

THE USEFULNESS OF ARTIFICIAL INTELLIGENCE IN ENERGY PROJECT MANAGEMENT

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ABSTRACT

This article examines the integration of Artificial Intelligence (AI) and Machine Learning (ML) into Project Management (PM) practices within the energy sector, highlighting how data-driven technologies enhance planning accuracy, risk assessment, and operational efficiency. The study combines a theoretical approach with a bibliometric analysis based on the Scopus and Web of Science-Core Collection databases for the period 2019-2025 to identify emerging research trends and leading contributors. After three successive filtering stages, 35 relevant articles were retained for our analysis. Methodological steps included data cleaning, network analysis using VOSviewer tool to map co-authorships, keywords, and interpretive synthesis of main themes. Results show a significant rise in AI applications after 2019, especially in predictive analytics, hybrid algorithm development, and predictive maintenance, indicating a transition from reactive to proactive project management in energy projects. Today, AI is currently applied in energy project management mainly for analytics, forecasting, optimization, and decision support, with strongest adoption in smart grids and energy storage. Limitations of this article include a lack of empirical validation, restricted access to industrial data due to confidentiality, and exclusive reliance on Scopus and Web of Science-Core Collection-indexed studies. However, the bibliometric evidence remains statistically solid. The study also brings into light several strengths and weaknesses in the current use of AI in energy project management, as well as the substantial electricity consumption associated with AI-focused data centres. The study concludes with several recommendations derived from its findings.

KEYWORDS: Artificial Intelligence (AI), bibliometric analysis, data centres, energy, Project Management (PM)

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1. INTRODUCTION

1.1 Background and problem statement

Artificial intelligence (AI) has greatly changed how projects are designed, managed, and completed. In the energy sector, before the pandemic, AI was mainly used for data analysis and monitoring; during the pandemic, it became essential for remote project coordination and risk management; and after the pandemic, its adoption expanded rapidly, focusing on automation and efficiency improvement. Project management (PM) remains vital in all industries because it provides structure and direction for achieving results. Recently, the growing use of AI has attracted attention for its ability to automate repetitive tasks, optimize resources, and improve risk assessment. Technologies

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like Artificial Neural Networks (ANN), Fuzzy Logic (FL), and Genetic Algorithms support complex decision-making and enhance planning.

However, challenges persist - limited training, poor data quality, high costs, and resistance to change slow adoption. Machine Learning (ML), a core part of AI, enables predictive insights that help forecast timelines, budgets, and risks. Although progress is evident, more research is needed to improve data reliability and algorithm selection, especially in construction and energy project management.

1.2 Research objectives

In the energy sector, there are several important pillars - production, transportation, storage and distribution.

The primary objectives of the present paper are:

- Is AI currently being used in energy project management (EPM)?
- To what extent does AI find its place in project management (PM), on these 4 pillars?
- To what extent does literature address the correlation between project management (PM) in the energy sector and the assistance provided by AI?

AI in energy project management (EPM). Nowadays, AI is being applied to energy project management, mainly as analytics, forecasting, optimization, and decision-support in grid and renewable projects. Adoption is strongest in distribution or smart-grid and storage engineering; explicit AI use for PM tasks in transportation is limited or undocumented.

AI finds its place in project management (PM), on these 4 pillars: production, transportation, storage and distribution. Artificial Intelligence clearly plays an important role in many sectors around the world, and its growing use is reshaping fields like healthcare, finance, education, and transportation.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Evidence of current use

AI applications that directly support energy project management appear in peer-reviewed studies and sector reports describing deployments, simulations, and review syntheses. These sources document measurable project-management benefits (simulation gains, O&M improvements) and multiple field examples (utilities, renewables) where AI augments planning, monitoring, and risk control:

- Power-grid digital transformation: Evidence from a simulation study of two enterprise models reported that an AI-based digital-transformation management mode produced a 3.02% higher informatization project-management level index and a 3.14% higher Operations and Maintenance (O and M) and service-management index versus a baseline model (Jariwala, M., 2024).
- Utility practice and interviews: Case material from a Dubai utility (DEWA) reports deployment of AI, IoT and analytics across smart-grid, digital-metering and customer projects and links AI use to improved project efficiency and lower project risk in power-sector programs (Li & Zhang, 2023).
- Renewables and PM tasks: Reviews of renewable-integration project management list AI/ML uses for forecasting, predictive maintenance and optimization of asset selection and planning in renewable projects (Adegboyega et al., 2024; Okereke et al., 2024).
- Safety and risk models: A recent paper proposing an AI-driven model documents use cases for safety, efficiency and risk mitigation across energy project phases (scheduling, risk assessment, monitoring) although it focuses on model design rather than large empirical deployments (El Khatib, 2024).

