Architecture of the Future Low-Carbon, Resilient, Electrical Power System

Future Architecture of the Network (FAN) – Te Whatunga Hiko

Workstream 2 – Proposed Summer Project

Project 3

Community Microgrids for Climate-Resilient Energy Futures

Workstreams: WS2 + Vision Mātauranga

Background and Motivation

FAN's Vision Mātauranga workstream (WS5) seeks to build Māori capability and understanding in energy transitions, working with specific Māori communities. WS2 provides the technical foundations for the topology and protection that enable community-scale DC and hybrid AC/DC microgrids to operate safely and autonomously during grid outages or extreme weather events.

A key 2025–26 summer research output already delivered under this theme is Jinbo Shi's work on a 'Mauri-Informed Digital Twin for Optimizing Marae-Based Renewable Energy Systems'. That project introduced the Mauri Impact Index (MII), a weighted multi-criteria indicator incorporating Environmental Integrity, Economic Integrity, Community Wellbeing, Autonomy and Kaitiakitanga, and Cultural Access and Infrastructure – alongside a Virtual Synchronous Generator (VSG) control strategy for seamless grid-connected and islanded operation. This 2026–27 project extends that foundation.

Building on the MII framework and the VSG results, this project will investigate how community microgrid topologies can be designed and operated to maximize Māori community resilience, energy autonomy, and cultural well-being, particularly for marae and remote settlements facing increasing climate and infrastructure risks.

Key FAN References

[1] J. Shi, "A Mauri-Informed Digital Twin for Optimizing Marae-Based Renewable Energy Systems", FAN WS2 Summer Research Output.

Research Aim

To extend the Mauri-Informed Digital Twin framework by investigating community microgrid topology options and control strategies that maximize energy resilience, cultural well-being, and climate adaptability for Māori communities.

Research Objectives

The student will:

- Review the MII framework and VSG results from the 2025–26 summer project and identify gaps or extension opportunities.
- Investigate community microgrid topologies (islanded, grid-tied, hybrid AC/DC) suited to marae and remote NZ communities.
- Analyze renewable integration, battery storage, and islanding transition strategies within the MII decision framework.
- Develop recommendations for culturally informed microgrid design guidelines or updated MII weightings.

Methodology

Literature review extending the 2025–26 summer outputs; engagement with Vision Mātauranga context materials; technical analysis of microgrid topology options; possible extension of the digital twin or MII model using MATLAB/Simulink or Python-based tools.

Expected Outcomes

- Extended MII framework with updated microgrid topology analysis.
- Conceptual resilient community microgrid design guidelines.
- Identification of future FAN/Vision Mātauranga research directions.
- Technical report and presentation.

Potential Supervisor(s):

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