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Leveraging Finance Models and AI to Achieve Net-Zero Emissions: Implications for Oil and Gas SMEs in the Energy Sector

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ABSTRACT: The transition to net-zero emissions is a critical goal for the global energy sector, with the oil and gas industry playing a pivotal role in achieving this target. This paper explores the implications of leveraging artificial intelligence (AI) and innovative financial models to support small and medium-sized enterprises (SMEs) in the oil and gas sector in their efforts to reduce carbon emissions. The study highlights the potential of AI technologies, such as predictive maintenance, emission monitoring, and energy management systems, to optimize operations, improve energy efficiency, and reduce the carbon footprint of oil and gas SMEs. In parallel, various financial mechanisms, including green bonds, sustainability-linked loans, and carbon trading, are examined as tools that can provide the necessary capital and incentives for decarbonization efforts. The paper discusses the challenges SMEs face in accessing these technologies and financial solutions, proposing strategies to overcome barriers such as high initial costs, lack of technical expertise, and limited access to financing. Additionally, the role of policymakers and financial institutions is emphasized in creating favorable conditions for SMEs to access AI technologies and sustainable finance. By combining AI-driven technologies with innovative financial instruments, oil and gas SMEs can make significant strides toward achieving net-zero emissions while enhancing operational efficiency and maintaining competitiveness. The study concludes by offering recommendations for future research in areas such as the long-term impact of AI on sustainability and the development of new financial instruments tailored to the unique needs of SMEs in the energy sector.

KEYWORDS: Net-Zero Emissions, Artificial Intelligence, Financial Models, Oil and Gas SMEs, Decarbonization, Sustainabilitylinked Loans

1. INTRODUCTION

1.1 Background on Net-Zero Emissions and the Oil and Gas Sector

The global shift towards achieving net-zero emissions has become a defining challenge of the 21st century. Governments, industries, and organizations worldwide are setting ambitious targets to reduce greenhouse gas emissions, with the aim of limiting global warming to 1.5°C, in line with the Paris Agreement. Within this context, the oil and gas sector, a significant contributor to global carbon emissions, faces increasing pressure to transition towards sustainable practices (Basiru, Ejiofor, Onukwulu, & Attah, 2022; Hassan, Collins, Babatunde, Alabi, & Mustapha, 2021). For small and medium-sized enterprises (SMEs) in the oil and gas industry, this transition is particularly challenging due to limited resources, access to technology, and financial support. SMEs in this sector, while crucial for global energy supply, often lack the capacity to invest in large-scale emissions-reducing technologies, which makes their role in the net-zero transition more complex (Paul, Abbey, Onukwulu, Agho, & Louis, 2021).

The oil and gas sector is intrinsically linked to high carbon emissions, as the extraction, refining, and distribution of fossil fuels are energy-intensive processes. Consequently, these SMEs must adopt innovative approaches, both in terms of technology and financing, to effectively reduce their carbon footprint. The adoption of new energy-efficient technologies and renewable energy solutions presents a substantial opportunity for these companies to reduce emissions, improve energy efficiency, and contribute to environmental sustainability (Basiru et al., 2022; Mustapha & Ibitoye, 2022). Furthermore, the oil and gas SMEs need to embrace new financial models that can support investments in clean technologies while still ensuring economic viability. Artificial intelligence (AI) and other emerging technologies offer significant potential in this regard, enabling companies

to monitor, optimize, and reduce their environmental impact more efficiently (Onukwulu, Fiemotongha, Igwe, & Ewim, 2022).

The urgency of meeting net-zero targets is compounded by increasingly stringent environmental regulations and rising consumer expectations for sustainability. For SMEs in the oil and gas sector, leveraging financial solutions and AI technologies will be pivotal in navigating these challenges. As the sector moves towards cleaner energy solutions, the integration of AI in managing operational efficiency and reducing emissions will be crucial in enabling these businesses to meet their sustainability goals (Abbey, Olaleye, Mokogwu, & Queen, 2023b; Otokiti, Igwe, Ewim, Ibeh, & Sikhakhane-Nwokediegwu, 2022).

1.2 Objective of the Study

The primary objective of this study is to explore how financial models and AI-driven technologies can be leveraged by oil and gas SMEs to achieve net-zero emissions. In this paper, the focus will be on identifying practical and scalable financial solutions that can help SMEs transition to more sustainable practices, particularly in the context of decarbonizing operations and reducing environmental impact. The research will delve into the feasibility of various financial mechanisms such as green bonds, sustainabilitylinked loans, and carbon trading systems that can provide SMEs with the capital needed to invest in clean energy technologies.

