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Job Mapping Model and Projection of Solar Energy Labor Needs in Indonesia: A *Systematic Literature Review Approach*

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Abstract

This study aimed to systematically synthesize the literature to identify job classifications, evaluate approaches used to project workforce demand, and develop an integrated competency-mapping framework for Indonesia's solar power industry. The review followed the PRISMA 2020 guidelines and searched five scientific databases: Scopus, Web of Science, ScienceDirect, IEEE Xplore, and Google Scholar, covering publications from 2021 to 2026. Following the screening process based on predefined inclusion and exclusion criteria and methodological quality assessment, 22 articles were deemed eligible for analysis using thematic analysis combined with narrative synthesis. The findings showed that the solar photovoltaic (PV) project value chain comprised four main stages: planning, construction, commissioning, and operation and maintenance (O&M), each requiring distinct technical competencies. The review also found that most workforce projection models remained oriented toward quantitative macroeconomic approaches and therefore did not adequately capture competency gaps (skill gaps) at the operational level. To address this limitation, this study developed the Integrative Solar Workforce Projection and Competency Mapping Model (IPPEC Model), which integrated quantitative workforce demand estimation with a regional competency standards framework. The findings indicated that accelerating solar PV deployment in Indonesia should be accompanied by a comprehensive national occupational competency standardization system to ensure that workforce availability and competencies align with the evolving requirements of the solar energy industry.

INTRODUCTION

Climate change, which has become an increasingly urgent global concern, has prompted countries worldwide to accelerate the transition toward more sustainable energy systems. In this context, renewable energy, particularly solar photovoltaic (PV) power, has emerged as a key component of the global electricity sector transition. In Indonesia, this commitment has been reflected in targets to increase the share of new and renewable energy and achieve net-zero emissions by 2060, as outlined in national climate commitments and electricity supply planning documents (Sari & Handayani, 2022). Although investment opportunities in the solar power sector continue to expand, successful deployment depends not only on the availability of financing and technology but also on the availability of a competent workforce aligned with industry requirements. The transition toward a green economy has transformed labor market structures, making skilled human resources essential throughout the project life cycle, from planning and feasibility assessment to construction, operation, and maintenance of solar PV facilities (International Renewable Energy Agency, 2023). Without systematic job mapping and

workforce capacity planning, investment in the solar energy sector may face workforce supply–demand mismatches, potentially reducing operational efficiency and increasing dependence on foreign expertise (Maulidia et al., 2019).

Over the past five years, scientific publications on solar energy have increased substantially. However, much of the existing research has focused on technological development, system performance, economic feasibility, and environmental impacts. Studies specifically addressing human resources in the renewable energy sector have generally adopted macroeconomic approaches, particularly input–output (I–O) models, to estimate aggregate employment creation (International Labour Organization, 2019). Other studies have examined the effectiveness of labor policies or the implementation of vocational education and training programs through regional case studies (Ramadhan et al., 2023). Collectively, these approaches indicate that solar power industry development depends not only on technological and regulatory readiness but also on the alignment of workforce competency standards with industry requirements. To date, the integration of competency standards frameworks with life-cycle-based workforce demand projections for solar PV projects in Indonesia remains limited and has not been comprehensively addressed (Adjei et al., 2024; Albertz & Pilz, 2025).

The need for a systematic literature review in this field is driven by the fragmentation of existing knowledge and the diversity of previously published findings. Most studies have separately addressed workforce requirements in solar module manufacturing and installation or the development of vocational education curricula (Muhaemanurrohmah & Widiaty, 2026). In addition, estimates of workforce requirements per megawatt of installed solar PV capacity have remained inconsistent because they are influenced by project characteristics, including rooftop, utility-scale, and floating solar PV systems, as well as by the degree of technological automation. These inconsistencies indicate the absence of a comprehensive synthesis integrating human capital theory with the concept of the green jobs transition developed by international labor organizations. Consequently, the development of occupational competency standards for Indonesia's solar energy sector continues to face substantial challenges.

Based on these conditions, the primary research gap is the lack of a systematic study that critically synthesizes the development of competency maps while simultaneously examining workforce demand projections for solar power projects in the context of industrial development and national regulations. Therefore, this study employed a systematic literature review (SLR) based on a standardized protocol (Page, McKenzie, Bossuyt, Boutron, Hoffmann, & Mulrow, 2021) to integrate key findings on job mapping and workforce demand estimation in the solar energy sector. Specifically, this study addressed three research questions: how have job mapping and competency classification been developed across the solar energy project value chain; what methods and variables have been most widely used to project workforce demand in the solar energy sector; and how can a job-mapping framework based on competency standards be formulated to support the acceleration of Indonesia's energy transition?

