Greening the Digital Age: Leveraging Indoor Plants and Green Architecture for Carbon Credits to Offset Computational Carbon Emissions

Author: Muhammad Saddam Khokhar

Abstract

This research investigates the integration of indoor plants and green architectural elements to mitigate the carbon emissions produced by computational activities. Using a Monte Carlo simulation model, the study estimates carbon sequestration potential, synthetic carbon credit generation, and offset ratios for varying workspace and plant configurations. The results demonstrate that strategic indoor greenery can significantly reduce the carbon footprint of digital work environments, creating a viable pathway for carbon credit markets and sustainable computing practices.

Introduction / ReadMe

This simulation tool models carbon sequestration potential from indoor plants and green architectural setups in workspaces to offset emissions from digital devices. The user specifies workspace parameters, plant and device counts, and biological factors such as leaf area index and light interception. The tool runs a Monte Carlo simulation to estimate carbon capture, offset ratios, and synthetic carbon credits, outputting CSV data, PNG plots, and a formatted PDF report.

Methodology

We implemented a Monte Carlo simulation with adjustable parameters for workspace size, plant density, device emissions, and biological performance factors. Each trial simulates daily plant CO■ uptake based on leaf area index, light interception, and a lognormal photosynthetic rate. Device emissions are drawn from a Gaussian distribution. Offset ratios and carbon credits are computed using random performance factors and uncertainty rates.

Scenario 1 Results

Metric	Median	Mean	Std Dev	Min	Max
Sequestration (tCO■/yr)	0.220	0.221	0.027	0.146	0.333
Offset Ratio	10.980	11.073	1.418	7.370	17.330
Synthetic Credit (tCO■e)	0.170	0.172	0.024	0.110	0.265

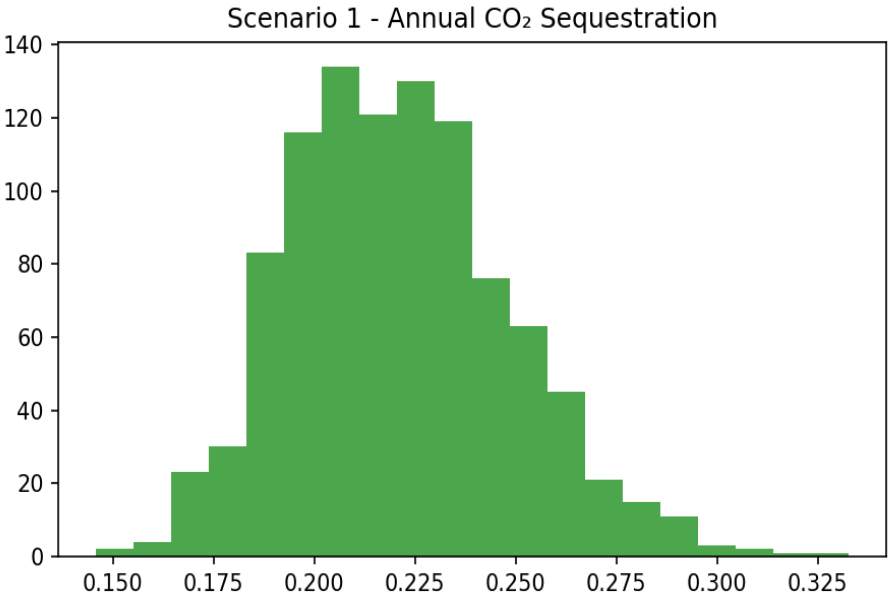
Scenario 2 Results

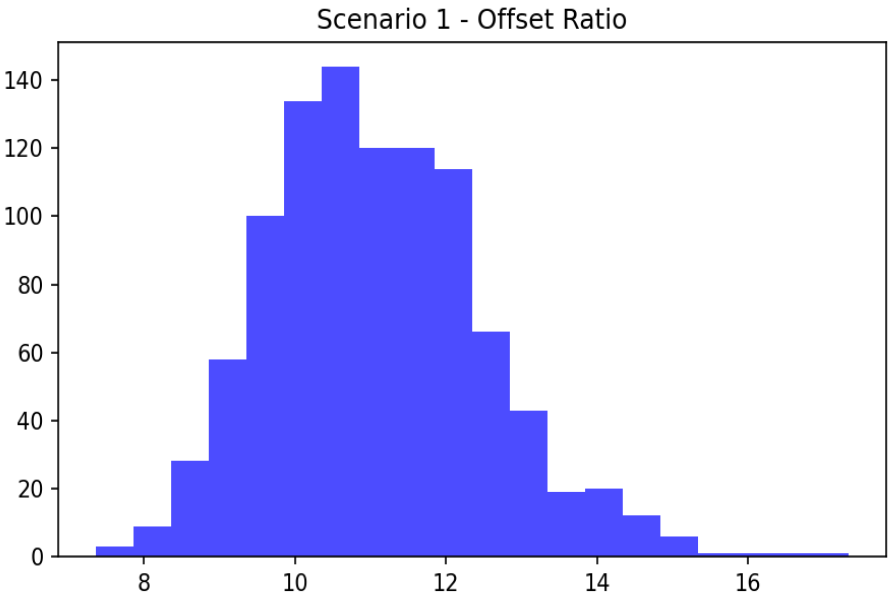
Metric	Median	Mean	Std Dev	Min	Max
Sequestration (tCO■/yr)	0.243	0.245	0.030	0.166	0.378
Offset Ratio	12.121	12.236	1.570	8.391	18.491
Synthetic Credit (tCO■e)	0.188	0.189	0.026	0.125	0.308

