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Computer design and modeling of energy systems in the educational process

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Annotation. Problem. *The article highlights the role of computer modeling in the training of energy specialists. Software complexes (MATLAB, ANSYS, ETAP, PSCAD) for the analysis and optimization of energy systems are described. Examples of application are given, in particular, the design of solar and charging stations. The advantages of modeling are determined: resource saving, accuracy of analysis. The importance of digital technologies in the training of specialists in sustainable development is emphasized.* ***Goal.*** *Analysis of the importance of computer design and modeling in the training of energy specialists, studying modern software packages, and evaluating their impact on the effectiveness of the educational process.* ***Methodology.*** *The study is based on the analysis of scientific sources, comparison of programs (MATLAB, ANSYS, ETAP, PSCAD), review of cases and experimental modeling of power systems. The impact of digital technologies on the formation of students' professional skills is assessed.* ***Results.*** *The effectiveness of computer modeling in the training of energy professionals was confirmed. Software packages (MATLAB, ANSYS, ETAP, PSCAD, HOMER Pro, Energy Plus) for modeling and optimizing energy systems were analyzed. The advantages of digital technologies were identified: resource saving, risk-free testing, accuracy of analysis. Cases of solar power plant design, network analysis, cooling optimization and charging stations were considered. Integrating modeling promotes the development of critical thinking and analytical skills.* ***Originality.*** *The study highlights the importance of computer modeling in the education of energy professionals. The use of modern programs (MATLAB, ANSYS, ETAP, PSCAD) in the educational process is analyzed. Their role in optimizing energy systems and developing critical skills is shown. The importance of modeling for innovation and interdisciplinary collaboration is emphasized. The integration of models strengthens theoretical knowledge and practical skills.* ***Practical value.*** *The results of the study contribute to the improvement of the training of power engineers. The integration of modeling (MATLAB, ANSYS, ETAP, PSCAD) improves the quality of training without significant equipment. The optimization of courses through interactive tasks and projects is useful for education, science and consulting.*

Key words: *Computer modeling, energy systems, software packages, MATLAB, ANSYS, ETAP, PSCAD.*

Introduction

Computer design and modeling have emerged as indispensable components of contemporary engineering education, particularly in the context of energy systems. As the global shift towards more sustainable and energy-efficient solutions accelerates, the demand for advanced tools to design, analyze, and optimize energy systems has grown exponentially. Energy production, distribution, and consumption continue to play a pivotal role in both the global economy and environmental sustainability. With growing concerns over energy consumption, the environmental impact of traditional energy sources, and the urgent transition to renewable and alternative energy sources, the ability to model, simulate, and optimize complex energy systems has become more than just a technical skill – it is a fundamental necessity for future engineers and energy professionals [1,2].

The relevance of this research is underscored by the ongoing transformation in the energy sector, which is being propelled by technological advancements, innovative practices, and the increasing demand for higher efficiency in energy systems. As global energy infrastructure becomes more complex and sophisticated, it is crucial to utilize advanced modeling techniques to ensure the design and functionality of these systems meet modern needs. Energy systems now involve not only traditional power generation technologies, such as fossil fuel-based plants, but also renewable sources like solar, wind, and hydroelectric power, as well as emerging technologies like smart grids and energy storage solutions. These systems must be carefully designed, modeled, and optimized to ensure that they are both reliable and sustainable under various conditions, which increases the importance of having accurate modeling tools [3].

In this context, computer-aided design (CAD) software and modeling platforms, such as ANSYS, MATLAB, and others, have become invaluable tools for both academic learning and practical application. These platforms provide students with the opportunity to simulate real-world scenarios and explore a wide range of system configurations and performance parameters. By using simulation tools, students can analyze the behavior of energy systems in virtual environments, assess potential risks, and explore alternative solutions to optimize system efficiency. This hands-on approach not only deepens students' understanding of theoretical concepts but also enables them to experiment with system behaviors and fine-tune designs before applying them to real-world situations.

Moreover, the use of these software systems in education serves a broader purpose, extending beyond just the technical aspects of energy system design. They also foster the development of critical thinking, problem-solving, and decision-making skills. Through the use of simulation tools, students gain a deeper understanding of how various components of an energy system interact with one another, such as power generation units, transmission lines, storage facilities, and renewable energy sources. They learn how to balance competing priorities, such as cost, environmental impact, efficiency, and reliability, when designing and optimizing energy systems. This practical experience not only strengthens their technical expertise but also equips them with the necessary skills to navigate the challenges and uncertainties associated with modern energy infrastructure.

Additionally, the study and simulation of energy systems using advanced computational methods empower students to experiment with innovative approaches to system optimization. For instance, students can model and evaluate different cooling strategies, including liquid cooling, hybrid systems, and phase-change materials (PCMs), assessing their impacts on system efficiency, overall cost, and environmental footprint. These experimental scenarios allow students to explore emerging technologies and assess their viability in real-world applications. By doing so, students not only gain hands-on experience with cutting-edge technologies but also develop the critical problem-solving skills required to address the increasingly complex energy challenges of tomorrow.