In addition to financial models, the role of AI technologies in monitoring and optimizing energy consumption will be critically examined. AI tools have the potential to streamline operations, predict emissions, and identify opportunities for energy efficiency improvements. By integrating AI into their operations, SMEs can not only lower costs but also enhance their ability to meet emissions reduction targets. This paper will assess the integration of AI in the oil and gas industry, focusing on how these technologies can be applied to enhance sustainability efforts and help SMEs in the sector transition to net-zero emissions.

The paper will also examine the barriers that SMEs face in adopting these financial and technological solutions. It will explore challenges related to access to finance, regulatory complexities, and the technological expertise required to implement AI systems effectively. Ultimately, the study aims to provide actionable insights for SMEs, policymakers, and financial institutions to enable a more sustainable and economically viable transition to net-zero emissions in the oil and gas sector.

1.3 Significance of the Study

The significance of this study lies in its timely exploration of the dual challenges of achieving net-zero emissions and ensuring the competitiveness of oil and gas SMEs. The global energy demand is increasing, and the pressure to reduce carbon emissions is simultaneously growing (Afolabi, Chukwurah, & Abieba, 2025). This dynamic creates a unique set of challenges for SMEs in the oil and gas sector, who often struggle to find the financial resources and technological capabilities to meet these demands. As governments and international organizations ramp up their efforts to combat climate change, SMEs in the oil and gas industry will be subject to stricter environmental regulations. They will also face increasing consumer and investor pressure to demonstrate their commitment to sustainability (Ajayi, Alozie, & Abieba, 2025a, 2025b).

Understanding how financial solutions and AI technologies can be leveraged by oil and gas SMEs is critical for shaping future policy and industry strategies. This study provides insights into how SMEs can access the necessary funding and tools to reduce their carbon footprint, enhance operational efficiency, and comply with increasingly stringent environmental regulations. The findings of this research can have significant implications for policymakers, financial institutions, and energy companies, offering a roadmap for how SMEs can transition towards more sustainable and profitable business models (Ayanbode, Abieba, Chukwurah, Ajayi, & Ifesinachi, 2024; Chukwurah, Abieba, Ayanbode, Ajayi, & Ifesinachi, 2024).

Additionally, this study contributes to the broader energy transition by highlighting the critical role that small and medium enterprises play in achieving global decarbonization goals. While large corporations often dominate the narrative on sustainability, SMEs represent a significant portion of the energy sector and must not be overlooked. The findings could influence energy policy by advocating for financial support structures and regulatory frameworks that foster a more inclusive transition to net-zero emissions. By focusing on the practical integration of finance models and AI technologies, the study aims to provide a blueprint for SMEs in the oil and gas sector to navigate the challenges and opportunities of achieving net-zero emissions, ensuring a sustainable future for the energy sector.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Theories of Sustainability and Decarbonization

Sustainability theories are crucial in understanding how businesses, including SMEs in the oil and gas sector, can transition to more environmentally responsible practices. One such widely adopted framework is the Triple Bottom Line (TBL) theory, which emphasizes the importance of three dimensions: social, environmental, and economic sustainability (Anyanwu, Dawodu, Omotosho, Akindote, & Ewuga, 2023; O Awoyemi, Attah, Basiru, & Leghemo, 2023). The TBL framework highlights that businesses must balance profit generation with the well-being of society and the environment. For SMEs in the oil and gas industry, adopting this holistic approach is especially important given the sector's significant impact on the environment and its

reliance on fossil fuels. The TBL encourages SMEs to take a broader view of sustainability, ensuring that economic viability does not come at the cost of environmental degradation or social harm (Abbey, Olaleye, Mokogwu, & Queen, 2023a; Adefila, Ajayi, Toromade, & Sam-Bulya, 2023).

Decarbonization refers to the reduction of carbon emissions through various strategies and technologies, aiming to minimize or eliminate carbon footprints. This process is crucial in the context of achieving net-zero emissions, a global target for addressing climate change (J. O. Basiru, C. L. Ejiofor, E. C. Onukwulu, & R. U. Attah, 2023c). Decarbonization strategies typically involve transitioning from fossil fuel dependence to cleaner energy sources, adopting more energy-efficient technologies, and implementing carbon capture or offset initiatives. For oil and gas SMEs, decarbonization is a challenging yet necessary process to meet increasingly stringent regulations and align with global sustainability efforts (Olanrewaju Awoyemi, Attah, Basiru, Leghemo, & Onwuzulike, 2023; J. O. Basiru, C. L. Ejiofor, E. C. Onukwulu, & R. Attah, 2023).

