

Exploration and Practice of the Training Mechanism of Energy and Power Undergraduate Talents Under the Background of “Double-carbon”

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Abstract: In order to meet the development requirements of the “two-carbon” strategy, to cultivate compound and innovative talents suitable for the new needs of the energy industry, this paper aims to analyze the characteristics and development trends of energy and power majors and the current situation of the training of traditional energy and power professionals. This paper starts from the emphasis on curriculum adjustment and upgrading, strengthening interdisciplinary integration education, deepening school-enterprise cooperation, highlighting projects and competition training, etc., to build a new mode of energy and power undergraduate talent training under the background of “double carbon.” The effective strategies for the construction and implementation of the culture mechanism can provide a new perspective and ideas for China’s energy and power undergraduate talent training to provide a steady stream of talent support for China to achieve the “double-carbon” strategic goal.

Keywords: “Double carbon”; Undergraduate; Energy and power talents; Training mechanism

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1. Introduction

In recent years, in order to cope with the severe challenge of global climate change, the country and even the world have vigorously advocated and called for the promotion of “carbon peak, carbon neutrality”, to achieve the “double carbon” goal, and help China to achieve the sustainable development goal. As the key position of cultivating energy and power talents, the dynamic major of colleges and universities plays an irreplaceable role in this process. However, the current university energy power talent training there are a series of problems, such as traditional education concept, old course content, teaching mode of single, learning and use, etc., lead to graduates after graduation is difficult to flexible with the future practical work of all kinds of complex engineering challenges, in virtually restricted the development in the field of energy power in our country. Based on this, this paper focuses on the training of energy and power talents in universities, from many aspects, and aims to cultivate more low-carbon technical talents, green electricity talents, etc., in order to promote the

“double carbon” economic development, help the “double carbon” goal to contribute insignificant strength.

2. Energy and power class professional characteristics and development trend analysis

2.1. Professional characteristics

According to the research results, the energy and power major is one of the popular majors widely established by universities at home and abroad in recent years ^[1]. Main research content for the traditional fossil energy mining and transformation, new energy technology research and development and application and power system design and optimization, etc., focus on the service of national “carbon peak, carbon neutral” major demand. It cultivates solid foundation, innovation spirit and engineering practice ability of high quality specialized talents, constantly take care of fossil energy efficiency and pollutant control, new energy and advanced energy system, energy equipment and system output. There is no doubt that energy and power majors will become the cradle of engineers in the field of power generation engineering in China, whether now or in the future. Due to its unique professional characteristics and the development trend in recent years, it has become the best choice in the eyes of many students ^[2].

2.2. Development trend

(1) The development of new energy and renewable energy sources

As far as China’s current situation is concerned, the layout of energy development is mainly focused on two points, namely, energy conservation and emission reduction, and the development of new energy and renewable energy. In contrast, China’s energy conservation and emission reduction technology is becoming more mature, but the development of new energy and renewable energy in terms of technology, market and policy need to be further improved and innovated, and started late. Based on this, the training of energy and power talents in universities is the training and education of graduate students, especially to cultivate management and high-end research talents ^[3,4].

(2) Interdisciplinary education

Energy power talents need to master the knowledge of multiple disciplines, such as mechanical manufacturing, thermal, chemistry, mechanics, etc., thus, to fit the development of the 21st century energy power discipline demand, energy power class in curriculum should pay attention to interdisciplinary, namely the knowledge of multiple disciplines, broaden students’ vision, help them to build a systematic knowledge system.

(3) Cultivate students’ awareness of green energy

Energy conservation, as an important part of China’s energy development strategy, has been widely concerned by the country and even the international community. Knowledge related to energy saving should not only to teach energy power students, but also to all engineering students promotion and popularization, which means that universities should not only pay importance to the cultivation of energy discipline students, but also should focus on all engineering students of energy saving education. To practice, in the process of daily teaching, teachers should consciously teach students the idea of energy conservation and emissions reduction, in virtually cultivate students’ energy saving literacy, help them set up the correct concept of new energy ^[5,6].