Academically, this study contributes a synthesis of solar energy workforce competency taxonomies and develops a conceptual framework explaining the relationship between renewable energy infrastructure investment and human capital development. From a practical perspective, the findings are expected to provide an evidence-based foundation for government institutions, particularly those responsible for employment and education, to harmonize national occupational competency standards, design vocational education curricula, and

develop national workforce planning strategies. The scope of this study was limited to reputable scientific publications from 2021 to 2026, including empirical and conceptual studies addressing human resources in the solar power sector, with particular attention to developing countries and energy transition policies relevant to Indonesia ("A Micro-Credential Approach for Life-Long Learning in the Urban Renewable Energy Sector," 2024; "The Failure to Decarbonize the Global Energy Education System: Carbon Lock-in and Stranded Skill Sets," 2024; Černý et al., 2024) .

This study was grounded in theoretical and conceptual perspectives relevant to job mapping and workforce demand projection in the renewable energy sector. Job mapping involves systematically identifying the competencies, occupational functions, responsibilities, and qualifications required throughout the solar energy industry value chain, from component manufacturing and system design to construction, installation, operation, and maintenance (Setiawan, 2020). Workforce projection involves estimating the number and characteristics of workers required to support targeted solar PV deployment over a specified period (Maulidia et al., 2021). These concepts were examined through two theoretical perspectives widely applied in contemporary research: Human Capital Theory and the Green Jobs Transition Framework developed by the International Labour Organization. Human Capital Theory emphasizes investment in education, technical training, and professional certification as mechanisms for enhancing productivity and strengthening workforce capacity to meet the requirements of technology-intensive industries (Vikriansyah et al., 2024). The Green Jobs Transition Framework, meanwhile, emphasizes that the transition toward a low-carbon economy not only creates new green occupations but also transforms existing occupations, thereby requiring continuous adaptation and updating of competency standards (International Labour Organization, 2019).

Previous studies have generally adopted three major approaches to employment analysis in the solar energy sector. The first uses a macroeconomic perspective, employing input–output (I–O) and computable general equilibrium (CGE) models to estimate employment multipliers and job creation at the national level (International Renewable Energy Agency, 2023). The second focuses on institutional and policy dimensions through qualitative analyses of labor regulations, national competency standards, and the effectiveness of vocational education and training (Ramadhan et al., 2023). The third focuses on human resource management at the organizational or project level by examining skill gaps within engineering, procurement, and construction (EPC) companies and among solar PV project implementers. Considerable methodological variation has also been observed across these approaches. Some studies estimate workforce demand using labor coefficients expressed as workers or job-years per megawatt of installed capacity, whereas others assess competency-unit fulfillment against established standards, including Regional Model Competency Standards (RMCS) (Setiawan & Budi, 2025).

These methodological differences have generated two major perspectives in renewable energy employment research. The technocratic-quantitative perspective assumes that workforce demand can be estimated from investment levels and planned generation capacity, with labor market equilibrium expected to emerge through supply-and-demand mechanisms (Maulidia et al., 2021). In contrast, the structuralist-institutional perspective emphasizes the role of active policy interventions in developing competency standards and education systems

because workforce skill mismatches may not be adequately resolved through market mechanisms alone (Prasetyo & Utomo, 2024). These perspectives also reflect the evolution of solar energy research. Earlier studies predominantly focused on photovoltaic technology feasibility and investment efficiency. As technology costs declined and large-scale solar deployment expanded, research increasingly addressed macroeconomic impacts and subsequently shifted toward workforce competency development, local workforce readiness, and a just transition for workers moving from conventional energy industries to clean energy sectors (Handayani et al., 2022).