- Smart-grid analytics: Systematic reviews synthesizing AI and analytics for smart grids document a range of ML and analytic methods used for monitoring, fault detection and operational decision support that are directly relevant to distribution project management (Zülfikaroğlu, 2024; Ajiboye, 2024).

AI is increasingly driving digital transformation across both energy and project management sectors. In renewable energy, AI supports smarter systems and sustainable infrastructure, covering production, distribution, and ESG goals, while improving performance in power grid management (Li & Zhang, 2023; Elhamahmy et al., 2025).

Specifically, Elhamahmy et al. (2025) highlight AI’s role in boosting sustainable project management in renewable energy infrastructure, emphasizing the production and distribution pillars alongside ESG objectives. Similarly, AI is used in DEWA’s distribution projects to enhance project efficiency and advance green energy objectives, as illustrated by interviews and case studies (El Khatib, 2024).

However, these advancements bring new challenges, including rising computational demands, which require careful policy design, equitable access, robust cybersecurity, and cross-sector collaboration to ensure technological progress benefits both society and the environment (Kyriakarakos, 2025).

Looking ahead, the project management profession is also undergoing transformation. PM2030 envisions a future where AI deeply shapes task management, decision-making, and automation, and despite ongoing debates on responsible and ethical AI, structured approaches such as the AI Augmented Ethics-Centric Model and the Predictive Model for AI Adoption and Human Trust provide guidance for transitioning the profession toward this AI-driven era (Hughes et al., 2025).

Table 1. Pillar comparison: Summary of AI technologies, project-management applications, maturity/adoption and representative literature by energy pillar

Pillar	AI technologies and methods	Project management (PM) applications	Maturity and adoption	Representative findings
1Production	ML, forecasting models, optimization, expert systems	Demand/producti on forecasting, site selection analytics, predictive maintenance, scheduling for renewables	Emerging in pilot and analytic stages for renewables; moderate adoption in planning/asset O&M	Reviews report ML for forecasting and predictive maintenance in renewable projects and planning tools for integration (Adegboyega et al., 2024; Okereke et al., 2024).
2Transportation	-	-	Insufficient documented adoption specific to project management	Insufficient evidence of peer-reviewed AI use for PM of pipelines/line construction or logistics; no solid empirical PM studies found in supplied corpus

Pillar	AI technologies and methods	Project management (PM) applications	Maturity and adoption	Representative findings
3Storage	Supervised learning, LSTM, reinforcement learning, multi-objective optimisation	State-of-charge estimation, predictive maintenance, operational optimisation; potential for planning/asset sizing in projects	Technical maturity high for control/estimation; linkage to PM (cost/schedule decision support) less mature	Reviews report RL and LSTM delivering SOC MAE~0.10 and RL frameworks reducing disruptions and operational costs in simulations (Khosrojerdi et. al., 2022).
4Distribution	ML, analytics, fuzzy systems, metaheuristics, IoT/edge AI	Grid planning, fault detection, O&M scheduling, risk monitoring, digital-transformation project KPIs	Relatively mature for operations and pilot project-scale deployment; stronger PM evidence (simulation + utility cases)	Simulation and enterprise DT studies show AI modes improve PM indices and O&M metrics; smart-grid SLRs list many analytic PM-relevant methods (Ajiboye, 2024; Jariwala, 2024; Zülfikaroğlu, 2024).

Source: Adegboyega et al., 2024; Ajiboye, 2024; Jariwala, 2024; Khosrojerdi et. al., 2022; Okereke et al., 2024; Zülfikaroğlu, 2024

3. HYPOTHESES DEVELOPMENT

A systematic literature review (SLR) was conducted in order to analyze published scientific articles whose main directions reveal the interest of the authors according to the combinations below:

- H1: Project Management (PM) + AI
- H2: Project Management (PM) + AI + E(nergy)
- H3: Project Management (PM) + E(nergy).

4. RESEARCH METHODOLOGY

4.1 Study design and data collection. Bibliometric analysis steps and findings

This study used Scopus and Web of Science-Core Collection database and VOSviewer tool for bibliometric mapping and trend analysis by employing a qualitative research approach using a systematic literature review methodology, combining content analysis and thematic synthesis in order to extract key patterns from the existing literature.