Analysis of publications

The article highlights the importance of computer design and modeling of energy systems in the educational process, particularly for preparing specialists in technical fields. Modeling energy systems using modern software tools, such as MATLAB/Simulink, ANSYS, and others, has become an integral part of education [4,5]. It allows students to analyze and optimize the operation of energy networks, renewable energy sources, as well as energy storage and distribution systems. Students use these tools to simulate real-world scenarios, assess potential risks, and explore alternative solutions for improving the efficiency of energy systems.

The use of software in education not only helps deepen students' understanding of theoretical concepts but also fosters the development of critical thinking, problem-solving, and decision-making skills. It enables them to analyze the interaction of various components within energy systems and find optimal solutions for reducing costs, minimizing environmental impact, and improving system reliability [6].

Modeling energy systems using computer platforms also helps students master new technologies, including cooling strategies such as liquid cooling, hybrid systems, and phase change materials (PCMs). This allows them to experiment with innovative approaches and evaluate their effectiveness in real-world conditions [7,8].

It is also worth noting that diagnostics and troubleshooting are an integral part of computer-aided design and modeling, as they ensure the efficient operation of both automotive technology and energy systems. This is why computer-aided design and modeling play a key role in training future specialists, enabling them not only to analyze the performance of energy systems but also to effectively identify and eliminate faults.

The article also presents real examples of modern projects implemented in the educational process for diagnostics and simulation modeling [9-11]. In particular, one practical application of computer modeling is the creation of various models of microgrid charging station systems for electric vehicles in the MATLAB software environment [12,13]. This allows students to simulate the operation of charging infrastructure, assess its efficiency, and develop optimal management strategies [14].

Thus, the use of computer-aided design and modeling in the educational process not only promotes the development of students' technical competencies but also helps them acquire practical skills in working with modern technologies, which are essential for solving challenges in the fields of energy and electric transport.

Purpose and Tasks

The purpose of this work is to analyze the importance of computer design and modeling of energy systems in the educational process, as well as to consider methods, tools and real examples of the application of these technologies in the training of students of technical specialties [12-14]. The main areas of research include:

– use of modern software complexes for modeling energy processes.

– integration of computer design into the educational process.

– analysis of advantages and challenges of computer modeling in the training of specialists.

– consideration of real examples of application of modeling technologies.

Specifically, the study aims to investigate how these digital tools can improve the development, analysis, and optimization of energy systems in an educational context. Through a comprehensive examination of various simulation platforms, their applications, and case studies of energy system modeling, the research will highlight both the key benefits and challenges of integrating these technologies into engineering curricula. Furthermore, the study will explore the ways in which these tools can be used to foster interdisciplinary learning and collaboration, encouraging students to work with others from diverse fields to develop holistic, energy-efficient solutions.

Ultimately, this research aims to contribute to a deeper understanding of how modern educational approaches, particularly the integration of computer-aided design and simulation technologies, can be leveraged to produce engineers who are well-equipped to meet the energy sustainability and efficiency challenges of the 21st century. By fostering innovation, critical thinking, and practical experience, these educational strategies will help prepare the next generation of energy professionals to design and optimize the systems that will power a sustainable, low-carbon future.

Description of the equipment, methodology, and results of the experimental studies

The value of simulation in education. Simulation allows you to build virtual models of energy systems, which gives students the opportunity to test different work scenarios, optimize energy distribution, and identify potential problems even before implementation in real conditions. This contributes to the development of analytical skills and understanding of complex technological processes in the field of energy [14,15].

Use of software packages. The most common software packages: MATLAB/Simulink, ETAP, PSCAD, ANSYS. These programs allow students to practice practical skills and prepare for real work. MATLAB/Simulink is used for modeling and analysis of dynamic processes in energy systems, ETAP is used for modeling electric power networks, PSCAD - for analysis of electromagnetic processes, and ANSYS - for thermal and mechanical analysis of system components.

Integration into the educational process. The use of computer modeling in educational programs contributes to the improvement of practical training of students. Labs and Course projects may include simulations of energy systems, allowing students to deepen their understanding of theoretical concepts and apply them in practice. Students also get the opportunity to experiment with various system parameters, analyze the results and make informed decisions.

Examples of the use of computer modeling.

1. Designing a solar power plant. As part of the course project, students can use the MATLAB/Simulink program to simulate the operation of a solar power plant. They analyze energy generation in different weather conditions, calculate the efficiency of using inverters and battery systems, optimize the location of panels for maximum energy production (Fig. 1) [16, 17].

2. Analysis of electrical grid stability. Using the ETAP program, students can perform voltage and load analysis in local power grids, evaluate the impact of alternative energy sources, such as wind power plants, and find optimal parameters for stable system operation (Fig. 2) [18].

