



Optimization of Carbon Dioxide Emissions Reduction Using Artificial Intelligence: A Review for Industrial and Electric Vehicle Perspectives

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ABSTRACT

Artificial intelligence systems are revolutionizing how industries reduce carbon dioxide emissions in numerous business fields. This study combines research on how artificial intelligence merges with carbon reduction methods, specifically in industrial procedures and electric vehicle manufacturing, with an environmental sustainability focus. Multiple empirical studies and advanced AI models provide insight into sustainability effects caused by AI systems and emission decrease processes. AI technology performs three essential functions: enhancing energy optimization, promoting eco-friendly research, and improving environmental prediction accuracy. The identified information provides essential guidance to policymakers and industrial leaders about AI applications for achieving zero emissions and sustainability targets. The review presents evidence that AI technology can redefine sustainability throughout vehicle production while managing transportation and other fields, thus helping solve escalating climate issues and drive eco-friendly developments.

Keywords: AI ▪ Carbon emission reduction ▪ Industrial processes ▪ Electric vehicles ▪ Sustainability ▪ Energy efficiency

1. INTRODUCTION

One of the genuine tools produced for global challenges is artificial intelligence (AI), which revolutionizes processes in reducing carbon dioxide emissions in various industries. AI structures are largely emerging to offer better solutions integrating the value of incorporating and optimizing energy efficiencies, stimulating environmentally friendly innovation, and improving accuracy in predicting emissions as the timeliness of energy generation vis-a-vis climate change becomes critical. This review examines the interface between AI and strategies to reduce carbon emissions, especially concerning their application in industrial processes and the production of electric vehicles (EVs). The review comprises empirical

studies and advanced AI models analyzing the effects of AI on sustainability while outlining major propositions for emission reduction mechanisms. The findings serve as guidance for policymakers and industrial leaders seeking to use AI to achieve net-zero emissions and sustainability.

The document extensively reviews artificial intelligence collaboration with carbon reduction methods with a focus on environmental sustainability outcomes. Due to increasing climate change and environmental deterioration, industries have become increasingly interested in technological approaches that lower their carbon emissions. AI-powered solutions play a central role within the automotive industry by optimizing procedures while enabling electric vehicle emission

reduction, energy management, and precise carbon emission prediction [1, 2].

The research demonstrates how AI leads to better energy efficiency, more innovative green practices, and more precise carbon-emission measurement. Research conducted in China demonstrates that implementing AI systems can follow a pattern in which low and high implementation levels emit more carbon than moderate amounts. AI can create higher emissions during its initial period because of heavy resource usage. However, it minimizes overall emissions through improved energy efficiency, optimized factor-market distribution, and industrial-structure change during technological maturity. Resource-based cities and highly industrialized areas show strong evidence of this phenomenon, whereas it remains weaker within non-resource cities and regions with lower industrialization levels [3, 4].

AI also acts as a catalyst for achieving net-zero emissions in manufacturing production. Recent studies using Chinese manufacturing-firm data confirm that artificial intelligence enables digital transformation toward low-carbon development. Emission reductions are boosted by combining green technological innovation with management practices and product-development initiatives. This strategic connection shows that AI technology can build intelligent manufacturing methods that meet environmental sustainability standards [5, 6].

The work further studies sophisticated AI prediction models for vehicle carbon dioxide emissions through deep learning structures, including LSTM and BiLSTM models. These predictive models demonstrate high accuracy when analyzing datasets containing complete vehicle parameters, including engine characteristics, fuel-consumption measurements, and fuel options. AI-powered predictive systems can therefore operate as policy-support tools that help administrators establish data-based environmental regulations [7, 8].

This review also explores the manufacturing and transportation sectors' use of industrial intelligence systems while examining their general effects on business carbon utilization. Implementing industrial intelligence improves production performance while simultaneously decreasing carbon emissions and total emission levels. Evidence from regions such as the Yangtze River Delta and Pearl River Delta indicates that the benefits of industrial intelligence vary across sectors and geographical areas [9, 10].

Finally, the introduction stresses that sustainable development goals require the integration of pollution-control initiatives with carbon-reduction frameworks. Integrating AI with climate finance can reduce carbon inequality between nations by transforming energy operations and industrial distribution. AI-supported energy-management systems for EVs can enhance thermal-energy use and operational performance in different climate conditions [11, 12, 13].