3. Analysis of the current situation and existing problems of traditional energy and power professional personnel training

3.1. Tradition of educational concept and insufficient infiltration of new engineering concept

The transformation and renewal of the talent concept of training cannot be achieved overnight, but requires long-term adaptation and persistence. However, nowadays, the traditional talent training mode of the energy and power majors still is in conflict with the new engineering education concept, and restrict the development. Since the new engineering concept was put forward, the emerging “three new” engineering disciplines have been gradually defined, but as one of the key elements of the new curriculum construction, the concept guidance has not been strictly implemented in practice ^[7]. The traditional educational concept still puts the basic theory teaching in the core position, but ignores the cultivation of students’ innovative thinking and innovative ability. New engineering education concept advocates interdisciplinary comprehensive training, emphasize the subject of interdisciplinary, advanced and practical, but these ideas failed to implement in practice. Students often accept from the teachers’ education, innovation practice link, directly restricts the students to solve complex engineering ability. Students’ prospective thinking may not get targeted training and engineering education should not only theoretical knowledge tools, but “people” with national strategy as value orientation, better construction education goal.

3.2. Outdated course content and unable adapt to the needs of the industry

Textbooks were originally an important basis and content support for teachers’ teaching, but nowadays, some textbooks of energy and power majors have problems such as outdated content ^[8]. It is important to know that the energy industry, especially the new energy field, is developing very fast, and the industry’s knowledge structure and skill requirements for talents are also changing. If the teaching content of teaching materials cannot keep up with the development speed of the industry, and the content of education and teaching lags behind the needs of scientific and technological innovation and industrial practice, then it is difficult for the cultivated talents to meet the requirements and needs of enterprises in the new era. For example, in today’s era, with the rapid development of intelligence and digitalization, fields such as renewable energy and distributed generation are also emerging. This means that the reform and innovation of the professional curriculum system of energy power should be put on the agenda, otherwise it is difficult to promote the vigorous development of the energy industry. In addition, the curriculum is not reasonable, some school experiment teaching equipment update slowly, many teachers’ teaching ideas failed to get updated, it will largely affected the energy practice teaching advanced nature, scientific, rationality, curriculum content, knowledge structure and the actual enterprise demand, is not conducive to the subsequent employment and development. Under the guidance of backward ideas, few teachers can actively update the teaching content and optimize the teaching form, and the introduction of information technology, big data technology, multimedia technology and other teaching AIDS is insufficient, which will also affect the teaching efficiency of energy professional courses to a certain extent.

All these problems restrict the improvement of the quality of talent training, resulting in the weak engineering practice ability and practical ability to solve problems, which is difficult to resonate with industrial upgrading and economic transformation and upgrading, which may lead to a series of problems in talent training.

3.3. Single teaching mode and difficult to highlight the diversified characteristics

With the progress and development of the era, the teaching reform of energy and power majors is also advancing

at the same time. Some schools exert great importance to the innovation of teaching content, teaching methods and even teaching modes, and it is significantly effective^[9]. However, there is a part of the school energy power class professional teaching mode that emphasize the teacher as the center, given priority to with classroom teaching and experimental operation, similar mode is difficult to fully stimulate students' interest in active learning, also difficult to meet the demand of talent various ability training, deep teaching reform remains to be further explored. To be specific, the new engineering concept advocates more project-driven, problem-oriented new teaching mode, and emphasizes the cultivation of students' independent learning ability, engineering literacy and innovative spirit in practice. However, the implementation of these teaching modes in energy and power majors is not in place, which leads to the effective improvement of students' creativity, teamwork ability and engineering practice ability, which is not conducive to the overall development of students.

3.4. Disconnection between learning and application, and the lack of production and education

The integration of industry and education and school-enterprise cooperation are the effective ways to cultivate applied talents in the new era^[10], However, research shows that some universities and enterprises in difficult to achieve consistent talent training goals, colleges and universities hope to borrow enterprise resources advantage to improve the quality of talent training and employment, and the fundamental goal is to pursue profit maximization, sometimes is not willing to invest more resources to the school, which directly affects the depth and breadth of university-enterprise cooperation. In addition, from the perspective of the school, they cannot timely update teaching plan according to the industry demand, rich teaching content, corresponding, from the perspective of the enterprise, they are lack of actual work requirements and challenges feedback to the school mechanism, these problems or insufficiency is likely to lead to university-enterprise cooperation or stay in the shallow. There is still a link between learning is not close problem and it is very bad to the rapid growth of students.