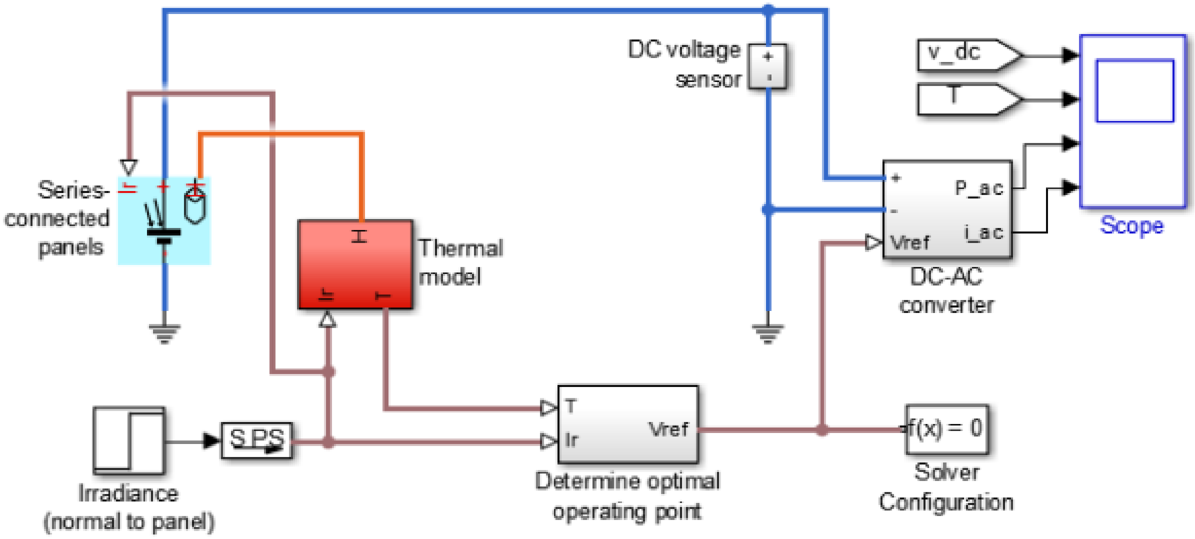

Fig. 1. General view of the photoelectric converter model

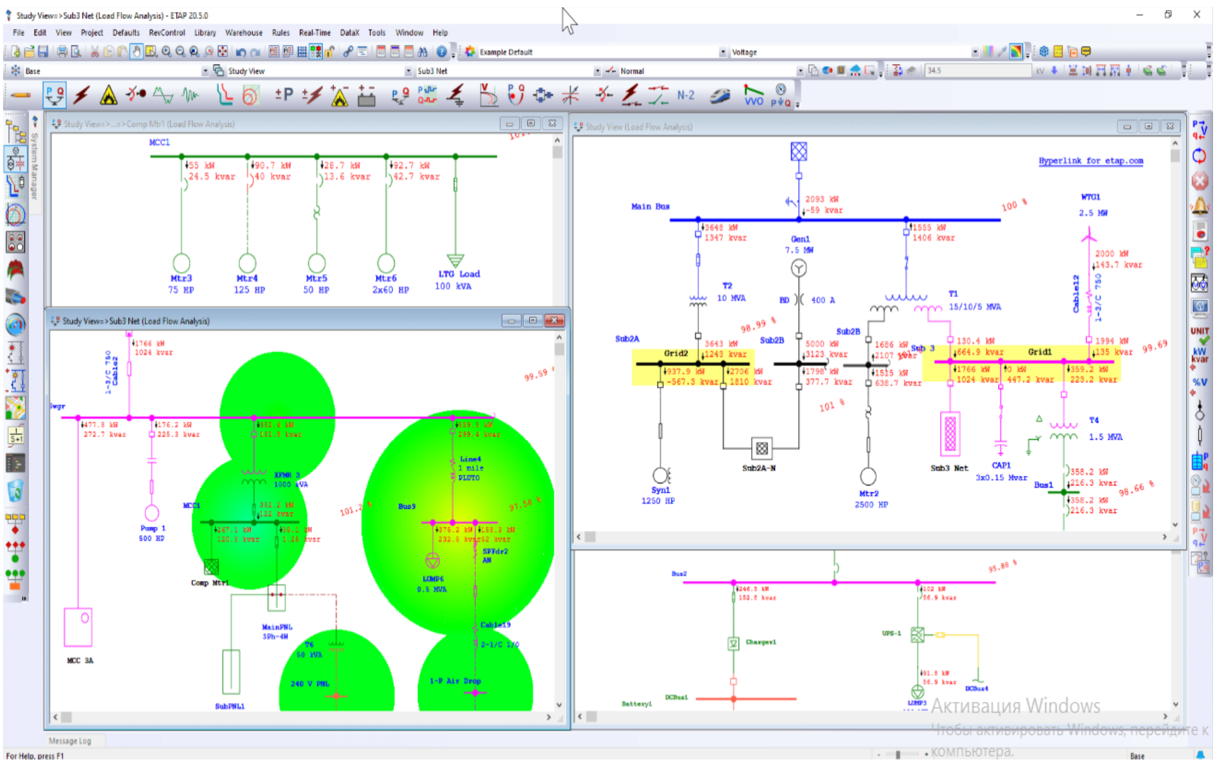

Fig. 2. ETAP software

3. Optimization of cooling systems for power plants. In ANSYS, students can simulate the effectiveness of various options for cooling generators and transformers. This makes it possible to determine the optimal design parameters for reducing heat losses and increasing the efficiency of the energy system [19].

