

Maximising Net Zero in Energy-Intensive Industries: An Overview of AI Applications for Greenhouse Gas Reduction

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Abstract: The impact of global warming on the environment is a significant concern, and finding effective ways to address climate change is a priority. This paper investigates how Artificial Intelligence (AI) can be utilised to reduce greenhouse gas (GHG) emissions and support efforts to combat climate change, with a particular focus on the chemical industry.

The study presents a theoretical framework and comparative analysis of both technological and non-technological solutions to achieve net-zero GHG emissions and establish a carbon-neutral status in the chemical industry. The aim is to assess the potential role of AI as a tool for reducing CO₂ emissions from the chemical industry and contributing to the global goal of achieving net-zero CO₂ emissions.

The analysis will evaluate the efficacy of AI as a tool in reducing GHG emissions in the chemical industry and explore its potential for optimising processes, predicting and reducing emissions, and supporting the development of sustainable practices. By utilising AI, it may be possible to identify and implement effective solutions that may not have been possible through conventional methods. Ultimately, the study aims to contribute to the ongoing efforts to address climate change by highlighting the potential of AI as a tool for reducing GHG emissions in the chemical industry.

Keywords: Artificial Intelligence; Net-Zero; Reducing Greenhouse Gases; Climate Change; Optimizing Energy Intensive Industry.

Introduction

The effects of global warming pose a significant threat to the environment, and the impacts of climate change are becoming increasingly evident. The concept of “Net Zero” refers to achieving a balance between the emissions produced by industries and those removed from the atmosphere, in order to mitigate the effects of global warming.

It is imperative to reduce harmful emissions as soon as possible, as failure to do so could render the planet

uninhabitable in just a few decades. Although the rise in temperature of 1.2°C may not appear significant at the moment, reports indicate that it has already caused severe weather conditions such as increased storms, heatwaves, floods, and other natural disasters. The Arctic region’s ice caps are melting rapidly, and it is predicted that by the year 2100, the temperature could rise by up to 2.7°C.

To address the impacts of emissions, a Net Zero approach is required. This involves reducing emissions from industries and ensuring that an equal amount is

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removed from the atmosphere. This can be achieved through various means, such as investing in renewable energy sources, optimising production processes, and adopting sustainable practices.

The urgency to reduce harmful emissions and implement Net Zero approaches is critical in preventing further environmental damage. Failure to do so could result in irreversible consequences for the planet and its inhabitants. It is vital that we take action now to mitigate the effects of global warming and protect our environment for future generations.

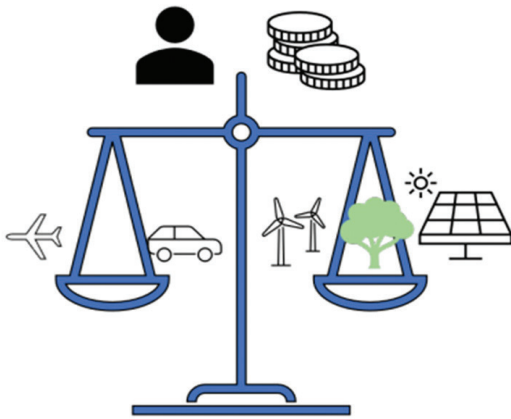


Figure 1: Carbon offset-A difficult balancing act.

In Figure 1, a heuristic-based approach was used to plan investments in carbon offsetting. At the time, there was no comprehensive solution available to manage energy usage from start to finish, to reduce carbon emissions and achieve Net-Zero objectives. This made it challenging to estimate energy demand accurately, and the estimation process was conducted manually. This was due to the lack of long-term data on energy needs for carbon offset planning.

As a result, a precise forecast was required to optimize the use of renewable energy sources and reduce the overall amount of carbon emissions. This could be achieved through a thorough understanding of energy usage patterns, which could help to identify areas where renewable energy sources could be integrated more effectively. By doing so, the organization could reduce its carbon footprint and move closer to achieving its Net-Zero goals.

The heuristic-based approach allowed for a flexible and adaptable strategy to be developed, taking into account the available data and the organization's goals. This approach allowed for the optimization of carbon offset investments, which was crucial in achieving Net-Zero objectives. As the availability of data and

technology continues to improve, organizations will have more tools at their disposal to manage energy demand and reduce their carbon footprint. This will enable them to take more targeted and effective action toward achieving Net-Zero goals.

The concept of net zero emissions is closely linked to the goal of reducing the negative impact of human activities on the environment. It was born out of the urgent need to mitigate the severe consequences of climate change, such as rising temperatures and natural disasters. The goal of achieving net zero emissions involves reducing or eliminating human-caused emissions of greenhouse gases such as carbon dioxide (CO₂) and methane through various reduction strategies.

This study specifically focusses on the challenges posed by the climate crisis for the chemical industry. The question at hand is how the chemical industry can continue to produce carbon-based goods and provide related services to all sectors of society while reducing their carbon footprint.

