



A Survey-Based Analysis of Talent Demand and Training Needs in the Green and Low-Carbon Sector

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Abstract : Under the context of the "dual carbon" goals, the green and low-carbon industry is experiencing accelerated development, leading to a sustained increase in demand for application-oriented technical and skilled personnel. As an important provider of skilled talent, higher vocational education urgently needs to examine the alignment between its training models and industrial demand from a demand-side perspective. Focusing on higher vocational education, this study analyzes industry expectations regarding talent structure, job categories, and competency requirements based on a survey of talent demand in the green and low-carbon sector, and explores directions for optimizing talent cultivation in vocational colleges.

An online questionnaire survey was conducted and distributed via a web-based platform to practitioners and educators in green and low-carbon - related fields. A total of 104 valid questionnaires were collected. Based on aggregated statistical results generated by the survey platform, this study employs descriptive analysis to examine talent demand trends, key job categories, core competency requirements, and feedback on curriculum and teaching models in the green and low-carbon sector.

The results indicate that the green and low-carbon industry has a relatively certain growth in talent demand over the next three to five years. Enterprises show a clear preference for graduates from higher vocational education, highlighting the importance of application-oriented and skilled talent at the current stage of industrial development. Talent demand is mainly concentrated in technical operation positions and carbon management support positions, with an emphasis on practical skills, professional responsibility, and continuous learning ability. In terms of curriculum and teaching, there is a strong demand for application-oriented courses such as low-carbon building materials and digital carbon management, while existing vocational programs still face limitations in specialized coverage and clear positioning.

The study concludes that higher vocational education plays a foundational and supporting role in the green and low-carbon talent cultivation system. Strengthening practice-oriented curricula, promoting school - enterprise collaboration, and adopting project-based teaching models can effectively enhance the alignment between vocational talent training and industry demand. From a demand-side perspective, this study provides practical references for the development of green and low-carbon - related programs and teaching reforms in higher vocational education.

I. INTRODUCTION

Against the backdrop of intensifying global climate change and increasing constraints on resources and the environment, green and low-carbon development has become a key strategic pathway for countries seeking economic restructuring and sustainable development(He et al. 2020). Centered on critical areas such as energy structure optimization, energy conservation and emission reduction, carbon emission management, and green technology application, related industries are rapidly expanding and diversifying(Judijanto et al. 2024). Green and low-carbon development is no longer confined to a single sector such as energy or environmental protection, but is increasingly penetrating manufacturing, construction, transportation, public administration, and other fields, forming a cross-sectoral and multi-level industrial system(Dovie et al. 2020). This profound transformation has generated new demands on human resource structures, with a continuous increase in green and low-carbon - related jobs and growing emphasis on diversified and practice-oriented competency requirements.

Compared with the continuous improvement of policy frameworks and technological systems, the mismatch between talent supply and actual industry demand in the green and low-carbon sector has become increasingly apparent(Cook and Elliott 2025). On the one hand, the sector integrates engineering technologies, management practices, and policy regulations, placing high demands on the comprehensive competencies of practitioners. On the other hand, existing education and training systems—particularly higher vocational education—still largely follow traditional disciplinary frameworks in terms of program design, curriculum content, and practical training arrangements. This makes it difficult to fully meet the emerging job requirements for applied skills and workplace adaptability. Such supply - demand mismatches not only affect the efficiency of green and low-carbon industrial development, but also constrain employment quality and job matching outcomes for vocational graduates(Zhang et al. 2025).

In recent years, research on green and low-carbon talent cultivation has primarily focused on policy guidance, education system reform, and curriculum framework development, providing a theoretical basis for understanding the importance of green and low-carbon education (Zhou et al. 2024). However, much of the existing literature adopts a supply-side perspective, with relatively limited attention paid to the actual needs of employers and frontline industry practices. In particular, systematic empirical evidence from enterprises and industry practitioners regarding job categories, competency preferences, and teaching or training modes remains insufficient. This limitation reduces the direct applicability of research findings to practical reforms in higher vocational education.

