

## From risk externalization to data commons: Aligning digital governance for sustainable microgrids

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### Extended Abstract

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### Abstract Summary

This research addresses the physical and economic deadlock of centralized power grids by proposing the DRA-VRA framework as a structural solution for microgrid sustainability. While the surge in power loads from the digital economy and AI intensifies the need for localized energy balancing, microgrids often face a paradox of stagnating resilience due to institutional friction and the externalization of operational risks.

To resolve these bottlenecks, this study introduces a governance-embedded architecture that aligns technical implementation with operational outcomes. The framework consists of the DRA layer (Digital, Risk-sharing, Algorithmic), which embeds governance rules into the technical design, and the VRA orientation (Visibility, Responsibility, Autonomy), which represents the resulting operational performance.

Applying a Most Different Systems Design (MDSD) to cases in the United States, Tanzania, and Australia, the findings demonstrate that the design quality of the DRA layer serves as the primary causal mechanism determining VRA performance. While the U.S. and Tanzania cases illustrate stagnation due to institutional and scalability bottlenecks, the Australian case (Project EDGE) demonstrates a breakthrough by internalizing governance rules directly into the technical layer via platform technology and dynamic algorithms.

The research concludes that energy policy must pivot from hardware-centric dissemination toward institutional flexibility and governance design. It advocates for the establishment of an "Energy Data Commons" to manage data as a standardized common-pool resource, fostering a polycentric self-governing order where rights and responsibilities are structurally aligned within the digital architecture. This shift is essential for establishing an autonomous, resilient energy ecosystem capable of meeting the demands of the modern digital economy.

## **Presenting Author Biography**

Sujin Park is a PhD candidate in the Technology Management, Economics, and Policy Program (TEMEP) at Seoul National University. Her research focuses on smart cities, green transformation, and data-driven public policy. She specifically examines the complex interactions between environmental infrastructure, governance arrangements, and citizen perceptions to shape urban sustainability and improve the quality of life. Through her work, she aims to develop integrated policy frameworks that leverage data to address contemporary urban challenges.