In other words, the challenge for the chemical industry is to find ways to innovate and improve their production processes while reducing greenhouse gas emissions. This could involve the development of more sustainable raw materials, the implementation of renewable energy sources, and the adoption of more efficient production techniques. By doing so, the chemical industry can help to reduce the negative impact of their activities on the environment and move towards achieving net zero emissions.

Figure 2 illustrates that bioenergy for storing carbon and bioenergy with carbon capture and storage (BECCS) observes expanding importance in the electricity industry, biorefineries, and hydrogen production using renewable sources. The residual emissions from the use of fossil fuels in the difficult-to-abate sectors are balanced out by harmful emissions related to BECCS and direct air CO₂ capture with storage (DACCS)

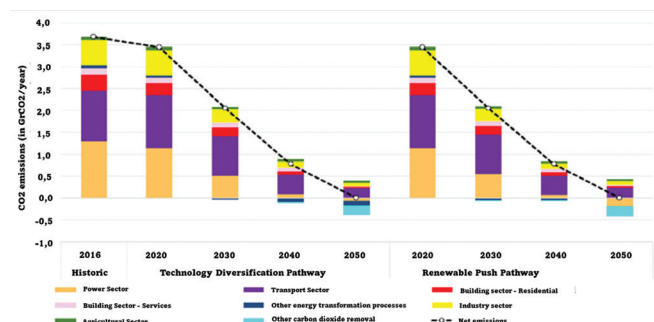


Figure 2: Evolution of the CO₂ emissions between 2016 and 2050.

(transport and industry). Due to the growing use of BECCS, the power sector's net CO₂ emissions will reach roughly 75 Mt CO₂ in TD and 195 Mt CO₂ in RP in 2050. The potential for DACCS to remove carbon dioxide also grows dramatically throughout this time, with 2050 seeing 225–235 Mt CO₂ of harmful emissions.

In this research, we examine the potential and current contributions of artificial intelligence (AI) as a technology in the fight against climate change. It is both conceivable and desirable to use AI to combat global climate change, but doing so requires making a sacrifice (ethical hazards and maybe a higher carbon footprint) in exchange for a huge benefit (a more effective reaction to climate change) (Cowls et al., 2021). Using greener, more sustainable, and more effective solutions, AI may assist in advancing and broadening our knowledge of the subject. AI is also becoming an increasingly important component of a set of answers necessary to tackle the climate issue (Gabrielli et al., 2020; Matemilola et al., 2020) effectively.

This study seeks to give a broad overview of the areas, where AI can be used to great advantage in the struggle over climate change, either through excellent engineering or ground-breaking research. The objectives of this paper are listed as follows:

- Educating and creating awareness as to why large-scale sustainability is so important for individuals or organizations.
- Scoping the Net Zero strategy and deciding for Scope 1, 2 or 3.
- Collecting the data for carbon footprint evaluation.
- Calculating the carbon footprint based on the data collected to identify GHG emission sources and the related factors.
- Establishing the Sustainability policy position
- Setting Science based (using AI tools/techniques) targets to achieve Net Zero goals.
- Keeping track and measuring (using AI tools/techniques) the set goals.

Artificial intelligence (AI) is increasingly being used in the energy industry to improve various processes, including energy generation, distribution, and consumption. AI can help to optimise energy production and distribution by predicting demand and adjusting energy production accordingly, reducing energy waste and inefficiencies. Additionally, AI can be used to improve energy efficiency in buildings and homes, by using smart systems to control heating and lighting, for example.

In the energy industry, AI algorithms can be used to analyse data from various sources, such as weather patterns, energy consumption patterns, and energy production data. This data is then used to make predictions about energy demand and to optimise energy production and distribution accordingly. AI can also help to identify issues and inefficiencies in the energy system and suggest solutions to improve energy efficiency. Artificial intelligence (AI) is being increasingly used in the energy industry to optimize various processes, improve operational efficiency, reduce costs, and enhance the overall performance of energy systems. Following are some of the areas where AI is being applied in the energy sector:

Predictive Maintenance: AI-powered predictive maintenance systems analyze data from sensors and devices to predict equipment failures, allowing energy companies to proactively address potential problems before they occur.

Smart Grid Management: AI algorithms are used to manage the distribution of energy, balance supply and demand, and ensure efficient use of resources.

Renewable Energy Optimisation: AI algorithms are used to optimise the performance of renewable energy systems, such as solar and wind power plants, by predicting output and adjusting production in real-time.

Energy Efficiency: AI is being used to improve energy efficiency in buildings and industrial facilities by optimizing heating, cooling, lighting, and other systems.

Oil and Gas Exploration: AI algorithms are used to analyse large amounts of data from seismic surveys, well logs, and other sources to identify the most promising areas for oil and gas exploration.

These are just a few examples of how AI is being used in the energy industry. Technology continues to evolve and is expected to play an increasingly important role in the sector in the coming years.