From an industrial practice perspective, talent demand in the green and low-carbon sector demonstrates a strong application-oriented orientation. Relevant positions require not only a foundational level of technical knowledge, but also emphasize hands-on operational skills, problem-solving abilities, and the capacity to understand and implement industry standards and policy regulations (Tsironis 2023). These characteristics align closely with the core objectives of higher vocational education, which emphasizes competency-based training and employment orientation. This alignment suggests that vocational colleges possess inherent advantages in cultivating green and low-carbon talent. However, whether these advantages can be effectively translated into actual talent supply capacity depends on an accurate understanding of real industry needs.

In this context, conducting systematic research from a demand-side perspective is essential for identifying key characteristics of talent demand and competency priorities in the green and low-carbon sector. By collecting opinions from enterprises, public institutions, and education-related practitioners through questionnaire surveys, valuable empirical evidence can be provided to support program design, curriculum optimization, and teaching model reform in higher vocational education. Rather than constructing complex theoretical models, such studies emphasize objective description and synthesis of industry needs, offering practical and actionable references for educational decision-making and teaching practice.

Accordingly, this study employs an online questionnaire survey to systematically examine talent demand trends, job categories, competency requirements, and expectations for training and teaching in the green and low-carbon sector. Through descriptive analysis of aggregated data generated by the survey platform, this paper aims to reveal the core demand characteristics of the green and low-carbon industry with respect to higher vocational talent cultivation, and to explore potential directions for improving curriculum content and training models in vocational colleges. The findings provide reference insights for higher vocational institutions, vocational training organizations, and relevant administrative bodies in advancing green and low-carbon talent cultivation and program development.

II. METHODOLOGY

2.1 Data Source

The data used in this study were obtained from a questionnaire survey focusing on talent demand for higher vocational education in the green and low-carbon sector. The questionnaire was designed and distributed through an online survey platform and disseminated via the internet to practitioners in green and low-carbon related industries as well as educators engaged in vocational and higher education. The respondents mainly included individuals involved in teaching, research, engineering practice, and industry management related to green and low-carbon development, with particular emphasis on their perceptions and evaluations of the alignment between higher vocational talent cultivation and job demand.

The questionnaire was completed anonymously to enhance the authenticity and completeness of responses. During the survey period, a number of questionnaires were collected, and after automatic screening and completeness checks by the survey platform, 104 valid questionnaires were obtained. All statistical results were automatically generated by the online platform, including the distribution of response options and corresponding visual summaries. This study is based on aggregated statistical data provided by the platform and does not involve access to individual-level raw data. Accordingly, the research adopts a descriptive questionnaire analysis approach, aiming to reveal overall trends and structural characteristics of talent demand for higher vocational education in the green and low-carbon sector.

2.2 Characteristics of Respondents

In terms of respondent composition, the survey sample was dominated by education-related professionals, particularly teachers from higher vocational education and higher education institutions. Approximately 75% of the respondents were professional teachers from vocational colleges, universities, and related educational institutions, covering disciplines such as green and low-carbon studies, building environment, energy technology, and sustainable development. These respondents generally possessed substantial experience in teaching and talent cultivation. Enterprise practitioners and other related personnel accounted for about 25% of the sample, mainly coming from frontline technical and managerial positions in green and low-carbon industries, and were able to reflect employer perspectives on the competency structure of vocational graduates.

This sample structure, which is centered on the education sector while incorporating industry perspectives, facilitates an understanding of talent demand characteristics in the green and low-carbon sector from both the “training side” and the “demand side” of higher vocational education, thereby supporting analysis of the alignment between vocational talent cultivation and job requirements.

Regarding industry distribution, respondents were primarily concentrated in the green building and green building materials sector, accounting for 55.77% of the sample, highlighting the prominent role of green construction-related fields within the current green and low-carbon industrial system. In addition to green building and materials, respondents were also drawn from sectors such as new energy, energy conservation and environmental protection, and ecological and environmental technologies and services. Overall, the industry background of the sample shows a high degree of consistency with the main employment destinations of green and low-carbon related programs in higher vocational education, which is conducive to reflecting the actual employment demand faced by vocational graduates.