The integration of finance models and AI technologies plays a pivotal role in supporting the decarbonization of oil and gas SMEs. Financial models such as green bonds and sustainability-linked loans provide the necessary capital for SMEs to invest in low-carbon technologies, while AI helps optimize operations and predict energy consumption patterns. These tools enable oil and gas SMEs to transition towards net-zero emissions while remaining competitive in a rapidly evolving energy landscape. The dual application of financial mechanisms and AI technologies fosters both economic sustainability and environmental responsibility, which is crucial for achieving long-term decarbonization goals (J. O. Basiru, C. L. Ejiofor, E. C. Onukwulu, & R. U. Attah, 2023a; J. O. Basiru, L. Ejiofor, C. Onukwulu, & R. U. Attah, 2023).

2.2 Role of AI and Financial Models in Achieving Net-Zero

Artificial intelligence (AI) offers immense potential in supporting the decarbonization process for oil and gas SMEs by improving operational efficiency, predicting emissions, and optimizing energy usage. AI technologies, such as machine learning and predictive analytics, can analyze vast amounts of data collected from operations to identify inefficiencies, energy waste, and opportunities for optimization (Fiemotongha, Igwe, Ewim, & Onukwulu, 2023b). These technologies can forecast emissions based on current processes, helping SMEs plan for future emissions reductions and better meet sustainability targets. AI-driven solutions like smart grids and automated energy management systems enable SMEs to monitor and adjust energy consumption in real time, ensuring that energy use is always optimized and carbon footprints are minimized (J. O. Basiru, C. L. Ejiofor, E. C. Onukwulu, & R. U. Attah, 2023b; Fiemotongha, Igwe, Ewim, & Onukwulu, 2023a).

Additionally, AI can assist in predictive maintenance, identifying equipment or machinery that may cause inefficiencies or lead to emissions spikes. By detecting issues before they occur, SMEs can avoid unnecessary downtime, reduce energy waste, and extend the lifespan of their assets. AI also supports real-time monitoring and analysis of emissions, making it easier for SMEs to track their progress toward net-zero targets, comply with regulations, and improve overall sustainability efforts (Hassan, Collins, Babatunde, Alabi, & Mustapha, 2023; E. K. Jessa, 2023).

In parallel, financial models have a crucial role in incentivizing oil and gas SMEs to invest in technologies that support decarbonization. Green bonds, which are used to raise capital specifically for environmentally sustainable projects, allow SMEs to secure funding at favorable terms for investments in clean energy technologies or emissions reduction initiatives (Onukwulu, Fiemotongha, Igwe, & Ewim, 2023). Similarly, sustainability-linked loans offer financial institutions the ability to tie loan terms to the borrower's environmental performance. These financial tools create a direct incentive for SMEs to reduce emissions, as loan terms improve as sustainability efforts progress. Additionally, carbon credit systems enable SMEs to generate revenue by reducing their emissions beyond regulatory requirements, thereby providing another financial incentive to invest in decarbonization (Myllynen, Kamau, Mustapha, Babatunde, & Adeleye, 2023; Ogundeji, Omowole, Adaga, & Sam-Bulya, 2023).

Together, AI technologies and financial models offer SMEs in the oil and gas sector a powerful toolkit for achieving netzero emissions while maintaining financial health and operational efficiency. These combined approaches foster innovation, reduce environmental impact, and support the broader goal of a sustainable energy future (Abbey, Olaleye, Mokogwu, Olufemi-Phillips, & Adewale, 2024).

2.3 AI in Oil and Gas SMEs: A Conceptual Overview

Artificial intelligence (AI) plays a transformative role in optimizing operations and enhancing sustainability efforts for oil and gas SMEs. AI technologies provide SMEs with the capability to monitor, predict, and optimize processes, resulting in more efficient operations that reduce both costs and environmental impact. One of the most significant ways AI can benefit SMEs is through predictive maintenance (Adebayo, Chukwurah, & Ajayi, 2024). AI algorithms can analyze equipment data in real-time, identifying potential failures before they happen. This proactive approach not only minimizes the risk of costly breakdowns but also reduces the environmental impact associated with inefficient or faulty equipment. By ensuring that machinery operates optimally, SMEs can reduce emissions caused by unnecessary energy consumption, thus contributing to their decarbonization goals (Adebayo, Ajayi, & Chukwurah, 2024; Adefila, Ajayi, Toromade, & Sam-Bulya, 2024c).