VOSviewer tool was also used to map co-authorships, keywords, and citation clusters (16).

Peer-reviewed journals, including policy reports from international organizations (EU, UN etc.) were used.

We focused on publications from 2019 to 2025 to ensure relevance to recent advancements.

Data cleaning process consisted in the removal of duplicates and non-relevant studies (from 6924 cited papers and open access articles, initially found, only 1,340 were selected, but, in the end, just 35 remained).

After refining by keywords like “energy,” “energetic field,” “artificial intelligence algorithms,” and related terms, a number of English-language papers were retained and, after another refining, 35 articles remained to be analyzed considering that only these met the criteria to treat the proposed topic.

We identified the leading countries in the field (Figure 1), the research trends, and collaborative networks (Figure 2).

We applied coding techniques to categorize data into key themes and sub-themes, we used SWOT analysis (showing strengths, weaknesses, opportunities, and threats) to underline the differences between traditional project management (PM) and AI-driven PM.

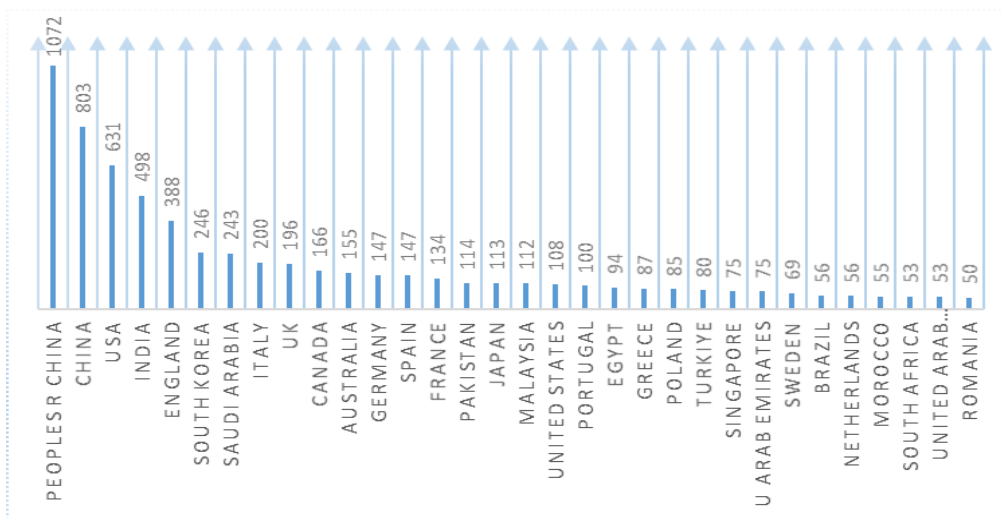


Figure 1. Distribution of articles by country

Source: Authors’ contribution using VOSviewer tool data

As can be seen from Figure 1, the countries most concerned about AI in project management (PM) are China, the USA India, UK, South Korea, Saudi Arabia etc., Romania being in 32nd place.

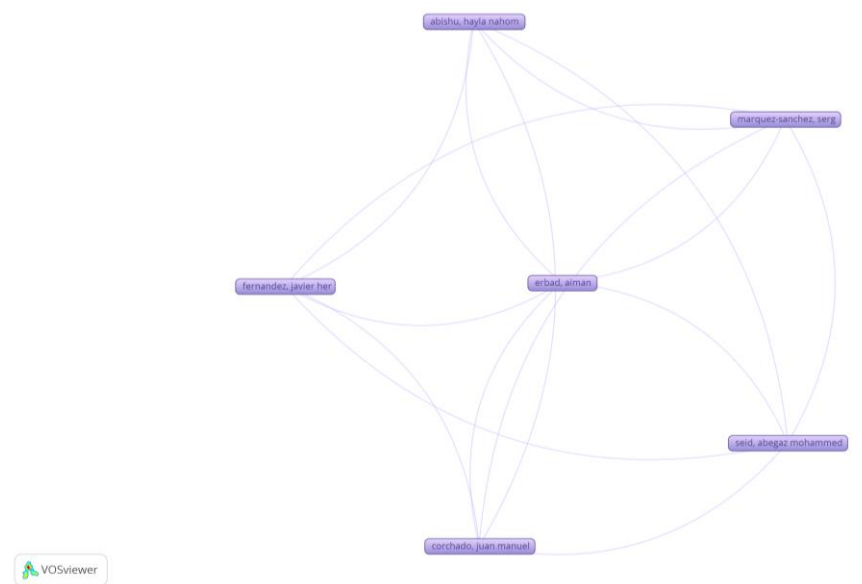


Figure 2. Network visualization. Co-authorship

Source: Authors’ contribution in VOSviewer

Mapping co-authorship in VOSviewer (Figure 2), we observed authors who collaborate more often with each other when writing scientific articles in English: Abishu and Hayla Nahom, Fernandez and Javier Her, Corchado and Juan Manuel, Erbad and Aiman, Marquez-Sanchez and Serg, Seid and Abegaz Mohammed.

