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# The Role of Industry 5.0 in ESG-Based Talent Management Transformation at National Energy Companies

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**ABSTRACT**

This study aims to analyze the role of Industry 5.0 in driving the transformation of Environmental, Social, and Governance (ESG)-based talent management in national energy companies. The research method used is a qualitative approach with a case study strategy, through in-depth interviews, observations, and analysis of company documents related to HR policies and sustainability reports. The results show that Industry 5.0 contributes to building a more personalized, adaptive, and human-centered talent management system supported by intelligent technologies such as AI and big data. The integration of ESG in talent management further strengthens company sustainability, increases competitiveness, and builds employee loyalty. Despite challenges such as employee resistance, initial investment costs, and gaps in ESG understanding, strategic opportunities in the form of developing smart HR systems and data analytics are potential solutions. This study emphasizes the novelty of the integration of Industry 5.0, ESG, and talent management as a strategic framework for HR development in the national energy sector.
**Keywords:** *Industry 5.0; Talent Management; ESG; National Energy*

## INTRODUCTION

Industry 5.0 emerges as a new development in the industrial revolution, emphasizing harmonious collaboration between humans and intelligent technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), big data, and robotics. Unlike the Industry 4.0 paradigm, which focused more on automation of production processes and machine-based efficiency, Industry 5.0 emphasizes a human-centric approach, placing humans at the center of innovation and decision-making (Khosravy et al., 2024).

This orientation emphasizes that technology is not just a tool to replace human labor, but rather a strategic partner that supports increased creativity, productivity, and employee well-being (Pedota & Piscitello, 2022). This concept is increasingly relevant amidst the increasing demands for sustainability and the implementation of Environmental, Social, and Governance (ESG) principles, as it combines the advantages of cutting-edge technology with humanitarian values and social responsibility. Thus, Industry 5.0 aims not only to create business efficiency but also to build a more inclusive, adaptive, and sustainable work ecosystem, thus becoming the answer to the needs of modern organizations in facing global complexity, climate change, and ever-evolving socio-economic dynamics (Mesiono et al., 2024).

National energy companies currently face a complex dual challenge: how to maintain global competitiveness through technological innovation while ensuring

sustainability in accordance with Environmental, Social, and Governance (ESG) principles (Ijaz et al., 2025). On the one hand, technological advancements require energy companies to continuously adapt to the use of intelligent technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), big data, and automation to improve operational efficiency, expand production capacity, and strengthen their position in the international market. However, on the other hand, there is increasing pressure from the public, government, and investors for energy companies to implement environmentally friendly business practices, pay attention to social aspects, and implement transparent and accountable governance.

Talent management is the main key in supporting the transformation of energy companies in the Industry 5.0 era, because human resources are required not only to master advanced technology, but also to be able to understand the sustainability values that are at the core of ESG (Environmental, Social, and Governance) principles (Ramdhani & Pramono, 2024). The role of HR in this regard is no longer limited to operational functions, but rather to becoming agents of change that can integrate technological innovation with social and environmental responsibility. Therefore, national energy companies require a more adaptive, visionary talent management strategy oriented toward human capacity development to synergize with smart technology.

Amidst the acceleration of digital transformation, the challenges faced lie not only in the availability of technology, but also in the readiness of individuals to utilize it (Dalimunthe et al., 2024). HR must possess new skills such as digital literacy, data literacy, and the ability to operate AI-based systems, IoT, and automation. However, mastery of technology alone is not enough. Employees must also understand the urgency of sustainability, from energy efficiency and emission reduction to social engagement that positively impacts the community. This integration of technical capabilities with ESG awareness is what makes talent management so relevant to strengthen in the context of Industry 5.0 (Sartika, 2024).

By strategically managing talent, energy companies can build a work culture that emphasizes continuous innovation and a human-centric orientation. Through training programs, competency development, and the formation of a mindset aligned with ESG values, human resources will be better prepared to face global complexities. ESG-based talent management not only supports business continuity but is also a crucial instrument for creating long-term value, strengthening global competitiveness, and ensuring a tangible contribution to the sustainable development agenda (Carayannis et al., 2022).

ESG implementation in the energy sector plays a strategic role that goes far beyond mere regulatory compliance. ESG is now seen as a crucial tool for increasing a company's attractiveness to investors, strengthening its reputation, and creating long-term operational efficiency. Global investors are increasingly focusing on sustainability performance as an indicator of business health, so energy companies that consistently implement ESG principles tend to have better and more stable access to funding (Kandpal et al., 2024). A company's reputation is also built through a concrete commitment to environmental, social, and good governance issues, ultimately increasing public trust. Furthermore, the implementation of ESG has been proven to create efficiencies, for example through more efficient energy management, waste reduction, and environmentally friendly process innovations that can reduce operational costs. Thus, ESG is not just an obligation, but a strategic investment that provides competitive advantages for energy companies in facing global market dynamics.