4. Construction of undergraduate energy and power talent training mode under the background of “double-carbon”

In recent years, China's environmental and energy problems have become more prominent, and the reconstruction of energy and power talent training mode has become the power source to promote China's sustainable development. On the one hand, in the training of energy and power talents, attention should be paid to cultivating students' innovative thinking, based on their comprehensive development, paying attention to interdisciplinary cooperation. On the other hand, it should also guide students to practice, focusing on cultivating students' ability to solve energy and environmental problems^[11]. Through course adjustment and upgrading, strengthening interdisciplinary integration education, deepening school-enterprise cooperation, highlighting projects and competition training and other measures, it will help promote the transformation and upgrading of energy and power majors and promote the realization of the goal of green development and applied innovative talents.

4.1. Pay attention to curriculum adjustment and upgrading

Under the background of “double-carbon,” the energy sector has ushered in great challenges and opportunities. Energy power talent training plan should be closely follow the industry development trend, to meet the needs

of the era. Besides, based on the policy guidance, it is also important to adjust and upgrade the corresponding course, change the traditional theory before the practice of teaching mode, the theory and practice of real integration project teaching, improve the condition of cultivating innovative talents. For example, new courses on new energy, clean energy and energy efficiency and traditional energy courses should be combined with green and low-carbon technologies such as carbon capture and storage technology^[12]. In addition, in order to enhance students' environmental awareness and sustainable development ability, the contents closely related to carbon neutrality such as carbon footprint calculation, carbon trading and environmental impact assessment should be appropriately added to the curriculum system, so as to adapt to the changing needs of the industry under the background of "two-carbon."

4.2. Strengthen interdisciplinary integration education

Energy and power engineering involves many disciplines such as mechanical engineering, electrical engineering, material science and other disciplines. In the context of "double-carbon," the application of intelligent energy systems and digital technology has become particularly important^[13]. Energy and power majors should break down the barriers of traditional disciplines and strengthen the integration of multiple disciplines by offering interdisciplinary courses, promoting interdisciplinary projects and establishing multidisciplinary teaching teams. At the same time, it exerts importance to the application of modern information technologies such as data analysis, artificial intelligence and Internet of Things technology in the field of energy and power, so as to cultivate students' ability to use comprehensive knowledge to solve practical problems and scientific communication skills^[14].

4.3. Deepening cooperation between schools and enterprises

School-enterprise cooperation is an important way to train energy and power talents to meet the needs of the industry, which helps to cultivate students' ability to solve problems. Colleges and universities should choose high-quality energy enterprises and research institutions and establish stable and long-term cooperative relations with them to promote the in-depth cooperation between universities and enterprises. On the one hand, enterprises have a wealthy energy and power projects, which can help provide students with many opportunities for engineering practice, so that students can actually participate in them and gradually cultivate skills in practice and improve their ability to solve practical problems. On the other hand, colleges and universities can also introduce high-quality talents and improve the quality of teaching by expanding their teachers. At the same time, enterprises can also use the channel of school-enterprise cooperation to provide feedback to the school on the talent demand and industry development trends, so as to form a benign interaction between talent training and industry demand. Under the teaching mode of integrating industry and education, enterprises can solve the problem of lack of talents to a certain extent, while colleges and universities can improve the employment rate of college students to a large extent. In university-enterprise cooperation, enterprises should often provide professional training, help them integrate the knowledge learned in school into the actual ability to work. This is not only conducive to the further development of college students, also can in virtually improve their work efficiency, enhance the sense of belonging in the enterprise, so as to better retain talent.

