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Exploration of Teaching in Building Electrical Engineering Specialty Courses in Colleges and Universities under the Dual-Carbon Background

Yan Wu*

Tongzhou Campus Construction Department Renmin University of China, Beijing 100021, China

**Author to whom correspondence should be addressed.*

Abstract: Currently, the global community is actively responding to climate change and accelerating the achievement of dual-carbon goals. Considerable efforts have been made in the field of building electrical engineering specialties in colleges and universities, enriching teaching content, activities, and tasks, as well as innovating teaching forms and practical training modules, significantly improving teaching effectiveness and quality. Therefore, for college administrators, and even all faculty and staff, it is crucial to fully understand the reform objectives under the dual-carbon background and strive to create an excellent teaching space conducive to independent exploration and comprehensive practice for students majoring in building electrical engineering. This warrants in-depth exploration and practice. This paper discusses the new requirements posed by the power industry and enterprises for talent under the dual-carbon background, as well as the current status and issues of teaching in building electrical engineering specialties, and ultimately proposes several feasible and effective teaching strategies [1].

Keywords: Dual-carbon; Colleges and universities; Building electrical engineering specialty; Teaching reform

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1. Introduction

"Dual-carbon" refers to striving to peak carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060, which is a strategic goal pursued by countries worldwide. The construction industry has always been a major energy consumer and occupies an important position in the implementation of the dual-carbon strategy. Focusing on the reform of teaching in building electrical engineering specialties lays a foundation for the realization of dual-carbon goals in terms of talent and technology. Therefore, schools must attach importance to this by optimizing curriculum systems, improving teaching methods, and strengthening practical teaching measures to cultivate building electrical engineering talents with dual-carbon concepts and professional skills [2]. The following discusses specific teaching strategies for building electrical engineering specialties courses in colleges and universities under the dual-carbon background.

2. New requirements for talent in the power industry and enterprises under the dual-carbon background

The dual-carbon goals are driving profound reforms in the power industry and enterprises. Specifically, the traditional power generation model dominated by fossil fuels is gradually shifting towards renewable energy sources such as wind, water, and solar, which are highly favored and have broad prospects [1]. Consequently, the growth direction for talent naturally changes, requiring adaptability to the design, installation, and testing of renewable energy power generation. This aligns with the long-term development of industry transformation. In addition to changes in core technology and operational models, the importance of intelligent and modern construction cannot be overstated. Today's smart grids utilize advanced technology to achieve intelligent management and control of power systems, further enhancing energy utilization efficiency. Therefore, corresponding talent cultivation should also trend towards intellectualization, ensuring proficiency in power system automation, power communication, and smart meter technology, laying a solid foundation for future rapid adaptation to industries and positions [2,3]. At this point, we can shift our perspective to specific enterprises. It can be seen that enterprises expect talent to possess lifecycle building energy management capabilities, capable of comprehensively considering energy consumption, carbon emissions, and other factors to conduct energy-saving designs; to strictly follow design requirements for the installation and commissioning of electrical equipment to ensure the energy-saving performance of the system; and to utilize advanced energy management systems for real-time monitoring and regulation of building electrical equipment to promptly identify and resolve energy waste issues, among other tasks. On the other hand, they increasingly value talent's innovative capabilities and interdisciplinary knowledge, requiring not only proficiency in electrical engineering expertise but also a certain level of interdisciplinary knowledge in architectural design, HVAC (heating, ventilation, and air conditioning), automation control, etc., to enable innovative designs in a multidisciplinary environment and provide enterprises with low-carbon, high-efficiency building electrical solutions [3,4].

3. Issues in the current building electrical engineering course teaching

3.1. Lack of systematicness and interdisciplinarity in the curriculum system

The knowledge of building electrical engineering involves multiple fields such as electrical engineering, architectural design, and automation control. However, there are still incomplete aspects in its construction, which belong to structural issues [5]. Specifically, courses are independent of each other, lacking systematicness and coherence. A prominent issue is the lack of connection between electrical design courses and building energy efficiency courses, preventing students from simultaneously considering these two key factors to solve problems and thus lacking the corresponding ability and quality development. The same applies to interdisciplinary practicality, with no simultaneous connection between architecture, energy, and the environment, resulting in a singular knowledge structure among students and difficulty in adapting to the actual requirements for interdisciplinary knowledge of building electrical engineering talents under the dual-carbon background.