The conceptual framework of this study was further informed by several important studies that have contributed to the international and national literature. The International Renewable Energy Agency (2023) reported that solar energy development can generate substantial employment opportunities across its value chain. In the Indonesian context, Maulidia et al. (2021) provided an important reference by estimating potential employment associated with achieving renewable energy targets using an input–output model. Prasetyo and Utomo (2024) broadened the theoretical perspective by integrating human capital development into energy transition strategies in Southeast Asia. Setiawan and Budi (2025) applied the Regional Model Competency Standards framework as a basis for mapping technical competency requirements in utility-scale solar PV projects. Meanwhile, Ramadhan et al. (2023) contributed empirical evidence by identifying skill gaps between vocational education graduates and the competencies required by Indonesia's photovoltaic installation industry (Arcelay et al., 2021; “Building a ‘Fair and Fast’ Energy Transition? Renewable Energy Employment, Skill Shortages and Social Licence in Regional Areas,” 2022; “Critical Skills Needs and Challenges for STEM/STEAM Graduates Increased Employability and Entrepreneurship in the Solar Energy Sector,” 2023; “The Renewable Energy (RE) Industry Workforce Needs: RE Simulation and Analysis Tools Teaching as an Effective Way to Enhance Undergraduate Engineering Students’ Learning,” 2021).

Although these studies provide a substantial scientific foundation, the literature indicates several remaining limitations. Theoretically, an integrated conceptual model connecting macroeconomic employment projections with micro-level competency mapping based on industry standards remains underdeveloped. Methodologically, substantial variation persists in the definition and measurement of workforce projection variables, particularly labor coefficients per megawatt, which often insufficiently account for technological differences and project characteristics across rooftop, floating, and ground-mounted utility-scale solar PV systems. To address these limitations, this study employed a systematic literature review to bridge the identified gaps. Following the PRISMA 2020 guidelines (Page et al., 2021), the study systematically synthesized the literature, integrated previously fragmented findings, developed a more consistent job-mapping classification, and formulated an integrative framework linking competency standards with projected workforce requirements in the solar energy sector to support evidence-based policy development in Indonesia.

METHOD

This study employed a systematic literature review (SLR) to synthesize empirical and conceptual evidence on job mapping and projected workforce demand in Indonesia’s solar energy sector. The review followed the Preferred Reporting Items for Systematic Reviews and

Meta-Analyses (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, et al., 2021) guidelines and relevant SLR guidance for systematic evidence synthesis (Page, McKenzie, Bossuyt, Boutron, Hoffmann, & Mulrow, 2021). This framework was used to ensure a transparent and reproducible literature identification, screening, and selection process.

Three research questions guided the review. RQ1 identified job categories and key competency units across the solar photovoltaic (PV) project value chain. RQ2 examined the methods and key variables used to estimate workforce demand in the solar energy sector. RQ3 examined the integration of Regional Model Competency Standards (RMCS) with life-cycle-based workforce demand projections to support Indonesia's energy transition.

The literature search was conducted across five scientific databases: Scopus, Web of Science, ScienceDirect, IEEE Xplore, and Google Scholar. Boolean operators (AND and OR) were used to combine English and Indonesian search terms. The search string included ("solar PV" OR "solar energy" OR "photovoltaic") AND ("job mapping" OR "skill gap" OR "occupational standards" OR "workforce projection" OR "human capital") AND ("Indonesia" OR "developing countries"). The search was limited to publications from 2021 to 2026 and to articles published in English or Indonesian.

Predefined inclusion and exclusion criteria were applied during the literature selection process. Eligible publications included peer-reviewed journal articles and indexed conference proceedings that addressed employment, workforce requirements, or competency standards in the solar energy sector and clearly reported their methodological approaches. Preprints, theses, dissertations, editorials, blog articles, publications without accessible full text, duplicate records, and studies assessed as having low methodological quality were excluded.

Article selection was conducted through sequential screening by two independent reviewers. Titles and abstracts were initially screened for relevance, followed by full-text assessment against the eligibility criteria. Methodological quality was subsequently assessed using the Critical Appraisal Skills Programme (CASP) and Joanna Briggs Institute (JBI) critical appraisal tools (Barker et al., 2023). Disagreements between reviewers were resolved through discussion or consultation with a third reviewer when consensus could not be reached. The selection process was documented using a PRISMA 2020 flow diagram showing the number of records identified, screened, assessed for eligibility, and included in the final synthesis (Page et al., 2021).

Data from eligible studies were extracted using a standardized data extraction form supported by Mendeley and Microsoft Excel. Extracted information included bibliographic characteristics, research objectives, methodological approaches, study samples or scope, variables, key findings, and theoretical and practical contributions. The extracted data were synthesized using thematic analysis and narrative synthesis (Popay et al., 2006). Qualitative coding was conducted using NVivo 14 to identify and categorize recurring competency patterns and workforce projection approaches. Bibliometric and keyword co-occurrence analyses were also performed using VOSviewer to examine research trends and relationships among major research themes (van Eck & Waltman, 2014).