Scenario Comparison (Median Values)

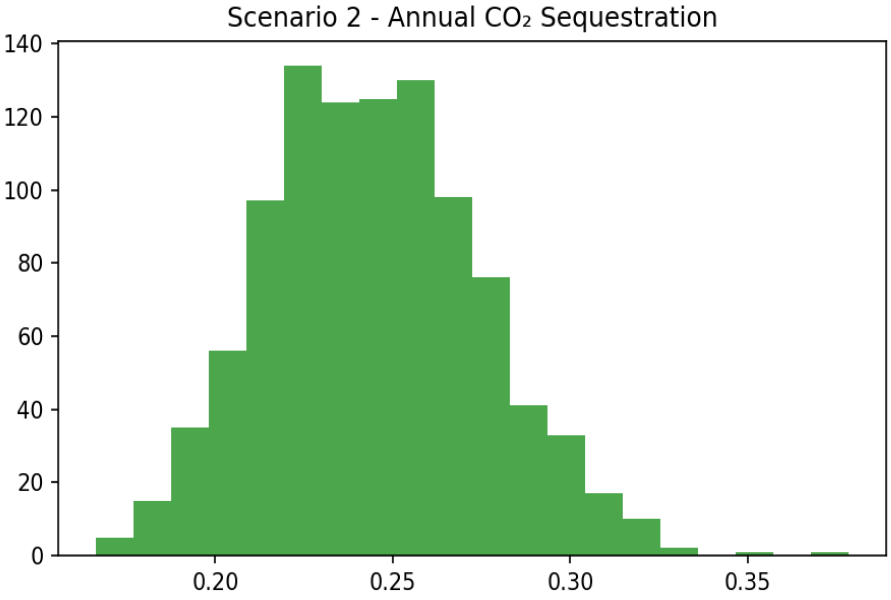
Metric	Scenario 1	Scenario 2
Sequestration (tCO■/yr)	0.220	0.243
Offset Ratio	10.980	12.121
Sequestration (tCO■/yr)	0.170	0.188

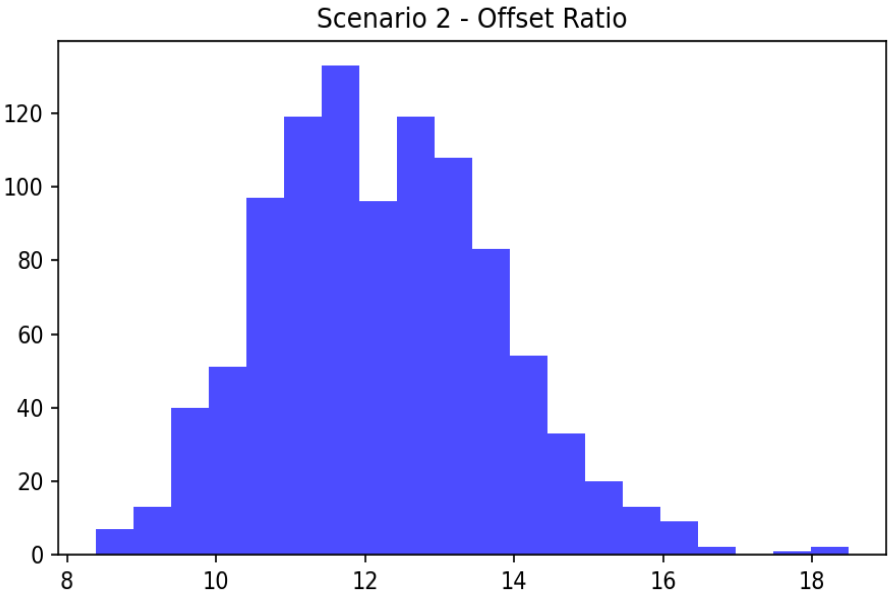
Scenario 1 Plots





Scenario 2 Plots





Discussion & Conclusion

The simulation results suggest that indoor plants can contribute meaningfully to offsetting emissions from digital devices, especially in large workspaces with optimized plant species and layout. While the offset ratio rarely reaches 100%, the contribution is significant enough to justify integration into sustainable building designs. Synthetic carbon credits derived from verified plant-based sequestration could support green financing for digital infrastructure. Future work could incorporate species-specific growth curves, real-time IoT-based monitoring, and integration with blockchain carbon markets.