3.2. Course content lagging behind industry development

Currently, the course content of building electrical engineering in some universities has a slow update iteration speed, lacking the incorporation of cutting-edge developments and technologies, making it difficult to keep pace with the development strides of the power industry and the construction industry under the dual-carbon background. In the context of dual-carbon goals, renewable energy power generation technologies, smart grid technologies, and building energy management systems are widely applied. However, they are introduced scarcely and insufficiently in depth in the corresponding course instruction. Many textbooks still teach conventional thermal power generation and transmission lines, with explanations on new energy power generation technologies such as solar photovoltaic power generation systems and wind power generation systems occupying only a small portion and lacking systematicness. This directly results in students studying diligently but struggling to compete for complex social positions, necessitating prompt optimization and improvement [6].

3.3. Inadequate practical teaching sessions

Building electrical engineering has strong practicality, with courses and knowledge teaching requiring students' hands-on practice for acquisition and consolidation. However, some universities still emphasize theoretical teaching more and have insufficient arrangements for practical teaching and training activities. On the one hand, practical teaching equipment is outdated and cannot meet the teaching needs of modern building electrical technology. For example, some laboratory electrical equipment was purchased years ago, lacking new smart electrical equipment and energy monitoring systems, which prevents students from accessing industry-leading technologies and equipment. On the other hand, practical teaching is not tightly integrated with actual enterprise projects [7,8]. Many practical courses are only simple simulations conducted in laboratories, lacking real-project experience. Students often follow predetermined steps during practical sessions, lacking the cultivation of abilities to analyze and solve actual engineering problems.

3.4. Monolithic and outdated teaching methods

Similar to traditional teaching models, there are also such cases in building an electrical engineering course. Many teachers still adopt traditional teaching methods, outputting information unidirectionally, ignoring students' genuine feelings and the development of their abilities and qualities. This lacks an enjoyable experience for students and is even more difficult in inspiring enthusiasm for building electrical engineering practice, detrimental to the development of students' core competitiveness and their future studies and employment. In the context of dual-carbon goals, new technologies and theoretical applications emerge endlessly, raising increasingly high and strict requirements for practitioners. Therefore, traditional teaching models cannot strengthen students' core competitive advantages, equivalent to restricting students' job search paths. It is evident that teaching methods in building electrical engineering are monolithic and outdated, urgently needing reform and innovation to improve the quality of teaching [9].

4. Reform strategies for building electrical engineering course teaching in universities under the dual-carbon background

4.1. Integrating carbon reduction technologies of power systems into course teaching

In the course teaching related to power systems, increase the teaching content of renewable energy power generation technologies, actively responding to dual-carbon requirements for content optimization and improvement. Specifically, teachers should prepare content beforehand, detailing the principles, component selection, system design, installation, and debugging methods of solar photovoltaic power generation systems during class. When necessary, through practical case analyses, help students understand how to design reasonable solar photovoltaic power generation systems based on the orientation, area, and electricity demand of different buildings [10]. At the same time, introduce in-depth the application of wind power generation systems in the building sector, including the selection of small wind turbines, the determination of installation locations, and their integration with building structures. Furthermore, introduce the application knowledge of carbon capture and storage (CCS) technology in power systems. Still, through case analyses, let students understand the application of CCS technology in actual power plants and how to consider CCS-related power demands and system design in the field of building electrical engineering. Alternatively, teach students how to use smart grid technology to achieve optimal dispatch of power systems, improving energy utilization efficiency. Introduce power load forecasting methods, enabling students to learn how to predict loads based on the electricity consumption patterns of buildings, reasonably arrange power generation plans, and reduce energy waste. This also cultivates students' abilities to achieve efficient utilization of distributed energy in building electrical systems. In summary, integrating carbon reduction technologies of power systems into course teaching enriches the teaching content, exposes students to newer and broader professional aspects, and lays a solid foundation for their future careers in related professional positions [11].

