

# Greenhouse Gas Emissions and the Challenges of Environmental Sustainability: Leveraging AI Technologies for Lasting Solution

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## Abstract

Greenhouse gas emissions pose serious challenges to the environment alongside humans and the non-humans, and limit the achievable extent of environmental sustainability. Previous studies are largely preoccupied with carbon emissions, leaving out the emission extent and effects of methane, propane, butane and ethane. Therefore, this study explores greenhouse gas emissions as challenges to environmental sustainability and proposes the judicious leveraging of AI technologies for lasting solutions to the challenges. It draws insights from Harold-Domar's Model of Economic Growth and Kuznets' Environmental Kuznets Curve theory. They both theorize and relate the effects of environmental hazards to economic growth and progress of society. The study relies on secondary data, which are subjected to a systematic review, and thematic and content analyses. The analysis shows a gap in literature on greenhouse gas emissions, and demonstrates that the adverse effects of gas emissions on environment and environmental sustainability can be mitigated significantly by leveraging AI technologies for lasting solutions. The study concludes that AI technologies are indeed capable of proffering lasting solutions to greenhouse gas emissions and other challenges of environmental sustainability. It calls on stakeholders to rise to the challenges and ensure maximal leveraging of AI technologies for lasting solutions to the challenges.

**Keywords:** Greenhouse Gas Emissions, Challenges, Environmental Sustainability, AI Technologies, Lasting Solutions.

## Introduction

Greenhouse gas emissions and wasted energy are caused by gas flaring (The World Bank, 2024; Rodrigues, 2022; Getty Images 2021). Gas flaring increases atmospheric carbon emissions (McEwen and Johnson, 2012). It causes severe environmental hazards (Bodin, 2021; Okoye et al., 2022; Shabestari, 2018; Ojjiagwo, 2017). Gas flaring is a high temperature oxidation process, used to burn combustible components having volatile organic compounds (VOCs) piped to a remote location and burned in an open air flame. The foregoing involves using a specially designed burner tip, auxiliary fuel, and steam or air to promote mixing for nearly complete 98% VOC destruction (Okoye et al., 2022; Nezhadfar, & Khalili-Garakani, 2020). The estimation of gas production and consumption across the

globe between 1990 and 2025 by Policy and Legal Advocacy Centre [PLAC] (2004) reveals the worrisome state of gas flaring and energy consumption among nations of the world. It is found that over 100 billion cubic meters of natural gas are flared annually across the globe (PLAC, 2004). This implies that gas flaring occurs in all nations that are involved in gas exploration, production and consumption.

Therefore, since the US is an oil producing country, there is need for new researches into the state-of-art regarding greenhouse gas emissions, so as to ascertain the extent of the effects of the emissions and devise measures capable of proffering lasting solutions to the problems. This research is informed by the need to find lasting solutions to threats posed by greenhouse gas emissions and other environmental challenges to environmental sustainability, which hamper the realization of its goals and social development goals. Considering the spate of greenhouse gas emissions and other challenges to environmental sustainability and the seeming inefficacy of the non-technological measures for mitigating them, this study proposes consistent and judicious leveraging of AI technologies for lasting solutions to the challenges. As a systematic review study, evidence will be drawn from extant literatures and observation to logically prove its central position that AI technologies can be leveraged for lasting solutions to gas emissions and other challenges to environmental sustainability in oil producing nations.

### **Statement of the Problem**

Extant studies on gas flaring, energy consumption and economic growth in different countries leave out the extent of greenhouse gas emissions. These emissions are neither engaged with nor emphasized. For example, the extent of the effects of methane, propane, butane and ethane emissions remains understudied. This is evident in studies such as Qin et al. (2024), Ostic, et al. (2022), Bodin (2021), Jayasinghea and Selvanathan (2021), Mulenga (2019), Hajilary, Rezakazemi & Shahi, (2020) and Oganessian (2017), which pay attention exclusively to carbon emission, leaving out methane, propane, butane and ethane emissions. Meanwhile, the greenhouse gases are found to be emitting higher and the highest quantities of gaseous pollution, causing global warming and other hazards and threats to environment, humans and animals (EPA, 2021; Koyuncu et al., 2021). To that end, this study rises to engage with these concerns, raise attention to them, and propose the leveraging of AI technologies for lasting solutions to the problems.