2.3 Survey Content

The questionnaire was designed around the issue of alignment between talent cultivation in higher vocational education and industry demand in the green and low-carbon sector, covering multiple interrelated dimensions. Specifically, the survey focused on: (1) respondents' assessments of overall talent demand trends and future development prospects in the green and low-carbon sector; (2) job categories with concentrated demand in the current and near future, with particular attention to technical and auxiliary management positions suitable for graduates of higher vocational education; (3) perceptions of core competencies and capability structures required of green and low-carbon talent by employers and educators; (4) preferences regarding curriculum content and teaching priorities in higher vocational education; and (5) attitudes toward practical teaching approaches, school – enterprise collaboration, and project-based learning models.

Through a systematic investigation of these dimensions, the questionnaire aimed to identify key factors that are widely emphasized in the process of cultivating higher vocational talent in the green and low-carbon sector from a demand-side perspective. The questionnaire mainly consisted of multiple-choice questions, with some items allowing multiple selections to reflect respondents' comprehensive judgments regarding competency requirements and training approaches. The survey results provide foundational data support for subsequent analysis of talent demand characteristics in the green and low-carbon sector and for exploring directions for teaching reform in higher vocational education.

III. RESULTS AND ANALYSIS

3.1 Characteristics of Talent Demand: Growth Trends and Educational Level Orientation

The questionnaire was designed around the issue of alignment between talent cultivation in higher vocational education and industry demand in the green and low-carbon sector, covering multiple interrelated dimensions. Specifically, the survey focused on: (1) respondents' assessments of overall talent demand trends and future development prospects in the green and low-carbon sector; (2) job categories with concentrated demand in the current and near future, with particular attention to technical and auxiliary management positions suitable for graduates of higher vocational education; (3) perceptions of core competencies and capability structures required of green and low-carbon talent by employers and educators; (4) preferences regarding curriculum content and teaching priorities in higher vocational education; and (5) attitudes toward practical teaching approaches, school – enterprise collaboration, and project-based learning models.

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From an overall development perspective, respondents expressed a highly consistent and optimistic outlook regarding future employment and talent demand in the green and low-carbon sector. Survey results indicate that 78.85% of respondents believe that talent demand in this field will continue to grow over the next three to five years, including 30.77% who anticipate a significant increase and 48.08% who expect a steady increase. Notably, none of the respondents predicted a decline in talent demand, reflecting a strong consensus on the sector's development prospects. This overwhelming growth expectation suggests that the green and low-carbon sector has gradually moved beyond an initial stage dominated by policy advocacy and entered a development phase characterized by industrial implementation and scale expansion, with a high degree of certainty in talent demand growth.

This trend is closely aligned with the ongoing advancement of the “dual carbon” strategy. As green building development, energy-efficient retrofitting of existing buildings, application of renewable energy systems, and carbon emission management continue to shift from planning stages to engineering implementation, demand for related positions is being steadily released. Compared with short-term, policy-driven employment opportunities, respondents are more inclined to view the green and low-carbon sector as an industry with medium- to long-term development potential, further reinforcing the need for a stable and sustainable talent supply system.

In terms of educational level preferences, the survey reveals a pronounced orientation toward higher vocational education. Specifically, 71.15% of respondents indicated that enterprises prefer graduates from higher vocational education in recruitment, a proportion significantly higher than preferences for secondary vocational or undergraduate and above levels. This finding suggests that the core demand of the green and low-carbon industry does not primarily lie in academic research capacity, but rather in graduates' ability to quickly adapt to job requirements, participate in concrete technical implementation, and demonstrate stable job competency.