Another key application of AI in the oil and gas sector is process optimization. AI-powered systems can analyze operational data to identify inefficiencies in energy usage and suggest adjustments to improve performance (Alozie, Collins, Abieba, Akerele, & Ajayi, 2024). For SMEs, this means enhanced energy efficiency, fewer emissions, and lower operational costs. AI also enables better integration of renewable energy sources into existing operations by optimizing how renewable energy can be utilized based on demand and supply, ensuring SMEs can reduce their reliance on fossil fuels (Apeh, Odionu, Bristol-Alagbariya, Okon, & Austin-Gabriel, 2024a).

Furthermore, AI-enabled energy management systems are becoming an essential tool in tracking and managing energy consumption and emissions across operations. These systems collect data from multiple sources, including sensors on equipment and energy usage logs, and use AI algorithms to optimize energy consumption in real-time (Apeh, Odionu, Bristol-Alagbariya, Okon, & Austin-Gabriel, 2024b). This proactive approach allows SMEs to make data-driven decisions to reduce waste, improve efficiency, and lower their carbon footprint. In the context of net-zero emissions, AI tools that focus on energy efficiency and emissions reduction are invaluable in helping SMEs in the oil and gas industry meet regulatory requirements while achieving long-term sustainability goals (Adefila, Ajayi, Toromade, & Sam-Bulya, 2024a, 2024b).

3. LEVERAGING FINANCIAL MODELS FOR NET-ZERO TRANSITIONS

3.1 Financial Mechanisms Supporting Emissions Reduction

Achieving net-zero emissions requires substantial financial investment, particularly in the oil and gas sector, where decarbonization can be capital-intensive. Green finance instruments are essential tools for supporting emissions reduction. These include green bonds, which are specifically issued to raise funds for environmentally sustainable projects, and sustainability-linked loans, where the terms of the loan are tied to the borrower's progress in meeting pre-defined environmental, social, and governance (ESG) targets (Chukwurah, Abieba, et al., 2024). These financial products enable SMEs in the oil and gas sector to access capital for investments in clean energy technologies, emission reduction initiatives, and energy-efficient operations. Green bonds can be particularly effective in funding large-scale projects like renewable energy infrastructure or the retrofitting of existing operations to be more energy-efficient, while sustainabilitylinked loans provide incentives for SMEs to improve their environmental performance (Apeh, Odionu, Bristol-Alagbariya, Okon, & Austin-Gabriel, 2024c; Ayanbode et al., 2024).

Another financial mechanism that supports decarbonization is carbon trading. In a carbon trading system, oil and gas SMEs can purchase and trade carbon credits to offset emissions beyond regulatory requirements. This creates a financial incentive for companies to reduce their emissions, as they can profit from excess credits or save on costs by minimizing their carbon footprint. Venture capital and private equity play a critical role in supporting SMEs engaged in the development and adoption of innovative clean energy technologies (Dada, Eyeregba, Mokogwu, & Olorunyomi, 2024). These investors seek high-growth opportunities in green technologies, providing necessary capital for research and development (R&D) in sustainable energy solutions. In addition, blended finance models, which combine public and private funds, offer a way to mitigate the high risks associated with decarbonization projects by de-risking investments for private sector participants. These financial instruments can help oil and gas SMEs overcome barriers to entry into the clean energy market, ensuring they have the capital needed to transition to sustainable operations (Chukwurah, Adebayo, & Ajayi, 2024; Chukwurah, Ige, Idemudia, & Adebayo, 2024).

3.2 Investment in AI for Emissions Management

Artificial intelligence (AI) plays a pivotal role in the emissions management efforts of oil and gas SMEs, enabling more precise monitoring and management of carbon emissions. Financial institutions are increasingly investing in AI technologies to assist companies in tracking, reducing, and optimizing their emissions (Evievien, Idemudia, Paul, & Ijomah, 2024a). AI tools can provide real-time data analysis, predictive maintenance, and process optimization, all of which are crucial for SMEs in the oil and gas sector as they strive to reduce their carbon footprints. For example, AIpowered energy management systems can help SMEs optimize energy consumption by predicting demand and adjusting supply from renewable and non-renewable sources accordingly. Such investments enhance operational efficiency and ensure that SMEs remain competitive while meeting sustainability targets (Durojaiye, Ewim, & Igwe, 2024; Eyieyien, Idemudia, Paul, & Ijomah, 2024b).