Structure of the Paper

The remainder of the paper is structured as follows: In Literature Review, a review of existing literature is presented. Section: AI-Based Methods for Net Zero provides an in-depth analysis of AI-based methods for achieving Net Zero, and Section: AI-Based Methods for Net Zero outlines the challenges and potential for future research in this field. Finally, the study concludes with a summary of the key findings and their implications.

Literature Review

Baba et al. (2020) proposed the back-propagation artificial neural networks (ANN) model to forecast CO₂ emission expenditure. The amount of bagasse, wood, and marine fuel oil utilised in the boiler machine is among the input variables that the model was created based on. This study's goal is to keep track of the CO₂ emissions based on the fuel used to run the boiler. The Sugar Industry provided the data that was used to test the models. It divides into 90% of the training set and 10% of the test dataset. To determine the ideal ANN model parameters, a trial-and-error methodology was used in the model experiment. The trained ANN's validity is assessed using the Root Mean Square Error (RMSE), which has an error value of 0.055. It shows that even the tiniest error can lead to more accurate predictions and even have an impact on industrial practice, particularly when it comes to assisting the executive manager in making decisions for business operations while considering the cost of CO₂ monitoring. This ANN model may be used with artificial intelligence (AI) and optimisation approaches to increase prediction accuracy in future studies.

Cowls et al. (2021) examined how AI may help the battle against climate change, the ethical issues that arise during this process and the computing requirements for AI development present several issues concerning energy use and GHG emissions.

Gabrielli et al. (2020) advised that in order to enable a carbon-neutral EII industry in a world with net-zero CO₂ emissions, this contribution offers a general explanation and a comparative statistical evaluation of three technological chains. In addition side, they emphasise that the carbon capture and storage route provides the opportunity to use existing systems and infrastructure facilities, without having to entirely reshape the chemical industry, and eliminate carbon dioxide from the air, thus showing an essential element not simply in the Net Zero-CO₂ emissions world researched here, as well as in a net-negative-CO₂ emissions world.

Bloomfield et al. (2021) suggested artificial intelligence (AI) technology development and application in the medical field is a new field. The National Health Service (NHS) England must develop and implement a systematic framework for evaluating the climate impact of AI technologies employed in the healthcare system, building on existing studies. More research is required to determine where and how these tools could be most helpful in decreasing emissions

associated with the NHS, even though there is a lot of potential for applying AI to improve the health system, management, and public health.

Bengio et al. (2022) explained how machine learning (ML) can be an effective tool for cutting emissions of greenhouse gases and assisting society in adapting to a changing environment. We find high-impact issues where existing gaps can be solved by ML, in combination with various sectors, ranging from smart grids to disaster management. They urge the ML community to support the international campaign to combat climate change.

Dhar et al. (2020) defined the role artificial intelligence (AI) plays in climate change has drawn criticism, especially from IT employees who participated in the 2020 worldwide climate strike. A friendly artificial intelligence infrastructure can be adopted, and tools to measure the carbon footprint of machine learning techniques can be developed.

Mulligan and Elaluf-Calderwood (2022) discusses the ethical ramifications of AI in relation to global warming. It has not yet been thoroughly discussed how AI contributes to climate change and the ethical ramifications of its participation in an unfair distribution of impacts on the environment, people, flora, and fauna. In this study, the authors discuss some of the challenges surrounding AI and climate justice and offer a framework for measuring the genuine environmental impact of the ICT and AI sectors, as well as a suggested organisational structure and future research directions for this vital subject.

Coeckelbergh (2021) identified and explored several concerns, focusing on themes about freedom and justice on a global scale. It also makes a case for the responsible use of AI for climate change.

Hermann et al. (2021) proposes a revolutionary approach to chemical research and development supported by AI and ethical standards that take the sustainability of the research process and results into account. To advance social and environmental good and sustainability while preventing any loss for all stakeholders affected, ethical principles must go hand-in-hand with research and development powered by artificial intelligence, especially in circumstances where ethics are essential.

Nguyen et al. (2017) examined how innovative technologies can lower carbon emissions. An intelligent and knowledge-based system called Autoflow has been developed to help: (i) It monitors and predicts carbon emission level from water consumption in real-time and (ii) suggest options for reducing water consumption

and carbon emission. This is due to the increasing deployment of Smart water meters across Australia over the past five years. This Autoflow system, which relies on intelligent algorithms like Dynamic Time Warping, Hidden Markov Model, Dynamic Harmonic Regression, and Artificial Neural Network, has the potential to spread outside of Australia very shortly to sustain the world's finite water supply and environment.

Kaack et al. (2022) present a paradigm with three categories for categorising the consequences of machine learning (ML) on greenhouse gas emissions: (A) compute-related impacts, (B) immediate impacts of ML application, and (C) system-level impacts. Using this approach, the author evaluates and prioritises research and data requirements for impact assessment and scenario. Analyse and pinpoint key policy levers.