### **Aim and Objectives**

The aim of this study is to propose the leveraging of AI technologies for lasting solutions to greenhouse emissions and other challenges of environmental sustainability. Its specific objectives are to:

- (i) Engage with greenhouse gas emissions, as understudied emissions thereby raising deserving attention to these threats to environmental sustainability.

- (ii) Examine the effects of gas emissions on environment and environmental sustainability.
- (iii) Show how the effects can be reduced by applying AI technologies that have the potentials of addressing environmental threats.

## Novelty of the Study

Although there are extant studies that engage with each of environmental sustainability, AI in addressing environmental issues, and greenhouse gas emissions, none of them combines them as the present study does. These themes are integrated by the present study, which adopts a nuanced approach. The novelty of the study rests on its proposal that AI technologies can be leveraged for lasting solutions to greenhouse gas emissions and other challenges of environmental sustainability.

While bridging the erstwhile laid-bare knowledge gap, the study makes unique contribution to knowledge and discourses on the aforementioned themes. By engaging with the effects of methane, propane, butane and ethane emissions, the study makes a deserving sporadic shift from the scholarship of concentrating on carbon dioxide and leaving out the aforementioned four greenhouse gases that are even more hazardous than carbon dioxide to the environment. By engaging with these gases, the study raises concerns about them and increases the chances of achieving the goals of environmental sustainability.

## Theoretical Framework

This study is rooted in Harold-Domar's Model of Economic Growth (HaDoMEG – short form herein) and Environmental Kuznets Curve (EKC). As Anyanwu (1995) point out, HaDoMEG posits that every economy must save a certain proportion of its national income in order to replace worn-out or impaired capital goods (i.e. buildings, equipment and materials). In other words, in order to grow, new investments, representing net additions to the capital stock, are necessary. The theory informs that by designing policies to influence savings rate or enhancing policies to reduce the capital output ratio of sales by investing in human capital, the capital can be increased. By so doing, economic growth is attained. This implies that HaDoMEG places emphasis on human development, as the first to be developed. Doing so means developing developers, as the developed humans go on to develop both their fellow humans, and the non-humans of Nature –the environment.

It follows that to attain environmental sustainability at an appreciable rate, human development has to be taken seriously, targeted at and achieved first, and be made sustainable. By so doing, other phases of development aptly fall in place. HaDoMEG considers savings, investment and favorable policies as viable means of attaining capital, human, and non-human development. Policies influence sales, savings, investment, economic growth and development. While favorable policies increase these variables, unfavorable policies cause their decrease. The study considers the emphasis on (new)

investment, leaving out other determinants, as the major pitfall of the HaDoMEG theory. Yet, its espoused views promote economic growth and development, developmental sustainability, and international trade and diplomacy.

Also being a study concerned with gas emissions and environmental sustainability, the Environmental Kuznets Curve (EKC) theory, proposed by Kuznets (1955), is considered apt for it. This popular theory is known to hold the view that there is an inverted U-shape relation between environmental degradation and gross domestic product (GDP) per capita, such that growth is reduced by the environmental impact of economic activity in the long run (Bodin, 2021; Chakravarty & Mandal, 2016). This means that EKC recognizes the wholesome effects of gas emissions and undeserving exposures of the environment to hazards. Be it so, EKC aligns with environmental sustainability movement and ideals. EKC is said to maintain the view that when a country's economy grows, it increases its emissions up until a maximum level is reached. That is, at a certain level of GDP, emissions start to decrease with an increasing GDP (Bodin, 2021). This means that environmental hazards increase with GDP per capita at first and then reduces thereafter.

Ericsson (2022) holds that EKC shows evidence for the correlation between economic growth and greenhouse gas emissions. Also, Oganessian (2017) argues that EKC aptly determines the causal and co-integration relationship between environmental trends and economic growth. Also, Ostic et al. (2022) observes that there is a specific inverted U-shaped relationship between income and environmental pollution. Their finding justifies the tenets of the EKC on environmental concerns. Economic growth is associated with lower quality of the environment at early stages of economic development, whereas after the turning point of economic growth (or the maximum of the curve), environmental pollution starts to decrease with increasing income (Ostic et al., 2022). Basically, the idea is that when a country reaches a certain level of income, pollution intensity of its industries starts to decrease (Oganessian, et al. 2017).