However, the cost of AI technologies can be prohibitive for small and medium-sized enterprises in the oil and gas sector. To address this, financial strategies such as grants, subsidies, and technology-driven investments are being used to make AI tools more accessible. Governments and financial institutions are increasingly offering funding opportunities for SMEs to adopt AI-powered emissions management solutions (Ezeife, Eyeregba, Mokogwu, & Olorunyomi, 2024a). These financial strategies not only reduce the initial capital burden on SMEs but also help them access the latest technologies that can drive decarbonization (Afolabi, Chukwurah, & Abieba). Grants for environmental innovation, subsidies for clean tech adoption, and low-interest loans for technology-driven upgrades are vital to helping SMEs in the energy sector overcome the financial challenges associated with AI adoption. By incentivizing the use of AI tools, these financial strategies support the transition to net-zero emissions while fostering technological innovation (Ezeife, Eyeregba, Mokogwu, & Olorunyomi, 2024b; Hassan, Collins, Babatunde, Alabi, & Mustapha, 2024).

3.3 Barriers to Accessing Financial Models for SMEs

While financial mechanisms such as green finance instruments and AI investments are essential for achieving net-zero emissions, oil and gas SMEs face several barriers to accessing these funding sources. One of the primary challenges is the high upfront costs associated with adopting decarbonization technologies, including AI tools, energyefficient equipment, and renewable energy infrastructure. Many SMEs struggle to secure the necessary capital to make these initial investments, particularly when they have limited access to traditional financing options due to perceived risks or lack of collateral (Hassan et al., 2024; Ige, Chukwurah, Idemudia, & Adebayo, 2024).

Another significant barrier is the complexity of financial instruments available for SMEs in the oil and gas sector. The paperwork, compliance requirements, and lack of understanding about how to structure and apply for green bonds, sustainability-linked loans, and carbon credits can overwhelm smaller enterprises that lack dedicated financial expertise. Additionally, there is often a lack of awareness about the benefits of decarbonization and the financial incentives available, leading SMEs to miss opportunities for funding or technological adoption. The technological knowledge gap is another obstacle, as SMEs may not have the expertise to implement AI-driven solutions or integrate them into their existing operations effectively (E. Jessa & Ajidahun, 2024; Kamau, Myllynen, Mustapha, Babatunde, & Alabi, 2024).

To overcome these barriers, several strategies can be implemented. Regulatory support is crucial in providing a clear framework for SMEs to access green finance products and AI technologies. Governments can offer tax incentives, subsidies, or direct funding for the adoption of clean technologies and AI tools, thereby lowering the financial burden. Public-private partnerships are also an effective way to de-risk investment in decarbonization for SMEs (Odionu, Bristol-Alagbariya, & Okon, 2024). In these partnerships, government bodies can share some of the financial risk associated with transitioning to sustainable practices, making it more attractive for private investors to fund AI and clean energy initiatives. Finally, financial incentives from financial institutions, such as low-interest loans or flexible repayment terms, can encourage SMEs to adopt technologies that contribute to emissions reduction. These mechanisms make it easier for SMEs in the oil and gas sector to access the funding they need to meet net-zero emissions targets (E. K. Jessa, 2024; Myllynen, Kamau, Mustapha, Babatunde, & Collins, 2024).

4. AI TECHNOLOGIES AND THEIR ROLE IN REDUCING EMISSIONS

4.1 AI in Emission Monitoring and Reporting

Artificial Intelligence (AI) has emerged as a powerful tool for real-time monitoring and reporting of emissions, offering oil and gas SMEs the ability to track their carbon footprints with high precision. Traditionally, emission tracking required manual data collection, which was often inaccurate and inefficient. AI, however, can continuously collect and analyze vast amounts of data from sensors, machinery, and operational systems, providing SMEs with near-real-time insights into their environmental impact. By using machine learning algorithms, AI can identify trends and patterns in emissions, allowing SMEs to understand the sources and dynamics of their carbon output (Kokogho, Onwuzulike, Omowole, Ewim, & Adeyanju, 2025; Oyenuga, Sam-Bulya, & Attah, 2025).