Chen et al. (2022) findings show that: (1) artificial intelligence has a significant inhibitory impact on carbon emission frequency; (2) the carbon reduction effect of AI is more significant in super- as well as megacities, big cities, and urban areas with better infrastructure and modern technology; (3) artificial intelligence reduces carbon emissivity. China should work harder to implement AI in production and life, build infrastructure, conserve energy, and reduce emissions, especially in developed cities, to reach carbon peaking and carbon neutrality as soon as possible throughout economic development.

Nathanael et al. (2021) said that modern CO₂ capture, conversion, and utilisation methods are briefly discussed in this article—the development of numerous carbon capture technologies, including membrane, biological, and adsorption. Additionally, there is a thorough discussion of the transformation of CO₂ into significant products using single-atom catalysts, plasma technology, metal-organic frameworks (MOFs), and covalent organic frameworks (COFs). As they provide material design freedom to improve CO₂ conversion efficiency, MOFs and COFs have drawn a lot of attention. Plasma technology hasn't gotten as much attention as the other technologies, but it can increase conversion rate, as shown. Commercial innovations that use CO₂ must balance performance improvement and environmental advantages. Opportunities and pilot-scale research programs have also been commented on.

Stern and Valero (2021) cites theoretical and empirical data about the possibilities, forces, and strategies for innovation-led sustained development. Additionally, they emphasize the significance of a coordinated system of long-term policies and institutions that can support and encourage private sector investments in

clean innovation and assets swiftly and on a large scale. They are motivated by Chris Freeman's research on the systemic drivers of innovation and his early idea of achieving a green environment through growth reorientation.

Jun et al. (2022) examined the impact of AI on carbon intensity using data from the Chinese industrial sector from 2005 to 2016 and the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. The empirical findings demonstrate that AI considerably lowers carbon intensity when measured separately by the industrial use of robotics and the number of scholarly papers linked to AI. After endogenous problems have been addressed, the results are still strong. We discover that the impacts of AI on carbon intensity vary between industries and developmental stages. Compared to the 11th Five-Year Plan, AI had a more significant impact on reducing carbon intensity during the 12th year. Compared to capital-intensive businesses, labor- and technology-intensive industries tend to experience a greater carbon intensity decrease due to AI. The government should encourage the research and deployment of AI and establish tailored policies in line with industry characteristics to increase the effects of AI on reducing carbon intensity.

Chen et al. (2021) suggested that in order to examine the effects of occupant density for different types of office buildings, this research suggests an energy and carbon footprint modeling technique utilizing artificial intelligence. They simulate energy use with EnergyPlus and calculate the associated CO₂ emissions using weather data from the last three years (2016–2018) of the Actual Meteorological Year (AMY). In order to assess the annual energy usage and CO₂ emission, several occupant densities were considered. This study developed a strong long short-term memory (LSTM) model to forecast time-series CO₂ emissions and energy consumption. In order to correlate the behaviour of annual energy use and CO₂ emissions for occupant densities ranging from 10 to 100 m²/person for each type of office building, a power exponential curve was proposed. The findings of the LSTM model demonstrates strong prediction performance and little variances across the three types of office building data, which may be used to predict and optimise energy consumption and CO₂ emission in a comparable building model.

Hanto et al. (2021) analyses how decarbonisation would affect South Africa's energy sector and associated employment. Two energy mix scenarios are projected together with the employment consequences at the

provincial level using the cost-minimising, global energy system model (GENeSYS-MOD). In contrast to the business as usual (BAU) scenario, which assumes that coal will continue to be used in South Africa's power sector until 2050, the 2°C scenario assumes that coal will be phased out by 2040 and that power generation will be more diverse, with solar and wind power generation taking the lead.

Boris et al. (2020) addressed the carbon loop problem in a highly interconnected energy system caused by increasing penetration of biomass and carbon capture, use, and storage. This article proposes a novel modeling approach by introducing carbon layers with specifications on the significant carbon sources and sinks based upon an optimisation algorithm. In support of long-term policy-making for sustainable development, this study makes a contribution to measuring the biogenic and nonbiogenic carbon emissions and optimizing the circular economy linked to a net-zero-emission society.

Yilmaz and Karakoc (2008) Examined global warming within the context of sustainability. The sustainability management-based model and global warming factor scoring system have been established to combat global warming. The Cgw (Sustainability Management Model to Global Warming) model was proposed as a practical means for a systematic and successful managerial response to the global warming problem. In the holistic management idea that is taken into account in the Cgw model, every aspect has two dimensions: threat and opportunity.

Wesseling et al. (2017) described EPIs' sociotechnical and innovation systems in terms of industrial structure, innovation strategies, networks, markets, and governmental actions. This research places EPIs within the transition literature. They next investigate how these traits might affect the transition to deep decarbonization, highlight gaps in the knowledge, and develop a plan for future transition research on EPIs while taking policy implications into account. In addition to enhancing policy considerations for attaining deep decarbonization, expanding this field of study would also advance transitions theory because the particular EPI characteristics are anticipated to produce novel patterns in transition dynamics.