Slice-only technology enables a cyclic repeatability simulation technique for electric motor applications. The analysis has been improved by efficiently solving just a slice of the motor, employing non-planar boundary conditions, using symmetric mesh and replicating results to the full model. To learn more about how "slice-only" technology helps simulate complex electric motors, read the blog: How to Model and Simulate Complex Electric Motors (see Fig. 3) [19].

Low-Frequency Electromagnetic Simulation With Maxwell, you can precisely characterize the nonlinear, transient motion of electromechanical components and their effects on the drive circuit and control system design. By leveraging Maxwell's advanced electromagnetic field solvers and seamlessly linking them to the integrated circuit and systems simulation technology, you can understand the performance of electromechanical systems long before building a prototype in hardware (see Fig. 4) [19].

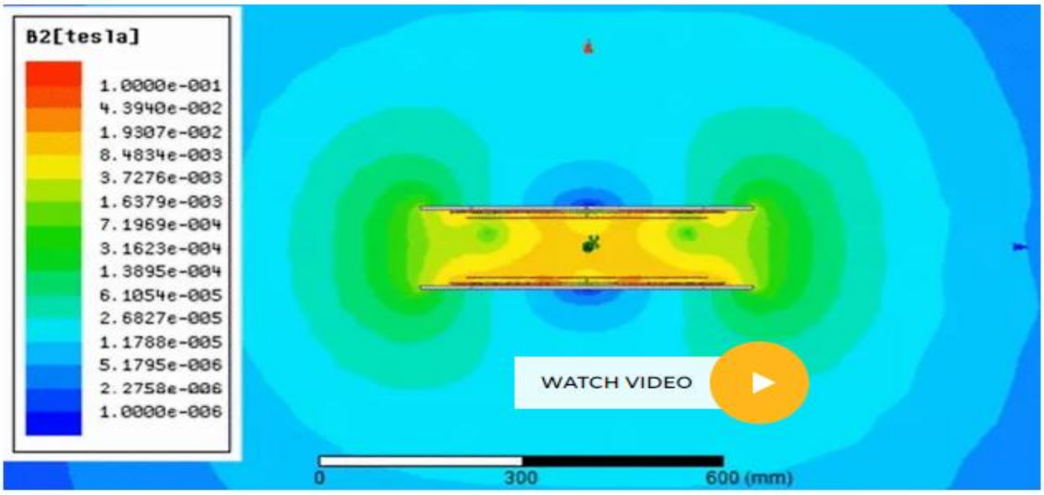

Fig. 3. Low-Frequency Electromagnetic Simulation

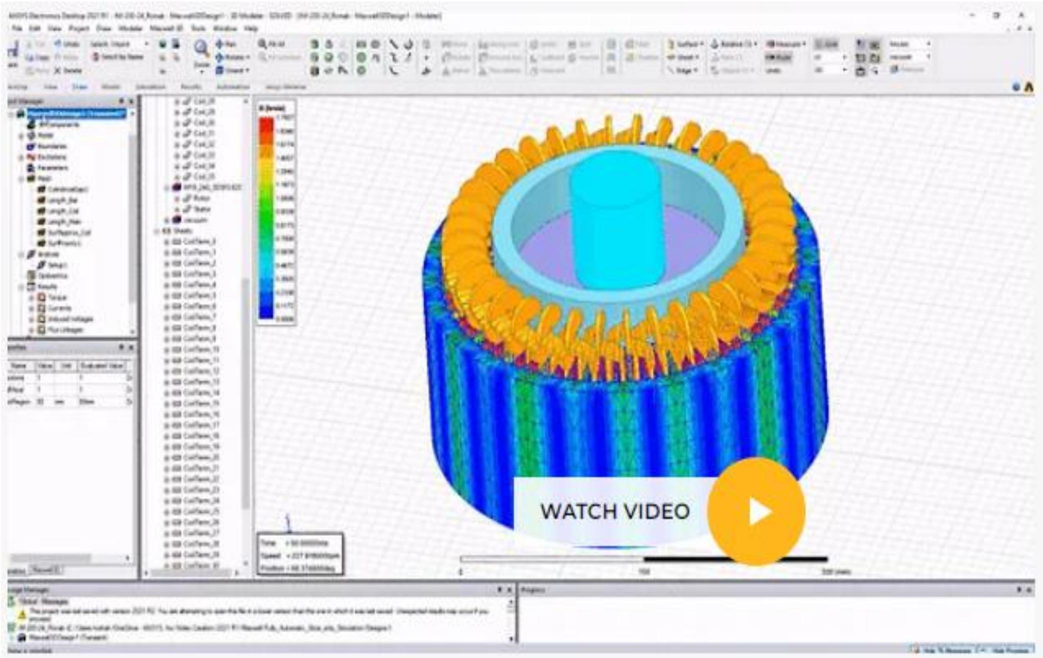

Fig. 4. Slice-only Technology

4. Modeling an Electric Vehicle Charging Station. In PSCAD, students can explore how different charging modes affect the electric vehicle grid and batteries. They can estimate the charging rate, energy efficiency of the process and optimize the control system to reduce peak loads (Fig. 5) [20].