For this study, the major problem with EKC is its postulation that: (i) the direction of change in the volume of environmental pollution produced by given countries likely determines whether or not the countries have reached the 'break-point' of economic development; and (ii) when countries reach a certain level of development, they begin to import rather than produce pollution-intensive goods. This study argues that no matter the level a country reaches, it still has some reasons to import. This is because no country is self-sufficient. Besides, based on comparative advantage, every country has reasons to import some goods and services. Practically, there is no level a country would reach that makes it to stop importing what it lacks or does not have in large quantity. What obtains is the fact that such countries at certain level import less and export more. If a developed country imports, it does not become a developing or an undeveloped country. Also, it is misleading to base the 'break-point' of economic development on the volume of environmental pollution, as its determinant.

Nevertheless, both HaDoMEG and EKC are considered apt for this study, based on their tenets that align with the thematic concerns of the study. The two theories explain how economic activities impact on the environment according to how the activities obtain. The centrality of their views is that high level of development breeds increase in economic growth. The adopted theories emphasize:

- A structural change that brings to place information-intensive industries and services;
- Implications of human exploitation of the environment;
- Higher environmental expenditures rising from threats and harms to the environment;
- Increase in environmental awareness and positive relations;
- Governance and legislative efforts at quelling environmental and socio-economic challenges;
- Enforcement of environmental regulations for sustainability;
- A gradual decline of environmental degradation, following sustainability measures.

## Methodology

The study relies on secondary data, drawn from library and the internet. The gathered data are subjected to a systematic review, involving thematic and content analyses of the data. Some of the sourced data were screened out, based on the application of systematic review exclusion criteria. The literatures considered to have been published by predatory journals and publishers are excluded, while those from credible sources were included in the study. Academic repositories, search engines and websites alone were relied on. These include Google Scholar, Semantic Scholar, Academia.edu, ResearchGate and websites of credible journals. The analysis is done qualitatively, employing suitable techniques of critical exposition, description and interpretation.

## Gas Flaring, Greenhouse Gas Emissions and Environmental Challenges

As The World Bank (2024) and Ojjiagwo (2017) note, gas flaring involves a systematic channeling of gas to the knockout drum, from where gas is directed to the flare stack. Bjorndalen et al. (2005) have noted that gas flaring is utilized to dispose unwanted gas or the gas not needed at the moment. This process or activity can take place at oil wells, refineries or even in chemical plants (Ojjiagwo, 2017). Atmospheric carbon emissions are increased by gas flaring, which cause serious hazards to the environment (McEwen & Johnson, 2012). Such hazards pose serious challenges to environmental sustainability. Flared gas consists of several compositions, with Methane (CH<sub>4</sub>) and Ethane having the highest mole fractions (McEwen & Johnson, 2012).

Gas flaring emerges from crude oil at the surface stage and separated from the oil earlier before being transported in the production and processing facilities (The World Bank, 2024;

Rodrigues, 2022; Nezhadfar & Khalili-Garakani, 2020). It is of three categories viz: emergency, process and production flares. According to McEwen and Johnson (2012), estimates of flared gas are most often complicated by the large diversity of flare designs, applications, and operating conditions encountered. There are major factors that affect flare performance. These include the exit velocity of gas from the flare, the composition of flared gas, flare stack diameter, ambient wind conditions, and flare tip design (Johnson & Kostiuik, 2000 & 2002). Nature gets threatened and even destroyed when exposed to different dangers, such as those from greenhouse gases, gas flaring and other pollutants (Okoye et al., 2022). One consequence is a fall in environmental quality. This is of serious concern to environmental sustainability, because environmental quality is one of its goals. In the efforts to tackle such problems, different policies are being enacted among nations. The policies are targeted at attaining environmental sustainability, green environment, social wellbeing, economic growth and development, etc. among nations. Economic growth is a long term process of sustainable rise in the capacity of a nation "to supply increasingly diverse economic goods and services to its growing population" (Musa, 2014, p. 101). It is conventionally measured by the increase in the Gross Domestic Production (GDP) of the country. According to Ufoeze et al. (2018), economic growth obtains when the real per capita income of a country increases over time. Besong (2017) opines that development in its real sense obtains where there is "significant all-round improvement, change, innovation, growth, increase, advancement and capacity that were hitherto lacking in a place and among a people" (p. 59). This study argues here that environmental sustainability is a framework that paves way for and facilitates all-round development, inclusive of economic growth and development, and protection and preservation of the environment in various regards.