Many companies still view digitalization and ESG as separate issues. Digitalization is seen as an effort to increase efficiency through the use of technology, while ESG is seen as merely a compliance obligation or sustainability program separate from core business strategies. However, Industry 5.0 opens up significant opportunities to integrate both into talent management systems. By leveraging intelligent technologies such as AI, IoT, big data, and automation, companies can develop talent management systems that not only focus on improving technical competency but also consistently embed sustainability values into their HR management practices (Zhou & Liu, 2023).

This integration enables the formation of a more innovative, adaptive, and responsible work culture, so that digital transformation not only drives productivity, but also supports the achievement of long-term sustainability goals (Sulaeman, 2025). Previous studies have indeed highlighted the role of Industry 4.0 in driving the digitalization of Human Resources (HR) functions and examining the contribution of ESG principles to company performance. Studies on automation, efficiency, and digital transformation within the Industry 4.0 framework dominate the literature, as does research emphasizing the importance of ESG in building reputation, investor trust, and corporate sustainability. However, research specifically examining the integration between Industry 5.0, ESG, and talent management, particularly in the national energy sector, remains very limited.

In fact, the context of Industry 5.0, with its human-centric orientation and intelligent technology, offers a significant opportunity to synergize digitalization with sustainability values in talent management systems. This gap in research represents a crucial research gap, allowing studies on the integration of Industry 5.0–ESG–talent management in the energy sector to provide new theoretical and practical contributions to addressing the increasingly complex challenges of global business transformation (Li & Duan, 2025).

The purpose of this study is to analyze the role of Industry 5.0 in driving ESG-based talent management transformation in national energy companies, identify challenges and opportunities in implementing ESG integration into talent management systems in the Industry 5.0 era, and provide strategic recommendations for the development of sustainable and adaptive talent management to technological disruption.

This research gap lies in the lack of studies directly linking Industry 5.0, ESG, and talent management, particularly in the national energy sector. Most previous studies have focused on HR digitalization within the context of Industry 4.0 without incorporating the sustainability dimension through ESG principles, thus failing to provide a comprehensive picture of the integration of the two. Furthermore, contextual studies of energy companies in Indonesia are still limited, despite the sector's unique characteristics, such as the dominance of state-owned enterprises (SOEs), stringent regulations, and the demands of a transition to green energy that require a more integrative and adaptive approach to talent management.

The problem formulation in this study is how Industry 5.0 plays a role in supporting ESG-based talent management transformation in national energy companies, what factors are the challenges and opportunities in integrating Industry 5.0 with ESG policies in talent management, and how ESG-based talent management strategies can improve the sustainability and competitiveness of national energy companies in the Industry 5.0 era.

The novelty of this research lies in offering a new perspective by integrating Industry 5.0, ESG, and talent management within a comprehensive analytical framework. This research specifically focuses on national energy companies, which

have rarely been studied regarding talent management transformation based on smart technology and sustainability. Furthermore, this research provides a practical contribution in the form of a strategic framework for human resource development in the energy sector, ensuring that they are not only adaptive to technological disruption but also oriented towards long-term sustainability in line with the demands of the Industry 5.0 era.

## METHOD

This research method uses a qualitative approach with a case study method selected to gain an in-depth understanding of the transformation of ESG-based talent management in the context of Industry 5.0. The approach used is descriptive-analytical, with the aim of describing the phenomena that occur and analyzing the role of Industry 5.0 technology in talent management practices, while comparing field findings with ESG theory and the human-centric approach (Dewi, 2020). The research was conducted at national energy companies such as PLN, Pertamina, or national private energy companies. The research subjects included HR managers, ESG unit leaders, and employees involved in digital transformation and sustainability programs. Data collection techniques included in-depth interviews with management and employees, participant observation of talent management practices based on Industry 5.0 technology (AI, IoT, automation, and others), and documentation in the form of sustainability reports, HR policies, and ESG-related publications. The research instruments used were semi-structured interview guides, field notes for observations, and a checklist to assess the integration of ESG aspects in talent management policies. Data analysis was conducted using thematic analysis techniques through the stages of data reduction (sorting relevant information related to ESG, HR, and 5.0 technology), data presentation in the form of a theme matrix (such as technological innovation, sustainability, and talent development), and drawing conclusions by linking field findings to Industry 5.0 theory and the ESG framework. To ensure the validity of the data, source triangulation (interviews, observations, and documents), member checking with informants, and peer debriefing with academics or HR practitioners were used.

