Title: Dynamic models of the New Zealand HVDC Link and North and South Islands

Relevant Workstreams:

Workstreams 1, 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. Workstream 2, the development of hybrid AC/DC network topologies and converter configurations for efficient and reliable transport of electricity.

Project Description:

Develop a simulation test platform and network models in established software, which will help benchmark future tool development in the FAN project.

When developing new simulation tools, it is important to have test models, with known results in the real world, to verify tool accuracy. However, it is very difficult to obtain real-world data for hybrid multi-terminal AC/DC networks, as very few of these networks exist. In this case, the new analysis tools are compared against established software that has the confidence of experience and practice. This summer project is the first step in developing test models of the present and potential New Zealand power system.

Student 1: Create a detailed model of the New Zealand HVDC link, between Benmore and Haywards substations, in PSCAD/EMTDC. Represent the two converter poles at each terminal with a 12-pulse converter. Include converter transformers, filters, DC reactors, and a PI representation of the transmission line and cables. Also include a control model for each converter pole, and demonstrate its stability to real power set-point changes. This is a significant challenge; therefore, use established component and control models where possible.

Student 2: Create an integrated network model for the New Zealand system using the North and South Island DIgSILENT PowerFactory network models, which are available on The Electricity Authority website. Represent the HVDC link between these systems, which is currently not in the model. Work with Student 1 in developing the HVDC converter control model. Demonstrate that the model works by performing a power-flow, short-circuit, and transient stability simulation.

Student 3: Develop a Frequency Dependent Network Equivalent (FDNE) model for the North and South Island AC power systems, separately, from the perspective of the AC terminal of the HVDC converter stations. The Electricity Authority (originally from Transpower) supplies a detailed dynamic model of both Islands, which are implemented in DIgSILENT PowerFactory, and also have the functionality of creating a FDNE (frequency scan option from harmonic analysis module could be used). Implement the produced FDNE model in PSCAD using its FDNE block component, and demonstrate that PowerFactory and PSCAD can produce the same results for a simulated fault, under a wide range of operating conditions.

At the end of the summer, combine the work of student's 1 and 3 to join the HVDC link model and the AC FDNE models in PSCAD. Demonstrate that the combined model runs for few selected events, namely, step change in load at HVDC inverter station, ac side and dc side faults. Furthermore, these simulations can be verified with the integrated PowerFactory model.

Specific Requirements: A good background knowledge in Control Theory, Power Systems Analysis, and Power Electronics.

Resources:

Power Factory models of the North Island and South Island power systems. link

Maps and Diagrams. ArcGIS, Line Diagrams

Example of a Frequency Dependent Equivalent Network model of the lower South Island. Upon request from Josh S.