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

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

Workstream 3 – Proposed Summer Project

Date: 7 Aug 2026
Submitted by Tek Tjing Lie

Project title: PLL-Free and Adaptive Control of Grid-Connected Converters for Weak and Low-Inertia Networks

Relevant Workstream(s): WS 3
This project is focussed on Workstream 3 (WS3) – 3.

To facilitate the seamless integration of DC grids into existing AC power systems by advancing real-time stability assessment and adaptive control strategies for power electronic converters.

Project Description

The increasing use of converter-interfaced renewable generation, battery systems and DC distribution networks is changing the operation of electricity systems. While AC/DC converters enable the connection of DC grids to conventional AC networks, they can also reduce effective system inertia and create stability challenges, particularly in weak or distorted AC networks.

Conventional grid-connected converter control commonly relies on a phase-locked loop (PLL) to establish a voltage phase and frequency reference. PLL-based operation can become unreliable where the voltage waveform is distorted or where fault levels and system inertia are low. This project supports Workstream 3 by investigating alternative converter-control approaches that use local measurements, minimise reliance on PLLs, and improve stability following network disturbances.

This research aims are to assess and compare converter-control strategies suitable for AC/DC converter terminals operating in weak, low-inertia electricity networks, with particular attention to PLL-free, adaptive and passivity-inspired control principles. The research questions are as follows:

1. What are the main limitations of conventional PLL-based control under weak-grid, low-inertia or voltage-distortion conditions?
2. How could PLL-free or locally adaptive control improve converter stability and power-quality performance?
3. Which locally measured electrical quantities are most useful for fast control following a disturbance?
4. What metrics and test scenarios should be used to compare candidate controller architectures?

Specific requirements:

- BE(Hons) - Electrical and Electronic Engineering (EEE) student
- Good knowledge of power system grids, power electronics and Control systems
- Familiarity with power system simulation tools e.g. PowerFactory DIgSILENT, PSCAD/EMTDC
- Excellent academic track record
- Proficiency in programming (PyTorch, NumPy, Matplotlib, MATLAB/Simulink, PLECS)
- High proficiency in written and spoken English
- Enthusiastic applicants (any nationality) that want to make a positive impact in the world and can work in a collaborative environment

Potential Supervisor(s): Tek Lie and Jeremy Watson

Based in: AUT