5. Microgrid development. Using HOMER Pro, students can model the integration of solar panels, batteries, and diesel generators into local microgrids. This helps to find optimal solutions for increasing the energy autonomy of the facility (Fig. 6) [21,22].

6.Building energy efficiency research. With the help of EnergyPlus and TRNSYS software packages, students can analyze the energy consumption of buildings and find the best methods for improving energy efficiency (Fig. 7) [23].

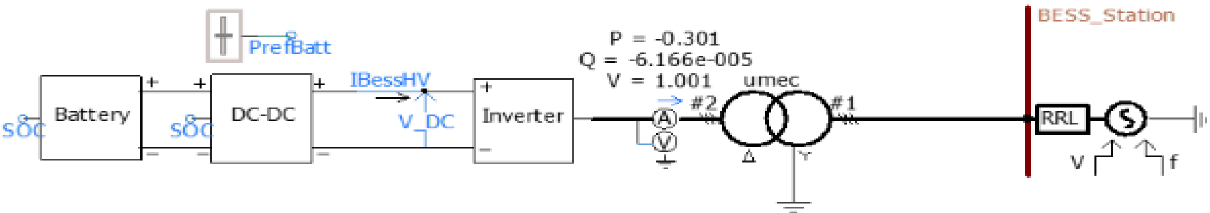

Fig. 5. A model of a charging station for electric cars in the PSCAD

Fig. 6. Microgrid development using HOMER Pro

Advantages of computer-aided design and modeling:

– economy of resources, the ability to conduct experiments in a virtual environment without spending on real equipment;

– increased accuracy of analysis, modeling allows to evaluate the effectiveness of various system configurations and identify potential shortcomings;

– flexibility in research, students can test different scenarios of system operation and check alternative approaches to their optimization.;

– preparation for real tasks, knowledge and skills acquired while working with software complexes allow future specialists to quickly adapt to the conditions of production and development of energy systems.

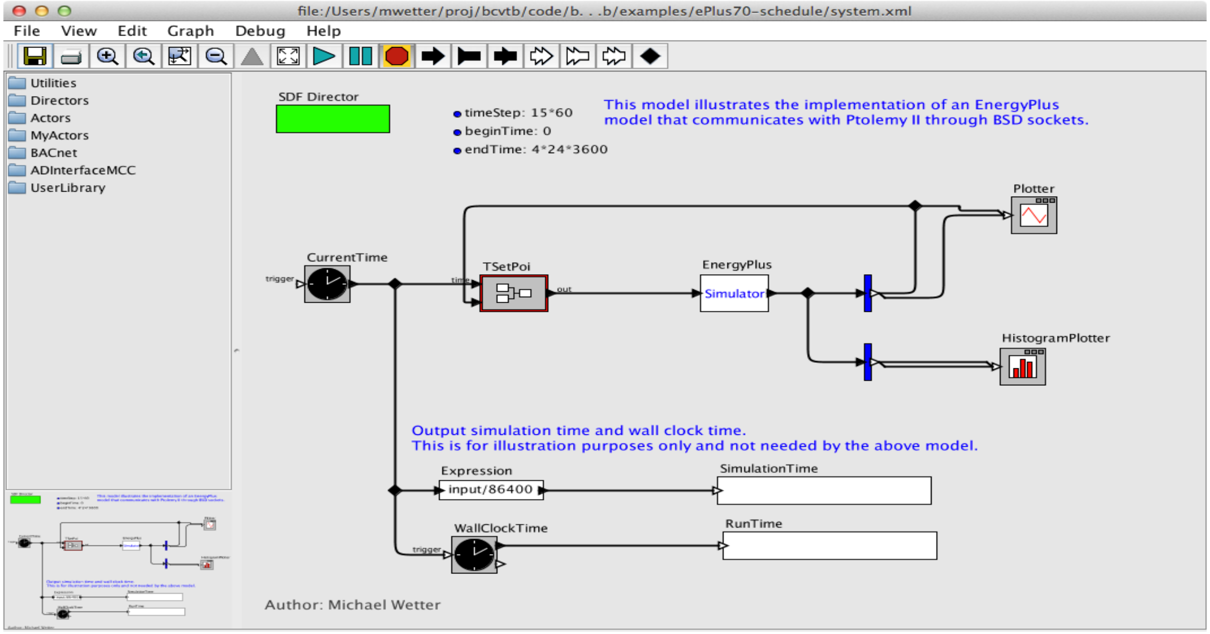

Fig. 7. Energy efficiency research with the help of Energy Plus and TRNSYS and Building software packages

Conclusion

Computer-aided design (CAD) and modeling of energy systems have become essential tools for the education and training of future specialists in the energy sector. These methods play a crucial role in equipping students with both theoretical knowledge and practical skills necessary to understand, design, and optimize modern energy systems. The integration of advanced software tools into the educational process exposes students to real-world scenarios and allows them to simulate various energy system configurations, helping them better understand the complexities of energy production, distribution, and management.