It follows that such policies are targeted at reducing the extent of gas flare, its adverse effects and the challenges of environmental sustainability in general. Of course, as noted earlier, gas emission is a major cause of threats to the environment, including humans and the non-humans in the ecosystem. This study observes that while gas flaring has reduced significantly in some countries, it is still at an increasing ratio in many other countries. Amidst the reduction in gas flares in some countries, there is still need to increase measures for lasting solutions to the problems of gas emission and threats to the environment so as to achieve environmental sustainability. Russia and Nigeria have been maintaining 1st and 2nd positions in the rankings of countries having the highest extent of gas-flare (Ojjiagwo, 2017; Morakinyo; 2015; Oni & Oyewo, 2011). For example, studies indicate that Nigeria records about 15.2 BCM of gas flares; loses about \$2.5b to gas flaring; and expels greenhouse gas (GHG) to the environment (Mansoor & Tahir, 2021; Odumugbo, 2010; Broere, 2008; PLAC, 2004).

Through the Global Gas Flaring Reduction (GGFR) initiative, a substantial amount of efforts and international attention has been focused on the reduction of gas flaring since 2002

(Elvidge et al., 2009). The GGFR is an initiative of the World Bank and the Government of Norway, which was launched at the World Summit on Sustainable Development in August, 2002 (The World Bank, 2024). The initiative is ultimately aimed tackling issues of gas flaring and venting at reasonable extent, if not totally eradicated. The GGFR is a joint public-private participation initiative involving governments of oil-producing countries, state-owned companies and major international oil companies. It has the task of identifying areas where gas flaring occurs and works with the countries and the companies to promote regulatory frameworks and infrastructural investment to bring flared gas to markets (The World Bank, 2024; Ericsson, 2022; Ojijiagwo, 2017).

Basically, the formation of GGFR was undoubtedly borne out of the desire to find lasting solutions to environmental issues arising from emissions. Thus, in its bid to find lasting solutions to emissions, this study proposes the leveraging of AI technologies for lasting solutions to greenhouse emissions and other challenges of environmental sustainability. Its proposal is given credence by previous studies that link AI to environmental sustainability, stressing the capacity of AI to tackle environmental issues, the challenges to environmental and the realization of environmental sustainability goals (Adanma & Ogunbiyi, 2024; Akter, 2024; Islam et al., 2024). The GGFR country partners include Algeria, Angola, Azerbaijan, Cameroon, Ecuador, Equatorial Guinea, Gabon, Indonesia, Kazakhstan, Khanty-Mansiysk (Russian Federation), Nigeria, Norway, Qatar, United States of America and Uzbekistan.

The participating oil companies include BP, Chevron, ConoPhillips, eni, ExxonMobil, Marathon Oil, Shell, Statoil and TOTAL. OPEC and the World Bank Group are also partners. Donor countries are the United States of America (USA), Canada, the European Union, France, Norway, and the UK (The World Bank, 2024; Ericsson, 2022; Elvidge et al., 2009). Considering United States of America's donor country status, this paper focuses on the US, while having all countries of the world as its audience. Yet, among the countries of the world, it sends its message specifically to oil producing countries and the donors. Its intent is to rouse the deserving attention of the countries' stakeholders to the challenges of environmental sustainability arising from greenhouse gas emissions and gas flare.

Ericsson (2022) explores methane emissions and economic growth through the lens of N-shaped Environmental Kuznets Curve theory. The Ericsson's (2022) study describes the challenging problems of climate change confronting the earth's population in contemporary time, stressing that the emission of greenhouse gases is major cause of global warming. This environmental situation poses serious threats to humans, non-humans and Nature in its entirety. The study submits that the consequences of the emission is why high level of attention is paid to "carbon dioxide emissions and its impact on the environment" (Ericsson, 2022, p. iii). The implication is that carbon dioxide emissions have gained a higher extent of attention, while the emissions of methane and other greenhouse gas are yet to gain a deserving attention. Unlike the many other studies paying utmost attention to carbon dioxide emissions alone, Ericsson's (2022) study pays attention to

methane, a much stronger greenhouse gas. Yet, it leaves out propane, butane and ethane emissions that the present study combines with methane in its engagement.

