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: HVDC Grid in New Zealand

Relevant Workstream(s): WS 1 and WS 2

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, which will be the focus of this project. Workstream 2 proposes the topological configuration of AC and DC circuits, which will impact and likely be impacted by the outcomes of this project.

Project Description:

This project develops two scenarios, one low and one high penetration, of HVDC grids in the New Zealand context. The main design considerations include meeting New Zealand's present and future electricity demand and generation profiles, maintaining static N-1 security constraints to avoid cascade outages, and satisfying transmission voltage limits.

The successful applicant will improve their skills in DIgSILENT PowerFactory as the main analysis tool for this project, which is commonly used in the New Zealand electricity industry. Furthermore, knowledge of the New Zealand electricity industry will be developed.

The outcome of the project will be a DIgSILENT PowerFactory file and design report detailing each scenario:

1. The low penetration scenario shall consider a Modular Multi-level Converter (MMC) Voltage Source Converter (VSC) terminal in North Canterbury connected to the present HVDC transmission link. Also, in the low penetration scenario consider extending the link from Benmore to Southland to anticipate a possible closure of the Tiwai Aluminium Smelter.
2. The high penetration scenario in addition to the low penetration scenario shall design a meshed HVDC grid in the North Island. Minimally, there should be additional HVDC transmission lines and converters connecting terminals at Haywards, and in the Taranaki and Auckland region.

Helpful Resources:

Electricity Authority, Electricity Market Information Website, https://www.emi.ea.govt.nz/, which has PowerFactory files of each Island
https://www.emi.ea.govt.nz/Wholesale/Datasets/Transmission/PowerSystemAnalysis

Transpower System Security Forecast, https://www.transpower.co.nz/system-operator/planning-future/system-security-forecast

Transpower Annual Planning Report, https://www.transpower.co.nz/our-work/industry/transmission-planning

Transpower Asset Management Plan, https://www.transpower.co.nz/our-work/industry/our-grid/asset-management

Transpower's creation of Security Constraints, https://www.transpower.co.nz/system-operator/information-industry/operational-information-system/security-constraints

EA Grid Code which includes Voltage Limits, https://www.ea.govt.nz/code-and-compliance/code/

Commerce Commission website with some of NZ's next major upgrades, https://comcom.govt.nz/regulated-industries/electricity-lines/electricity-transmission/transpower-capital-investment-proposals/transpower-major-capital-proposal

Transmission Line Maps, https://data-transpower.opendata.arcgis.com/

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
- Experience with programming languages, e.g. MATLAB or Excel
- Some familiarity with power system simulation tools like PowerFactory DIgSILENT and PSCAD/EMTDC 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): Josh Schipper, Veerabrahmam Bathini, Neville Watson

Based in: University of Canterbury, EPECentre