In VOSviewer, choosing a binary counting analysis, considering 2 as the minimum number of occurrences of a term, from all the 2572 terms, 333 meet the threshold (Figure 3):

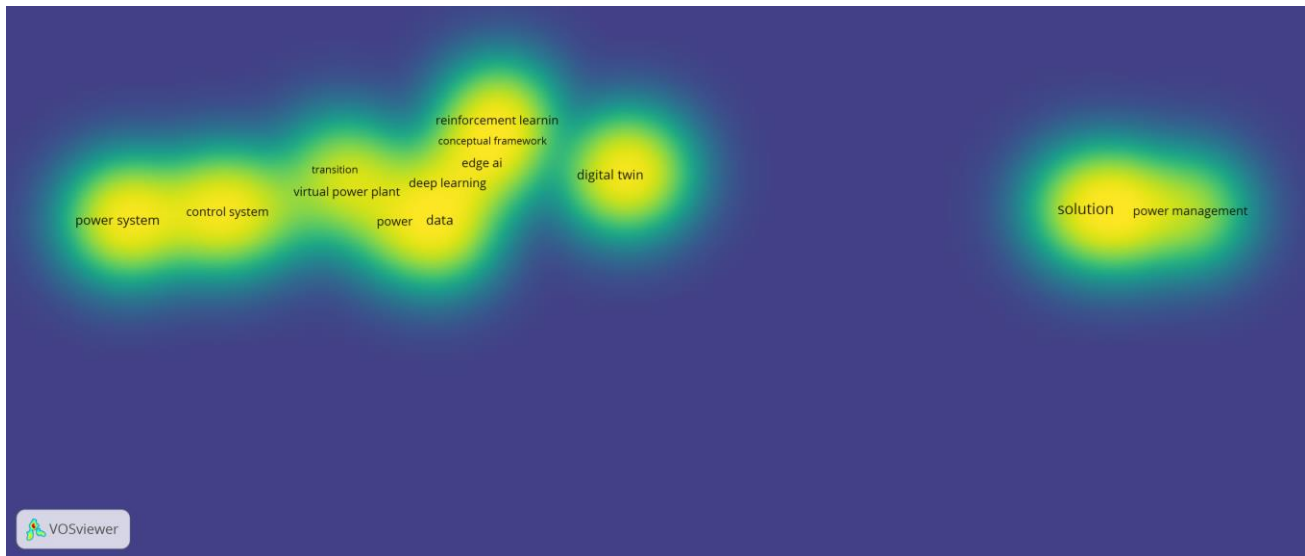


Figure 3. Main key words density visualization

Source: Authors' contribution in VOSviewer

Thus, 16 clusters were formed as follows: cluster1 (13 items: „artificial intelligence“, „PM“, „energy“, „transport management“), cluster 2 (13 items: „deep learning“, „digital twins“, „edge AI“, storage), cluster 3 (11 items: „AI enhanced renewable energy“, „circular economy“, „mart grid era“), cluster 4 (9 items: „advanced energy management“, „distributed energy management“, „micro grid“), cluster 5 (7 items: „control system“, „energy supply“, „residential energy management“), cluster 6 (7 items: „5G base station“, „artificial intelligence apply“, „AI technology“), cluster 7 (7 items: „digital“, „AI“, „digital twin“, „OT networks“), cluster 8 (6 items: „home energy management“, „project management“), cluster 9 (6 items: „AI techniques“, „energy management“, „hybrid electric vehicle“, „modelling“), cluster 10 (6 items: „dvanced data“, „energy sector“, „Europe policy“, „energy project management“, „AI“), cluster 11 (5 items: „AI software developpment“, „software development“, „algorithms“), cluster 12 (5 items: „transition“, „project management“, „artificial intelligence“), cluster 13 (5 items: „machine intelligence“, „ML“, „power management“), cluster 14 (4 items: „battery energy storage system“, „grid integration“, „AI“), cluster 15 (3 items: „artificial intelligence“, „power electronics dominance“), cluster 16 (3 items: „virtual power player“, „AI“, „PM“).