Gilley et al. (2017) investigated the possible governance approaches that combine politics, policy, and administration are necessary to cut GHG emissions. In China (Guangzhou) and India (Gujarat), where integrated governance solutions are employed, this is

reduced at the local level through various links. It is a state society mainly tied to India, while it is primarily intra-governmental linkages in China. International talks on emissions targets have no substantial impact in either situation, whereas national frameworks barely make a difference. This comparative approach makes it easier to understand how greenhouse gas governance functions in each nation, the lessons it can teach about central-local environmental relations and the implications it has for international aid.

Recent studies have focussed on the use of AI to integrate renewable energy sources and optimise energy usage in industrial processes, particularly in the chemical industry, to reduce emissions and promote sustainability. While AI has shown potential in reducing CO₂ emissions, it is only one component of a larger strategy that requires a multi-faceted approach.

Several studies have been conducted to examine the usefulness of AI in reducing CO₂ emissions in the chemical industry.

Here is a list of some previous studies carried out to assess the usefulness of AI as a tool for reducing CO₂ emissions from chemical industry factories:

"Artificial intelligence for energy efficiency: A case study in a chemical plant" by Cossentino et al. (2020) examines the use of AI-based control systems to improve energy efficiency and reduce emissions in a chemical plant.

"AI-driven optimisation of energy systems in the chemical industry: A review" by Zhang et al. (2019) provides a comprehensive overview of AI-based methods for energy optimisation and carbon reduction in the chemical industry.

"Reducing CO₂ emissions in the chemical industry using artificial intelligence" by Lin et al. (2018), discusses the use of AI algorithms for predicting emissions and identifying opportunities for reduction in chemical production processes.

"AI for sustainability: An assessment of artificial intelligence applications for reducing greenhouse gas emissions" by Kim et al. (2017) evaluates the potential of AI technologies for reducing emissions and achieving sustainability in various industries, including the chemical industry.

"Artificial intelligence and the chemical industry: An assessment of the potential for reducing greenhouse gas emissions" by Alonso et al. (2015), who investigated the use of AI for reducing emissions in the chemical industry and identify areas for future research.

These studies highlight the potential of AI as

a tool for reducing CO₂ emissions from chemical industry factories and achieving global net-zero CO₂ emissions. However, they also acknowledge that the implementation of AI-based solutions requires careful consideration of factors such as data quality and accuracy, system scalability, and regulatory issues.

AI-Based Methods for Net Zero

United Nations is currently prioritising the reduction of non-renewable resource consumption and implementing measures to minimise harmful emissions that cause irreversible environmental changes, such as climate change, floods, storms, and earthquakes. The continuous emission of greenhouse gases (GHG) into the atmosphere has caused an imbalance in nature, which has led to a significant increase in CO₂ emissions. According to Table 1, China generates the highest amount of CO₂ emissions, with the United States and India following in second and third place, respectively. The consequences of these emissions are detrimental to both humans and the environment, causing long-term harm to future generations and wildlife. Thus, there is an urgent need to control GHG emissions.

Table 1: CO₂ emissions of different countries across the world (Ghosh et al., 2021)

Rank	Country	Emissions in 2017 (MtCO ₂)	% of Global Emissions
#1	 China	9,839	27.2%
#2	 United States	5,269	14.6%
#3	 India	2,467	6.8%
#4	 Russia	1,693	4.7%
#5	 Japan	1,205	3.3%
#6	 Germany	799	2.2%
#7	 Iran	672	1.9%
#8	 Saudi Arabia	635	1.8%
#9	 South Korea	616	1.7%
#10	 Canada	573	1.6%
#11	 Mexico	490	1.4%
#12	 Indonesia	487	1.3%
#13	 Brazil	476	1.3%
#14	 South Africa	456	1.3%
#15	 Turkey	448	1.2%
	 Top 15	26,125	72.2%
	 Rest of World	10,028	27.7%

In response to this, the Net Zero initiative has been launched to reduce GHG emissions, with many countries aiming to achieve this target within a few decades. Figure 3 displays the country-wise statistics of the net zero target, highlighting the challenging nature of achieving such targets. It requires significant

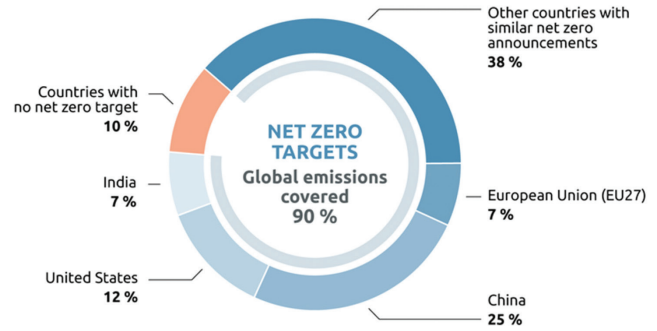


Figure 3: Country-wise net zero targets.

effort from both the governing bodies and society to accomplish the goals set by the initiative.