The use of such software complexes enables students to experiment with different approaches to energy system design, fostering creativity and problem-solving abilities. These technologies also support the analysis and optimization of energy systems by enabling students to visualize and simulate real-time system behaviors, which enhances their decision-making skills. As a result, students gain valuable hands-on experience that will help them successfully transition into the energy industry, where they can apply their knowledge to develop innovative solutions for sector challenges.

Moreover, the integration of CAD and modeling tools contributes to the formation of highly qualified professionals proficient in using cutting-edge technologies to address energy efficiency, sustainability, and the transition to renewable energy sources. By incorporating these tools into the curriculum, educational institutions ensure that their graduates are well-prepared to meet the evolving demands of the energy industry [24].

As digital technologies continue to advance, the potential for modeling and simulation in energy system design will expand, offering even more powerful tools for training the next generation of energy professionals. This progress will lead to further improvements in system optimization, cost-effectiveness, and sustainability, supporting the development of innovative energy solutions for the future. Ultimately, the continued development and application of CAD and modeling technologies will play a vital role in creating a workforce capable of tackling global challenges related to energy sustainability, environmental impact, and the transition to a low-carbon economy.

Furthermore, with the advancement of digital technologies, the application of artificial intelligence (AI) and cloud computing in computer-aided modeling of energy systems is becoming increasingly significant. (AI) enables in-depth analysis of large datasets, prediction of energy system behavior, real-time optimization of operations, and early detection of potential failures or inefficiencies before they lead to critical issues. This enhances the accuracy of simulations, which is particularly important for the integration of renewable energy sources with their variable and unpredictable nature.

At the same time, cloud technologies provide access to powerful computing resources without the need for significant capital investment in local infrastructure. They offer extensive opportunities for remote access to software, collaborative project development, scalable computations, and real-time updates of energy system models. Cloud platforms also facilitate the deployment of machine learning-based models and support flexible simulation environments.

Thus, the implementation of (AI) and cloud-based solutions in computer modeling opens new horizons for training future specialists, allowing them to master the most advanced tools for analysis, design, and management in the context of the digital transformation of the energy sector.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Багач, Р. В. (2024). Підвищення ефективності експлуатації автомобільного електротранспорту з використанням зарядних станцій постійного струму (Докторська дисертація, Харківський національний автомобільно-дорожній університет). Bahach, R. V. (2024). Pidvyshchennia efektyvnosti ekspluatatsii avtomobilnoho elektrotransportu z vykorystanniam zaryadnykh stantsii postijnoho strumu. [Improving the efficiency of electric vehicle operation using DC charging stations.] (Doctoral dissertation, Kharkivskyi natsionalnyi avtomobilno-dorozhnii universytet). https://dspace.khadi.kharkov.ua/handle/123456789/20343 [Ukrainian].
2. Гнатов, А., Аргун, Щ., Багач, Р., Гнатова, Г., Тарасова, В. ., & Ручка, О. (2021). Аналіз найбільш поширених методів визначення стійкості енергетичних систем. *Vehicle and electronics. Innovative technologies*, (20), 17-26. Hnatov, A., Arhun, S., Bagach, R., Hnatova, H., Tarasova, V., & Ruchka, O. (2021). Analiz naybilʹsh poshyrenykh metodiv vyznachennya stiykosti enerhetychnykh system. Vehicle and electronics. Innovative technologies [Analysis of the most common methods for determining the stability of energy systems] *(Vehicle and electronics. Innovative technologies)* https://doi.org/10.30977/VEIT.2021.20.0.02 [Ukrainian].
3. Нерубацький, В. П., Плахтій, О. А., Гордієнко, Д. А., Філіп'єва, М. В., & Багач, Р. В. (2023). Підвищення точності моделювання перехідних процесів і розрахунку втрат потужності напівпровідникових перетворювачів у програмному середовищі NI Multisim. *Інформаційно-керуючі системи на залізничному транспорті*, *28*(2), 22-35. Nerubatsʹkyy, V. P., Plakhtiy, O. A., Hordiyenko, D. A., Filipʺyeva, M. V., & Bahach, R. V. (2023). Pidvyshchennya tochnosti modelyuvannya perekhidnykh protsesiv i rozrakhunku vtrat potuzhnosti napivprovidnykovykh peretvoryuvachiv u prohramnomu seredovyshchi NI Multisim. Informatsiyno-keruyuchi systemy na zaliznychnomu transporti. [Increasing the accuracy of simulation of transient processes and calculation of power losses of semiconductor converters in the NI Multisim software environment] (Information and control systems in railway transport) https://doi.org/10.18664/ikszt.v28i2.283312 [Ukrainian]
4. Kassa Mersha, T., & Du, C. (2022). Active damping control of HEVs using Ansys and Matlab/Simulink software. *Journal of Vibroengineering*, *24*(7),1340-1353. https://www.extrica.com/article/22511
5. Bhuiyan, M. S. R., El-Shahat, A., & Soloiu, V. (2019, April). Thermoelectric generator analysis through Ansys and matlab/simulink.In *2019 SoutheastCon* (pp.1-5).IEEE. https://ieeexplore.ieee.org/abstract/document/9020528
6. Silas, A., Agyeman, K. I., Adetsi, P., & Agyei, F. O. (2025, February 19). The use of open-source software by library users in some private universities in Ghana. *Seminars in Medical Writing and Education*, *4*, 666. Retrieved March 11, 2025, from https://mw.ageditor.ar/index.php/mw/article/view/666
7. Müller, B., Gardumi, F., & Hülk, L. (2018). Comprehensive representation of models for energy system analyses: Insights from the Energy Modelling Platform for Europe (EMP-E) 2017. *Energy strategy reviews*, *21*, 82-87. https://www.sciencedirect.com/science/article/pii/S2211467X18300154
8. Zhang, L., Liu, Y., Laili, Y., & Zhang, W. (2020). Model maturity towards modeling and simulation: Concepts, index system framework and evaluation method. *International Journal of Modeling, Simulation, and Scientific Computing*, *11*(03), 2040001. https://www.worldscientific.com/doi/abs/10.1142/S1793962320400012
9. Hnatov, A., Arhun, S., Hnatova, H., Bagach, R., Patlins, A., & Zabasta, A. (2021). Implementation of the double degree master's program on the