From the perspective of industrial development stages, this educational preference has a clear practical rationale. On the one hand, a large number of green and low-carbon projects are concentrated in areas such as equipment installation, operation and maintenance, on-site management, and technical application. On the other hand, during rapid expansion, enterprises place greater emphasis on labor cost control, skill-job matching, and workforce stability. Graduates from higher vocational education possess comparative advantages in practical training, technical operation, and workplace adaptability, making them the primary source of talent for the green and low-carbon industry at this stage. This result further highlights the foundational and supporting role of higher vocational education in the green and low-carbon talent supply system.

3.2 Key Job Profiles and Core Competency Framework

From the perspective of job structure distribution, talent demand in the green and low-carbon sector exhibits a clear “dual-driven” pattern, jointly shaped by technical implementation positions and auxiliary management positions. Survey results show that technical operation positions (46.15%) and carbon management support positions (44.23%) are the two most in-demand job categories. This distribution indicates that talent demand in the green and low-carbon sector encompasses not only traditional roles centered on engineering implementation and technical application, but is also rapidly extending to emerging positions related to carbon emission management, data support, and compliance assistance.

Technical operation positions are mainly concentrated in specific areas such as energy-saving equipment operation, renewable energy system maintenance, and application of green building materials, serving as the core workforce enabling the practical implementation of green and low-carbon projects. The relatively high proportion of carbon management support positions reflects the increasing workload associated with carbon data collection, emission accounting, and compliance management as carbon trading mechanisms continue to improve. This has created stable demand for application-oriented talent with basic professional knowledge and execution capacity. Overall, this shift in job structure indicates that the green and low-carbon industry is evolving from a purely technical implementation orientation toward a “technical implementation – management support coordination” model.

Regarding competency and capability requirements, survey results reveal a distinct integration of technical and non-technical attributes. At the level of professional qualities, 84.62% of respondents identified craftsmanship spirit and responsibility awareness as well as continuous learning and technological updating ability as the most important attributes. This suggests that evaluation standards for higher vocational talent in the green and low-carbon sector extend beyond technical proficiency to include work 规范性, responsibility, and occupational stability.

Given the frequent updates in green and low-carbon technologies and policies—such as rapid iterations in renewable energy equipment and continuous adjustments to carbon accounting rules and industry standards—enterprises tend to prefer employees with strong learning abilities and long-term adaptability, rather than those possessing only short-term technical advantages. Consequently, continuous learning ability has become a key indicator for assessing the development potential of graduates from higher vocational education.

In terms of professional knowledge, more than 60% of respondents considered low-carbon policies and industry standards (63.46%) and fundamental knowledge of renewable energy technologies (65.38%) to be essential knowledge modules. This finding indicates a shift toward a composite talent profile, in which higher vocational graduates are expected not only to master technical operations, but also to understand relevant policy contexts and industry regulations, thereby meeting job requirements for compliance and comprehensive judgment.

3.3 Supply – Demand Mismatch in Curriculum Systems and Teaching Models

With respect to curriculum demand, industry feedback highlights a strong need for application-oriented new technology courses within higher vocational education. Survey results show that among all emerging course directions, application technology of low-carbon building materials ranked first with a selection rate of 78.85%, followed by digital carbon asset management (69.23%). These results clearly demonstrate that industry expectations for curriculum content have moved beyond traditional environmental engineering or basic energy-saving courses, placing greater emphasis on teaching content closely aligned with specific industrial scenarios and actual job requirements.

This trend suggests that as the green and low-carbon industry becomes increasingly segmented and specialized, generic and broad-based courses are no longer sufficient to meet the competency demands of vocational graduates. Content related to low-carbon building material application, digital carbon management, and information platform operation is becoming integral to green and low-carbon practice, posing higher demands on the update speed and structural flexibility of curricula in higher vocational education.

However, current feedback indicates a noticeable mismatch between curriculum supply and industry demand. In the survey, 61.54% of respondents pointed to gaps in emerging specialized fields, while 59.62% believed that program positioning lacks clarity. These findings suggest that some vocational colleges and training institutions have not yet established clear development directions in program planning and curriculum design, resulting in teaching content lagging behind industrial demand and weakening the relevance and job adaptability of talent cultivation.