RESULTS AND DISCUSSION

The process of searching and selecting articles was carried out strictly following the PRISMA 2020 protocol. At the initial identification stage, a total of 485 documents were

successfully netted from five academic databases, namely Scopus (n = 142), Web of Science (n = 98), ScienceDirect (n = 115), IEEE Xplore (n = 65), and Google Scholar (n = 65). After the removal of 120 duplicate documents, a total of 365 articles underwent title and abstract scanning. From this stage, 255 articles were excluded because they were not relevant to the realm of employment or solar energy. Furthermore, 110 full-text articles were evaluated for eligibility based on inclusion and exclusion criteria as well as CASP and JBI critical assessment instruments. A total of 88 articles were excluded on the grounds that they did not focus on job mapping, were precast documents, or had methodological defects. In the end, 22 final qualification articles were included in this systematic synthesis. This selection flow is transparently visualized through the following PRISMA flowchart.

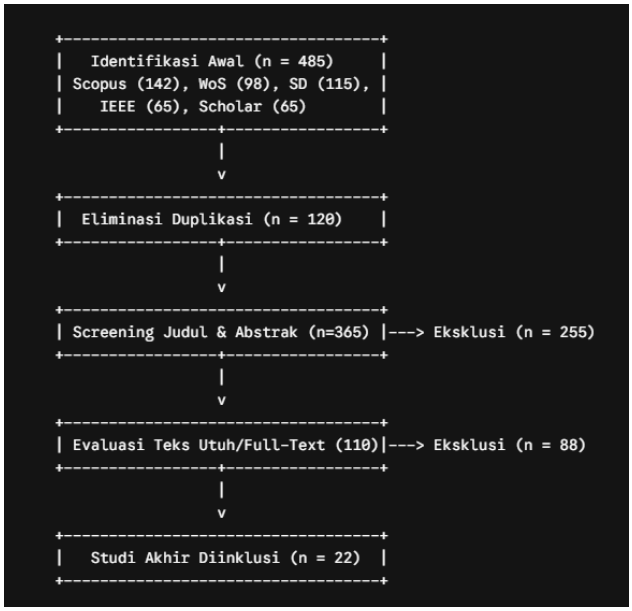

Figure 1. Research Prism Flow Diagram

The characteristics of the 22 studies reviewed show a significant trend of increasing publications in the period 2021 to 2026, reflecting the escalation of global and national interest in energy transition employment. Based on annual distribution, the number of consecutive publications is 2 studies in 2021, 3 studies in 2022, 5 studies in 2023, 6 studies in 2024, 4 studies in 2025, and 2 studies in early 2026. Geographically, the majority of studies focused on developing countries in Southeast Asia and South Asia (14 studies), with a particular emphasis on Indonesia (8 studies), followed by other developing regions (5 studies), as well as global comparative analysis (3 studies). The types of publications were dominated by articles from reputable international journals (18 studies) and proceedings of indexed international conferences (4 studies). Methodologically, quantitative research based on input and output modeling dominated (10 studies), followed by descriptive qualitative research and case studies (7 studies), as well as mixed *methods* approaches that combined industrial surveys with competency mapping (5 studies).

Synthesis of Findings Based on Research Questions (RQ)

In order to answer the First Research Question (RQ1) regarding the classification of work and competency units in the value chain of the solar PV project, the literature synthesis

identifies four main phases in the project life cycle, namely assessment and planning, construction and installation, testing and commissioning, and operation and maintenance. In the planning phase, the key competencies focus on photovoltaic system design engineering, solar radiation analysis, and financial feasibility studies. The construction phase is dominated by technical work such as the installation of support structures, the installation of solar modules, and direct and alternating current wiring. In the testing and commissioning phase, the qualifications of electrical safety experts and network integration testing engineers are vital. Meanwhile, in the operation and maintenance phase, the need shifts towards intelligent data-driven performance monitoring, module cleaning, and predictive maintenance. An empirical study from Setiawan and Budi (2025) confirms that most of the operational failures of utility-scale solar power plants in developing countries are caused by the absence of competency standard certification in the operation and maintenance phases.

