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

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

Workstream 1 – Summer Project

Project title: Using Power-Flow Results for Initializing Voltage Source Converters in Electromagnetic Transient Simulation

Relevant Workstream(s): WS 1

This project is offered to help in the ongoing research in the Future Architecture of Network (FAN) programme, where the benefit, design and analysis of DC electricity grids are explored. The FAN project is a 7-year, New Zealand wide research program led by the University of Canterbury. The project is broken into five workstream, where this summer student project is a part of Workstream 1, which is the development of fast and accurate numerical analysis tools to simulate large-scale hybrid AC/DC grids, such as for Power-Flow Analysis, Fault Analysis, Harmonic Analysis, Transient Stability, and Electromagnetic Transients. Also, WS1 proposes a future architecture of the hybrid AC/DC.

Project Description:

This project is proof of concept for initializing 3-phase two-level voltage source converters in dynamic simulations from power-flow results created in the FAN power-flow tool. The project will focus on both grid following (GFL) and grid forming (GFM) generic control methods in electromagnetic transient (EMT) simulations. PSCAD/EMTDC software will be used for these simulations. Three types of VSC converters will be modelled: one with a detailed IGBT switch model, another with a switching function average model, and a third with a dynamic average model. The outcomes of this project will significantly contribute to the development of a transient simulation tool under WS1 of the FAN project.

The successful candidate will learn how to perform power-flow studies involving power electronic converters using the FAN power-flow tool. Additionally, they will gain experience in modelling various VSC converter models and implementing generic GFL and GFM controls in PSCAD/EMTDC software. This skill set is crucial for analysing modern power systems in industry.

Helpful Resources:

A. Allabadi, J. Mahseredjian, K. Jacobs, S. Dennetière, I. Kocar and T. Ould-Bachir, "Initializing Large-Scale Multi-Terminal HVDC Systems Using Decoupling Interface," in *IEEE Transactions on Power Delivery*, vol. 39, no. 3, pp. 1600-1609, June 2024, doi: 10.1109/TPWRD.2024.3373657.

B. Lekić, Aleksandra; Ergun, Hakan; Beerten, Jef: 'Initialisation of a hybrid AC/DC power system for harmonic stability analysis using a power flow formulation', High Voltage, 2020, 5, (5), p. 534-542, IET Digital Library, DOI: 10.1049/hve.2020.0066.

C. Y. Liu, Y. Song, L. Zhao, Y. Chen and C. Shen, "A General Initialization Scheme for Electromagnetic Transient Simulation: Towards Large-Scale Hybrid AC-DC Grids," *2020 IEEE Power & Energy Society General Meeting (PESGM)*, Montreal, QC, Canada, 2020, pp. 1-5, doi: 10.1109/PESGM41954.2020.9281495.

Specific requirements:

- BE(Hons) - Electrical and Electronic Engineering (EEE) student- Third (second Pro) or Fourth (Third Pro) year.
- Good knowledge of power system grids and power electronics
- Some familiarity with GFL and GFM control methods will be very helpful, however not necessary.
- Some familiarity with power system simulation tools like PSCAD/EMTDC and PowerFactory DIgSILENT will very helpful.
- Excellent academic track record
- 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): Veerabrahmam Bathini, Josh Schipper, Neville Watson

Based in: University of Canterbury, EPECentre