

Abstract

IMPACT OF ARTIFICIAL INTELLIGENCE USE ON AIR POLLUTION

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Abstract

The rapid global advancement of Artificial Intelligence (AI) has positioned it as a critical driver of industrial progress. However, this digital transformation is accompanied by a significant environmental footprint that is often overlooked in mainstream discourse. The analysis examines the dual impact of AI on air pollution by employing a Life Cycle Assessment (LCA) methodology and a quantitative analysis of emission factors (EFi). Particular attention is given to the indirect environmental pressures generated by AI infrastructure, specifically data centers, which require massive amounts of electricity to power Graphics Processing Units (GPUs) during the training phases of deep learning models. In areas where the energy mix heavily relies on fossil fuels, these processes lead to significant emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter (PM), and carbon dioxide (CO₂).

A quantitative comparison between the energy systems of Serbia and the United States was conducted using specific emission factors. The results indicate that the environmental cost of training AI models is highly dependent on the sustainability of the local power grid. For instance, training a large language model such as Gemini requires approximately 1,600 MWh of energy. In Serbia, where coal-fired power plants dominate electricity generation, this process results in emissions exceeding 15 tons of SO₂ and 350 kg of particulate matter per model. In contrast, the same process in the United States generates approximately 260 kg of SO₂ and 14 kg of PM, corresponding to a more than 50-fold difference for certain pollutants. These findings highlight that the environmental impact of AI development is strongly influenced by the carbon and pollutant intensity of the underlying energy infrastructure.

The findings suggest that AI may act as a catalyst for the energy transition. AI systems can optimize smart grids, improve renewable energy forecasting, and enhance resource efficiency in industrial sectors. The concept of "Green AI" is proposed as an essential strategy, emphasizing algorithm optimization, hardware efficiency metrics such as Power Usage Effectiveness and Datacenter Infrastructure Efficiency (PUE/DCiE), and a systemic shift toward renewable energy sources. Sustainable AI development must be supported by

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transparent regulatory frameworks and rigorous LCA applications to ensure that digital innovation does not compromise global air quality.

Keywords: artificial intelligence, air pollution, energy mix, life cycle assessment

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