Regarding the Second Research Question (RQ2) regarding the methodology and projection variables of labor needs, the results of the review show a diversification of the main variables used by the researchers. The most common independent variables include the target installed capacity of megawatts, the value of capital investment, the ratio of labor coefficients per megawatt, and the level of domestic components. Macroeconomic quantitative methodologies such as input-output modeling and *Computable General Equilibrium* (CGE) are widely used to measure the impact of direct, indirect, and induction job creation (Maulidia et al., 2021). However, a study from Ramadhan et al. (2023) shows that macro quantitative methods often fail to capture the dynamics of skill *gaps* at the operational micro level. Therefore, recent studies have begun to combine quantitative modeling with qualitative analysis based on *Regional Model Competency Standards* (RMCS) standards to map the availability of competency units with precision.

In answering the Third Research Question (RQ3) regarding the competency standard-based job mapping framework in Indonesia, the thematic analysis resulted in a synthesis that the existing framework is still fragmented between the needs of the industry and the vocational education curriculum. The inconsistency of the findings between studies occurs due to differences in the use of assumed labor coefficients, where global-scale studies tend to overestimate the absorption of local labor because they do not take into account the level of automation and technology imports in developing countries (Prasetyo & Utomo, 2024). As a solution, this study proposes an Integrative Model for Solar Energy Employment Mapping and Projection (IPPEC-Model). This conceptual model connects investment targets and megawatts capacity of national solar power plants with project value chain mapping, determination of RMCS-based competency units, evaluation *of vocational skill gaps*, and the formulation of national work qualification standards.

Table 1. Summary of the Comparative Matrix of Key Study Reviews

Yes	Author & Year	Focus & Methodology	Key Variables & Indicators	Key Findings & Synthesis
1	Maulidia et al. (2021)	Projected Impact of Solar Power Plant Employment in Indonesia; Quantitative (*Input-Output*).	MW capacity, investment value, labor coefficient per MW.	The NRE target has the potential to create tens of thousands of jobs, but it is constrained by the supply of skilled local human resources.

Yes	Author & Year	Focus & Methodology	Key Variables & Indicators	Key Findings & Synthesis
2	Ramadhan et al. (2023)	Analysis of the skills gap in solar PV installation; Qualitative (Case Studies & Interviews).	Installation competency units, technical certifications, vocational standards.	A significant gap was found between the qualifications of vocational graduates and the safety standards of the PV industry.
3	Odyssey & Odyssey (2024)	Human capital development of energy transition in Southeast Asia; Systematic Review.	*Human capital*, vocational curriculum, green employment policy.	It is necessary to harmonize regional qualification standards to support the mobility of skilled workers in the NRE sector.
4	Setiawan & Budi (2025)	Mapping of utility-scale solar PV work competency standards; *Mixed Methods*.	Job classification, RMCS standards, PLTS O&M efficiency.	The development of RMCS-based competency standards improves operational efficiency and reduces O&M costs.

The results of the synthesis of this systematic review provide confirmation as well as expansion of the Human *Capital Theory* and the *Green Jobs Transition Framework*. The findings of the review prove that the accumulation of human capital through specific competency certification not only increases individual productivity, but is an absolute prerequisite for the successful acceleration of renewable energy infrastructure investment (Prasetyo & Utomo, 2024). Furthermore, this study challenges the conventional view of the technocratic stream that assumes that green job creation will occur automatically with the influx of capital investment. Data shows that without institutional interventions that structure work competency units, large investments in solar power plants actually trigger *employment mismatches* and dependence on foreign workers (Handayani et al., 2022).

When compared to the previous *systematic review* which generally focused on the estimation of global macroeconomic aggregates (International Renewable Energy Agency, 2023), the added *value* of this review lies in integrating the qualitative dimension of RMCS competency mapping into the specific employment projection model of the context of developing countries such as Indonesia. The evolution of the understanding of this topic shows a shift in focus from simply calculating the quantity of work (*job creation*) to improving job quality and qualification standards (*job quality and competency standards*).

The implications for future research require a more in-depth study of the impact of automation, artificial intelligence, and the use of *the Internet of Things* (IoT) in the maintenance of solar power plants on shifting work competency standards. Methodologically, the researcher is further advised to apply an agent-based modeling-based longitudinal research design to capture the dynamics of job market changes in *real-time*. For practitioners and managers of vocational education institutions, this research provides concrete recommendations to revise the training curriculum by adopting standardized competency units recognized by the national and regional photovoltaic industries.

