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Sustainable AI–Enhanced Direct Air Capture (DAC): Transforming Air Recycling for Future Pollution Control

Mrs. Manu K. Baby[1] and Dr. Sudhir Kumar Rai[2]
Research Scholar, Ph D Psychology, K. S. Saket P. G. College, Ayodhya. UP.[1]
Assistant Professor, Department of Psychology, K. S. Saket P. G. College, Ayodhya. UP.[2]
Dr. Ram Manohar Lohia Avadh University, Ayodhya, UP.

Abstract: *Direct Air Capture (DAC) has emerged as a viable negative-emissions technology capable of extracting carbon dioxide (CO□) directly from ambient air. However, current DAC systems remain energy-intensive, financially demanding, and difficult to scale for urban environmental applications. Sustainable artificial intelligence (AI)—defined as efficient, low-energy computational systems—offers new pathways for optimizing DAC performance while reducing environmental burdens linked to algorithmic processes. This paper presents a comprehensive and original academic framework for integrating sustainable AI with DAC to support future air-recycling capacities and pollution-control strategies. Through an enhanced literature review, refined case study analyses, and expanded ethical reasoning, this study argues that AI-optimized DAC can significantly strengthen urban air-quality management, catalytic carbon recycling, and climate mitigation efforts. The paper concludes with policy-oriented recommendations to guide the responsible deployment of AI-enabled DAC systems within climate-neutral infrastructures.*

Keywords: sustainable artificial intelligence, direct air capture, air recycling, climate mitigation, pollution control

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