AI has emerged as a game-changing technology that can revolutionise how complex tasks are automated and simplify survival. It presents an opportunity to minimise resource wastage and optimize renewable resource usage. AI has a broad range of applications, from building automation to making smart cities. For instance, buildings can be optimised for efficiency by reducing water and electricity consumption, and AI systems can track this to reduce overall resource consumption. In the same vein, AI can be leveraged to optimise transportation by identifying the shortest paths to destinations, thereby reducing the use of fossil fuels. AI can also help regulate the usage of non-renewable resources, promote the use of green energy, and optimise energy-intensive industries such as hydro, chemical, coal, and aluminum plants to minimise energy loss. For example, machine learning algorithms can be used to increase the efficiency of wind energy utilisation. These are just a few scenarios where AI can be a powerful tool to achieve net zero emissions by the set target years, as shown in Figure 4.

A model for achieving net zero using AI is depicted in Figure 5. The process begins by collecting and analysing various atmospheric parameters, such as temperature, pressure, rainfall, flood frequency, and more, to establish a dataset for future analysis and prediction. An AI model is trained using this dataset through AI-based methods that learn from the input data and apply that knowledge to future predictions. The AI model can optimise resource usage to achieve the most efficient outcome. Results obtained from the AI model are verified, and predictions are made for unobserved data. The tool is then used for the specified area, where it can be utilised for resource management and energy optimisation based on the model's predictions.

AI is increasingly being used to address the challenge of achieving zero emissions and combating climate

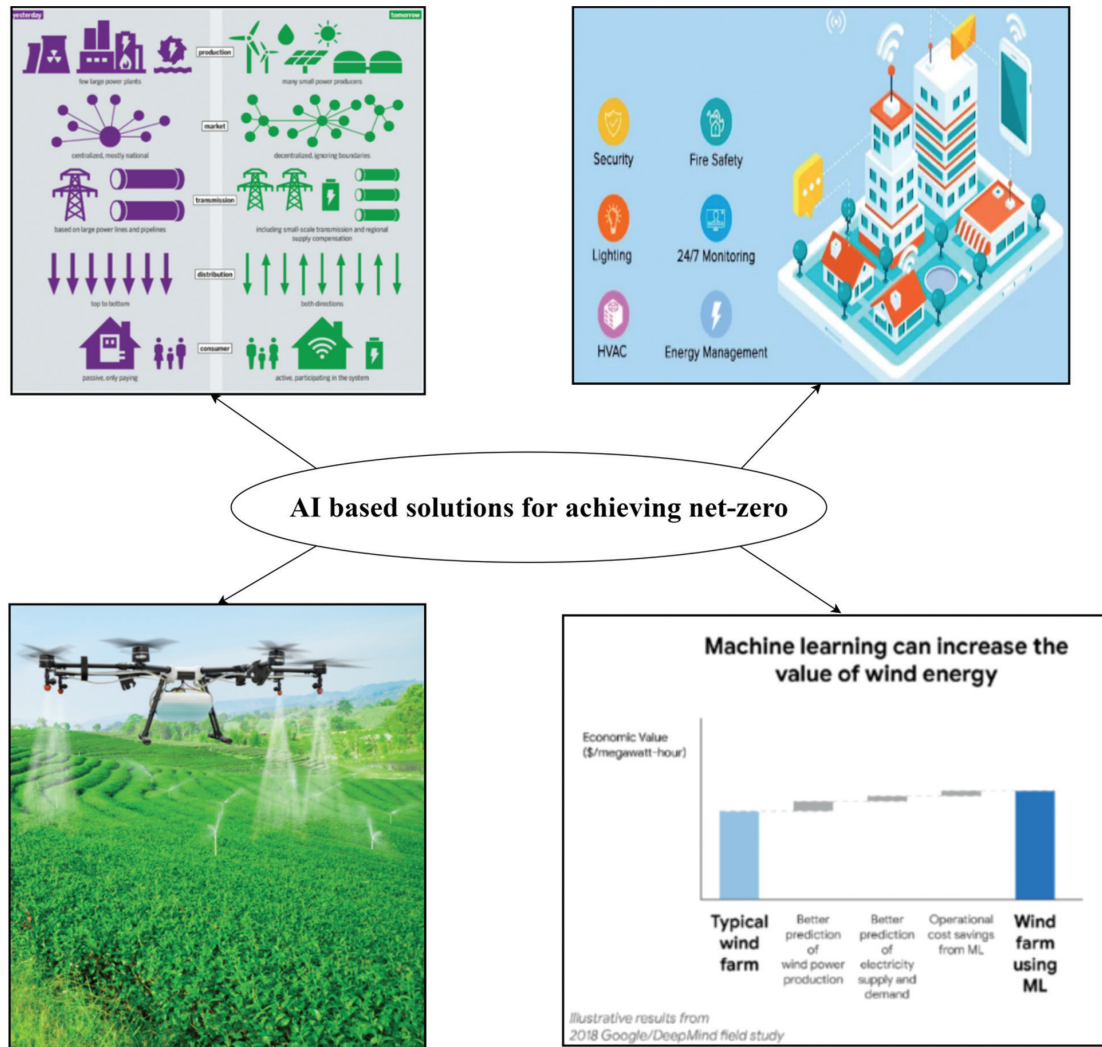


Figure 4: AI based solutions to achieve net zero emissions.