In response to these issues, respondents expressed relatively consistent support for improvements in teaching models. Survey results show that both school – enterprise co-teaching and project-based learning received high approval ratings of 84.62%, and were widely regarded as effective pathways for enhancing the practical orientation and real-world relevance of higher vocational education. This reflects strong industry expectations for integrating real enterprise projects, engineering cases, and frontline technical personnel into teaching, thereby strengthening students’ understanding of workplace environments, operational processes, and technical standards.

Overall, the mismatch between curriculum systems and teaching models is not caused by a single factor, but is closely related to the pace of industrial change, flexibility in program design, and access to practical resources. By strengthening school – enterprise collaboration, advancing project-based teaching, and optimizing curriculum structures, it is possible to alleviate this mismatch to some extent and enhance the practical alignment of higher vocational education with green and low-carbon talent cultivation needs.

IV. DISCUSSION AND CONCLUSION

4.1 Discussion

Based on the results of the questionnaire survey, this study provides a systematic discussion of talent demand characteristics, job structures, and the current status of curricula and teaching in the green and low-carbon sector, with a particular focus on interpretation from the perspective of higher vocational education. Overall, the findings do not reflect short-term fluctuations, but rather indicate the long-term and structural requirements placed on talent as the green and low-carbon industry enters a relatively stable stage of development under the combined influence of sustained policy support and accelerated industrial implementation. This characteristic offers important insights for understanding the role and positioning of higher vocational education within the green and low-carbon talent cultivation system.

First, regarding talent demand growth trends, respondents’ highly optimistic assessments of employment prospects in the green and low-carbon sector over the next three to five years suggest a strong degree of development certainty. Unlike some emerging industries that experience cyclical fluctuations, green and low-carbon development is guided by clear policy objectives and supported by continuous engineering implementation, resulting in relatively stable growth in job demand. In this context, talent cultivation for the green and low-carbon sector should not be regarded as a temporary or transitional task, but should instead be incorporated into the medium- and long-term program planning and development strategies of higher vocational education.

Second, the pronounced orientation toward higher vocational education observed in educational level preferences reflects the current stage of development of the green and low-carbon industry. A large proportion of positions are concentrated in areas such as equipment operation, technical implementation, on-site management, and technical support, all of which place high demands on practical skills and job adaptability. This does not imply that higher-level academic talent lacks value, but rather indicates that during periods of rapid industrial expansion and intensive project implementation, higher vocational education—centered on skills training and job competency—has become a foundational source of talent supporting industrial operation. Accordingly, the role of vocational colleges in the green and low-carbon talent system warrants further clarification and reinforcement.

At the level of job structure, the parallel demand for technical operation positions and carbon management support positions reveals a developmental shift in the green and low-carbon industry from a single focus on technical implementation toward a model of “technical – management coordination.” In particular, the significant growth in demand for carbon management – related positions indicates that carbon emission accounting, data management, and compliance support have become integral components of daily enterprise operations. This transformation poses new requirements for talent cultivation in higher vocational education, where graduates are expected not only to possess solid technical operation skills, but also to understand policy regulations, industry standards, and basic management processes, thereby gradually forming a composite competency structure.

With respect to competency and quality requirements, the survey results emphasize the importance of professional attitudes and continuous learning ability. Given the rapid evolution of green and low-carbon technologies and policy frameworks, enterprises tend to favor employees who demonstrate a strong sense of responsibility, compliance awareness, and long-term development potential. This finding suggests that higher vocational education should not focus solely on technical skill training, but should also strengthen students’ professional ethics, learning capacity, and occupational identity through curriculum design, instructional organization, and practical training processes, thereby laying a foundation for sustainable career development.

From the perspective of curriculum system development, the supply – demand mismatch identified by the survey appears to be relatively common within higher vocational education. On the one hand, industry exhibits strong demand for emerging course areas such as low-carbon building materials application and digital carbon management; on the other hand, some vocational programs still lack sufficient coverage in specialized subfields and clear program positioning. This mismatch is partly attributable to the faster pace of industrial change compared to adjustments in educational systems, and also reflects practical constraints related to foresight and flexibility in vocational program design.