The resulting policy implications emphasize the importance of cross-ministerial synergy, particularly the Ministry of Energy and Mineral Resources, the Ministry of Manpower, and the Ministry of Education, Culture, Research, and Technology. Policymakers are encouraged to revise the Indonesian National Work Competency Standard (SKKNI) for the solar energy sector to cover the entire project value chain from downstream to upstream, as well as require

professional certification for engineering, procurement, and construction contractors. This strategic step is important to ensure that the energy transition not only impacts reducing carbon emissions, but also promotes industrial independence and optimal absorption of local labor.

Critically, the limitations of this study need to be acknowledged. The potential *for publication bias* or *file drawer problems* can occur because this research is limited to reputable published articles, so it does not include internal industry reports that are not published. The language limitations of publications that only include English and Indonesian also risk missing empirical literature in other languages. In addition, the variation in methodology between the reviewed studies makes it difficult to compare meta-analyses purely quantitatively. Nevertheless, the strength of this SLR lies in the strict application of the PRISMA 2020 standard, the transparency of the search strategy on five main databases, and the integrative synthesis that is able to bridge the gap between human capital theory and the practices of the solar energy industry in Indonesia.

CONCLUSION

This study employed a systematic literature review (SLR) to synthesize job classifications, evaluate methods used to project workforce demand, and develop an integrated competency-mapping framework for solar photovoltaic (PV) infrastructure development in Indonesia. The review of relevant scientific publications addressed the three research questions formulated in this study. The synthesis identified four main stages in the solar PV project value chain: planning, construction, commissioning, and operation and maintenance (O&M), each requiring distinct technical competencies. The findings also showed that most existing workforce projection models relied predominantly on quantitative macroeconomic approaches focused on estimating employment demand, whereas competency gaps (skill gaps) at the operational level received insufficient attention. Based on the integration of these findings, this study proposed the Integrative Solar Workforce Projection and Competency Mapping Model (IPPEC Model) as a framework linking quantitative workforce demand estimation with the identification of competency units aligned with the Regional Model Competency Standards (RMCS) framework.

The primary contribution of this systematic literature review lies in integrating research findings that previously addressed photovoltaic industry workforce requirements and vocational education curriculum development in Indonesia separately. By combining Human Capital Theory with the Green Jobs Transition Framework, this study reinforces the understanding that accelerated solar PV infrastructure development requires a planned and sustainable workforce competency standardization system. From a practical perspective, the findings provide guidance for industry stakeholders and vocational education institutions in developing professional training and certification programs that are more closely aligned with industry competency requirements. In addition, the findings provide a basis for policymakers to formulate evidence-based green employment policies, update the Indonesian National Work Competency Standards (Standar Kompetensi Kerja Nasional Indonesia [SKKNI]) for the renewable energy sector, and strengthen coordination among relevant government institutions.

Overall, this systematic review strengthens the theoretical and methodological foundations for understanding changing workforce requirements associated with Indonesia's energy transition. However, the study was limited by methodological heterogeneity across the

included studies and restrictions related to publication language. Future research should develop dynamic simulation models capable of generating real-time workforce projections and further investigate the effects of automation and artificial intelligence on the operation and maintenance of solar PV systems. Ultimately, the findings emphasize that achieving Indonesia's transition toward a low-carbon and ultimately net-zero-emissions energy system depends not only on technological advancement and investment but also on the availability of a competent, appropriately certified local workforce capable of supporting the sustainable development of the solar energy industry.

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CONFLICT OF INTEREST
The author states that there are no conflicts of interest in this study, whether personal, commercial, or financial, that can affect the objectivity of the research results.

AUTHOR'S CONTRIBUTION
All authors contribute equally to the entire research process, starting from the formulation of ideas and concepts, data collection and analysis, to the preparation and editing of the final manuscript.

AI USAGE STATEMENT
In the process of preparing this manuscript, the author uses the help of Artificial Intelligence (AI) on a limited basis, which is solely for the purpose of grammar examination and language refinement. AI is not used in the process of data collection, substantive analysis, or drawing research conclusions.