Leaning on Environmental Kuznets Curve (EKC) theory, Bodin (2021) examines gas emissions and issues of economic growth in relation to environmental degradation in Austria, Portugal and Sweden. The study proves a strong positive sloped curve in Portugal, but the opposite obtained in Austria and Sweden, showing a graphic curve resembling the EKC. Although it engages with salient environmental issues, the Bodin's (2021) study does not concern itself with methane, propane, butane and ethane emissions. What it leaves out are parts of the concerns of the present study. The study tallies with the present one, as it situates EKC in issues of environmental sustainability, though Bodin's (2021) study does not look at the issues from the perspective of environmental sustainability. Zhang (2024) shows that ultra-deep fractured tight gas reservoirs are sources of gas emissions and hazards to the environment.

### Leveraging AI Technologies for Lasting Solution

Akter (2024) and Onifade and Alola (2022) indicate that AI has been offering huge innovations to various sectors. Thus, the environmental sector is not left out. The central viewpoint here is that different AI technologies can be leveraged for lasting solutions to the different threats to the environment, which are also the challenges of environmental sustainability. There are different AI technologies. Lasting solutions to the problems of environmental sustainability can be attained through some of them. The technologies include:

| AI Technologies                       | Citations                               |
|---------------------------------------|-----------------------------------------|
| Computer Vision                       | Akinola (2024)                          |
| Deep Learning (DL)                    | Ivanova et al. (2023)                   |
| Natural Language Processing (NLP)     | Kim et al. (2015)                       |
| Robotics                              | Kodete et al. (2024)                    |
| Expert Systems                        | Naser (2019)                            |
| Digital Image Analysis                | Nikitas et al. (2020)                   |
| Internet of Things                    | Nwadinobi et al. (2024)                 |
| Machine Learning (ML)                 | Okusi (2024)                            |
| AI in Personalization                 | Oyeyemi et al. (2024) Pasupuleti et al. |
| AI in Cybersecurity                   | (2024) Thuraka et al. (2024)            |
| Reinforcement Learning                | Pasupuleti et al. (2024)                |
| AI Algorithms & Hardware Accelerators | Qasim and Kharbat (2020)                |
|                                       | Rasheed et al. (2024)                   |
|                                       | Srivastava (2021)                       |

Source: Authors, 2024

It should be noted that each of the above tabulated AI technologies has its several sub-categories or types and tools or techniques. For examples:

- Machine Learning has supervised learning, unsupervised learning and reinforced learning.
- Natural Language Processing has Chatbots and Virtual Assistants, Sentiment Analysis, and Machine Translation.
- Computer Vision has Facial Recognition, Autonomous Vehicles, and Medical Imaging.
- Industrial Automation, Service Robots, and Exploration are to Robotics.
- Deep Learning has the following: Image and Speech Recognition, Generative Adversarial Networks and Healthcare Diagnostics.
- Expert Systems are AI programs that have the following: Medical Diagnostics, Financial Services and Manufacturing.
- AI in Cybersecurity comprises Anomaly Detection, Automated Threat Response and Phishing Detection.
- AI in Personalization consists of Recommendation Systems, Targeted Advertising and Content Curation, which are all AI applications.

Among others, Machine Learning, Deep Learning, and Digital Image Analysis are proven cost-effective AI technologies (George et al., 2022; Wusu et al., 2022; Bidhendi & Azizi, 2021; Xu et al., 2021). These can be leveraged for cost-effectiveness lasting solutions to greenhouse gas emissions and the challenges of environmental sustainability. Since addressing greenhouse gas emissions and the challenges of environmental sustainability requires huge expenses, leveraging AI for such purposes would reduce the costs of addressing greenhouse gas emissions and the (other) challenges of environmental sustainability. Also, studies show that Digital Image Analysis and Canny Edge Detector smart technologies can maximize the monitoring of safety (Alsakka et al., 2023; Baduge et al., 2022; Seo et al., 2015). This implies that they can be leveraged for effective management of environmental safety. In the summing words of Thuraka et al. (2024), "all AI technologies and techniques are capable of innovations, multifaceted tasks, solving different problems, and making huge impact on different spheres of life" (p. 51).