change. Researchers from academia and industry are collaborating on solutions that leverage machine learning and other algorithms to optimise the use of non-renewable resources, track greenhouse gas emissions, forecast energy usage, and improve energy storage and conversion. For example, Google's DeepMind developed an AI-based wind power forecast service, while the Open Catalyst project aims to identify low-cost electrocatalysts for converting renewable energy to storable forms. These and other initiatives demonstrate the potential for AI to play a critical role in achieving a sustainable, net-zero future.

AI technologies can play a critical role in developing sustainable agriculture systems. With agriculture being a major consumer of non-renewable resources such as water and soil, it's essential to optimise their usage. Prediction methods can help with better field monitoring, reduced water wastage, pest and soil

management, and sustainable irrigation processes. Figure 6 illustrates the AI technologies that can be utilised in sustainable agriculture (Bhagat et al., 2022).

Challenges and Future Scope

Artificial Intelligence (AI) has the potential to play a significant role in reducing greenhouse gas (GHG) emissions in Energy-Intensive Industries (EIIs) such as the chemical industry. Process optimization is one of the key areas where AI can be used to reduce emissions in this industry. By using AI algorithms to monitor and analyze process data in real-time, organisations can identify opportunities to reduce energy consumption and emissions. This can include optimising equipment usage, adjusting operating conditions, and identifying inefficiencies in the production process. AI-powered supply chain optimization can also help to reduce

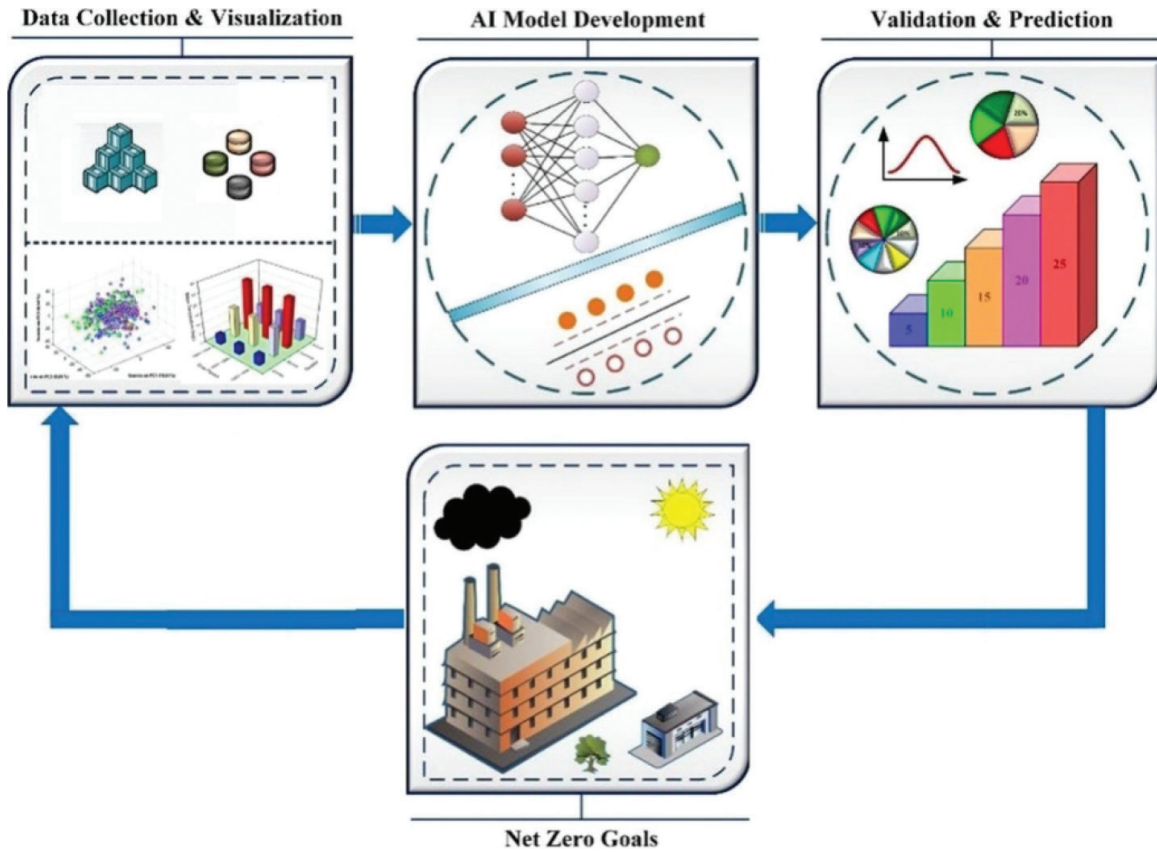


Figure 5: A basic prototype of AI deployment to achieve net zero goals.