2. LITERATURE REVIEW

The convergence of AI-carbon-reduction strategies has become a central theme in environmental sustainability. With growing concerns about climate and environmental degradation, industries worldwide are turning to technology to help reduce their carbon footprints. Within the automotive sector, AI-powered solutions are examined for optimizing operations

and reducing emissions in the production of electric vehicles, energy management, and forecasting carbon emissions. This literature review presents studies indicating how AI can improve energy efficiency, promote green innovation, and ensure higher accuracy in predicting carbon emissions. The findings highlight that AI can transform sustainability across various industries, particularly vehicle manufacturing and transportation.

AI is a tool for energy transformation and global promotion of green and low-carbon goals. Liu et al. [4] empirically analyzed the impact of AI on carbon emissions and its mechanism through panel data from 285 prefecture-level Chinese cities during 2011–2022. The results revealed an inverted U-shaped relationship between AI and carbon emissions, meaning that AI first increases emissions and then reduces them. The study identifies three main channels through which AI affects carbon emissions: improving energy efficiency, optimizing the allocation of factor markets, and restructuring industrial composition. Heterogeneity analysis shows that this dynamic is significant in resource-based cities, low-carbon pilot regions, and highly industrialized areas, but weaker in non-resource cities, non-pilot regions, and less industrialized regions.

Carbon dioxide emissions have become a universal phenomenon during the industrial era, and net-zero emissions in manufacturing are essential for combating climate change while offering avenues for sustainable development. Liu et al. [5] examine the effect of AI on carbon emissions in manufacturing through data from Chinese A-share listed manufacturing firms from 2012 to 2021 using a fixed-effects regression model. The paper underlines AI as a principal digital-transformation driver toward low-carbon development inside organizations. It shows that the integration of AI technology can significantly reduce carbon emissions. Green technological innovation, management innovation, and product innovation buffer and amplify the positive effect of AI adoption on emission reduction.

Fossil-fuel combustion produces massive carbon dioxide emissions that alter the atmosphere and disturb climatic parameters. Alam et al. [1] present an advanced AI technique for a predictive modeling framework for vehicle-related CO₂ emissions. The authors build deep-learning models based on long short-term memory (LSTM) and bidirectional LSTM (BiLSTM) architectures using a dataset containing parameters such as vehicle class, engine size, fuel type, and fuel-consumption metrics. The dataset is divided into training and testing subsets, and performance is measured using MSE, RMSE, Pearson's correlation coefficient, and coefficient of determination. The BiLSTM model outperforms LSTM, achieving high predictive accuracy and demonstrating robustness for CO₂ emission estimation.

The influence of industrial intelligence on corporate carbon performance is investigated using micro-level data from 1,072 listed manufacturing companies in China's A-share market from 2012 to 2021. As outlined by Niu et al. [3], industrial intelligence combines AI, the Internet of Things, and big-data analytics in industry, significantly improving corporate carbon performance as measured through carbon intensity and total emissions. The net effect favors emission reduction, with production-efficiency improvement exerting a strong

influence. The reduction effect is more pronounced in heavy and moderate carbon-intensity sectors, while regional differences show larger gains in the Yangtze and Pearl River Delta regions than in the Beijing–Tianjin–Hebei region.

Industrial robots and intelligent manufacturing also contribute to environmental sustainability. Lv et al. [9] show that industrial robots reduce carbon emissions and particulate matter through green technological innovation and energy efficiency. Ding et al. [14] examine whether AI is associated with carbon-emissions reduction in China, while Xu et al. [10] consider whether industrial intelligence can promote carbon-emission reduction toward sustainable development. Together, these studies suggest that AI-oriented industrial transformation can support both productivity and environmental goals.

At the global level, Cao et al. [15] investigate whether artificial intelligence technology can reduce carbon emissions from a worldwide perspective. Their findings indicate that AI can reduce emissions through energy-efficiency improvement and technology changes, with stronger effects in developing countries and regions highly dependent on fossil fuels. Zhao et al. [13] further show that AI and industrial-robot applications can influence carbon-emissions inequality through structural changes in energy and industry. These results emphasize that AI policy must account for national capacity, industrial structure, and financing differences.