With the prediction, detection and safety potentials of AI affirmed by different studies (Juhrich, 2023; Bidhendi & Azizi, 2021), this study argues that AI technologies can be judiciously leveraged for lasting solutions to greenhouse gas emissions and the challenges of environmental sustainability to a large extent. With compliance management, efficient planning and increased performance (Obiuto et al., 2024; Singh, 2024; George et al., 2022; Yigitcanlar et al., 2020), AI technologies can be leveraged for lasting solutions to greenhouse gas emissions and the challenges of environmental sustainability. The due or significant leveraging of AI technologies for lasting solutions to greenhouse gas emissions and the challenges of environmental sustainability would bring to place reduced costs and

planning and performance optimisation in all that concerns environmental conversation and sustainability.

Studies, such as Kamble and Gaikwad (2024), Obiuto et al. (2024) and Regona et al. (2023), prove the benefits of AI in terms of efficiency, cost reduction, and planning and performance optimization. Similarly, Kamble and Gaikwad (2024), George et al. (2022), Srivastava (2021), Yigitcanlar et al. (2020) and Jarrahi(2018) show that AI technologies can ensure safety and efficient management of risks and businesses. By implication, AI technologies can also be leveraged for these affirmed results in the area of environmentalism to attain lasting solutions to gas emissions and the challenges to environmental sustainability. The study by Adanma and Ogunbiyi (2024), which makes a systematic review of various literatures of between 2014 and 2024, proves that AI contributes to environmental sustainability, as its technologies:

- Speed up human efforts at addressing the challenges to the environment as well as environmental sustainability.
- Help ease the processes of conserving the environment.
- Increase efficiency and optimization in resource management.
- Enhance and increase predictions aimed at improving biodiversity and environmental sustainability.
- Proffer more vibrant, result-oriented and technology-based solutions to climate change issues
- Present efficient strategic management techniques to humans with which environmental sustainability is achieved much more than ever.
- The predictive analytics of the AI are viable mechanisms for advanced monitoring and analysis of environmental impact.

Adefemi et al. (2023) and George et al. (2022) show that AI technologies play the role of mitigating environmental degradation very efficiently. By so doing, AI technologies can be indeed leveraged for lasting solutions to greenhouse gas emissions to lessen the effects they exert on the environment, which constrain the attainment of environmental sustainability (goals). Also, since AI technologies are proven to facilitate detection and prediction of safety threats (Juhlich, 2023), there is no doubt that they can be leveraged for lasting solutions to environmental threats. They are capable of ensuring as well as fostering the attainment of environmental safety. With their detection and prediction capacities, AI technologies help greatly in tackling risks to humans and the environment (Okusi, 2024; Bulama & Shirivastata, 2022; George et al., 2022; Thakkar & Lohiya, 2021).

Also, AI technologies can be leveraged for efficient decision-making on environmental matters and how best to go about pursuing the realisation of environmental sustainability agenda. Studies such as Kamble and Gaikwad (2024), Regona et al. (2023), Regona et al. (2022) and Wang (2019) indicate that decision-making processes, rationality in the human mind, and stimulation of learning and teaching are some of the major functions and

benefits of AI technologies. Besides, as technological innovations known for innovations, discoveries, inventions and huge contributory role to growth and development in various spheres (Bidhendi & Azizi, 2021), this study is convinced that AI technologies can be leveraged for lasting solutions to greenhouse gas emissions and the challenges to environmental sustainability. In addition, with their proven capacity for provision of massive data sets (Onifade & Alola, 2022; Yigitcanlar et al., 2020), it is logical to assert that AI technologies can be leveraged for lasting solutions to gas emissions and challenges to environmental sustainability.

Akter (2024) proves that AI can be leveraged for the attainment of environmental sustainability, stressing that it is a viable means of addressing problems of environmental degradation, climate change, and biodiversity loss. Akter (2024) is of the view that as technological advancements or innovations, AI technologies correlate with sustainability, resource management, and energy consumption in terms of structural functionality. That is, when energy consumption is managed well, the potential risks to the environment are averted or brought under appropriate control. Therefore, AI can be leveraged for effective management of energy consumption. Islam et al. (2024) indicate that AI has been impacting positively on environmental sustainability in India amidst the challenges to the supposed extent of its ideal positive impact. The complex challenges are broadly grouped into environmental, developmental, technological, political and socio-economic factors (Islam et al., 2024).