5. COUNTRIES LEADING AI ADOPTION IN ENERGY PROJECT MANAGEMENT

5.1 Data centre market in Europe. AI and energy consumption



Figure 4. European data centre market

Source: European Data Centre Association, European Data Centre Overview
(adapted by Stephanie Pradier, October 2024)

In Figure 4, countries with a red bullet belong to tier 1 markets (FLAP-D refers to a group of major European data-center markets: Frankfurt, London, Amsterdam, Paris, and Dublin.), those in blue to tier 2 markets (emerging countries), and those in dark blue to tier 3 markets (to whom AI is of interest).

AI can support a smarter energy system through grid optimization, better integration of renewables, and higher efficiency. Yet, as the EU aims to strengthen its position in the global AI race, the rising power needs of data centres already accounting for around 3 % of Europe’s electricity use and growing rapidly in places like Ireland pose new challenges. Although currently small at the global scale, this demand is increasing fast as AI technologies expand across Europe’s economy.

According to Figure 4, China, the United States, South Korea, Australia, and Germany are leading in AI-driven project management research and implementation.

Developing economies like Nigeria and Brazil are rapidly integrating AI tools for infrastructure and energy management. This reflects a global shift toward data-centric and automated project ecosystems.

Although the energy use of artificial intelligence varies by query (ChatGPT text, video or audio type), increasingly AI-driven services, such as search summaries, are significantly raising electricity consumption. This surge is linked to the rapid growth of data centres, which now use about 415 TWh globally, representing roughly 1.5% of worldwide electricity demand in 2024. The United States, China, and Europe together account for nearly 85% of this consumption, with data centres representing around 4% of total electricity use in the US, 2% in Europe (3% in the EU), and about 1% in China. Due to expanding digitalization and accelerating AI deployment, energy consumption continue to rise and place growing pressure on energy systems.

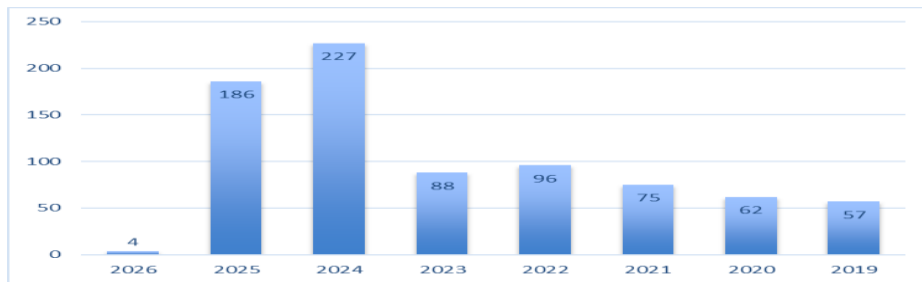


Figure 5. Annual distribution of articles throughout the period 2019–2026

Source: Authors’ contribution using VOSviewer with data from Scopus and Web of Science-Core Collection databases

We note from Figure 5 that in 2024-2025, the most articles were written that increasingly talk about AI in project management (PM) in various fields.

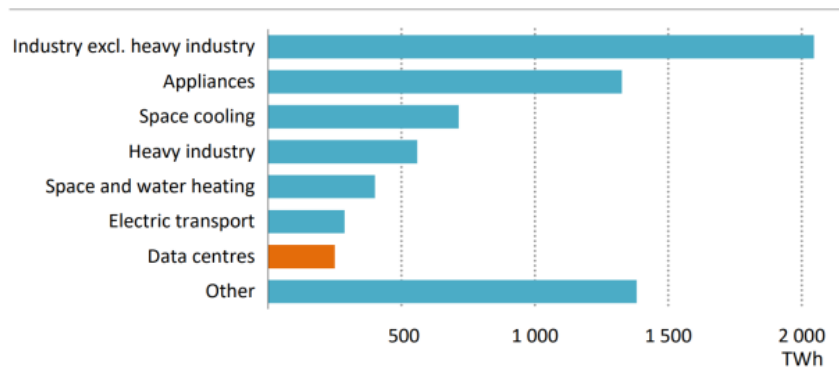


Figure 6. Projected increase in global electricity demand by sector, 2024-2030

Source: European Parliament

6. LIMITATIONS AND RECOMMENDATIONS OF THE STUDY

Table 2. Traditional vs. AI-Driven Project Management

Aspect	Traditional PM	AI-driven PM
Decision-Making	Based on human expertise	Predictive and data-driven
Data Processing	Manual and retrospective	Automated and real-time
Risk Assessment	Experience-based	Quantitative and predictive
Planning and Scheduling	Fixed, static plans	Adaptive and optimized dynamically
Monitoring in energy sector management	Periodic updates	Continuous IoT-based feedback
	Manual forecasting	AI-based predictive maintenance and load
	Manual and retrospective	Automated and real-time