4.2. Integrating new electrical devices and equipment into course teaching

By introducing new electrical devices and equipment in class, students can fully engage with them during their academic years, even through simulated applications and practical training exercises, thereby laying a solid foundation for their long-term career development. Detailed explanations should be provided on the working principles, performance characteristics, and application advantages of new electrical equipment such as high-efficiency energy-saving transformers, energy-saving motors, and intelligent lighting systems in building electrical systems. Coupled with actual product demonstrations and case analyses, students can understand how to select and apply these new electrical devices to reduce energy consumption in building electrical systems. With the popularity of new energy vehicles, building electrical engineering professionals need to master the design and installation techniques of new energy vehicle charging facilities. In the curriculum, introduce the types, working principles, power configurations, and connection methods for building power distribution systems of charging piles. Furthermore, showcase actual project cases to teach students how to plan and design charging facilities in residential areas, commercial parking lots, and other venues [12]. There are many more aspects to consider; we can also focus on the development of intelligent electrical equipment and control systems, explaining the functions and applications of intelligent electrical devices and systems such as intelligent circuit breakers, smart meters, and Building Energy Management Systems (BEMS). This will enable students to master the operation and debugging methods of intelligent electrical devices and how to use BEMS for real-time monitoring and control of building electrical systems to achieve refined management of building energy.

4.3. Improving the curriculum system based on AI technology

Optimize the content of professional courses with the application of AI technology, expanding the originally singular and traditional teaching content and converting it into visual and specific audio-visual and graphic materials. Combining the latest technological development trends in the field of building electrical engineering and the changing trends in enterprise demand for talent, analyze real building electrical project cases, extract key knowledge points and technologies, broaden students' cognitive horizons, and cultivate their core competitiveness. At the same time, strengthen the development of related teaching resources, such as teaching slides, micro-lecture resources, and virtual simulation experiments. Among them, intelligent teaching slides can automatically adjust teaching content and progress based on students' learning situations and feedback, achieving personalized teaching; the virtual simulation experiment platform can simulate various complex building electrical experiment scenarios, allowing students to conduct experimental operations in a virtual environment, improving the effectiveness and safety of experimental teaching. It is believed that shortly, intelligent and smart building electrical engineering courses will also form in scale up, independently offered and extending into new training directions [13]. For example, the course "Application of Artificial Intelligence in Building Electrical Engineering" introduces the application principles and methods of AI technology in building electrical design, fault diagnosis, energy management, etc., cultivating students' abilities to solve practical problems in building electrical engineering through theoretical teaching and practical projects. Furthermore, encouraging students to participate in related scientific research projects and competitions can effectively improve their innovation abilities and overall qualities, achieving dual educational reforms.

4.4. Work-integrated learning practice in electrical engineering courses

Firstly, strengthen cooperation with enterprises to establish stable internship bases. Schools and colleges can deepen cooperation with architectural design firms, electrical engineering enterprises, building energy management companies, etc., to provide internship opportunities for students. In this way, students can participate in actual building of electrical projects, understand the entire project process, and learn practical work experiences and skills through communication and cooperation with corporate engineers, thereby enhancing their abilities to solve practical problems. Secondly, integrate the above aspects into real theoretical or practical courses. In practical teaching links such as course design and graduation design, select real projects from enterprises as topics for students to complete under the joint guidance of teachers and corporate engineers. Using actual commercial building projects as an example, students are required to design electrical systems according to corporate design specifications and requirements, enabling them to apply theoretical knowledge learned in class to actual projects, thus improving their design abilities and engineering literacy. Finally, it is necessary for both parties to jointly carry out industry-academia-research cooperation projects, contributing to accelerating the realization of the dual-carbon goals. The study encourages teachers to cooperate with enterprises to conduct industry-academia-research projects, converting scientific research results into actual productivity. At the same time, involving students in these industry-academia-research projects cultivates their research abilities and innovative spirits. For instance, teachers can cooperate with enterprises to carry out research and development projects on building energy management systems, allowing students to participate in data collection, analysis, and system testing within the projects. Through practical experience, students can improve their professional competencies. These approaches are all feasible and effective [14].

5. Conclusion

In the context of the dual-carbon goals, the reform of teaching in college building electrical engineering courses is imperative. It is crucial to deeply analyze the new requirements of the power industry and enterprises for talents, face up to the problems existing in the current course teaching, and adopt a series of practical reform strategies to effectively improve the quality of teaching in building electrical engineering courses. This will cultivate high-level professionals with a dual-carbon mindset, innovative abilities, and practical skills [15]. These professionals will also provide strong support for the low-carbon transformation and sustainable development of the construction industry in China, helping to achieve the dual-carbon goals. In the future, colleges of building electrical engineering and their teachers should continue to pay attention to industry developments, constantly optimizing the course teaching system to adapt to evolving market demands and cultivate more excellent building electrical engineering talents for society.

Disclosure statement

The author declares no conflict of interest.

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