Xing et al. (2024) explore the implications of carbon emissions in relation to environmental sustainability challenges, for which AI technologies are considered to be workable measures for tackling them. The study holds that bioenergy with carbon capture and storage (BECCS) is a key negative emission technology, which has adverse effects on the environment. It affects the goals of sustainability, thwarting their realization. The study concludes that to strike a balance between environmental, social, and economic considerations, different pragmatic and sustainable interventions should be deployed for lasting solutions. For the present study, AI technologies can be leveraged for lasting solutions to gas emissions, as challenges to environmental sustainability, and the other challenges.

Furthermore, Olawade et al. (2024) and Koyuncu et al. (2021) stress the capability of AI to address the challenges of environmental sustainability in the 21st century. According to the study, deploying AI for solutions to the challenges can lead to maximal results in the sector, such that the challenges would be eliminated sooner or later in the nearest future. The common challenges, found across the different literatures subjected to a systematic review, concern issues of governance, quality, bias, human-AI collaboration, fairness, and data availability and privacy. The results Olawade's et al. (2024) study prove that AI technologies are capable of optimizing energy systems, facilitating the modelling of climate change, and providing sustainability opportunities in waste management, agriculture and

transportation. The study concludes that judicious leveraging of AI for gas emissions and other challenges of environmental sustainability can realistically lead to the attainment of net-zero emissions and lasting solutions to other causes of climate change and threats to sustainable development. The study calls for more studies, stakeholder, institutional, group and personal collaborations, policy reviews and enactments for legislative and political supports, and capacity building.

Obviously, despite the huge prospects of AI (technologies), the adoption of AI in various fields remains constrained by various challenges. The question of the shortcomings of AI (technologies) abounds. For this study, the shortcomings are insignificant compared to other challenges to its wide adoption and ideal contributions to solving issues like those confronting the environment in its broadest term. The challenges include high costs of AI technologies, lack of technological skills and competencies, shortage of skilled or trained personnel, negative attitude to innovation (adoption), over reliance on the conventional ways, shortage of resources, leadership lapses, perception, preference, and socio-cultural, political, legislative and environmental embargoes. The challenges posed by AI technologies include personal data protection issues, identity theft, cyber security threats arising from the use of AI, unethical use of AI by many who abuse it variously, and over reliance on AI for various tasks, and knowledge inhibition.

### **Conclusion**

In the course of the exploration, the study evidently shows evidence from extant literatures that gas emissions and other forms of environmental degradation pose serious threats to Nature, human and animal health, economy, socio-economic growth and development, capital development, governance, and frustrate efforts made at conserving the environment. These shatter or hamper the ideal success of the advances made toward attaining environmental sustainability. The exploration also reveals a significant gap in literature on the extent to which attention is paid to greenhouse gas emissions, as serious concerns of environmentalism and environmental sustainability. The novelty of the present study rests on bridging the gap and rousing significant attention to these concerns.

Beyond doing so, it proposes the judicious leveraging of AI technologies for lasting solutions to greenhouse gas emissions, gas flares in general, issues of climate change, and other challenges of the environment on one hand and environmental sustainability on the other. Its proposition is given credence by the findings of the extant studies subjected to a systematic review and qualitative analysis. The study concludes that AI technologies are indeed capable of proffering lasting solutions to greenhouse gas emissions and other threats to the environment, which constitute challenges to environmental sustainability.

### **Recommendations**

The following recommendations are made:

- i. Government, agencies of government, corporate organizations and well-to-do individuals should make concerted efforts to increase the adoption cum application of AI in the fields of environmentalism and environmental sustainability. The efforts include tackling financial, technological, logistic, and personnel constraints to adopting AI in various spheres.
- ii. More research studies should be carried out on greenhouse gases rather than continually focusing on carbon emissions. By so doing, significant scholastic attention and policy impact on methane, propane, butane and ethane emissions, which are even high and more hazardous than carbon emissions, would be attained.
- iii. Favorable legal and political measures would foster the leveraging of AI for lasting solutions.
- iv. Consistent sensitization of the masses of oil producing and industrial countries would foster effective waste management and the reduction of gas emissions.
- v. Substantial stakeholder engagement would allow for meaningful contributions from agents of socialization and other state institutions to solving the problems at stake.
- vi. Interdisciplinary and agency collaboration would also help a lot in addressing environmental issues using AI, and in ensuring environmental sustainability.

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