In electric-vehicle contexts, AI-driven energy-management systems can optimize thermal-energy use and operational efficiency. Wang [11] presents an intelligent energy-management approach based on AI algorithms and thermal-energy optimization. Gu et al. [12] examine the relationship between AI and new-energy vehicles and show that short-term synergy can exist between AI and EV growth, whereas mid- and long-term challenges may arise from resource competition and policy uncertainty. Greene et al. [16] and Syed [17] also highlight the importance of lifecycle thinking, carbon accounting, predictive analytics, and zero-carbon manufacturing frameworks in transportation and automotive production.

As summarized in Table 1, the reviewed research establishes AI participation in emission reduction through improved energy efficiency, industrial transformation, and sophisticated predictive systems. AI adoption can have asymmetric effects on emissions, with an initial upward trend before lasting reductions. BiLSTM and integrated ML/DL frameworks help transportation-sector personnel make more accurate emissions predictions to support evidence-based policy choices. AI applications in industrial intelligence and EV energy-management automation demonstrate technology's ability to optimize sustainability. Nevertheless, resource competition, scalable implementation, data accuracy, and global disparities remain essential challenges.

3. DISCUSSION

Artificial intelligence represents a revolutionary tool for dealing with global carbon-emission problems, demonstrating its most significant impact on industrial facilities and transportation systems. The reviewed research shows how AI improves energy efficiency, green-innovation capabilities, and emission-forecasting accuracy. A study of cities throughout China demonstrates that AI deployment can follow an in-

verted U-shaped pattern regarding carbon emissions: at an early stage AI raises emissions, but it transitions to substantial reduction through improved industrial operations and energy-optimization strategies. Environmental-sustainability benefits therefore require integrating AI within broader sustainability plans [4].

The manufacturing industry heavily depends on AI because it accelerates digital transformation toward low-carbon development. Adoption of AI by Chinese manufacturing companies leads to emission reduction because AI fosters green technological innovation and enables better management practices and product-development tactics. These findings give intelligent manufacturing strategic value because it can achieve productivity while supporting environmental sustainability. AI speeds up the creation of green technologies, enabling companies to pursue net-zero emissions targets without sacrificing competitive performance [5, 6].

The dedicated use of artificial intelligence in predictive modeling demonstrates its capability to calculate vehicle carbon dioxide emissions accurately. Deep-learning architectures, including LSTM and BiLSTM, provide accurate results when processing datasets containing vehicle information such as engine specifications, fuel characteristics, and fuel-usage measurements. These predictive models work as decision-making systems that support environmental policies through data-based emission-trend analysis. The success of this predictive framework indicates that AI is critical in developing sustainable transportation solutions [1, 7, 8].

Modern businesses have achieved better carbon performance by adopting industrial-intelligence systems that blend artificial intelligence technology with the Internet of Things and big-data analysis. Various studies demonstrate that industrial intelligence increases efficiency and decreases carbon-emissions intensity and total emissions released during production. Improvements in carbon management are stronger in the Yangtze and Pearl River Delta regions than in the Beijing–Tianjin–Hebei region. This evidence demonstrates why organizations need customized strategies that resolve regional and sector-based obstacles to achieve optimal carbon reduction through industrial-intelligence applications [3, 9, 10].

Reducing international carbon inequality becomes more powerful when AI technology is combined with climate-finance initiatives. Research confirms that AI technology decreases emissions between regions because it changes energy systems and industrial structures, particularly in developing countries that use more fossil fuels. The collaborative force between AI and climate finance demonstrates why organizations must unite around fair climate solutions. Public officials should use financial approaches alongside digital innovations to solve sustainability challenges worldwide [15, 13].

The evaluated research shows that artificial intelligence can help carbon reduction, yet future success depends on solving technology limitations and coordinating policy areas and regions worldwide. Additional research should concentrate on implementing large-scale AI systems, improving technical data accuracy, and developing joint efforts among stakeholders to create complete carbon-neutral plans. Industrial organizations can establish a sustainable future through AI and sustainable practices that help combat climate change for future generations.

