 4 161-172
- [12] Rogotskaya S About sustainable development and eco-innovations: new opportunities <http://www.newsland.ru/news/detail/id/678725>
- [13] Podoprigora Y, Ufimtseva E, Zaharova T, Eliseev A 2019 Ecotechnologies as a Promising Component of Innovative Development of University Cities in Siberia: Increasing the Comfort of Living International Science and Technology Conference "FarEastCon" (ISCFEC 2019)

- Advances in Economics, Business and Management Research* pp 315-317
- [14] PEEC 2030 un programme ambitieux d'efficacité énergétique des campus à l'horizon 2030
URL <http://www.cpu.fr/actualite/peec-2030-un-programme-ambitieux-defficacite-energetique-des-campus-a-lhorizon-2030/>
 - [15] Program of energy saving of TPU <https://tpu.ru/university/strategy/development/energy>
 - [16] Kolesov P V 2014 Energy saving and increase in energy efficiency at the Tomsk state Energy efficiency university *Science and education: collection of theses of reports* (Moscow: MGIU) pp 58-63