4.4. Highlight the project and competition training

In order to achieve the strategic goal of "double carbon," energy and power talents should have good innovative thinking and practical ability. Universities should encourage students to actively participate in science and

technology competitions and innovation projects in the field of energy and power at home and abroad ^[15]. For example, energy saving and emission reduction challenge, green energy design competition, etc., with the help of similar comprehensive practice activities, are able to cultivate students' ability to put theory into practice, at the same time, students' innovative spirit and innovative thinking will also be significantly improved. At the same time, students can also strengthen their cooperation with team members from different backgrounds in the comprehensive practice activities to enhance their teamwork and communication skills, and develop new technologies, new products or new services in the field of energy and power. In addition, in order to fully mobilize students' enthusiasm for innovation, colleges and universities should set up innovation funds to support students' independently proposed projects, which is crucial to the cultivation of students' independent innovation consciousness and scientific research ability.

5. Effective strategy for the construction and implementation of the undergraduate energy and power talent training mechanism

5.1. Leading talent training and innovation with the concept of green development

Today's society is more towards the direction of green and sustainable development, to adapt to the global trend. Colleges and universities must reshape the talent training concept, the concept of green development in the whole process of energy talent training, such as the green development concept into the course content, teaching methods, practice, build green, systematic talent training system.

First of all, teachers should exert importance to classroom teaching, integrate the concept of green development into the course content and lead students to fully realize the importance of green development to the development of human society from a macro perspective through new special courses related to green technology, sustainable energy and environmental ethics. For example, the relevant content of ecological philosophy is introduced in ideological and political classes, and the value significance of green low-carbon cycle in ecological civilization construction is explained in depth in professional courses, aiming to cultivate students to form a good way of thinking and green value orientation.

Secondly, as for the teaching mode, teachers should strengthen the problem-oriented and project-driven teaching mode, and encourage students to carry out subject research and group discussion on energy consumption, environmental protection and other issues, to cultivate students' critical thinking and improve their ability to solve problems. Teachers, for example, should encourage students to actively declare green low carbon fuel engine key technology, pollutants efficient comprehensive treatment key technology, real scientific research achievements into characteristic teaching resources, guide students to gradually form green development concept, make it fully realize the low carbon culture, green and low carbon value of research and practice and fully mobilize students in the field of energy power interest and enthusiasm, for the internationalization of talent training quality promotion and promote disciplines and connotative development lay a solid foundation.

Finally, for the integration of green development concept into practical activities, universities should actively cooperate with enterprises and scientific research institutions, and build a platform for students to experience and participate in green development projects through internship, practical training or project research, so as to cultivate students' innovative spirit and practical ability. For example, students are encouraged to take the initiative to participate in the "Challenge Cup," "Internet +," energy conservation, emission reduction and other high-level discipline competitions, and gradually integrate the concept of green development into

professional practice activities from the preparation of the competition to the competition to the final summary and reflection. In addition, the school should also cooperate with enterprises to set up college students' energy saving and emission reduction association, power plant association, refrigeration association, etc., to encourage students to participate in the association from their personal interests and take the initiative to complete the practice, so as to improve students' practical operation ability. With the help of enterprises, the school can also organize scientific and technological activities for college students to continuously improve students' scientific research ability and practical cognitive ability.

5.2. Promote the optimization of curriculum setting according to the competent job requirements

In order to make the graduates of energy and power majors better qualified for the future jobs, the curriculum of universities should be closely consistent with the actual needs of the industry, and be continuously optimized and upgraded on the basis of traditional courses.

(1) Refine the focus of education

Under the guidance of the concept of green development, universities should use the KSAO model in human resource management to aim at specific industries and analyze the typical work tasks of energy and power engineers. For example, for engineering thermophysics and automation majors, the education that can be extracted from knowledge, skills, ability and other characteristics, focuses on knowledge (mathematics and natural science, artificial intelligence science, etc.); skills (engineering drawing expression ability, test and inspection technology, green manufacturing technology, etc.); skills (innovation ability, cross-border ability, practical ability, communication ability); other characteristics (craftsman spirit, green development concept, etc.).