example of the Erasmus project CybPhys. *Proceedings of the 2021 IEEE 62nd International Scientific Conference on Power and Electrical Engineering of Riga Technical University* (pp. 277-282). Riga, Latvia: Riga Technical University; Piscataway: IEEE. ISBN 978-1-6654-3805-6,e-ISBN978-1-6654-3804-9. https://www.researchgate.net/publication/358714378_Implementation_of_the_double_degree_master's_program_on_the_example_of_the_Erasmus_project_CybPhys

10. Mygal, V., Arhun, S., Hnatov, A., Bagach, R., & Kunicina, N. (2022, October). Methods for Diagnosing Vehicles by an Operator-Diagnostician. *2022 IEEE 63th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON)* (pp. 1-6). https://www.researchgate.net/publication/366432772_Methods_for_Diagnosing_Vehicles_by_an_Operator-Diagnostician

11. Bahach R. Study of the efficiency of a charging station for electric vehicles using an active rectifier in a micro-grid system / Ruslan Bahach // Sustainable production and consumption in industry: challenges and opportunities : collection of scientific articles. – Dresden, 2024. –pp.126-133. http://ir.nmu.org.ua/handle/123456789/167810

12. Багач, Р. (2023). Дослідження акумуляторних блоків електромобілів та зарядних станцій на основі активного трифазного випрямляча струму. Автомобіль і електроніка. Сучасні технології, (24), 62–71. Bahach, R. (2023). Doslidzhennia akumuliatornykh blokiv elektromobiliv ta zariadnykh stantsii na osnovi aktyvnoho tryfaznoho vypriamliacha strumu. [Research of battery units of electric vehicles and charging stations based on an active three-phase rectifier] Car and electronics. Modern technologies, (24), 62–71. https://dspace.khadi.kharkov.ua/items/6482ea9d-df14-40c7-9393-37aee29da84a [in Ukrainian].

13. Багач, Р.(2024).Підвищення електромагнітної сумісності і енергоефективності зарядної станції електромобілів. Автомобіль і електроніка. Сучасні технології, (25), 53–62. Bahach, R. (2024). Pidvyshchennia elektromahnitnoi sumisnosti i enerhoefektyvnosti zaryadnoi stantsii elektromobiliv. [Improving electromagnetic compatibility and energy efficiency of electric vehicle charging stations.] Avtomobil i elektronika. Suchasni tekhnolohii, (25), 53–62. https://doi.org/10.30977/VEIT.2024.25.0.6 [Ukrainian].

14. Багач, Р. В., Гнатов, А. В., & Аргун, Щ. В. (2024). Імітаційне моделювання зарядного кон-тролера LTC4020 для літій-іонних акумуляторів. Автомобіль і електроніка. Сучасні технології, (26), 25–35. Bahach, R. V., Hnatov, A. V., & Arhun, SHCH. V. (2024). Imitatsiyne modelyuvannya zaryadnoho kontrolera LTC4020 dlya litiy-ionnykh akumulyatoriv. [Simulation modeling of the LTC4020 charge controller for lithium-ion batteries] Avtomobil i elektronika. Suchasni tekhnolohii,(26),25–35. https://dspace.khadi.kharkov.ua/handle/123456789/23229 [Ukrainian]

15. Osmancik, T. (2023). *Design and Simulation of Vehicle-to-Load System with Nissan Leaf* (Doctoral dissertation, Concordia University). https://spectrum.library.concordia.ca/id/eprint/993203/

16. Оробчук, Б. Я., & Кіт, Н. Я. (2022). Дослідження режимів роботи моделі сонячної електростанції в пакеті MATLAB. *Матеріали XI Міжнародної науково-практичної конференції молодих учених та студентів „Актуальні задачі сучасних технологій“*, 84-85. Orobchuk, B., & Kit, N. (2022). Doslidzhennya rezhymiv roboty modeli sonyachnoyi elektrostantsiyi v paketi MATLAB. *Aktual'ni zadachi suchasnykh tekhnolohiy, 84*. [Study of operation modes of thesolar power plant model in the MATLAB package] (*Actual Problems of Modern Technologies*). https://elartu.tntu.edu.ua/bitstream/lib/39372/1/Zbirnyk_%D0%A1IIMT_2022.pdf#page=86 [Ukrainian].