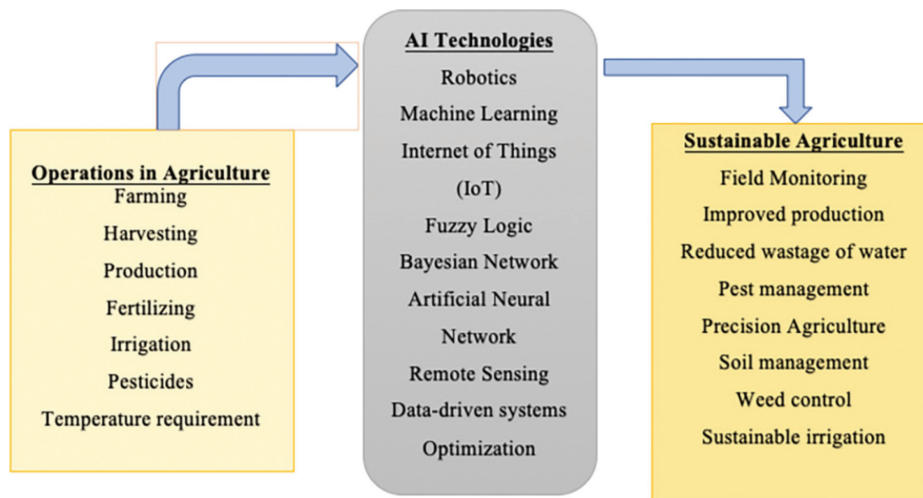


Figure 6: AI technologies for sustainable agriculture system.

emissions associated with transportation and material handling.

Another area where AI can make a significant impact is carbon capture and storage. Carbon capture and storage systems are critical in reducing GHG emissions from industrial processes. AI algorithms can be used to monitor and optimize these systems, improving their efficiency and reducing emissions.

However, implementing AI in the chemical industry can present challenges, such as the cost of implementing new technology, data management, and cybersecurity risks. To address these challenges, companies can work with experts to develop a strategic plan for implementing AI, ensuring that data is properly managed and secured.

Furthermore, it is essential to have government regulations in place to reduce the usage of non-

renewable resources by EII. This can help to incentivise companies to adopt AI-powered technologies and reduce their carbon footprint. Additionally, creating awareness and educating the public on the importance of reducing emissions can help to support more efficient governance and create a more innovative environment. In the future, the use of AI in combination with smarter living and policies can lead to sustainable growth and reduce GHG emissions in the chemical industry.

Conclusion

Climate change and the need to reduce greenhouse gas (GHG) emissions are critical issues of our planet. Achieving net zero emissions, where the amount of GHG emissions released into the atmosphere is balanced by the amount removed, is a crucial goal in mitigating climate change. The chemical industry, being one of the most energy-intensive industries, has a significant role to play in achieving this goal.

Several strategies can be employed to achieve net zero emissions in the chemical industry, including AI-based methods. Predictive maintenance using AI can help in predicting equipment failures, reducing downtime and energy waste. AI algorithms can optimise energy consumption in real-time, reducing overall energy usage. Demand response management using AI can balance supply and demand and reduce peak energy consumption. AI can be used to manage renewable energy sources such as wind and solar power, ensuring their integration into the energy grid. Carbon capture and storage can be optimised using AI, reducing the amount of CO₂ released into the atmosphere. Building energy management using AI can reduce energy waste and increase efficiency, while AI can optimise industrial processes, reducing energy consumption and waste.

Energy efficiency is another crucial strategy for reducing GHG emissions in the chemical industry. This can be achieved by using better equipment, modernising facilities, and implementing energy-saving practices. Investing in renewable energy sources such as wind, solar, hydro, and geothermal power to replace fossil fuels is another effective strategy. Capturing carbon dioxide emissions from industrial processes and storing them underground using carbon capture and storage (CCS) can help prevent their release into the atmosphere.

Implementing advanced energy management systems (EMS) that monitor and control energy usage in real-time can reduce waste and optimise performance. Green procurement practices, including procuring

energy-efficient products and services and sourcing raw materials from sustainable sources, can help reduce the industry's carbon footprint. Encouraging employees to adopt sustainable practices in their daily work and personal lives is another effective strategy. Implementing sustainable practices throughout the supply chain, including the use of sustainable transportation and the reduction of waste, can also help achieve net zero emissions in the chemical industry.

In addition to these strategies, electrification of energy-intensive processes such as transportation and heating can also reduce GHG emissions. Sustainable land use and forest management practices, such as reforestation and sustainable agriculture, can help remove carbon dioxide from the atmosphere and store it in vegetation and soil. Green finance can accelerate the transition to a low-carbon economy and support the development of clean energy solutions.

By combining these strategies, the chemical industry can significantly reduce its energy consumption and achieve net zero emissions while contributing to a sustainable future. The industry needs to prioritise and implement these strategies to mitigate the effects of climate change and achieve a sustainable future.

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