## RESULTS AND DISCUSSION

### The Role of Industry 5.0 in Talent Management

Industry 5.0 encourages personalization in human resource development by utilizing artificial intelligence (AI) and big data as the main tools to identify employee competency needs more precisely and accurately (T. et al., 2024). Through comprehensive data analysis, companies can map the potential, strengths, and weaknesses of each individual, allowing training and development programs to be tailored to their personal needs and the organization's strategic objectives. This approach not only increases training effectiveness but also boosts employee engagement and motivation, as they feel their career development is truly taken into consideration. Furthermore, technology-based personalization enables energy companies to develop human resources that are adaptive to change, ready to face the challenges of the energy transition, and aligned with ESG principles, ensuring talent development is oriented not only toward short-term productivity but also toward long-term sustainability.

Technology in the context of Industry 5.0 enables the integration of a human-centric approach with ESG aspects, so that talent management practices are no longer only oriented towards short-term productivity, but also towards long-term sustainability (Rehman & Umar, 2025). Through the use of artificial intelligence, big data, and IoT, companies can build HR management systems that are more inclusive,

adaptive, and responsive to individual and organizational needs. This enables every employee to be empowered to their full potential, while also being directed to contribute to achieving sustainability goals, both in environmental, social, and governance aspects. Thus, technology serves not only as a tool to increase efficiency but also as an enabler in creating a balance between innovation, human well-being, and environmental responsibility, ultimately strengthening the competitiveness and legitimacy of energy companies amidst global demands.

**ESG Integration in HR Strategy**

National energy companies have begun adopting ESG principles in their Human Resources (HR) systems through green talent development policies that focus on developing human resources with sustainable competencies (Vinnikova et al., 2024). The implementation of this policy is evident in the provision of renewable energy training, energy efficiency programs, and employee capacity building in aspects of social sustainability. These steps not only aim to improve employees' technical capabilities in facing the transition to clean energy but also instill awareness of the important role of human resources in supporting the company's sustainability agenda. With green talent development, energy companies can ensure that employees are not only adaptive to technological disruption but also able to actively contribute to emission reduction, social responsibility, and good governance. This approach also demonstrates that ESG-based talent management is a crucial instrument in creating a balance between technological innovation, environmental sustainability, and social development.

The implementation of ESG in HR management systems is now starting to be directly linked to recruitment, retention, and career development programs, thus fostering employee awareness of environmental and social issues as part of the organizational culture. In the recruitment process, for example, national energy companies are starting to emphasize sustainability criteria by seeking candidates who are oriented towards green innovation, environmental awareness, and integrity in governance (Bamfo et al., 2019). At the retention stage, ESG is realized in the form of incentives, awards, or facilities that support an environmentally friendly lifestyle and employee social well-being. Meanwhile, in career development, training programs based on renewable energy, energy efficiency, and social engagement are provided to ensure employees develop not only professionally but also have a strong awareness of sustainability. The integration of ESG in these three aspects makes talent management more human-centric, where employees are empowered as agents of change capable of contributing to the company's sustainability while strengthening competitiveness in the Industry 5.0 era.

**Implementation Challenges**

In the transformation process towards Industry 5.0, there is still resistance from some employees towards the use of Artificial Intelligence (AI) and Internet of Things (IoT) based technology (R et al., 2024). This resistance generally arises from concerns that advanced technology will replace human roles, thus creating a sense of insecurity regarding their job positions. Furthermore, limited digital skills among some employees also pose a barrier to adopting new systems based on automation and data. This situation shows that the success of technology implementation depends not only on technical readiness, but also on the readiness of the organization's culture to embrace change. Therefore, a human-centric approach in Industry 5.0 is crucial so that technology is understood as a strategic partner, not a threat.

On the other hand, limited digital infrastructure and high initial investment costs in implementing Industry 5.0 technology are real challenges for national energy

companies (Maria et al., 2024). The implementation of AI, IoT, big data, and robotics requires a robust digital ecosystem, including high-speed internet networks, advanced hardware, and reliable data security systems. Large initial investments often require companies to calculate more carefully, especially as the energy industry faces pressures to transition to green energy. This can slow the pace of transformation if not balanced with strategic policies, incentives, or cross-sector collaboration to support accelerated technology adoption.

Furthermore, the understanding of ESG among HR managers remains diverse, resulting in inconsistent implementation across all company units. Some managers view ESG solely as a regulatory compliance issue, while others view it as a strategic part of talent development and organizational culture. These differing perceptions can lead to misalignment in policy implementation, for example in recruitment, employee development programs, and performance appraisal systems. As a result, efforts to integrate ESG with talent management often fall short of optimal results. To address this, alignment of vision through managerial training, effective internal communication, and clear policy guidelines is needed to ensure that all company elements share a common understanding of the importance of ESG in supporting long-term sustainability (Lin, 2024).