17. ETAP. Software Comprehensive Software Suite (ETAP, SEE, Caneco) to Design, Build, Operate and Maintain Electrical Systems. (n.d.). https://etap.com/ru/product/load-flow-software

18. Ansys. Powering Innovation. That Drives Human Advancement. (n.d.). https://www.ansys.com/products/electronics/ansys-maxwell

19. PSCAD. The world's most advanced tool for power systems EMT simulations. (n.d.). https://www.pscad.com/knowledge-base/article/462

20. Plakhtii, O., Prokhorova, V., Bagach, R., Zhuchenko, O., Yermilova, N., & Perets, K. (2023, October). Research of Accumulator Blocks of Electric Vehicles and Charging Station Based on Current Source Rectifier. In *2023 IEEE 4th KhPI Week on Advanced Technology (KhPIWeek)* (pp. 1-6). IEEE. https://ieeexplore.ieee.org/abstract/document/10312968

21. Tremblay, O., Dessaint, L. A., & Dekkiche, A. I. (2007, September). A generic battery model for the dynamic simulation of hybrid electric vehicles. In *2007 IEEE vehicle power and propulsion conference* (pp. 284-289). Ieee.

https://www.researchgate.net/publication/434293 0_A_Generic_Battery_Model_for_the_Dynamic_Simulation_of_Hybrid_Electric_Vehicles
22.DS New Energy - Zhejiang DongShuo New Energy Co., Ltd. (n.d.). https://ua.dsisolar.com/info/7-most-popular-solar-pv-system-design-and-simu-34952960.html
23.Energy Plus .Chapter 5. Configuring programs for use with the BCVTB. (n.d.).https://simulationresearch.lbl.gov/bcvtb/releases/latest/doc/manual/tit-EnePluCon.xhtml
24.Bahach, R., & Bushara, M. (2024). Use of simulation technologies in the training of students for the diagnostics of electric vehicles nd charging stations. *Automobile and Electronics. Modern Technologies*, Proceedings of the IX International Scientific and Technical Internet Conference (Kharkiv, November 21-22, 2024) (pp. 158-160). Kharkiv: KhNADU.

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Комп'ютерне проєктування та моделювання енергетичних систем у навчальному процесі

Анотація. Проблема. *Стаття висвітлює роль комп'ютерного моделювання в навчанні енергетиків. Описано програмні комплекси (MATLAB, ANSYS, ETAP, PSCAD) для аналізу та оптимізації енергосистем. Наведено приклади застосування, зокрема проєктування сонячних і зарядних станцій. Визначено переваги моделювання: економія ресурсів, точність аналізу. Наголошено на важливості цифрових технологій у підготовці фахівців зі сталого розвитку.* ***Мета.*** *Аналіз значення комп'ютерного проєктування та моделювання в підготовці фахівців з енергетики, вивчення сучасних програмних комплексів та оцінка їх впливу на ефективність освітнього процесу.* ***Методологія.*** *Дослідження базується на аналізі наукових джерел, порівнянні програм (MATLAB, ANSYS, ETAP, PSCAD), огляді кейсів та експериментальному моделюванні енергосистем. Оцінено вплив цифрових технологій на формування професійних навичок студентів.* ***Результати.*** *Підтверджено ефективність комп'ютерного моделювання у підготовці енергетиків. Проаналізовано програмні пакети (MATLAB, ANSYS, ETAP, PSCAD, HOMER Pro, Energy Plus) для моделювання та оптимізації енергосистем. Визначено переваги цифрових технологій: економія ресурсів, безризикове тестування, точність аналізу. Розглянуто кейси проєктування сонячних електростанцій, аналізу мережі, оптимізації охолодження та зарядних станцій. Інтеграція моделювання сприяє розвитку критичного мислення та аналітичних навичок.* ***Оригінальність.*** *Дослідження підкреслює важливість комп'ютерного моделювання в освіті енергетиків. Проаналізовано використання сучасних програм (MATLAB, ANSYS, ETAP, PSCAD) у навчальному процесі. Показано їхню роль в оптимізації енергосистем та розвитку критичних навичок. Наголошено на значенні моделювання для інновацій і міждисциплінарної співпраці. Інтеграція моделей зміцнює теоретичні знання й практичні навички.* ***Практичне значення.*** *Результати дослідження сприяють удосконаленню підготовки енергетиків. Інтеграція моделювання (MATLAB, ANSYS, ETAP, PSCAD) підвищує якість навчання без значного обладнання. Оптимізація курсів через інтерактивні завдання й проєкти корисна для освіти, науки та консультування.*

Ключові слова: *Комп'ютерне моделювання, енергетичні системи, програмні комплекси, MATLAB, ANSYS, ETAP, PSCAD.*

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