Sources: Liu, (2024); Planview (n.d.); Hughes et al. (2025); Salimimoghadam et al. (2025); Dartai (n.d.); Shadi et al. (2025); Intellias (2024)

In Table 2 you can clearly see the differences between traditional PM and AI-driven PM. Several studies present valuable insights into AI use in energy and project management but share notable limitations. Some articles lack detailed AI methods, challenge discussion, or comparative experiments (Jariwala, 2024), while others provide no real-world challenges or focus on environmental, social, and governance (ESG) aspects (Li & Zhang, 2023). In addition, certain

research lacks concrete AI methods, case studies, or benchmark analyses (Adegboyega et al., 2024), or offers only limited detail on specific algorithms, practical implementations, or ESG impacts (Okereke et al., 2024). Further, some studies do not include detailed PM processes, challenges, or benchmarking components (El Khatib, 2024), nor do they present thorough scheduling frameworks or benchmark comparisons (Zülfikaroğlu, 2024). Other works partially address sustainability pillars but still lack detailed exposition of AI techniques (Ajiboye, 2024), and some fall short in providing project management case studies or in-depth methodological comparison (Khosrojerdi et al., 2022). Finally, research exploring sustainable project management in renewable energy acknowledges strong coverage of production and distribution pillars but still lacks concrete AI methods, case analyses, or comparative evaluation (Elhamahmy et al., 2025).

Table 3. SWOT Analysis: AI in PM (energy and other fields)

Strengths	Weaknesses
Automation of repetitive tasks	Dependence on high-quality data
Improved forecasting accuracy	High implementation costs
Enhanced risk management	Lack of AI expertise
Opportunities	Threats
Renewable energy optimization	Data privacy and security issues
Smart infrastructure development	Resistance to digital transformation
Global collaboration and hybrid AI systems	Regulatory uncertainty

Sources: Widuto (2025); Salimimoghadam et al. (2025); Pereira et al. (2025); PMI (n.d.); Nenni et al. (2024)

6.1 Limitations of the study

Some studies lack empirical validation or industrial case data. Confidentiality restrictions prevent access to real-world project databases.

Despite these limitations, the bibliometric evidence remains robust and statistically representative.

6.2 Recommendations

It is essential for the future to implement comprehensive training programs that equip project managers with the skills to effectively understand, interpret, and act on AI-generated insights. Equally important is fostering intergovernmental collaboration to promote data sharing, standardization, and coordinated policies across borders. To ensure responsible AI adoption, ethical and regulatory frameworks must be integrated to maintain transparency, accountability, and public trust in AI systems. Furthermore, supporting strong public–private partnerships will be critical to scaling AI deployment across the energy sector, enabling innovation while balancing sustainability, security, and social objectives. By combining education, policy, ethics, and collaboration, the energy sector can fully leverage AI’s potential while mitigating its risks.

7. CONCLUSIONS

The future project manager will be a data-driven leader, capable of understanding predictive models and working alongside AI systems. Essential skills will include data analytics, AI ethics, and strategic decision-making in digital environments. Hybrid AI systems represent the future of automated project management, particularly in the energy sector, providing measurable advantages in cost efficiency, risk management, and sustainability. However, successful adoption depends on human expertise, continuous training, high-quality data, and cooperation across countries and industries.

As AI systems become increasingly popular in the energy sector, they contribute to rising electricity consumption. According to the International Energy Agency, data centres currently account for only 1.5% of global electricity, but their demand is expected to more than double by 2030. In Europe, data centres already consume about 2–3% of electricity, and this share continues to grow with increasing AI workloads. To support AI in energy, more data centres will be needed, but this brings challenges including energy use, data protection, bias, data errors, and cybersecurity risks.

At the same time, AI can help reduce energy consumption through intelligent cooling, workload distribution, and integration with renewable energy. According to the European Commission, AI has the potential to transform Europe’s energy infrastructure while optimizing efficiency and sustainability.

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