Table 1. Summary of Literature Review

Reference	Focus Area	Key Findings	Methodology
[4]	Impact of AI on carbon emissions in Chinese cities	Found an inverted U-shaped relationship; AI initially increases emissions but later reduces them through energy efficiency, factor-market optimization, and industrial restructuring.	Panel-data analysis of 285 prefecture-level cities in China (2011–2022).
[5]	AI's role in low-carbon manufacturing	AI significantly reduces manufacturing carbon emissions, with green technological, management, and product innovation amplifying this effect.	Fixed-effects regression using Chinese A-share listed firms (2012–2021).
[1]	Predictive modeling for vehicle CO ₂ emissions	BiLSTM models outperformed LSTM in predicting emissions, offering accurate tools for policy decisions.	Deep learning (LSTM/BiLSTM) on vehicle parameters and fuel-consumption data.
[3]	Industrial intelligence and corporate carbon performance	Industrial intelligence reduces carbon intensity and total emissions, especially in heavy/moderate carbon sectors and the Yangtze/Pearl River Delta regions.	Analysis of 1,072 Chinese A-share manufacturing firms (2012–2021).
[9]	Industrial robots and environmental sustainability in China	Industrial robots reduce carbon emissions and particulate matter, driven by green technological innovation and energy efficiency.	Two-way fixed-effect model on panel data from 30 Chinese provinces (2006–2020).
[15]	Global AI patents and carbon emissions	AI reduces emissions through energy efficiency and skill/routine-biased technological changes, with stronger effects in developing countries with high fossil-fuel dependency.	Empirical analysis of 30 countries (2005–2020) addressing endogeneity and robustness.
[13]	AI and carbon inequality across nations	AI development reduces carbon inequality, especially in high-inequality regions, synergized by climate finance and structural changes in energy and industry.	Generalized Method of Moments on 74 countries (2000–2019).
[11]	AI-driven energy management for EVs	AI optimizes thermal-energy use and EV operational efficiency under diverse climates with significant energy savings.	Machine/deep-learning models analyzing real-time driving data.
[12]	AI and EV market dynamics	Short-term synergy exists between AI and EV growth, but mid-to long-term challenges arise from resource competition; policy frameworks are needed.	Wavelet-based quantile-on-quantile regression analyzing AI and EV indicators.
[8]	ML/DL for vehicle emission prediction	Integrated ML/DL models improve emission-prediction accuracy by capturing nonlinear dependencies in vehicle data.	Advanced machine/deep-learning frameworks on high-dimensional vehicle data.
[17]	Zero-carbon EV lifecycle	Proposed AI-enabled technologies, including digital twins and predictive analytics, to decouple emissions from manufacturing and support stakeholder collaboration.	Conceptual framework and technological roadmap for sustainable automotive manufacturing.

4. CONCLUSION

The analyzed studies confirm that artificial intelligence functions powerfully to decrease carbon emissions throughout manufacturing sectors and transportation systems. AI technologies provide extensive opportunities to pursue global sustainability goals because they deliver energy-sustainability features and predictive emission-modeling capabilities. These capabilities make AI an essential tool for industries seeking to reduce environmental impact.

The complete realization of AI's potential to fight climate change demands the resolution of multiple obstacles. Implementing AI requires closing regional gaps, solving technological limitations, and establishing effective policy integrations. The sustainable use of AI depends on addressing these challenges because they determine its capacity to offer equitable and efficient benefits in different contexts.

Future investigations should concentrate on enlarging AI systems for wider application and boosting the accuracy of AI model input data. Better data precision and broader application fields will improve carbon-emission control and the reliability of sustainability programs that use artificial intelligence. Further development depends on continuous investment in data systems and AI exploration initiatives.

Strategic development toward carbon neutrality demands cooperation among researchers, policymakers, and industry leaders. Company partnerships will enable the successful creation and deployment of AI-based solutions to support universal sustainable-practice implementation. A cooperative method among stakeholders is vital to achieve major cuts in worldwide carbon emissions.

The reduction of global temperature rise requires businesses to unite sustainable practices with AI-based solutions. Strong outcomes arise when AI technologies connect with existing sustainable practices because this produces more effective environmental-conservation methodologies. The proactive

deployment of AI technologies and sustainable practices can help create safer and greener conditions for future generations.

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