**Strategic Opportunities**

Industry 5.0 opens up opportunities for energy companies to create smart HR systems that not only serve as HR performance monitoring tools but also measure an organization's compliance with ESG principles. This system allows companies to integrate data related to productivity, employee engagement, and sustainability contributions within a single talent management framework (Putri R et al., 2024). With the support of AI-based technology, IoT, and big data, a smart HR system can provide a comprehensive overview of training program effectiveness, environmental and social awareness levels, and the implementation of good governance at both the individual and organizational levels. This approach aligns with the human-centric orientation of Industry 5.0, as it leverages technology to strengthen the role of humans as centers of innovation and agents of change.

Furthermore, leveraging data analytics in HR management enables energy companies to align employee competencies with sustainable energy transition targets. Data-driven analysis can help companies identify skills gaps, design relevant development programs, and ensure every employee has the capacity to support the transformation to green energy (Johnson et al., 2021). For example, training related to renewable energy, energy efficiency, and environmentally friendly technologies can be targeted to specific employee groups strategically involved in the transition process. This ensures that HR development strategies are not merely generic but truly contextualized to the business needs and sustainability challenges facing national energy companies.

The implementation of an ESG-based smart HR system ultimately contributes directly to improving the company's reputation among global investors. Many international investors now consider ESG performance a key indicator in their investment decisions. Energy companies that demonstrate the integration of technology, talent management, and sustainability will gain added value in the form of market trust, broader access to funding, and a more competitive position globally. Therefore, the adoption of Industry 5.0 in HR systems not only supports improved internal performance but also strengthens the company's external legitimacy as an

innovative, responsible, and future-oriented business entity (KINFORMS/KAABA et al., 2024).

**Impact on National Energy Companies**

ESG-based talent management transformation has proven effective in enhancing the competitiveness of energy companies in the transition to cleaner and more sustainable energy sources. By integrating sustainability principles into their HR management strategies, companies not only build employees' technical competency in utilizing new technologies but also instill awareness of the importance of social and environmental responsibility. This makes talent management a strategic instrument that focuses not only on short-term efficiency but also on creating long-term value in line with global demands for green energy and sustainable business practices (Işık et al., 2025).

Furthermore, implementing ESG-based talent management encourages employees to be more adaptive to new technological developments, including AI, IoT, and big data, while also understanding their relevance to the company's sustainability goals. Employees equipped with digital skills and environmental awareness will be better prepared to face technological disruption and actively contribute to supporting the green energy transition. This not only increases productivity but also strengthens the role of HR as a strategic partner in the innovation and organizational transformation process.

ESG integration into HR systems also has a positive impact on increasing employee engagement and loyalty. When employees see that the company is committed to sustainability values and provides space for them to contribute to social and environmental issues, their level of job satisfaction and emotional attachment to the organization increases. Thus, ESG-based talent management not only produces technically competent human resources but also builds a strong bond between employees and the company, ultimately strengthening organizational stability and company competitiveness amidst the dynamics of Industry 5.0 (Fallah et al., 2025).

**CONCLUSION**

In conclusion, Industry 5.0 plays a crucial role in driving talent management transformation through the application of intelligent technology that maintains a human-centric focus. ESG integration within talent management systems is increasingly relevant for national energy companies to support sustainability, enhance competitiveness, and meet global investor expectations. While the implementation of this transformation still faces challenges such as employee resistance to new technologies, limited ESG understanding, and significant investment requirements, strategic opportunities exist through the use of smart HR systems and data analytics to align HR competencies with the goals of a sustainable energy transition. ESG-based talent management transformation in the Industry 5.0 era has also been shown to have positive impacts, such as increased employee loyalty, improved corporate reputation, and increased adaptability in the face of global change. Therefore, this study confirms the novelty of the integration model between Industry 5.0, ESG, and talent management as a strategic foundation for HR development in the national energy sector.

This research is limited by its focus on national energy companies in Indonesia, making the findings less generalizable to other industrial sectors or international energy companies. The approach employed was a qualitative perspective with case studies and in-depth interviews, making the research more exploratory and descriptive than quantitative generalization. The research variables were limited to three main aspects: Industry 5.0, ESG, and talent management, without delving into other external

factors such as government policies, global market conditions, or social dynamics. Furthermore, the research data relied heavily on company documents, sustainability reports, and interviews with specific informants, potentially exposing respondents to bias. The limited timeframe also meant that the results only reflected conditions at the time of the study and may not necessarily represent long-term changes.

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