AI-powered platforms also facilitate predictive emission analytics, forecasting when and where emissions are likely to increase based on operational changes, energy usage, and environmental factors. This predictive capacity enables oil and gas SMEs to make proactive adjustments before emissions exceed regulatory thresholds or environmental limits. Additionally, AI can provide actionable recommendations for operational changes that reduce emissions, such as optimizing equipment performance, reducing energy waste, and adjusting production processes (Famoti, Omowole, Nzeako, Shittu, et al., 2025; Hassan, Collins, Babatunde, Alabi, & Mustapha, 2025). For instance, AI algorithms can suggest adjusting combustion processes or switching to lower-emission energy sources during peak demand periods. This helps SMEs reduce their carbon footprint, ensuring compliance with environmental standards and improving overall sustainability. Moreover, AI-driven tools can automate the reporting process, making it easier for SMEs to generate accurate emissions reports, which are essential for regulatory compliance and transparency in ESG (Environmental, Social, and Governance) disclosures (Kokogho, Okon, Omowole, Ewim, & Onwuzulike, 2025).

4.2 AI in Operational Efficiency and Energy Management AI technologies are particularly beneficial in optimizing operational efficiency and energy management within the oil and gas sector. By leveraging AI, SMEs can streamline energy consumption, thereby reducing their environmental impact and cutting costs. For example, AI can be used in predictive maintenance, where it analyzes data from machinery to predict failures before they occur. This helps SMEs avoid energy losses due to unexpected breakdowns and improve the lifespan of equipment. AI can also optimize the performance of assets, ensuring that operations run at maximum efficiency and with minimal energy consumption (Daramola, Apeh, Basiru, Onukwulu, & Paul, 2025; Famoti, Omowole, Nzeako, Muyiwa-Ajayi, et al., 2025).

In the context of energy management, AI can help SMEs in the oil and gas industry reduce energy waste by adjusting the energy usage of pumps, compressors, and other equipment. AI algorithms analyze real-time data from various operational systems and adjust energy consumption based on demand, weather conditions, and equipment status. By optimizing energy usage, SMEs can lower operational costs while reducing their carbon footprint. Case studies of SMEs in the oil and gas sector that have successfully implemented AI tools for emission management highlight the significant benefits of such technology (Olanrewaju Awoyemi, Attah, Basiru, Leghemo, & Onwuzulike, 2025; Babatunde, Mustapha, Ike, & Alabi, 2025). For instance, an SME involved in offshore drilling adopted AI-based predictive maintenance, which led to a 15% reduction in energy consumption and improved operational uptime. Another case involved the integration of AI-powered energy management systems that reduced the overall carbon emissions of an oil extraction site by 10% over a year. These cases demonstrate that AI-driven solutions are not only effective in reducing emissions but also contribute to cost savings and operational improvements, making them a compelling option for SMEs in the oil and gas sector (Afolabi et al., 2025; Alabi, Mustapha, & Akinade, 2025).

4.3 Barriers to AI Adoption in Oil and Gas SMEs

Despite the clear advantages of AI in emission reduction, several barriers exist that prevent SMEs in the oil and gas industry from fully adopting AI technologies. One of the primary challenges is the high upfront cost of implementing AI solutions. Many SMEs face financial constraints, and the investment required to adopt AI tools—such as purchasing the necessary hardware, software, and training personnel— can be prohibitive. While the long-term savings and emissions reduction may offset the initial cost, the financial burden can deter SMEs from making the leap toward AI-driven sustainability (Paul, Ogugua, & Eyo-Udo, 2024a).

Another significant barrier is the lack of technical expertise within SMEs. Many oil and gas companies, particularly smaller enterprises, may not have the internal capabilities to integrate and manage AI solutions effectively. The specialized knowledge required to implement AI tools and maintain their functionality is often beyond the scope of most SMEs, leading to challenges in adoption (Oyedokun, Ewim, & Oyeyemi, 2024; Oyenuga, Sam-Bulya, & Attah, 2024). Furthermore, resistance to change within organizational cultures can hinder the adoption of AI. Employees and management may be skeptical about the benefits of AI, particularly if they are not familiar with how the technology works or how it can be integrated into existing systems. This resistance to new technology can slow down the transition to AI-based solutions (Paul, Ogugua, & Eyo-Udo, 2024b; Shittu et al., 2024).

