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

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

Workstream 2 –Summer Project

Project title: Development of experimental setup dedicated to investigations on Arc Faults in LVAC and LVDC grids

Relevant Workstream(s): WS 2

This project is focussed on Workstream 2

Workstream 2, the development of hybrid AC/DC network topologies and converter configurations for efficient and reliable transport of electricity including fault location and detection…

Project Description

The continuous expansion of new energy resources and the increasing variety of load types have resulted in the growing utilization of DC power in electrical grids. While a complete transition to DC is a long-term objective, the implementation of hybrid AC/DC grids presents a practical solution applicable across various voltage levels, from transmission to distribution and household networks. Ensuring the reliable operation of hybrid AC/DC grids necessitates a focus on protection and fault location, which are crucial areas of study. Among the various concerns, DC and AC arc faults at LV levels have garnered significant attention due to their potential to cause equipment failures, endanger residents' safety, and increase the risk of fire.

The objective of this project is to construct an experimental setup dedicated to studying LVAC/LVDC arc faults. This setup will serve as an effective tool for researching the characteristics of AC and DC arc faults at LV levels, thereby facilitating the improvement of fault detection and isolation methods. Ultimately, this research aims to prevent arc faults from causing more severe consequences for individuals, personnel, and equipment.

This project requires the involvement of two students, each assigned specific responsibilities:

Student 1:

- Develop an Arc generator following the UL-1699B standard to control the distance between electrodes and create arc faults. The arc generator will consist of step motor controllers, two electrodes (one fixed and one moveable).

Student 2:

- Investigate other equipment necessary for the setup, including DC/AC power sources, various load banks, and measuring and recording units …

Both tasks are expected to be completed within the first four weeks of the project duration.

Benchmark Formation and Validation:

Once the individual tasks are finished, both students will collaborate to form the setup, which will then undergo validation through several test cases. The students will also apply recently published methodologies to analyse the features of the obtained voltage and current waveforms and compare them against the published results.

Specific requirements:

- Good knowledge of power system grids and power electronics
- Basic skills in Data Processing.
- Enthusiastic applicants (any nationality) that want to make a positive impact in the world and can work in a collaborative environment

Resources:

High power equipment in high-risk lab at the University of Auckland

W. Miao, Z. Wang, F. Wang, K. H. Lam and P. W. T. Pong, "Multi-characteristics Arc Model and Autocorrelation-Algorithm Based Arc Fault Detector for DC Microgrid," in IEEE Transactions on Industrial Electronics, vol. 70, no. 5, pp. 4875-4886, May 2023, doi: 10.1109/TIE.2022.3186351.

Q. Lu, Z. Ye, M. Su, Y. Li, Y. Sun and H. Huang, "A DC Series Arc Fault Detection Method Using Line Current and Supply Voltage," in IEEE Access, vol. 8, pp. 10134-10146, 2020, doi: 10.1109/ACCESS.2019.2963500.

Potential Supervisor(s):

- Nirmal Nair
- Abhisek Ukil
- Andre Cuppen
- Yuan Liu

Based in: The University of Auckland