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Modeling of Interconnected Microgrids With a Focus on Agricultural Energy Communities

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Extended Abstract

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Abstract Summary

Increasing human activity and rising energy demand are placing significant pressure on regional ecosystems and energy systems. Agricultural communities are particularly affected, as activities such as irrigation and post-harvest processing require substantial energy and often depend on conventional sources. This reliance increases vulnerability to fuel price fluctuations, grid instability, and environmental constraints, highlighting the need for resilient and locally adapted energy solutions.

Microgrids have emerged as a promising approach for decentralized energy supply. When interconnected, they enable energy exchange, improve reliability, support renewable integration, and enhance voltage and frequency stability. However, interconnected microgrid systems also introduce challenges related to coordination, planning, and operation, particularly at the distribution level.

This work investigates the interconnection of isolated microgrids within agricultural communities in Spain and its impact on system design and operation. The study considers three interconnected microgrids with renewable generation, storage, and demand driven by agricultural activities. To represent realistic conditions, agricultural holding sizes are estimated using regional data, resulting in an average irrigated area of approximately 5.55 hectares, validated with local irrigation community data.

The system design is carried out using HOMER Pro to determine optimal configurations of generation and storage. These outputs are then used for system analysis within the POMATWO framework, which is extended by incorporating AC optimal power flow (ACOPF) concepts into its DCOPF structure. This integration improves the representation of voltage behavior, reactive power, and network constraints while maintaining market-based dispatch.

The results indicate that the proposed framework enhances the consistency between Local Energy Market dispatch and physical system operation. It provides insights into energy exchange between microgrids, line flow behavior, and price formation, while supporting improved coordination, reliability, and renewable integration in interconnected agricultural microgrid systems.

Presenting Author Biography

Amira Arif is a PhD researcher at Technische Universität Berlin (TU Berlin), focusing on sustainable energy systems and microgrid modeling. She holds a bachelor's degree in Renewable Energies in Electrical Engineering and a master's degree in Electrical Networks from Mohamed Khider University of Biskra, Algeria, as well as a Master's degree in Energy Engineering from the Pan African Institute of Water and Energy Sciences (PAUWES).