To overcome these barriers, several potential solutions can be pursued. Government incentives such as tax credits, grants, or subsidies for technology adoption can help reduce the financial burden for SMEs looking to invest in AI solutions. These incentives would make it easier for smaller enterprises to afford the upfront costs associated with AI adoption. Additionally, collaborative platforms for knowledge sharing can help bridge the expertise gap (Okon, Odionu, & Bristol-Alagbariya, 2024). By participating in industry networks or partnering with technology providers, SMEs can gain access to the technical knowledge required to implement AI effectively. Finally, training and capacity-building programs can help employees at SMEs understand the value of AI and how to use it to drive sustainability. Encouraging a culture of innovation and providing ongoing education about AI's capabilities can reduce resistance and foster an environment conducive to technological adoption (Olaleye, Mokogwu, Olufemi-Phillips, & Adewale, 2024; Olufemi-Phillips, Ofodile, Toromade, Igwe, & Adewale, 2024; Omowole, Olufemi-Phillips, Ofodile, Eyo-Udo, & Ewim, 2024).

5. CONCLUSION AND RECOMMENDATIONS

This paper highlights the crucial role that AI and innovative financial models play in helping oil and gas SMEs transition to net-zero emissions. Key findings indicate that AI technologies, such as predictive maintenance, emission monitoring, and energy management systems, can significantly reduce the carbon footprint of SMEs in the energy sector. AI enables real-time tracking, optimization of energy consumption, and prediction of emission patterns, which ultimately lead to increased operational efficiency and emissions reduction. Financial mechanisms like green bonds, sustainability-linked loans, and carbon trading also provide the necessary capital to fund decarbonization initiatives, helping SMEs overcome financial barriers to adopting sustainable practices.

Additionally, combining AI with finance models offers scalable solutions that can be replicated across various SMEs in the oil and gas industry. By leveraging these solutions, SMEs can reduce their environmental impact while enhancing operational efficiency, competitiveness, and profitability. The integration of financial models and AI is pivotal in creating a roadmap for achieving net-zero emissions, fostering sustainability, and ensuring compliance with increasingly stringent environmental regulations. These findings underscore the need for a holistic approach where both technological and financial innovations work together to drive the transition to a low-carbon future for SMEs in the energy sector.

For oil and gas SMEs, the practical implication is that they must adopt AI-driven technologies and explore various financial instruments to meet net-zero emissions targets. SMEs should start by identifying opportunities where AI can optimize operations and reduce energy consumption, such as in predictive maintenance, emission tracking, and energy management. Additionally, they should explore green finance

options, such as sustainability-linked loans and carbon credits, which provide financial support and incentives for emission reductions. By integrating AI and financial tools, SMEs can significantly improve their sustainability practices and achieve their environmental targets more effectively.

Policymakers play a vital role in creating an enabling environment that allows SMEs to access these technologies and financial models. Governments should consider offering subsidies, grants, or tax incentives to make AI adoption and sustainable finance more affordable for SMEs. Furthermore, policymakers should promote the development of clear regulatory frameworks and support the creation of industry standards for AI integration in the oil and gas sector. Financial institutions, on their part, should tailor their financial products to meet the unique needs of oil and gas SMEs, providing them with more accessible and flexible financing options for sustainability initiatives. A collaborative approach between SMEs, policymakers, and financial institutions will be critical in achieving net-zero emissions.

Future research in this field could focus on understanding the long-term impact of AI on the sustainability of SMEs in the oil and gas sector. While the current applications of AI demonstrate significant potential for emissions reduction and efficiency, more research is needed to assess the long-term benefits of AI technologies in terms of operational performance, cost savings, and overall environmental impact. Studies could explore the effectiveness of AI in different segments of the oil and gas industry, such as upstream versus downstream operations, to provide a more detailed understanding of its potential.

Another promising area for future research is the exploration of new financial instruments that are specifically tailored to the needs of SMEs in the energy sector. This could include developing more accessible and flexible funding options that address the unique risks and challenges of the oil and gas SMEs, such as project-based financing for clean energy projects or green bonds with reduced interest rates for small enterprises. Additionally, research could delve into the intersection of emerging technologies-such as blockchain and AI-and sustainable finance models. Understanding how these technologies can be combined to enhance transparency, traceability, and accountability in financing emissions reduction initiatives would be crucial for advancing the sustainable energy transition. Overall, future studies should aim to provide actionable insights that help oil and gas SMEs adopt innovative technologies and financial solutions for achieving net-zero emissions.

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