REFERENCES
A micro-credential approach for life-long learning in the urban renewable energy sector. (2024). *Renewable Energy*, *228*, 120660. https://doi.org/10.1016/j.renene.2024.120660

Adjei, A., Mulyanti, B., Abdullah, A. G., Ampimah, B. C., & Osei-Bonsu, P. (2024). Exploring approaches in green technical and vocational education training (TVET): A systematic and bibliometric review. *Journal of Vocational Education Studies*, *7*(2), 313–334. https://doi.org/10.12928/joves.v7i2.10416

Albertz, A., & Pilz, M. (2025). Green alignment, green vocational education and training, green skills and related subjects: A literature review on actors, contents and regional contexts. *International Journal of Training and Development*, *29*(2), 243–254. https://doi.org/10.1111/ijtd.12359

Arcelay, I., Goti, A., & Oyarbide-Zubillaga, A. (2021). Definition of the Future Skills Needs of Job Profiles in the Renewable Energy Sector. *Energies*, *14*(9), 2609. https://doi.org/10.3390/en14092609

Building a 'Fair and Fast' energy transition? Renewable energy employment, skill shortages and social licence in regional areas. (2022). *Renewable and Sustainable Energy Transition*, *2*, 100039. https://doi.org/10.1016/j.rset.2022.100039

Černý, M., Bruckner, M., Weinzettel, J., Wiebe, K., Kimmich, C., Kerschner, C., & Hubacek, K. (2024). Global employment and skill level requirements for 'Post-Carbon Europe.' *Ecological Economics*, *216*, 108014. https://doi.org/10.1016/j.ecolecon.2023.108014

Critical skills needs and challenges for STEM/STEAM graduates increased employability and entrepreneurship in the solar energy sector. (2023). *Renewable and Sustainable Energy Reviews*, *187*, 113776. https://doi.org/10.1016/j.rser.2023.113776

International Labour Organization. (2019). *Skills for a greener future: A global view based on 32 country studies*. International Labour Office. https://www.ilo.org/publications/skills-greener-future-global-view

International Renewable Energy Agency. (2023). *Renewable energy and jobs: Annual review 2023*. International Renewable Energy Agency. https://www.irena.org/Publications/2023/Sep/Renewable-Energy-and-Jobs-Annual-Review-2023

Maulidia, M., Dargusch, P., Ashworth, P., & Ardiansyah, F. (2019). Rethinking renewable energy targets and electricity sector reform in Indonesia: A private sector perspective. *Renewable and Sustainable Energy Reviews*, *101*, 231–247. https://doi.org/10.1016/j.rser.2018.11.005

Muhaemanurrohmah, H., & Widiaty, I. (2026). Mapping the research landscape of green skills in vocational education: A systematic literature and network analysis. *Journal of Informatics and Vocational Education*, *9*(1), 1–15. https://doi.org/10.20961/joive.v9i1.2972

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., & Mulrow, C. D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Britten, N., Rodgers, M., & Duffy, S. (2006). *Guidance on the conduct of narrative synthesis in systematic reviews: A product from the ESRC Methods Programme*. Lancaster University. https://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/fhm/dhr/chir/NSsynthesisguidanceVersion1-April2006.pdf

Ramadhan, A. I., Dwinanto, A., & Triwiyanto, A. (2023). Skill gap analysis in the Indonesian solar PV installation sector. *International Journal of Renewable Energy Development*, *12*(3), 512–521. https://doi.org/10.14710/ijred.2023.49811

Sari, K. P., & Handayani, D. (2022). Psychological Well-Being of School-Age Children in Orphanages. *Journal of Developmental Psychology*, *10*(1), 34–42.

Setiawan, H. (2020). Characteristics of halal thayyiban food in the Qur'an. *Halalan Thayyiban: Journal of Halal Management and Sharia Tourism Studies, 3(2), 1–10*.

The failure to decarbonize the global energy education system: Carbon lock-in and stranded skill sets. (2024). *Energy Research & Social Science*, *110*, 103446. https://doi.org/10.1016/j.erss.2024.103446

The Renewable Energy (RE) Industry Workforce Needs: RE Simulation and Analysis Tools Teaching as an Effective Way to Enhance Undergraduate Engineering Students' Learning. (2021). *Sustainability*, *13*(21), 11727. https://doi.org/10.3390/su132111727

van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring scholarly impact: Methods and practice* (pp. 285–320). Springer. https://doi.org/10.1007/978-3-319-10377-8_13

Vikriansyah, M. F., Prasetyo, H. D., & Latuconsina, H. (2024). Analisis kualitas fisikokimia air di daerah aliran Sungai Jilu Kabupaten Malang Jawa Timur. *AQUACOASTMARINE: Journal of Aquatic and Fisheries Sciences*, *3*(1), 21–28. https://doi.org/10.32734/jafs.v3i1.15701