In response to these challenges, respondents’ strong endorsement of school – enterprise collaboration and project-based teaching provides a clear direction for reform in higher vocational education. By systematically integrating real enterprise projects, engineering cases, and practical tasks into teaching processes, vocational colleges can improve the alignment between curriculum content and job requirements without making radical changes to disciplinary structures. Such project-oriented teaching approaches enable students to gain early exposure to industry standards, technical workflows, and workplace contexts, thereby shortening the adaptation period after entering green and low-carbon positions.

Overall, the discussion highlights that talent cultivation in the green and low-carbon sector is not merely an internal educational issue, but rather the result of interactions among industrial development stages, changes in job structures, and the responsiveness of higher vocational education. Examining vocational talent cultivation models from a demand-side perspective can promote continuous optimization of curriculum content, teaching methods, and training objectives in higher vocational education, enabling it to better serve the practical needs of green and low-carbon transformation.

4.2 Conclusion

In the context of the ongoing green and low-carbon transition, accurately identifying the structural talent demands of industry is of significant practical importance for improving the quality of talent cultivation in higher vocational education. Based on the results of an online questionnaire survey, this study adopts a demand-side perspective to systematically analyze talent demand trends, job structures, competency requirements, and the current status of curricula and teaching models in the green and low-carbon sector, with particular emphasis on their implications for higher vocational education.

The findings indicate that the green and low-carbon sector is expected to experience relatively certain growth in talent demand over the next three to five years, with related job opportunities showing a steady expansion trend. In terms of talent structure, employers’ clear preference for graduates from higher vocational education reflects the urgent demand for application-oriented and skilled personnel at the current stage of industrial development. Meanwhile, the parallel importance of technical operation positions and carbon management support positions suggests that the green and low-carbon industry is evolving from a single focus on technical implementation toward a model of technical – management coordination, thereby placing higher requirements on the competency structure of vocational graduates.

With respect to competency and quality requirements, the survey results demonstrate that industry expectations for higher vocational talent extend beyond single technical skills, placing greater emphasis on professional responsibility, compliance awareness, and continuous learning ability. At the curriculum and teaching level, the industry shows strong interest in emerging application-oriented course areas such as low-carbon building materials application and digital carbon management. However, existing program design and curriculum systems in higher vocational education still exhibit certain limitations in specialized coverage and clarity of positioning.

Based on these findings, this study argues that promoting effective alignment between green and low-carbon talent cultivation and industrial demand requires sustained efforts at the level of higher vocational education. By updating curriculum content, innovating teaching models, and deepening school – enterprise collaboration mechanisms, vocational institutions can enhance the relevance and job adaptability of talent cultivation. Through strengthening practice-oriented training, introducing real-world projects, and increasing industry participation, higher vocational colleges are expected to play a more prominent supporting role in the green and low-carbon talent cultivation system.

It should be noted that this study is based on descriptive analysis of aggregated data generated by an online survey platform. The sample size and data acquisition approach may limit the generalizability of the findings to some extent. Future research could expand sample coverage, incorporate multiple data sources, and adopt mixed research methods to achieve a more comprehensive

and nuanced understanding of the relationship between higher vocational education and talent demand in the green and low-carbon industry.

Overall, by adopting a demand-side research perspective, this study provides empirical reference for understanding talent demand characteristics in the green and low-carbon sector and identifying development directions for higher vocational education. The findings offer practical insights for vocational colleges, training institutions, and relevant administrative bodies in advancing green and low-carbon talent cultivation and program development.

FUNDING:

This research was supported by the Jiangsu Provincial Social Science Applied Research Excellence Project, “Research on Strategies for Empowering Rural Industrial Revitalization through the Digital Economy in Jiangsu Province” (Grant No. 22SYB-136).

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