(2) Design the course module

The design of course modules should pay attention to the deep integration of theory and practice, aiming to consolidate the engineering foundation of students. Meanwhile, at the same time, the design should put the ability cultivation of students' engineering design and project management in the core position, and at the same time, improve the teaching quality of the experimental link. In this process, colleges and universities should actively cooperate with enterprises, gradually understand and accurately grasp the industry trends and technology development trends through industry research and other ways, and at the same time, comprehensively investigate the demand of enterprises for talents. Based on this, it constantly adjust the curriculum structure, highlight the practicality and foresight of the curriculum system. Generally speaking, the courses should cover new energy technology, energy management, environmental assessment, energy policy and other modules. For example, in engineering thermal physics and automation professional, in the design course module, universities can be classified according to the nature, such as innovative, professional, professional, directional, etc., to form targeted course system, such as direction of the course is given priority to with general courses, and professional course can cover turbine technology frontier, ship digital design, ship damping noise reduction, professional courses include metalworking practice, processing technology training, enterprise training, while innovative courses aims to cultivate students' creative ability, such as innovative entrepreneurial competition, open experiment, etc.

5.3. Promote the teaching mode reform by improving the engineering ability

Under the background of “double-carbon,” the energy and power industry has put forward higher requirements for students’ engineering ability. In contrast, teachers should actively introduce advanced teaching modes, drive classroom upgrading with innovation, and lay the foundation for enhancing students’ interest in learning.

First of all, colleges and universities should actively promote the close integration of mass entrepreneurship and innovation competition and practical teaching links. As an effective carrier of practical education in colleges and universities, the mass entrepreneurship and innovation competition should be the key attention of teachers and students. National college students ship energy and power innovation competition has gradually developed into a national college students discipline competition, covers the diesel engine disassembly game, internal combustion engine design competition, to further cultivate students ‘creative thinking, improve their ability of design and practice, to promote students timely put theory into practice, comprehensive test students’ practical creative ability.

Secondly, pay attention to the organic combination of school-enterprise cooperation and experimental teaching. Experimental teaching plays a vital role in deepening the school-enterprise cooperation. Colleges and universities can actively cooperate with enterprises to provide a broad platform for students to practice, practical training and innovation. Specifically, colleges and universities can be based on the campus laboratory, with external engineering technology center, expanding outside administration production base, around the professional, compound energy power class talent training target, for college students to build practical practice as an integrated platform, attaches great importance to the cultivation of students’ engineering application ability, promote the reform and innovation of experimental teaching link. In addition, the school can introduce interdisciplinary projects or team cooperation projects to simulate the real working environment for students, requiring students to complete the projects in groups, and gradually cultivate their engineering practice ability and teamwork spirit.

5.4. Expand the path of collaborative education according to the needs of industrial development

The talents trained by colleges and universities should be able to serve and help to the development of local economy, and cultivate innovative and highly skilled talents with innovative consciousness, innovative thinking and innovative ability. So, talent training plan has to adapt to the development of the enterprise in the course setting to consider the enterprise demand. It can be done through universities and enterprise training “double type” teachers, establish and improve the teacher’s enterprise training system, encourage more teachers to complete training, by participating in scientific research, technology research and development, production management, greatly improve the teachers’ comprehensive education ability. At the same time, colleges and universities should also develop industry mentor system, namely invite enterprise experts as energy power professional part-time teachers, hire excellent professor to teach, in this way, students can accept even from industry mentors and expert guidance and advice, in order to help them better planning personal career, improve the competitiveness of employment. In recent years, a university has actively signed cooperation with enterprises and built a number of practice bases, training centers, etc. At the same time, it has introduced 12 part-time enterprise teachers, and also set up a IMarST maritime chartered engineer teaching team. Today, the energy and power majors have more than 70% of the full-time teachers and they all have rich engineering practice experience. In addition, schools and enterprises jointly build teaching resources. Specifically, it means that colleges and universities should work with enterprises to build laboratories and training bases and

constantly optimize and upgrade practical teaching equipment, facilities and instruments, which is conducive to ensure steady development of students' experiment and training, and make the teaching content more in line with the needs of the industry and the actual industry.

6. Summary

To sum up, under the background of “double-carbon,” it is of great significance to establish and improve the training mechanism of undergraduate energy and power talents, and it has a far-reaching impact on the development of disciplines, schools and even the industry. Colleges and universities should constantly meet the needs of enterprises, deepen school-enterprise cooperation and innovate the talent training mode. At the same time, they should actively introduce new talent training concepts, take multiple measures to comprehensively improve the quality of energy and power talent training, and help related industries to achieve vigorous development.

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