Pretoria florida microgrids

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The rise of affordable small-scale renewable energy, like rooftop solar panels, is reshaping energy systems around the world. This shift away from fossil fuel-powered grids creates new opportunities for energy distribution that prioritize decentralized energy ownership and community empowerment. Despite this progress, centralized energy systems still dominate, often failing to provide vulnerable communities with reliable, affordable renewable energy. In response, Microsoft researchers are collaborating with local communities to explore how AI can enable community-scale energy solutions focused on energy availability and equity as well as decarbonization.

Microgrids, small and localized energy systems, hold promise as a solution to the challenges of centralized energy systems. These microgrids can operate independently from the larger grid, providing participants with resilience and control. Figure 1 shows how these systems integrate renewable energy sources and storage to efficiently manage local energy needs.

AI improves energy reliability by integrating data about energy consumption, market prices, and weather forecasts, necessary when using wind and solar power, which rely on weather conditions. Advanced forecasting predicts renewable energy availability, while AI-driven analytics determine when to generate, store, or sell electricity. This increases efficiency and stabilizes the grid by balancing supply and demand.

When powered by AI, microgrids can also contribute to energy equity. In many rural parts of the US, flat-rate billing models are still common, often leading to unfair pricing. AI-enabled microgrids provide an alternative by allowing communities to pay only for the energy they use. By analyzing consumption patterns, AI can ensure optimized distribution that promotes equitable pricing and access. These systems also improve resilience during crises, enabling communities to manage energy distribution more effectively and reduce reliance on centralized utilities. AI allows microgrids to predict energy demands, identify system vulnerabilities, and recover quickly during outages.

To explore AI"s potential in improving efficiency and equity in energy management, a team of Microsoft researchers collaborated with community organizations on simulations and a case study. They built a tabletop simulator to test whether AI could effectively determine when to generate, store, or sell electricity based on real-time data. The AI model was optimized for resilience and efficiency, using reinforcement learning to control grid and battery processes, enabling microgrids adapt to changing energy conditions and market dynamics.

This simulation used a theoretical model with external data to show how an AI-driven microgrid could autonomously buy and sell energy based on strategic design parameters. By controlling when the battery is charged and discharged based on energy production and consumption patterns, the model maximized efficiency and maintained local power availability. Figure 2 shows the AI-controlled grid’s optimal

decisions using open-source data from the California Independent System Operator (CAISO), serving as a proof of concept (PoC) for AI-driven microgrids operating under real-world conditions.

Microsoft researchers, in partnership with community-based organizations Remix: The Soul of Innovation (opens in new tab), Maverick IQ (opens in new tab) and Ayika Solutions (opens in new tab), are designing and implementing an AI-powered microgrid system in West Atlanta. Working closely with the Vicars Community Center (VCC) resilience hub (opens in new tab), they aim to address challenges faced by the community due to rapid development. West Atlanta, like many Atlanta neighborhoods, faces rising housing prices and energy costs that disproportionately affect long-time residents. Communities relying on centralized grids are more vulnerable to outages, with slow recovery times, highlighting systemic inequalities in energy distribution.

The VCC resilience hub is tackling these issues by helping to establish a solar microgrid for the West Atlanta Watershed Alliance (opens in new tab) (WAWA) community farm and surrounding neighborhoods. Microsoft researchers and collaborators are integrating AI into the microgrid to achieve energy savings, improve resilience, and create local job opportunities. Figure 3 shows the VCC resilience hub and WAWA community farm powered by the microgrid, highlighting key infrastructure for installing distributed energy resources (DERs).

Microsoft researchers, architects, and community partners held a participatory design session with state and utility representatives to define the project’s mission and key metrics. The CDC"s Social Vulnerability Index informed the site selection, supporting the project"s diversity, equity, and inclusion goals.

A renewable siting survey conducted by community partners identified the VCC as a key resilience hub for solar panel and battery installation.

To deliver these benefits, the site first needed upgrades. Older homes required energy-efficiency improvements, such as electrical upgrades and better insulation, before they could be integrated into the microgrid. As a PoC, the team collaborated with community partners to modernize an older home with inefficient energy consumption. Sensors were installed to track energy usage and environmental conditions (Figure 4).

Students from Morehouse College (opens in new tab) used this data to create a digital twin of the home, which provided actionable insights (Figure 5). The analysis confirmed issues like high radon levels and energy drains from outdated appliances. Guided by these findings, the team upgraded the house into a "smart home" where AI monitors energy and environmental conditions, enabling it to join the microgrid and making it eligible for LEED certification (opens in new tab).

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